Agricultural Economics Research Review
Vol. 27 (No.1) January-June 2014 pp 49-60
DOI: 10.5958/j.0974-0279.27.1.004

Do Different Approaches to Measurement of Risk Behaviour Yield Different Results?

Hari K. Choudhury[a] and Kishor Goswami[b*]

[a]National Institute of Technology Sikkim, Ravangla Campus, South Sikkim - 737 139
[b]Department of Humanities and Social Sciences, Indian Institute of Technology-Kharagpur, Kharagpur – 721 302, West Bengal

Abstract

Risk and uncertainty play an important role in the adoption of new technology, new crop, and new management practices. However, direct information about attitudes towards risk is seldom available; hence has remained one of the unexplored aspects of technology adoption behaviour. Also, because of differences in measurement methods often there are conflicting views on the issues related to risk preferences. This paper has investigated the inconsistency in measurement of risk preference through subjective question and through risk game with real incentives using responses of 426 jatropha-growing farmers in the states of Assam and Arunachal Pradesh. These approaches to measurement of risk preferences have yielded different results in terms of magnitude, direction, and significance.

Key words: Risk behaviour, risk game, risk measurement, incentives, Probit model

JEL Classification: D13, D81, Q12

Introduction

Risk and uncertainty play an important role in the farmers' decision on adoption of a new technology, a new crop or a new management practice, and have been the focus of many empirical studies on agriculture in the recent years (Moschini and Hennessy, 2001; Akay *et al*., 2009; Fletschner *et al*., 2010; Brown *et al*., 2011; Reyes and Lensink, 2011; Winden *et al*., 2011; Vlaev, 2012). However, the direct information on the attitudes towards risk is seldom available in the empirical studies on technology adoption (Donkers *et al*., 2001) and thus has remained one of the under-studied aspects of farmers' technology adoption behaviour (Mercer, 2004). There are different ways of determining risk preference. According to Mercer (2004), researchers often use proxies such as tenure, experience, and extension service, to capture the risk behaviour. Hypothetical questions are also used to measure respondents' risk behaviour, as these generate the best all-round predictions on risky behaviour (Dohmen *et al*., 2011). For simple choice problems, respondents do not need real incentives to reveal their risk preferences (Donkers *et al*., 2001). In contrast, Binswanger (1980) is of the view that interview method is subject to interviewer's bias and its results are totally inconsistent with the experimental measures of risk aversion. Thus, there are conflicting views on the measurement of risk.

In view of the conflicting views, in this paper we have made an attempt to verify 'whether there is inconsistency in the measurement of risk preference through subjective questions and through actual risk preference measured by risk game with real incentives.'

Measurement of Risk Preference: An Interpretative Review

The expected utility model originally developed by John von Neumann and Oskar Morgenstern allows

* Author for correspondence
Email: kishor@hss.iitkgp.ernet.in

us to capture the notion of risk aversion, which is a fundamental feature of the problem of choice under uncertainty (Sen, 2007). The standard gamble procedure is a classic method for measuring risk preferences (or more specifically Neumann-Morgenstern utilities) in economics. It makes use of a hypothetical lottery to measure people's utilities, which reflect preferences for outcomes and attitude towards risk (Melnick and Everitt, 2008). Hershey and Schoemaker (1985) have compared *certainty equivalence* with *probability equivalence*, the two most frequently used procedures for constructing Neumann-Morgenstern utility functions. They had devised a consistency test using four related experiments, and their findings revealed serious inconsistencies between *certainty equivalence* and *probability equivalence* responses for each of the four experiments.

Studies have also analyzed inter-linkages of factors with individual risk behaviour. Gender, age, height, and parental background have been reported to have a significant impact on willingness to take risk. However, such individual responses are quite often not incentive-compatible, which is a serious concern with the use of hypothetical questions (Dohmen *et al*., 2011). And, it is unclear as to what extent the general risk question is a reliable indicator of actual risk behaviour. However, to avoid this concern, Binswanger (1980) using an experimental gambling approach with real payoffs, measured the farmers' attitudes towards risk in rural India. Individuals become more risk averse when the high payoffs are actually paid in cash. In contrast, in a hypothetical situation, scaling-up of all payoffs makes little difference in risk-averse behaviour (Holt and Laury, 2002).

