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Measuring risk aversion among the urban poor in Kolkata, India

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We examine risk preferences in an urban setting in a low-income developing country with nonstudent subjects by adapting the experimental approach of Holt and Laury (HL; 2002). We conducted 22 group experiments with 404 participants and used in-kind payoffs. The average respondent was 'risk-averse' (the midpoint of Constant Relative Risk Aversion (CRRA) intervals among participants was 0.53, roughly in line with most similar studies in poor countries). Like most other studies, we find weak correlations between risk aversion and most socio-economic characteristics. Importantly, a sizeable minority had difficulty understanding the experiment, and participants were influenced by the context in which the experiments occurred (these problems are not unique to our study). Our article adds to a growing literature that suggests that risk aversion elicitation approaches are sensitive to context and cognitive abilities of participants.

Keywords: risk aversion; India; urban; experiment

JEL Classification: C91; C93; D81

I. Introduction: Measuring Risk Aversion in Poor Countries

How the poor make choices under uncertainty has significant implications for predicting household responses to policy interventions in areas ranging from agriculture to public health.[1] Most early studies attempted to infer risk preferences from observed behaviour. In contrast, Binswanger (1980) asked farmers in rural India to choose among hypothetical coin toss lotteries with different expected values and variances. A number of studies have replicated his approach (Miyata, 2003; Wik *et al.*, 2004; Yesuf and Bluffstone, 2009; see Fig. 1).

In the United States, Holt and Laury (2002) (hereafter 'HL') varied the probabilities rather than the payouts in a 'Multiple Price List' (MPL) task similar to that shown in Table 1. For each row participants indicate whether they prefer Lottery A or Lottery B. Several recent studies have used a modified form of the MPL experiment in rural populations in poor countries (Humphrey and Verschoor, 2004; Chakravarty and Roy, 2009; Jacobson and Petrie, 2009; Harrison *et al.*, 2010; Tanaka *et al.*, 2010).

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[1] Interested readers should consult a longer working paper version of this study (Cook *et al.* 2009) which discusses this literature, as well as our experimental design, results and conclusions in more detail.

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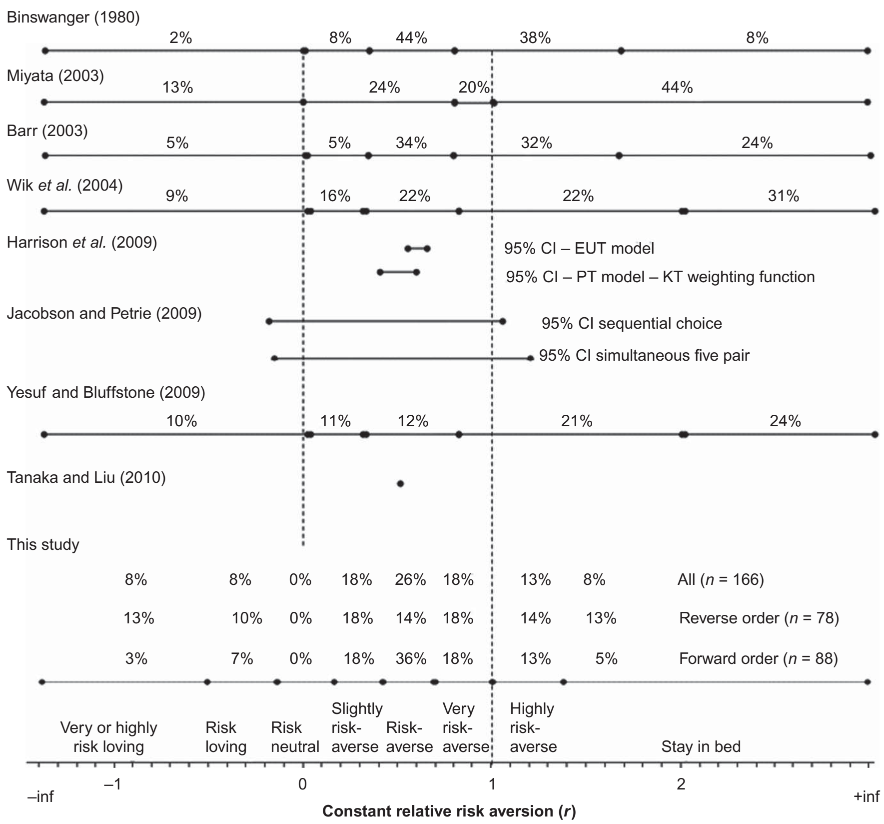

