

## Attitudes Toward Uncertainty Among the Poor

*Evidence from Rural Ethiopia*

**Alpaslan Akay, Peter Martinsson, Haileselassie Medhin, and  
Stefan Trautmann**



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# **Attitudes Toward Uncertainty Among the Poor: Evidence from Rural Ethiopia**

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## **Abstract**

We looked at risk and ambiguity attitudes among Ethiopian peasants in one of the poorest regions of the world and compared their attitudes to a standard Western university student sample elicited by the same decision task. Strong risk aversion and ambiguity aversion were found with the Ethiopian peasants, and these attitudes are similar to those of the university students. Testing for the effect of socioeconomic variables on uncertainty attitudes showed that poor health increased both risk and ambiguity aversion.

**Key Words:** risk attitudes, ambiguity attitudes, poverty, cultural differences

**JEL Classification:** D81, C93, O12

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## Attitudes toward Uncertainty among the Poor: Evidence from Rural Ethiopia

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### Introduction

In decision under uncertainty, research shows that agents distinguish between prospects for which they have a clear probability assessment or feel competent because of their own expertise, and prospects for which probabilities are unknown and the agents feel less competent (Chow and Sarin 2002; Fox and Tversky 1995; Heath and Tversky 1991; Viscusi and Chesson 1999; Viscusi and Magat 1992, Zeckhauser 2006). The extreme case of objectively known probabilities (e.g., tails come up in a coin flip) is called *risk*, and the extreme case of completely unknown probabilities (e.g., rain tomorrow) is called *ambiguity*. Ellsberg (1961) suggested that people often prefer to bet on risky prospects instead of ambiguous prospects, even if normative theory (Savage 1954) implies indifference. Confirming Ellsberg's conjecture, *ambiguity aversion* has been found in many empirical studies, under market conditions, and with monetary incentives (e.g., Halevy 2007; Sarin and Weber 1993).

Most experiments on ambiguity are conducted using university students in a laboratory environment. Few studies have used non-student samples. For example, Viscusi and Chesson (1999), Maffioletti and Santoni (2005), and Cabantous (2007) show ambiguity effects for small business owners, union delegates, and insurance managers, suggesting its importance in real-world decisions.

A significant number of decisions under uncertainty are also made by farmers in developing regions of the world, who, in contrast to the above mentioned groups, live near or

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below the poverty line. The objective of this paper is to measure attitudes toward uncertainty among small-scale farmers in one of the poorest regions in the world. Knowledge of attitudes toward uncertainty is important to understand choices in traditional production activities involving well known risks, as well as to understand the uptake and adaptation of new production technologies (e.g., fertilizer) and investments (e.g., water harvesting) that involve unknown risks, leading to ambiguity. While uncertainty has been identified as an important determinant of farm technology adoption (Feder 1980; Feder et al.1985; Kebede 1992), the literature does not systematically differentiate between the effect of risk aversion and ambiguity aversion.

Although ambiguity attitudes have been widely observed, there is little direct evidence in the context of development and subsistence farming. Henrich and McElreath (2002) conducted an experimental study of risk and ambiguity attitude among Chilean Mapuche small-scale farmers and found no evidence for ambiguity aversion. They argued that ambiguity aversion may be driven by cultural factors, and that it does not generalize to non-western farming societies. Their explanation is consistent with the finding of a strong social component in ambiguity attitude (Curley et al. 1986; Trautmann et al. 2008a). Pursuing ambiguous options for which there is little available information about the risk is perceived as poor decision making; people seem to anticipate this and therefore avoid ambiguous risks. Such a social stigma for poor information options may not exist in non-western culture, reducing ambiguity aversion.

Henrich and McElreath's study shows the problems of generalizing attitudes under uncertainty from standard experimental participant pools toward culturally different groups that are of economic interest. Their findings, however, may not generalize toward other farming societies either. Two points of concern with their results are that 1) the Mapuche were unusually risk seeking for known probabilities, and 2) there was no control group among a standard participant pool for the ambiguity experiment. It is conceivable that the Mapuche held especially optimistic attitudes to the chance events, possibly due to friendly long-term relations with the experimenters, and therefore had optimistic views concerning the distribution of payoffs in the ambiguous task. Situations under ambiguity are even more sensitive to framing than situations of known risks (Trautmann et al. 2008b). Small differences in the decision tasks, compared to studies with standard student samples at Western universities, could provide an obvious explanation for the observed ambiguity attitudes in the absence of a student control group.