Bar-shira *et al*. (1997) developed an econometric model to determine the structure of risk preferences due to changes in the wealth of farmers. Relying on the production theory under uncertainty, they used the elasticity of absolute risk aversion with respect to wealth change to see its effect on the measures of absolute, relative, and partial aversions. Based on the expected future profit and variability therein, they found that the absolute risk aversion decreases with wealth, the relative risk aversion increases with wealth, and the measure of partial risk aversion increases in risky income and decreases with non-stochastic initial wealth.

The influences of personal and household characteristics are crucial in analyzing how attitude towards risk varies across individuals. Donkers *et al*. (2001) have found a significant relationship between risk aversion and age, gender, income, and education level.

Titration and variance experiments are the other approaches for analysing the risk behaviour. In the titration experiment, participants are asked to choose among a series of binary choices involving some assured amount of money (option A) and a fixed risky bet (option B). From such experiment one can pinpoint the approximate point at which participants become indifferent between a fixed amount of money and a risky bet, and thereby assign a value to the risky option (Henrich and Mcelreath, 2002).

On the other hand, the variance experiment is used to explore how variation in outcomes influences the economic decisions when the expected value of options is the same. The basic structure of the variance experiment is similar to that of the titration experiment (Henrich and Mcelreath, 2002). The experiments of Henrich and Mcelreath (2002) reveal that economic and demographic variables do not significantly influence the likelihood of taking the risky gamble. More specifically, the results of the experiments lack sufficient evidence to support the intuition that wealthier individuals are more risk-prone. In contrast, Belaid and Miller (1987) in their experiment on El-Eulma farmers in Algeria have observed that the years of formal schooling, percentage of working children and cropped area are inversely associated with risk aversion. These results are consistent with the prior expectations because schooling years and cropped area could be proxies for wealth. Higher schooling, more working children, and larger cropped area presumably reduce risk aversion. Similarly, Harrison *et al*. (2007) have found that risk attitudes vary significantly with respect to several socio-demographic characteristics. In their study, they have found the age of respondents to be inversely related to risk aversion.

It is necessary to understand farmers' attitudes toward risk and uncertainty for analyzing their adoption behaviour. It requires incorporation of risk preferences and subjective probabilities of the riskiness of alternative technologies into data collection efforts (Mercer, 2004). Reviewing the agro-forestry adoption studies, Mercer (2004) has stated that, in only a few instances, risk is directly evaluated in agro-forestry adoption studies. He has observed that studies are required that directly measure risk preferences and perceptions, and relate them to the adoption decision process. Similarly, most of the empirical studies on the role of subjective risk are unfortunately not rigorous enough to allow validation of the existing risk theory. The problem may lie simply in the fact that, in some instances, the proxy does not measure what it is supposed to approximate (Feder *et al*., 1985). In the same line, Just and Zilberman (1983) are of the view that risk-loving and risk-aversion are often used to explain the differences in input-use and the relative rate of adoption of modern technologies by the farmers of different holding-sizes. Different patterns of behaviour are observed in different regions, and thus the importance of risk needs to be examined in relation to factors and constraints that may exist in the system in certain areas and not in others.

Study Area and Sampling Strategy

This study is based on the primary data collected from the growers and non-growers of jatropha in the states of Assam and Arunachal Pradesh. Assam was selected for the study as it is different from the other North-Eastern (NE) states in terms of altitude and topography. In contrast, Arunachal Pradesh was a representative of most other states such as Manipur, Nagaland and Tripura, as these are similar in topography. The primary data were collected from 22 villages in five districts of Assam (Cachar, Karimganj, Karbi Anglong, North Lakhimpur and Dhemaji), and from 6 villages in the Papumpare district of Arunachal Pradesh. The districts, blocks, and villages were selected based on the intensity of present and past jatropha-growers.

The primary data were collected from 426 respondents by using multi-stage random sampling technique. In the first stage, purposive sampling was used based on fair availability of present-growers, past-growers, and non-growers of jatropha. After selection of villages, the respondents were selected randomly. The present-growers, past-growers, and non-growers of jatropha were sampled from the same places to ensure that the respondents face a similar environment. The selection of areas for primary data collection at household level was based on personal visits, discussions with block development officers, and agricultural extension officials. The respondents comprised 144 present-growers, 137 past-growers, and 145 non-growers of jatropha. They were interviewed during November 2011 to March 2012.