Fig. 1. Review of experimental risk preference studies in developing countries
Notes: Constant Relative Risk Aversion (CRRA) is based on $U(x) = x^{1-r}$. Verbal descriptions at bottom are based roughly on those given by Holt and Laury (HL; 2002). Most studies cited here had participants complete multiple tasks with multiple payoff levels. The figure reports results from tasks that were broadly representative of the authors' results. The results shown here respond to Binswanger's Task 12 (Rs. 50), Miyata's Task 3 (10 000Rp), Wik *et al.*'s 10 000Kw real gain (no losses) with real payment, Yesuf and Bluffstone's Set 3 gains-only and Jacobson and Petrie gain only. We report point estimates for the south from Tanaka and Liu (see Fig. 1 in their paper for the distribution). For Binswanger, 10% of participants chose an 'inefficient' lottery; these results recode the percentages from his table 3 to include only those who did not make an inefficient choice. The results shown from Harrison *et al.* (2010) correspond to models with no covariates. CI, Confidence Interval; EUT, Expected Utility Theory; PT, Prospect Theory; KT, Kahneman–Tversky.

Although these two methods should be equivalent, evidence from head-to-head comparisons have found they can lead to different estimates of risk aversion (Jacobson and Petrie, 2009; Dave *et al.*, 2010).

How can we know if participants understood the experimental tasks? Binswanger included a number of 'risk-inefficient' choices in his design, although this gives only a 25% chance of detecting a confused participant. For MPL tasks, participants may switch back and forth between Lottery A and Lottery B, even though differences in expected value change monotonically. This 'multiple switching' may indicate that the monetary incentive is not salient or that the participant is indifferent over the interval of switching or confused. Most MPL studies in industrialized countries find this behaviour in a fairly low percentage of participants (~10% or less). However, Dave *et al.* (2010) found the fraction three times higher among Canadian participants with low math skills. In poor countries, 55% of Rwandan participants switched multiple times (Jacobson and Petrie, 2009), as did 40% of rural Peruvian subjects in Galarza (2009). One recent adaptation of the MPL approach in Vietnam is not designed to detect confusion at the level of the individual participant (Tanaka *et al.*, 2010).

II. Methods and Study Setting

Setting and recruitment

Participants were recruited from respondents in a companion stated preference survey of private demand for cholera and typhoid vaccines in Kolkata (Whittington *et al.*, 2008).[2] We conducted 22 experimental sessions with a total of 404 participants. 42%

[2] A more detailed treatment of this section, as well as copies of the experimental script and materials shown to participants, is available at the first author's website: http://faculty.washington.edu/jhcook/research.html.

Table 1. The 10 binary choice tasks used in the experiments patterned after Holt and Laury (2002)