This paper measures attitudes toward uncertainty among small-scale farmers in rural Ethiopia. Our subjects differ from standard subject pools in terms of their occupation, wealth, and cultural background. The experiment used actual monetary incentives with high stakes and

compared the results to data from university students in the Netherlands facing the same decision tasks. The measure of ambiguity-aversion controls for individual differences in risk attitudes, and we related both risk and ambiguity attitude to socioeconomic variables. The next section gives a description of the participant pool and introduces the experimental design. The results are presented in sections 2 and 3 and discussions are in sections 4–6. The last section offers concluding remarks.

## 1. Participants and Experimental Design

The experiment was conducted in the village of Abraha We Atsbaha in the northern highlands of Ethiopia. The majority of the Ethiopian population resides in the highlands, where small-scale subsistence agriculture is the main economic activity. Highland agriculture in Ethiopia is characterized by population pressure, extreme land fragmentation, severe soil degradation, and heavy dependence on rainfall. As a result, the overall outcome is one of the lowest agricultural productivity levels in the world. During the last few decades, the number of droughts has exacerbated the problem, especially in the northern parts of the country. Abaraha We Atsbaha is one of many very poor villages in a region where most people depend on food aid programs to survive between the two annual harvests.

Our sample consisted of 92 adults with little or no formal education, and 30 percent of those who participated in our experiment were illiterate. Subjects were randomly selected from a list of 584 households, with either the male or female household head participating. All subjects were peasants, mainly growing wheat, maize, barley, and teff. Most families also owned some livestock (cattle and sheep). All participants were Christians.

Each participant could win up to 20 Ethiopian birr (ETB). At the time of the experiment, the exchange rate was  $\text{ETB } 9.67 = \text{US\$ } 1$ , and the 2007 purchasing power parity conversion rate was 6.02 for Ethiopia.<sup>1</sup> Note that, in this region, the daily wage for unskilled farm labor varies between 10–15 ETB, depending on the season.

We elicited each participant's certainty equivalents for a risky and an ambiguous prospect using a choice list. The risky prospect allowed the participant to bet on the color of a ball drawn from a bag with exactly 5 white and 5 yellow balls to win ETB 20, if they guess the correct color. This prospect offered a 50-percent chance to win the prize. The ambiguous prospect

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<sup>1</sup> IMF World Economic Outlook Database (April 2008).

allowed participants to bet on the color of a ball drawn from a bag with 10 yellow and white balls, but the proportion of colors was unknown. If participants guess the color correctly in this game, they also win ETB 20.

The two prospects are the risky and ambiguous option in the Ellsberg (1961) two-color choice task. The ambiguous option is always at least as good as the risky option. If participants are indifferent to betting on either color in the ambiguous option, they should be indifferent when betting on the both the risky option and the ambiguous option. The participants should, therefore, have identical certainty equivalents for both options. If they believe that there are more white balls than yellow balls in the ambiguous bag, they will bet on white in the ambiguous prospect and should prefer this prospect to the risky prospect because it gives the participants a higher chance to win the prize, given their beliefs. A similar argument holds if the participants believe that there are more yellow balls in the ambiguous bag.

To elicit participants' certainty equivalents, we offered them 20 choices between a sure payoff and playing the prospect. Choices were arranged in a choice list. The sure payoff increases from ETB 1 to ETB 20. For very small sure payoffs, most participants will prefer to play the prospect; for very large sure payoffs, most participants will prefer the sure cash. That is, most participants will switch from sure cash to playing the prospect at some point. We calculate the certainty equivalent as the midpoint between the lowest sure payoff for which the participant takes the sure cash and the highest sure payoff for which the participant prefers to play the prospect (see table A1 in the appendix).

Note that this choice list methodology differs from the list employed by Binswanger (1980), where participants were asked to choose one prospect from a list of prospects that differed with respect to their expected payoff and variance, so the selected prospect then serves as an index of risk aversion. Our method is closer to Henrich and McElreath's (2002) because it directly elicits the certainty equivalent of one prospect, but it avoids the chained procedure that these authors used. In the chained procedure, the decision problems that participants are offered depend on their previous choices. With the choice list, all participants face the same decision problems. Also, in contrast to chained procedures, the choice list is incentive compatible.

In our experiment, participants made choices in one choice list for each prospect, and therefore made 40 choices in total. After the participants made all choices, one of these choices was randomly selected for real play for each participant. Depending on the decision in the selected choice problem, the participant received either the sure cash amount or played the prospect with a chance to win ETB 20.



Because most of our subjects had no formal education and many were illiterate, the instructions were given verbally in local language using posters as visual aids. All probabilities and randomizations were demonstrated using balls and dice, and no explicit reference to probabilities was given. Visual aids have been shown to improve the understanding of risks by participants without formal training in probability theory and were clearly necessary in our sample (Carlsson et al. 2004; Corso et al. 2001). The prospects and the betting tasks were demonstrated for the risky option by filling the bag with 5 white and 5 yellow balls. A subject chose a color by putting a ball of this color on the table. Next, a ball was randomly drawn. If the colors matched, the subject was paid ETB 20. The binary choices between the prospects and the sure amounts of money were presented to the participant by the experimenter one at a time. The experimenter filled out the choice list according to the participant's preference in each choice.