Measurement of Risk Preference

The study has measured the farmers' risk preferences from two directions and has finally categorized whether a farmer was risk-taker or risk-averter. First, following Dohmen *et al.* (2011), a direct subjective question asked to a farmer was "Are you generally a person who is fully prepared to take risks or do you try to avoid taking risks?" Secondly, the farmer was given to choose an option from the two alternatives: (A) the famer could have INR 10 now for sure or (B) a coin would be flipped, if it is a head, he would receive INR 30 now and if it is tail, he would receive nothing. A farmer was categorized as risk-averter if he chose option A and risk-taker on choosing option B. However, a third option (C) was kept as 'indifferent', but in the present study no respondent chose the option C. Accordingly, this option was not considered. The incentive payoffs were kept at a lower level, as literature shows that nearly all individuals are moderately risk-averters at higher payoff levels with little variation according to personal characteristics (Binswanger, 1980). Moreover, financial constraint of the study did not allow paying higher amount for multiple payoffs to the respondents, which may be a limitation of the study.

Statistical Tools of Analysis

In order to check the consistency in measurement of the risk preference, non-parametric tests, namely McNemar's chi-square, Pearson chi-square, continuity correction, likelihood ratio, linear-by-linear association, phi, Cramer's V, and contingency coefficient were used in the study.

Literature shows that different econometric models are used for analysis depending upon the nature of dependent variables. Probit and logit models are the most commonly used models to analyze the binary choice (Pattanayak and Mercer, 1998; Subejo, 2000; Neupane *et al*., 2002; Johnson, 2005; Adeogun *et al*., 2008; Muneer, 2008; Kassie *et al*., 2009; Goswami *et al*., 2012; Saweda *et al*., 2012). In the present study, two separate probit models have been estimated to

Table 1. Distribution of respondents by risk behaviour

Risk behaviour	Number of respondents	
	Risk game (Method 1)	Subjective question (Method 2)
Risk-takers	186 (43.66)	281 (65.96)
Risk-averters	240 (56.34)	145 (34.04)
Total	426	426

Note: Figures within the parentheses indicate percentage of column total.

analyse the influence of independent variables on farmers' risk preferences, as the dependent variables are binary in nature taking the value 1 for risk-taker and 0 for risk-averter. Following Wang (2009), the structure of the Probit model is presented as unobserved latent variable as Equation (1):

$$y^* = X'\beta + \varepsilon \qquad ...(1)$$

where, y* is the latent variable and $\varepsilon \sim N(0, 1)$. Y is viewed as an indicator for whether this latent variable is positive, i.e.,

$$Y = \begin{cases} 1 \text{ if } y^*>0 \\ 0 \text{ if } y^* \leq 0 \end{cases} \qquad ...(2)$$

Given the latent variable in Equations (1) and (2), we have

$$\begin{aligned} Pr(Y = 1) &= Pr(X'\beta + \varepsilon > 0) \\ &= Pr(-\varepsilon < X'\beta) \\ &= F(X'\beta) \end{aligned}$$

where, $F(X'\beta)$ is the cumulative distribution function of ε.

Results and Discussion

The distribution of respondents by their risk behaviour, measured through two different approaches, is presented in Table 1. It is observed that risk behaviour measured through different approaches was not the same. About 44 per cent of the total respondents were categorized as risk-takers from the risk game approach (Method 1), while with the subjective question approach (Method 2) their proportion was 66 per cent. However, it was not clear whether risk behaviour measured through these methods was consistent or not. To probe into this, the respondents were classified according to different characteristics such as age, educational level, income level, and primary occupation.

The age group-wise distribution of respondents' risk behaviour measured through two different methods is shown in Table 2. The majority of respondents, who were risk-taker, were in the age group of 30 - 40 years. However, the results of the McNemar's chi-square test showed that the risk behaviour measured through Method 1 and Method 2 was not consistent across the age groups. The value of McNemar's chi-square test was significant in each age group (Table 3).