Order in which tasks were shown						
Forward order	Revised forward order	Reverse order	*Lottery A* – Safe choice[a]	*Lottery B* – Risky choice[a]	EV(A)–EV(B)	Implied CRRA if switch to B[b]
	1		\$1.11 with $p = 0$, \$0.67 with $p = 1.0$	\$1.78 with $p = 0$, \$0.22 with $p = 1.0$	\$0.44	n/a[c]
1	2	10	\$1.11 with $p = 0.1$, \$0.67 with $p = 0.9$	\$1.78 with $p = 0.1$, \$0.22 with $p = 0.9$	\$0.33	(<–1.54)
2	3	9	\$1.11 with $p = 0.2$, \$0.67 with $p = 0.8$	\$1.78 with $p = 0.2$, \$0.22 with $p = 0.8$	\$0.22	(–1.54, –0.83)
3	4	8	\$1.11 with $p = 0.3$, \$0.67 with $p = 0.7$	\$1.78 with $p = 0.3$, \$0.22 with $p = 0.7$	\$0.11	(–0.83, –0.37)
4	5	7	\$1.11 with $p = 0.4$, \$0.67 with $p = 0.6$	\$1.78 with $p = 0.4$, \$0.22 with $p = 0.6$	\$0.00	(–0.37, 0)
5	6	6	\$1.11 with $p = 0.5$, \$0.67 with $p = 0.5$	\$1.78 with $p = 0.5$, \$0.22 with $p = 0.5$	–\$0.11	(0.00, 0.33)
6	7	5	\$1.11 with $p = 0.6$, \$0.67 with $p = 0.4$	\$1.78 with $p = 0.6$, \$0.22 with $p = 0.4$	–\$0.22	(0.33, 0.65)
7	8	4	\$1.11 with $p = 0.7$, \$0.67 with $p = 0.3$	\$1.78 with $p = 0.7$, \$0.22 with $p = 0.3$	–\$0.33	(0.65, 1.0)
8	9	3	\$1.11 with $p = 0.8$, \$0.67 with $p = 0.2$	\$1.78 with $p = 0.8$, \$0.22 with $p = 0.2$	–\$0.44	(1.0, 1.41)
9	10	2	\$1.11 with $p = 0.9$, \$0.67 with $p = 0.1$	\$1.78 with $p = 0.9$, \$0.22 with $p = 0.1$	–\$0.56	(1.41, 2.0)
10	(11)[d]	1	\$1.11 with $p = 1.0$, \$0.67 with $p = 0$	\$1.78 with $p = 1.0$, \$0.22 with $p = 0$	–\$0.67	>2.0

Notes: n/a, not applicable.
[a]Winnings were not cash; participants won '1 – prize' notes and selected from prizes worth approximately Rs. 10 (US\$0.22).
[b]The interpretation here is for participants who choose Lottery A in all rows above and continues choosing Lottery B in all subsequent games. As discussed in the text, this interval is more difficult to interpret for participants who switch multiple times.
[c]A participant who chooses Lottery B in this row has misunderstood the task, since it involves no uncertainty and the prize in A is larger.
[d]We revised 'forward' order after several sessions so that it would begin with a certainty question like 'reverse' order. Participants were *not* presented with this task in 'revised forward' order. It is labelled as Task 11 because all tasks were standardized to this order for analysis.

of the stated preference participants who were invited to the experiments showed up.

Experimental procedure

In each session, participants were instructed as a group, although they answered the risk preference questions individually. Our design of binary choices (Table 1) is based on HL, although participants answered each question (row) sequentially rather than being presented with all 10 choices simultaneously. We represented lotteries using coloured spinners (shown in black and white in the print version of Fig. 2). After making 10 choices, one choice would be randomly selected. The spinner representing the lottery chosen in that row would be spun by the participant to determine her winnings (Fig. 3). Participants won 'prizes' that could be redeemed for one of the six goods that were carefully selected to be the most common household staple goods in Kolkata (e.g. rice, cooking oil). Each was worth Rs. 10 (US\$0.22); average winnings were Rs. 46, roughly equal to the average per capita daily household income in the full sample of all stated preference respondents. We varied the order in which the choices were asked (Table 1). After the moderator's instructions, one volunteer agreed to demonstrate the task from beginning to end (including payouts). Although participants could not observe all of the volunteer's choices, they could observe their choice and actual winnings for the randomly selected row.