As a comparison standard, we used data from an experiment with undergraduate university students at a Dutch university facing the same decision task above (Trautmann et al. 2008b, experiment 4). The tasks and randomizations were identical to the Ethiopian sample, apart from the following. The prize was €50 for the two prospects for the student sample and 2 of 79 students were randomly selected for real play of their choices. Students received written instructions and filled out the choice lists by themselves.

## 2. Experiment Results: Risk and Ambiguity Attitudes

The certainty equivalents for the risky prospect allowed us to control for risk attitude in the measurement of ambiguity below. Risk attitudes are of independent interest, however, and we report the data here. In this subsection, we assume expected utility with power utility and report constant relative risk aversion coefficients. With the simple two-outcome gain prospects studied here, the results do not change if we assume linear utility and interpret risk aversion in terms of probability weighting as in rank dependent utility and prospect theory.<sup>2</sup>

The median coefficient of relative risk aversion in the Ethiopian sample is  $\rho=0.73$ , which is significantly larger than the median of  $\rho=0.34$  in the Dutch student sample (Mann-Whitney U test,  $z=4.391$ ,  $p<0.01$ ). Table 1 shows that the percentage of risk-neutral and -seeking

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<sup>2</sup> Because we have only one indifference point (one certainty equivalent for one risky prospect), we would have to restrict the analysis to single-parameter probability weighting functions. Econometric estimation of more flexible weighting functions requires more information and, therefore, more complex elicitation procedures (Abdellaoui 2000; Bleichrodt and Pinto 2000; Viscusi and Evans 2006).

participants is similar in both groups, but that among the peasants there are few mildly and medium risk averse. In particular, 41 of the 92 participants in Ethiopia preferred the sure payoff in all choices. The table also includes the distribution of individual CRRA (constant relevant risk aversion) parameters, as estimated by Holt and Laury (2002), for a sample of U.S. students using real payoffs up to \$77 (see Holt and Laury 2002, table 3, last column). Their study indicated more risk aversion than did the Dutch study and the distribution was closer to our Ethiopian sample. However, Holt and Laury (2002) had only about 40-percent highly risk-averse participants, compared to the 60-percent highly risk averse people in our experiment.

**Table 1. Distribution of Constant Relative Risk Aversion Parameters in Ethiopian Peasants versus University Student Samples**

	Risk neutral/ loving	Mildly risk averse	Risk averse	Highly risk averse
	$\rho \leq 0.15$	$0.15 < \rho \leq 0.41$	$0.41 < \rho \leq 0.68$	$\rho > 0.68$
Ethiopian farmers (n=92)	22%	11%	10%	58%
Dutch students (n=79)* <i>Trautmann et al. (2008b)</i>	19%	35%	44%	1%
U.S. students (n=93)** <i>Holt and Laury (2002)</i>	19%	19%	23%	39%

In our experiment, the individual ambiguity attitudes are determined by the participant’s certainty equivalents for the risky and the ambiguous prospect. As a measure of ambiguity aversion, we employ the value:

$$\frac{\text{certainty equivalent risky prospect} - \text{certainty equivalent ambiguous prospect}}{\text{certainty equivalent risky prospect} + \text{certainty equivalent ambiguous prospect}}$$

This measure ranges from -1 (ambiguity loving) to 0 (ambiguity neutrality) to 1 (ambiguity averse). The larger the difference between the two certainty equivalents is, the stronger the ambiguity attitude, controlling for the absolute level of risk attitude. The normalization controls for the fact that a difference of ETB 2 weighs more heavily for a subject who is very risk averse (e.g., certainty equivalent risky prospect of ETB 4) than for a subject who is relatively risk neutral (e.g., certainty equivalent risky prospect of ETB 9).