The distribution of respondents' risk behaviour by their level of education is shown in Table 4. Most respondents who took risk had education up to high school. The results of the McNemar's chi-square test show that the risk behaviour measured through Method

Table 2. Age group-wise distribution of respondents' risk behaviour

Age group (years)	Risk game (Method 1)			Subjective question (Method 2)		
	Risk-takers	Risk-averters	Total	Risk-takers	Risk-averters	Total
Less than 30	44 (23.66)	47 (19.58)	91 (21.36)	65 (23.13)	26 (17.93)	91 (21.36)
30-40	70 (37.63)	63 (26.25)	133 (31.22)	99 (35.23)	34 (23.45)	133 (31.22)
40-50	34 (18.28)	66 (27.50)	100 (23.47)	65 (23.13)	35 (24.14)	100 (23.47)
50 and above	38 (20.43)	64 (26.67)	102 (23.94)	52 (18.51)	50 (34.48)	102 (23.94)
Total	186	240	426	281	145	426

Note: Figures within the parentheses indicate percentage of column total.

Table 3. McNeMar's chi-square test across age groups

Age group (years)	Risk game (Method 1)	Subjective question (Method 2)				
		Risk-averters	Risk-takers	Total	McNemar Test	
					Value	Significance level
Less than 30	Risk-averters	17	30	47	11.31	0.001
	Risk-takers	9	35	44		
	Total	26	65	91		
30 - 40	Risk-averters	25	38	63	17.89	0.000
	Risk-takers	9	61	70		
	Total	34	99	133		
40 - 50	Risk-averters	31	35	66	24.64	0.000
	Risk-takers	4	30	34		
	Total	35	65	100		
50 and above	Risk-averters	42	22	64	6.53	0.016
	Risk-takers	8	30	38		
	Total	50	52	102		

Table 4. Educational level-wise distribution of respondents' risk behaviour

Educational level	Risk game (Method 1)			Subjective question (Method 2)		
	Risk-takers	Risk-averters	Total	Risk-takers	Risk-averters	Total
Illiterate	24 (12.90)	59 (24.58)	83 (19.48)	35 (12.46)	48 (33.10)	83 (19.48)
Primary	20 (10.75)	36 (15.00)	56 (13.15)	29 (10.32)	27 (18.62)	56 (13.15)
Middle school	25 (13.44)	35 (14.58)	60 (14.08)	38 (13.52)	22 (15.17)	60 (14.08)
High school	53 (28.49)	52 (21.67)	105 (24.65)	83 (29.54)	22 (15.17)	105 (24.65)
Higher secondary	34 (18.28)	33 (13.75)	67 (15.73)	50 (17.79)	17 (11.72)	67 (15.73)
Beyond higher secondary	30 (16.13)	25 (10.42)	55 (12.91)	46 (16.37)	9 (6.21)	55 (12.91)
Total	186	240	426	281	145	426

Note: Figures within the parentheses indicate percentage of column total.

1 and Method 2 are not consistent across educational levels (Table 5).

The distribution of respondents' risk behaviour by income level is shown in Table 6. It came out that the majority of respondents, who were risk-takers had income in the range of INR 5,000–-10,000. The risk behaviour measured through Method 1 and Method 2 was inconsistent for the four income groups starting from the lowest, while it was consistent for the other groups (Table 7).

Table 8 shows the occupation-wise distribution of the respondents' risk behaviour. Agriculture is the primary occupation for majority of the respondents. The results of the McNemar's chi-square test show that

Table 5. McNeMar's chi-square test across educational levels

Educational level	Risk game (Method 1)	Subjective question (Method 2)				
		Risk-averters	Risk-takers	Total	McNemar Test	
					Value	Significance level
Illiterate	Risk-averters	42	17	59	5.26	0.035
	Risk-takers	6	18	24		
	Total	48	35	83		
Primary	Risk-averters	21	15	36	3.86	0.078
	Risk-takers	6	14	20		
	Total	27	29	56		
Middle school	Risk-averters	15	20	35	6.26	0.019
	Risk-takers	7	18	25		
	Total	22	38	60		
High school	Risk-averters	15	37	52	20.45	0.000
	Risk-takers	7	46	53		
	Total	22	83	105		
Higher secondary	Risk-averters	15	18	33	12.80	0.000
	Risk-takers	2	32	34		
	Total	17	50	67		
Beyond higher secondary	Risk-averters	7	18	25	12.80	0.000
	Risk-takers	2	28	30		
	Total	9	46	55		

Table 6. Annual per-capita income-wise distribution of respondents' risk behaviour