Modelling approach

We use a Constant Relative Risk Aversion (CRRA) utility function of the form $U(x) = x^{1-r}$, where x is lottery winnings and r is the coefficient of risk aversion. Under expected utility theory, the participants' choices imply interval values of r, as shown at right in Table 1. To explore the role of socio-economic characteristics in the simplest manner, we follow HL by regressing the number of 'safe choices' with Ordinary Least Squares (OLS). We report similar results from an interval model in the first author's website (see footnote 2), as well as results from a more flexible maximum likelihood approach following Harrison *et al*. (2010).

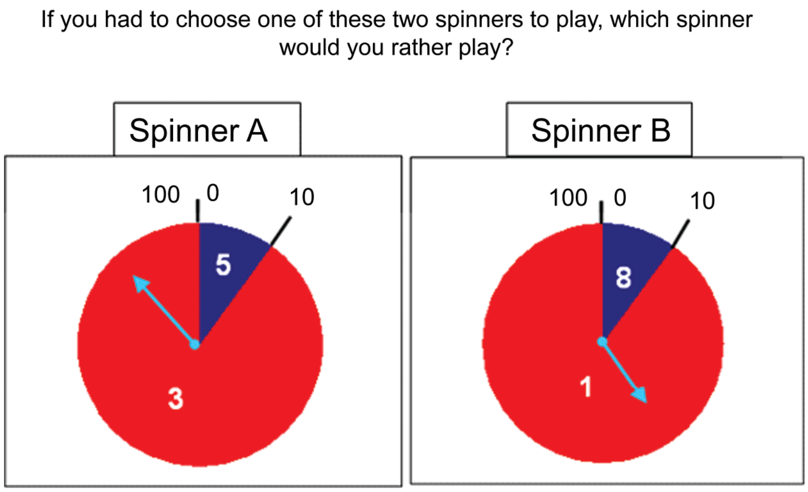

Fig. 2. Choosing between two lotteries where the prize is the number of bars of soap

Fig. 3. Subject spinning the wheel to determine his prize winnings

III. Results

The typical participant in our experiment is a 35-year-old woman with 6–9 years of formal education (Table 2). Compared with the full sample of stated preference participants, those who participated in the experiments were more likely to be female, poorer and less educated (Table 2). We ignore this selection effect here, but present results in the first author's website (see footnote 2) from a double selection model which accounts for selection at both the participation level and the level of who understood the lottery tasks.

Did participants understand the tasks?

Figure 4 plots the raw response intervals. It excludes 77 participants (19%) who answered the 'certainty' task (first and last rows of Table 1) incorrectly and 4 participants who were unable to fill out the form correctly. Each bar represents one participant and the vertical axis represents the task numbers standardized to 'revised forward order'. A bar that is one vertical unit tall represents a participant who switched only once. A bar that is more than one vertical unit tall represents the range over which the participant was indifferent or uncertain (above the bar they always chose Lottery A, below the bar they always chose Lottery B and within the bar they switched back and forth). The upper left panel shows 90 participants who switched over an interval of greater than 4 tasks and most likely did not understand the task.

We estimate three probit models to explore who misunderstood the task using three definitions of misunderstanding (see Fig. 5). Participants with lower levels of education, lower incomes and those aged 35–45 years were more likely to make mistakes (Table 3), although the results are most robust for education. The volunteer was more likely to make a mistake under the second definition, confirming that some participants may need to see the whole exercise in order to understand it. Participants whose first task was not a 'certainty' task were more likely to be confused (for more discussion, see Cook *et al.*, 2009).

Following Jacobson and Petrie (2009), we tested whether making mistakes was correlated with real risk decisions. We tested pairwise correlations of a dummy variable indicating whether the participant made a mistake with variables for whether they never boiled their water, ate street food more than three times per week (a health risk in Kolkata) or spent any money on the lottery in the past 30 days. Under all three definitions of mistakes, none of the correlation coefficients were above 0.10 nor statistically significant.

For the remainder of this article, we present results using only the third, most restrictive definition of understanding. We provide parallel results using the

Table 2. Socio-economic and attitudinal characteristics of participants and correlation with number of safe choices

Variable	Definition	Stated preference participants (n = 959) [a]Mean (SD)	All risk experiment participants (n = 404) Mean (SD)	Pairwise correlation with number of 'safe'choices (exclusion definition C)[b]
Male	= 1 if participant is male	49%	38%	–0.13
Age	Participant age (continuous)	35 (7.8)	35 (7.7)	0.012
AgeMid	= 1 if age 35–45 years	46%	46%	–0.0007
AgeOlder	= 1 if age >45 years	10%	9%	0.062
Edu2	= 1 if participant completed 1–9 years of school	43%	51%	–0.12
Edu3	= 1 if participant completed 12 years of school or vocational school	32%	29%	0.037
Edu4	= 1 if participant completed university, postgraduate or professional course	16%	10%	0.13
Illiterate	= 1 if participant said they could not read a newspaper	12%	15%	–0.15*
Income	Per capita monthly household income (US$)	$28 ($38)	$20 ($18)	0.13
Elecbill	Per capita monthly electricity bill (US$)	$2.0 ($2.8)	$1.5 ($0.4)	0.095
NumAdult	Number of adults (age ≥ 16 years) in household	3.8 (1.9)	3.6 (1.8)	0.083
NumChild	Number of children (age ≤ 15 years) in household	1.4 (0.9)	1.4 (0.8)	–0.039
Reverse	= 1 if reverse order	n/a	46%	–0.029
VolunteerLuck	= 1 if in group where volunteer won maximum number of prizes	n/a	27%	–0.24*
PlayLottery	= 1 if spent any money on lottery in the past 30 days	5%	6%	–0.060
Volunteer	= 1 if volunteer for group	n/a	8%	0.052
NeverBoil	= 1 if never boil drinking water	61%	62%	–0.12
StreetFood	= 1 if eat food from street vendors three or more times per week	23%	21%	–0.053
EconDecline	= 1 if participant reported household's economic situation will 'probably decline somewhat' or 'certainly get much worse'	9%	9%	–0.039
WorseOthers	= 1 if participant classifies economic status relative to neighbours as 'below average' or 'much worse than average'	27%	37%	–0.17*
TimePref	Continuous rate of time preference	19 (24)	17 (23)	–0.16*
NumRooms	Number of rooms in house	2.7 (2.0)	2.2 (1.3)	0.21*
DifficCredit	= 1 if 'somewhat difficult' or 'very difficult' or 'impossible' to borrow Rs. 1000	63%	70%	–0.061
NoWindow	= 1 if participant's home has no windows	3%	5%	–0.026
CeilFan	= 1 if participant has ceiling fan	34%	22%	0.12
Car	= 1 if participant has car	7%	3%	0.023

Notes: n/a, not applicable.
[a]Stated preference participants only in Beliaghata neighbourhood.
[b]Excludes participants who answered the certainty question incorrectly or switched more than once or never switched at all.
*The correlation coefficient is significantly different from 0 at the 5% level or better.

second definition of understanding in the first author's website (see footnote 2).

What were the risk preferences of participants?

Among the 166 participants who switched only once, 84% would be classified as risk-averse based on the midpoint of their implied CRRA interval. A sizeable fraction (16%) was risk seeking (Fig. 1). The average CRRA midpoint was 0.53, roughly in line with results from other studies in poor countries. Average CRRA midpoints were not statistically different by task order ($r = 0.51$ for forward or 'revised forward' order versus 0.55 for reverse order, $t = 0.36$). If the volunteer who demonstrated the full experimental procedure in front of the group won the maximum of eight prizes, the remaining participants in that session showed less risk aversion. The midpoint for the 41 participants in these 'volunteer luck' groups was 0.26 versus 0.62 among other participants ($t = 3.05$). This is similar to the 'good luck' effect found by Binswanger (1980), Wik *et al.* (2004) and Yesuf and