Annual per-capita income (INR)	Risk game (Method 1)			Subjective question (Method 2)		
	Yes	No	Total	Yes	No	Total
Less than 5,000	16 (8.60)	19 (7.92)	35 (8.22)	26 (9.25)	9 (6.21)	35 (8.22)
5,000 – 10,000	78 (41.94)	138 (57.50)	216 (50.70)	137 (48.75)	79 (54.48)	216 (50.70)
10,000 – 15,000	53 (28.49)	46 (19.17)	99 (23.24)	71 (25.27)	28 (19.31)	99 (23.24)
15,000 – 20,000	17 (9.14)	22 (9.17)	39 (9.15)	23 (8.19)	16 (11.03)	39 (9.15)
20,000 – 25,000	11 (5.91)	8 (3.33)	19 (4.46)	13 (4.63)	6 (4.14)	19 (4.46)
25,000 and above	11 (5.91)	7 (2.92)	18 (4.23)	11 (3.91)	7 (4.83)	18 (4.23)
Total	186 (100)	240 (100)	426 (100)	281 (100)	145 (100)	426 (100)

Notes: 1. Figures within the parentheses indicate percentage of column total.
2. Value of upper limit was not included in the respective categories.

Table 7. McNeMar's chi-square test across income groups

Annual per-capita income (INR)	Risk game (Method 1)	Subjective question (Method 2)				
		Risk-averters	Risk-takers	Total	McNemar Test	
					Value	Significance level
Less than 5,000	Risk-averters	7	12	19	7.14	0.013
	Risk-takers	2	14	16		
	Total	9	26	35		
5,000 – 10,000	Risk-averters	65	73	138	40.01	0.000
	Risk-takers	14	64	78		
	Total	79	137	216		
10,000 – 15,000	Risk-averters	21	25	46	10.13	0.002
	Risk-takers	7	46	53		
	Total	28	71	99		
15,000 – 20,000	Risk-averters	15	7	22	4.50	0.070
	Risk-takers	1	16	17		
	Total	16	23	39		
20,000 – 25,000	Risk-averters	4	4	8	0.67	0.688
	Risk-takers	2	9	11		
	Total	6	13	19		
25,000 and above	Risk-averters	3	4	7	0.00	1.000
	Risk-takers	4	7	11		
	Total	7	11	18		

Note: Value of upper limit is not included in the respective categories.

Table 8. Occupation-wise distribution of respondents' risk behaviour

Primary occupation	Risk game (Method 1)			Subjective question (Method 2)		
	Yes	No	Total	Yes	No	Total
Agriculture	94 (50.54)	141 (58.75)	235 (55.16)	167 (59.43)	68 (46.90)	235 (55.16)
Non-agriculture	92 (49.46)	99 (41.25)	191 (44.84)	114 (40.57)	77 (53.10)	191 (44.84)
Total	186	240	426	281	145	426

Note: Figures within the parentheses indicate percentage of column total.

the risk behaviour measured through Method 1 and Method 2 was inconsistent with regard to the nature of primary occupation (Table 9).

Other non-parametric tests were also carried out to see whether there was consistency in the risk behaviour measured through different methods (Table 10). The results of the non-parametric tests showed that the risk behaviour measured through different methods produced statistically inconsistent results. The findings of the study support the view of Binswanger (1980) that interview method is subject to the interviewer's bias and its results are inconsistent with the experimental measures of risk aversion.

Table 9. McNeMar's chi-square test across primary occupation

Annual per-capita income (INR)	Risk game (Method 1)	Subjective question (Method 2)				
		Risk-averters	Risk-takers	Total	McNemar Test	
					Value	Significance level
Agriculture	Risk averters	62	79	141	62.69	0.000
	Risk takers	6	88	94		
	Total	68	167	235		
Non -agriculture	Risk averters	53	46	99	6.91	0.012
	Risk takers	24	68	92		
	Total	77	114	191		

Table 10. Difference between revealed preference (actual) and stated preference (subjective) on risk behaviour

Risk game (Method 1)	Subjective question (Method 2)		
	Risk-averters	Risk-Takers	Total
Risk-averters	115	125	240
Risk-takers	30	156	186
Total	145	281	426

Non-parametric tests

Tests	Value	Degree of freedom	Asymp. significance level (2-sided)
Pearson chi-square	47.160	1	0.000
Continuity correction	45.755	1	0.000
Likelihood ratio	49.730	1	0.000
Linear-by-linear association	47.050	1	0.000
Symmetric measures			
Phi	0.333	-	0.000
Cramer's V	0.333	-	0.000
Contingency coefficient	0.316	-	0.000

Since non-parametric tests provide mixed results, we explored the risk behaviour using Probit regression, wherein risk behaviour measured through two different methods (directions) was used as a dependent variable in two separate Probit models. The descriptive statistics and the impact of the independent variables on the risk behaviour are presented in Table 11 and Table 12, respectively. It was found that there was a variation in the estimates of the models in terms of magnitude, direction, and significance.