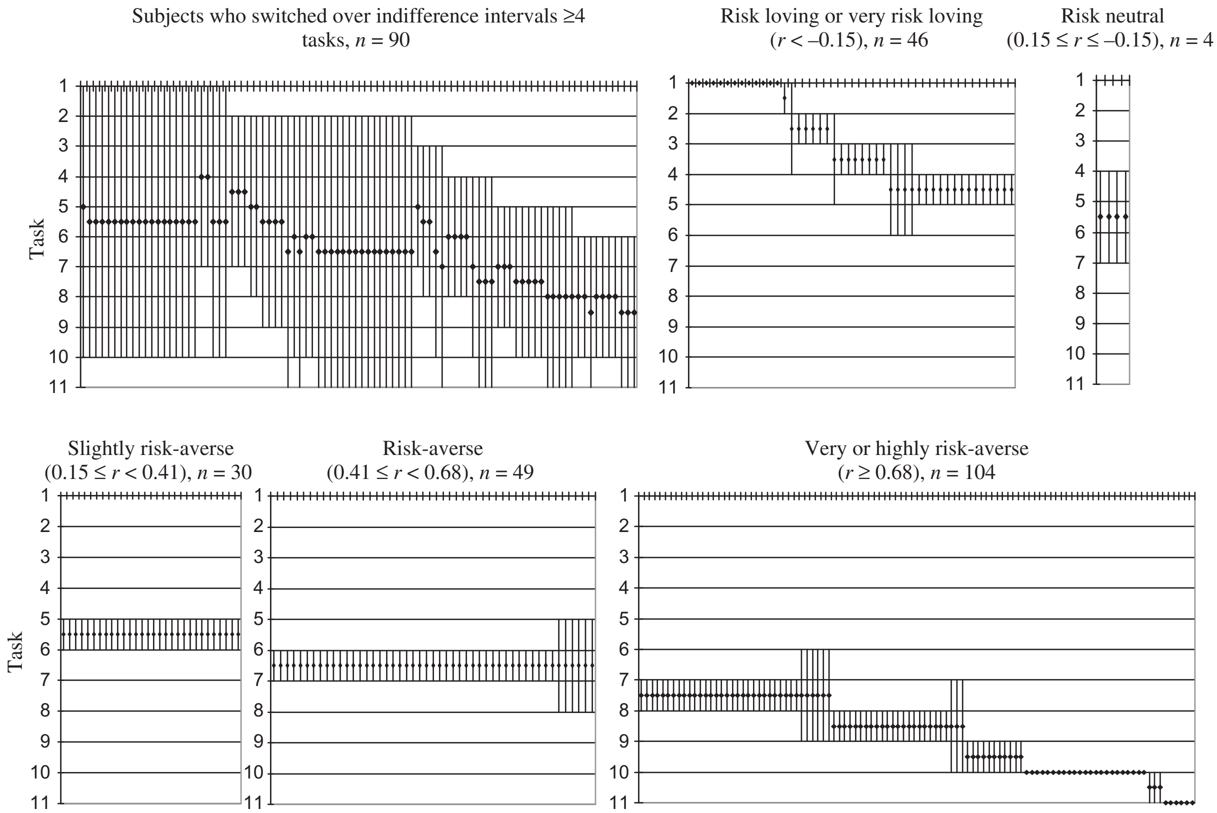

Fig. 4. Distribution of risk responses classified by midpoint of implied Constant Relative Risk Aversion (CRRA) interval
Notes: Eighty-one participants who got the certainty question wrong or could not complete the form are not shown. Labels are drawn from Holt and Laury (HL; 2002).

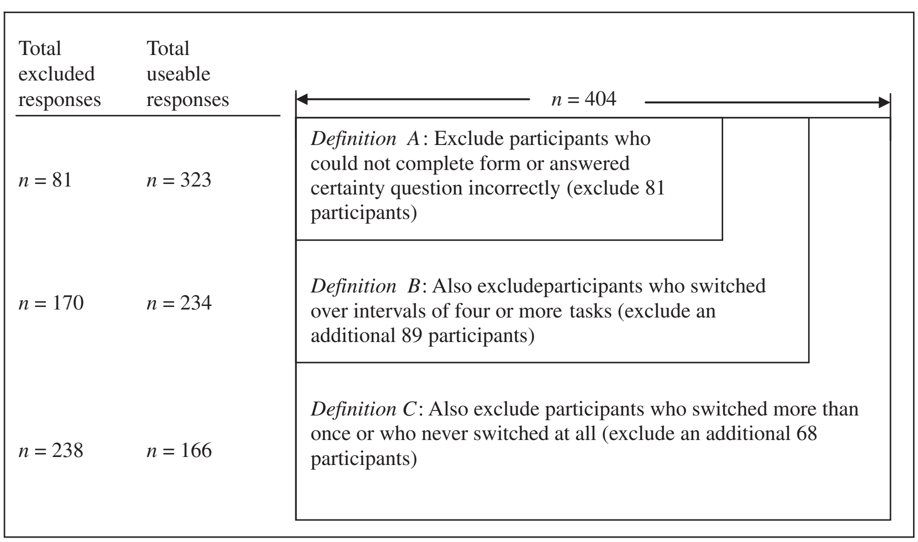

Fig. 5. Summary of three definitions of whether participants made a mistake or misunderstood the task

Bluffstone (2009): When participants realized the outcome of one risky choice before making another choice, those who were lucky in earlier rounds began making riskier choices in later rounds.

Are preferences associated with socio-economic characteristics?

Table 2 lists the variables that we hypothesize may be associated with risk aversion, their summary

Table 3. Multivariate probit models of whether a participant made a 'mistake' or misunderstood task, using three definitions

	Definition A: Exclude incorrect 'certainty' question or bad form		Definition B: Definition A + exclude indifference interval ≥4 tasks		Definition C: Definition B + exclude those who switch more than once or never switched	
Male	–0.076	(0.18)	–0.082	(0.15)	–0.25	(0.15)
AgeMid	0.14	(0.18)	0.29**	(0.14)	0.48***	(0.15)
AgeOlder	–0.16	(0.33)	–0.069	(0.27)	0.21	(0.28)
Education						
1–8 years education	–0.080	(0.25)	0.27	(0.23)	–0.20	(0.24)
9–12 years education or vocational	–0.40	(0.29)	–0.056	(0.25)	–0.67**	(0.26)
University or postgraduate education	–1.05**	(0.48)	–0.13	(0.32)	–0.74**	(0.33)
Income (US$ per capita)[a]	-3.0×10^{-2}***	(9.0×10^{-3})	-8.8×10^{-3}*	(5.1×10^{-3})	-7.1×10^{-3}	(4.6×10^{-3})
Subject was volunteer	0.31	(0.32)	0.51**	(0.25)	0.26	(0.26)
'Reverse' order[b]	0.21	(0.19)	0.049	(0.14)	–0.18	(0.14)
Revised 'forward' order[b]	1.41***	(0.23)	1.00***	(0.20)	0.72***	(0.21)
Constant	–0.58**	(0.30)	–0.47*	(0.25)	0.56**	(0.26)
Number of participants making mistakes	81		170		238	
Total N for regression	403		403		403	
Pseudo-R^2	0.19		0.08		0.09	

Notes: SEs are in parentheses. Convenience sample participants for whom we have no socio-economic data are excluded from regressions.
[a]Total household income reported by the participant divided by the number of household members, and converted to US$ at August 2004 exchange rate of Rs. 45 = 1US$.
[b]Original 'forward' order is excluded category.
*, ** and ***Significant at the 10%, 5% and 1% levels, respectively.

statistics and their one-way correlation coefficient with the number of safe choices using the third exclusion definition.[3] As suggested by these correlations and the discussion above, our OLS results show that lucky volunteers induced more risky choices in their groups (Table 4). Game order is weakly statistically significant in two of the three models, but the magnitude of the effect is large. Like a number of studies, we find that men were less risk-averse, as were present-oriented participants. Literacy, levels of formal education and household income are not associated with choices in the experiment, although one income proxy (whether the house has a ceiling fan) is significant but in an unexpected direction.