The magnitudes of impact of annual per-capita income and primary occupation are overestimated in the first model, whereas of age and education are underestimated (Table 12). In terms of the direction of effects of the independent variables, it was found in Model 1 that income positively influences the likelihood of being a risk-taker, whereas in Model 2 it has a negative impact. Similarly, it was found that a farmer is less likely to be a risk-taker in Model 1, whereas it is the opposite in Model 2. The impact of education, primary occupation, non-growers, and past-growers was significant in Model 1, whereas in Model 2, it was only the primary occupation that stood significant. These evidences clearly indicate that different approaches yield different risk behaviours.

Table 11. Descriptive statistics of the variables used in Probit models

Variable	Present-growers			Past-growers			Non-growers		
	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
Age (years)	41.19 (12.39)	18	74	41.39 (12.06)	18	75	37.46 (11.33)	18	66
Education (years)	7.44 (4.92)	0	17	7.50 (5.10)	0	17	7.290 (5.03)	0	18
Annual per capita income (APCI) ('000 INR)	10.64 (6.60)	1.25	45	10.46 (6.30)	3	45.71	11.50 (8.64)	2.12	55
Primary occupation (1 for farmer and 0 otherwise)	0.61 (0.49)	0	1	0.50 (0.50)	0	1	0.55 (0.50)	0	1

Note: Figures within the parentheses indicate standard error.

Table 12. Probit estimates of the determinants of risk behaviour

Factors	Dependent variable							VIF
	Model 1				Model 2			
	Actual behaviour measured through risk game				Subjective question (Method 2)			
	Coef.	z	P>z	dy/dx	Coef.	Z	P>z	
Age	-0.002	-0.310	0.759	-0.001	-0.006	-0.930	0.351	1.26
Education	0.050	3.410	0.001	0.020	0.082	5.400	0.000	1.27
Annual PCI	0.012	1.320	0.186	0.005	-0.007	-0.700	0.482	1.07
Primary occupation	-0.314	-2.380	0.017	-0.123	0.213	1.570	0.116	1.05
Farmers' category								
Non- growers	-0.420	-2.680	0.007	-0.161	-0.513	-2.990	0.003	1.36
Past- growers	-0.857	-5.500	0.000	-0.315	-0.844	-5.060	0.000	1.37
Constant	-0.012	-0.040	0.971	-	0.512	1.430	0.153	-

Model 1		Model 2	
No. of observations	= 426	No. of observations	= 426
Wald Chi^2 (6)	= 48.43	Wald Chi^2 (6)	= 66.26
Prob > Chi^2	< 0.001	Prob > Chi^2	< 0.001
Pearson Chi-square (416)	= 422.54	Pseudo R^2	= 0.13
Prob > Chi-square	= 0.402	log pseudo likelihood	= -237.14
Area under ROC curve	= 0.70		
Pseudo R^2	= 0.09		
log pseudo likelihood	= -266.40		
Y= Pr (risk) (predict)	= 0.43		

We considered Model 1 for further discussions on farmers' risk behaviour. The marginal effects obtained from the Probit model show that, holding other factors constant, one year increase in education (schooling) increases the probability to be a risk-taker by 2 per cent. The finding supports the view that higher level of education is associated positively with risk-taking behaviour (Moscardi and Janvry, 1977). This might be due to the fact that higher level of education facilitates farmers with information, which in turn helps

Table 13. Specification test of Probit models

Variables	Model 1			Model 2		
	Coef.	z	P>z	Coef.	z	P>z
Y^	0.909	5.520	0.000	0.955	4.920	0.000
Y^2	-0.312	-1.140	0.255	0.057	0.300	0.765
Constant	0.052	0.640	0.519	-0.007	-0.090	0.931
No. of observations	= 426			No. of observations	= 426	
LR Chi^2 (2)	= 52.21			LR Chi Square (2)	= 72.19	
Prob > Chi-square	< 0.001			Prob > Chi^2	< 0.001	
Pseudo R^2	= 0.09			Pseudo R^2	= 0.132	
log pseudo likelihood	= -265.75			log pseudo likelihood	= -237.09	

Note: Y^ indicates estimated probability

them to realize the benefit of risk-taking behaviour for getting opportunity. On the other hand, being a farmer or cultivator reduces the probability to become a risk-taker by 12 per cent. This might be because of the fact that farmers give first priority to livelihood security due to low level of capital accumulation. As a result, their risk-taking capacity is low. Our findings support the view that poor farmers are more risk aversion (Tasie and Nelson, 2012). Further, the findings also suggest that being a non-grower and past-grower of jatropha causes a decline in the likelihood to take risk by 16 per cent and 32 per cent, respectively.

Link test was performed to test the model specification, which was based on the idea that if a regression was correctly specified, one would not find any additional independent factors that are significant. The results of Link test, presented in Table 13, suggest that the Probit models were correctly specified. Moreover, Wald Chi-square and area under Receiver Operating Characteristic (ROC) curves also showed that the models had a good fit (Table 12).

Conclusions

The paper has investigated an important empirical question 'whether there is any inconsistency in measurement of risk preference through subjective question and through risk game with real incentives'. The results have shown that risk preference measured through subjective question and through risk game is not similar. The estimates of the Probit models also support the view that there is a variation in the estimates of the models in terms of magnitude, direction, and significance level. The study has also shown that education and occupation (cultivation) have significant positive and negative impacts, respectively on farmers' risk-taking behaviour. An important implication emerging from this study is that while studying risk behaviour it is important to carefully select the measure of risk taking into consideration the socio-cultural and economic environment surrounding an activity. The wrong selection may lead to erroneous results and mis-targeting of policies and programmes aimed at reducing risk.

Acknowledgements

The authors are thankful to the South Asian Network for Development and Environmental Economics (SANDEE) for supporting this study. They are also thankful to SANDEE Advisor, Prof. Subhrendu K. Pattanayak, Nicholas School of the Environment, USA, for motivating the authors into this direction with helpful suggestions and comments.

References

Adeogun, O.A., Ajana, A.M., Ayinla, O.A., Yarhere, M.T. and Adeogun, M.O. (2008) Application of logit model in adoption decision: A study of Hybrid Clarias in Lagos State, Nigeria. *American-Eurasian Journal of Agricultural & Environmental Science*, **4**: 468–472.

Akay, A., Martinsson, P., Madhin, H. and Trautmann, S. (2009) Attitudes toward uncertainty among the poor: Evidence from rural Ethiopia. *IZA Discussion Paper No. 4225*, Available at http://www.econstor.eu/handle/10419/35316.

Bar-shira, Z., Just, R.E. and Zilberman, D. (1997) Estimation of farmers' risk attitude: An econometric approach. *Agricultural Economics*, **17**: 211–222.

Belaid, A. and Miller, S.F. (1987) Measuring farmers' risk attitudes: A case study of the eastern high plateau region of Algeria. *Western Journal of Agricultural Economics*, **12**:198–206.

Binswanger, H.P. (1980) Attitudes toward risk: Experimental measurement in rural India. *American Journal of Agricultural Economics*, **62**: 395–407.

Brown, S., Dietrich, M., Nuñez, A.O. and Taylor, K. (2011) Self-employment and attitudes towards risk: Timing and unobserved heterogeneity. *Journal of Economic Psychology*, **32**: 425–433.

Dohmen, T., Falk, A., Huffman, D., Sunde, U., Schupp, J. and Wagner, G.G. (2011) Individual risk attitudes: Measurement, determinants, and behavioural consequences. *Journal of the European Economic Association*, **9**: 522–550.

Donkers, B., Melenberg, B. and Soest, A.V. (2001) Estimating risk attitudes using lotteries: A large sample approach. *The Journal of Risk and Uncertainty*, **22**: 165–195.

Feder, G., Just, R.E. and Zilberman, D. (1985) Adoption of agricultural innovations in developing countries: A survey. *Economic Development and Cultural Change*, **33**: 255–298.

Fletschner, D., Guirkinger, C. and Boucher, S. (2010) Risk, credit constraints and financial efficiency in Peruvian agriculture. *The Journal of Development Studies*, **46**: 981-1002.