IV. Discussion

Like Jacobson and Petrie (2009) and Galarza (2009), we find that a significant fraction of respondents may not have understood the task in the way intended. Watching the volunteer improved the participant's chance of understanding the task, although the volunteer's luck influenced their risk preferences. This trade-off is important in improving experimental methods in settings like ours. Rather than using a volunteer to improve understanding, one could use warm-up tasks, although the subject's luck on those tasks might also influence their subsequent choices. Yesuf and Bluffstone argue that this 'prior luck' effect is policy relevant. Policymakers might focus initially on projects with slightly higher expected values but very moderate increases in risk. For example, it may be that risk-averse farmers will only feel sufficiently confident to plant riskier seed varieties with higher returns after some initial successes. Similarly, people may not make risky decisions in isolation; they may first observe the decisions and outcomes of their neighbours. Focusing on adoption of lower risk policies among influential community members with large social networks may improve other farmers' risky decisions.

There is much to be learned about decision making under uncertainty from people who are confused by risky situations. Risk parameters alone have generally not been shown to correlate well with real-world decisions, although Jacobson and Petrie show that risk aversion is more explanatory when coupled with information on mistakes. Future experiments should be designed both to maximize the chance that

[3] All participants who made 0–2 safe choices are recoded as having made two safe choices, and all participants who made 9–11 safe choices are recoded as having made nine safe choices.

Table 4. Ordinary Least Squares (OLS) model of the number of safe choices

	Model 1		Model 2		Model 3	
	Estimate	SE	Estimate	SE	Estimate	SE
'Reverse' order	0.88*	(0.52)	0.85*	(0.51)	0.83	(0.51)
Revised 'forward' order	0.89	(0.55)	0.84	(0.53)	0.81	(0.54)
VolunteerLuck	–0.73**	(0.33)	–0.81**	(0.33)	–0.84**	(0.33)
Volunteer	0.18	(0.49)				
Male	–0.63**	(0.28)	–0.67**	(0.27)	–0.73***	(0.28)
AgeMid	–0.080	(0.28)	0.026	(0.27)	–0.056	(0.28)
AgeOlder	0.90*	(0.52)	0.73	(0.49)	0.92*	(0.51)
Education						
1–8 years education	0.11	(0.57)			–0.48	(0.59)
9–12 years education or vocational	0.35	(0.57)			–0.44	(0.60)
University or postgraduate education	0.84	(0.67)			–0.026	(0.67)
Income (US$ per capita)	2.5×10^{-3}	(6.6×10^{-3})				
TimePref	–0.013**	(5.6×10^{-3})	–0.015***	(5.4×10^{-3})	–0.016***	(5.5×10^{-3})
Illiterate			–0.51	(0.45)		
NumRooms			0.15	(0.092)	0.11	(0.099)
CeilFan			0.90*	(0.52)	1.16**	(0.52)
NoWindow			–0.38	(0.55)	–0.41	(0.56)
PlayLottery					0.055	(0.64)
NeverBoil					–0.43	(0.27)
StreetFood					–0.012	(0.16)
Constant	5.24***	(0.97)	4.55***	(0.94)	4.93***	(1.15)
Observations	166		164		164	
R^2	0.164		0.217		0.234	

Notes: SEs are in parentheses. Only participants who switched once and only once between rows (exclusion definition C) are included. Excluded categories are original 'forward' order and no formal education.
*, ** and ***Significant at the 10%, 5% and 1% levels, respectively.

participants *will* understand (by tailoring the language and materials to local customs) and to detect if they in fact still do *not* understand. We can then have more confidence in knowing what we are learning from the experimental gamble studies that are proliferating around the globe.

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