Goswami, K., Choudhury, H.K. and Saikia, J. (2012) Factors influencing farmers' adoption of slash and burn agriculture in North-East India. *Forest Policy and Economics*, **15**, 146–151.

Greene, W.H. (1997) *Econometric Analysis*. Prentice Hall, New Jersey.

Harrison, G.W., Lau, M.I. and Rutstrom, E.E. (2007) Estimating risk attitudes in Denmark: A field experiment. *The Scandinavian Journal of Economics*, **109**: 341–368.

Henrich, J. and Mcelreath, R. (2002) Are peasants risk averse decision-makers? *Current Anthropology*, **43**: 172–181.

Hershey, J.C. and Schoemaker, P.J.H. (1985) Probability versus certainty equivalence methods in utility measurement: Are they equivalent? *Management Science*, **31**: 1213–1231.

Holt, C.A. and Laury, S.K. (2002) Risk aversion and incentive effects. *American Economic Review*, **92**: 1644–1655.

Johnson, J.E. (2005) Agroforestry adoption potential in Cape Verde. *Small-Scale Forest Economics, Management and Policy*, **4**: 205–214.

Just, R.E. and Zilberman, D. (1983) Stochastic structure, farm size, and technology adoption in developing agriculture. *Oxford Economic Papers*, **35**: 307–328.

Kassie, M., Zikhali, P., Manjur, K. and Edwards, S. (2009) Adoption of organic farming techniques. *Environment for Development*, Discussion paper series, 1–19.

Melnick, E.L. and Everitt, B. (2008) *Encyclopedia of Quantitative Risk Analysis and Assessment*. John Wiley & Sons Ltd, England.

Mercer, D.E. (2004) Adoption of agroforestry innovations in the tropics: A review. *Agroforestry Systems*, **61**–**62**: 311–328.

Moscardi, E. and Janvry, A. de (1977) Attitudes toward Risk among Peasants: An econometric approach. *American Journal of Agricultural Economics*, **59**: 710–716.

Moschini, G. and Hennessy, D.A. (2001) Uncertainty, risk aversion, and risk management for agricultural producers. In: *Handbook of Agricultural Economics*, Eds: B. Gardner and G. Rausser. North-Holland, Elsevier. pp. 88–153.

Muneer, S.E.T. (2008) Factors affecting adoption of agroforestry farming system as a mean for sustainable agriculture development and environment conservation in arid areas of Northern Kordofan State, Sudan. *Saudi Journal of Biological Sciences*, **15**: 137–145.

Neupane, R.P., Sharma, K.R. and Thapa, G.B. (2002) Adoption of agroforestry in the hills of Nepal: A logistic regression analysis. *Agricultural Systems*, **72**: 177–196.

Pattanayak, S. and Mercer, D.E. (1998) Valuing soil conservation benefits of agroforestry: Contour hedgerows in the Eastern Visayas, Philippines. *Agricultural Economics*, **18**: 31–46.

Reyes, A. and Lensink, R. (2011) The credit constraints of market-oriented farmers in Chile. *The Journal of Development Studies*, **47**: 1851-1868.

Saweda, L., Tasie, O.L. and Nelson, A.W. (2012) Social learning and farm technology in Ethiopia: Impacts by technology, network type, and poverty status. *The Journal of Development Studies*, **48**: 1505-1521.

Sen, A. (2007) *Microeconomics: Theory and Applications*. Oxford University Press, New Delhi.

Stock, J.H. and Watson, M.W. (2003) *Introduction to Econometrics*. Pearson Education, Delhi.

Subejo, S.P. (2000) Adoption of agricultural crops cultivated on coastal land in the southern coastal area of Yogyakarta. *Journal Agro Ekonomi*, **8**: 1-8.

Tasie, L. S. O. L. and Nelson, A. W. (2012) Social learning and farm technology in Ethiopia: Impacts by technology, network type, and poverty status. *The Journal of Development Studies*, **48**: 1505-1521.

Vlaev, I. (2012) How different are real and hypothetical decisions? Overestimation, contrast and assimilation in social interaction. *Journal of Economic Psychology*, **33**: 963-972.

Wang, P. (2009) *Financial Econometrics*. Routledge, New York.

Winden, F.V., Krawczyk, M. and Hopfensitz, A. (2011) Investment, resolution of risk, and the role of affect. *Journal of Economic Psychology*, **32**: 918-939.

Received: October, 2013; Accepted: January, 2014