Because of the strong risk aversion in the Ethiopian sample, we have 41 participants who revealed the lowest feasible certainty equivalent for the risky prospect. These participants could not reveal ambiguity aversion by having a lower certainty equivalent for ambiguous, and we

excluded them from the analysis. Ambiguity attitudes did not differ between the Ethiopian peasants and the Dutch students (Mann-Whitney U tests,  $z=1.535$ ,  $p>0.1$ ). In both samples, we found clear ambiguity aversion (Wilcoxon tests,  $ps<0.01$ ). Table 2 shows the distribution of ambiguity attitudes in the Ethiopian and the Dutch samples, based on certainty equivalents, in three comparison studies. Roca et al. (2006) gave British university students a simple choice between betting on the color in the risky or the ambiguous Ellsberg two-color urn, as in our

**Table 2. Ambiguity Attitudes in Ethiopian Peasants versus Comparison Samples**

	Ambiguity seeking	Ambiguity neutral	Ambiguity averse	Elicitation method
Ethiopian farmers (n=51)	20%	24%	57%	CE, gains, real incentives
Dutch students (n=79) <i>Trautmann et al. (2008b)</i>	15%	43%	42%	CE, gains, real incentives
British students (n=72) <i>Roca et al. (2006)</i>	39%	n.a.	61%	Choice, gains, hypothetical
Business owners (n=130) <i>Chesson and Viscusi (2003)</i>	56%	n.a.	44%	Choice, losses, hypothetical
Dutch students (n=39) <i>Keren and Gerritsen (1999)</i>	3%	46%	51%	Willingness to pay, gains, hypothetical

experiment. The distribution of ambiguity aversion in their basic experiment replicated standard findings in the literature and is similar to our results in Ethiopia.<sup>3</sup>

The two other studies illustrate the effect of two design features on ambiguity attitude and show that the induced differences are much stronger than the differences between the different samples of participants in the first three rows of the table. Chesson and Viscusi (2003) studied ambiguity attitude for loss prospects among business owners in the U.S. Clearly, there is more ambiguity seeking in their study, compared to our study, consistent with findings for losses in the literature (Cohen et al. 1985; DiMauro and Maffioletti 1996; Ho et al. 2002; Hogarth and Kunreuther 1985; Kahn and Sarin 1988). Keren and Gerritsen (1999) elicited Dutch university

<sup>3</sup> Note that 8 (20%) of the 41 subjects with extreme risk aversion that we excluded were ambiguity seeking, while the remaining subjects were ambiguity neutral or averse. This is similar to the distribution for the unconstrained subjects in table 2.

students' willingness to pay for the risky and the ambiguous Ellsberg two-color urn. They found clear ambiguity aversion, and almost none of the subjects were willing to pay more for the ambiguous option.<sup>4</sup>

### 3. Experiment Results: Effects of Demographic Variables

Before the experiment was conducted, the Ethiopian participants were interviewed on a number of socioeconomic background variables beyond the normally observed age and gender for student samples. The descriptive statistics are summarized in table 3.

We regressed the risk and ambiguity attitudes on this set of explanatory variables. For risk attitude, we avoided dependence on expected utility assumptions by using the pure certainty multiplied by  $-1$  as an index of risk aversion. In the regressions, we controlled for censoring of our measures because a sizable fraction of participants revealed the lowest possible certainty equivalent. Thus, we used a Tobit model for our analysis of risk attitude. We also tested whether socioeconomic variables explain the presence of extreme risk attitudes by including a Probit regression for dummy variable that assumes the value of 1 if the certainty equivalent is censored at 1, and 0 otherwise. For ambiguity attitude, we applied OLS regressions for the measure described in section 2.1 because there is no censoring of ambiguity attitude. Regression results are shown in table 4. Positive parameter values in the regressions imply increasing risk or ambiguity aversion, or increasing likelihood to show extreme level of risk aversion respectively. Marginal effects are reported for the probit regression.

The regression results show that poor health is related both to stronger risk aversion and stronger ambiguity aversion. In particular, for risk, the subjects with poor health status demonstrated extreme risk aversion. Apart from health effects, we found that household size increased risk aversion, while being married reduced ambiguity aversion. No other socioeconomic variables had an influence on uncertainty attitudes in our data.

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<sup>4</sup> Trautmann et al. (2008b) illustrated this strong effect of willingness to pay (WTP) elicitation on ambiguity attitudes and provided a model that suggests that WTP overestimates ambiguity aversion.

**Table 3. Socioeconomic Background Variables for the Ethiopian Sample (n=92)**

	Mean	Min.	Max.
<b>Personal</b>			
Age in years	43	22	80
Female	51%	0	1
Poor health (yes = 1)	28%	0	1
<b>Family</b>			
Married (yes = 1)	81%	0	1
Household size (not including respondent)	4.59	0	11
Number of dependent children	2.58	0	6
<b>Economic</b>			
Land size (in timads; 1 hectare $\approx$ 4 timads)	1.84	1	4
Monthly consumption per household (ETB)	578	50	3000

To control for the possibility of nonlinear effects of the economic variables land and consumption, we plotted uncertainty attitudes against these variables. If anything, for risk aversion, these plots suggested a U-shaped relation for land size and a logarithmic shape for consumption. We included the nonlinear transformations in another set of regressions. The nonlinear effects were not significant and did not affect the above shown results.

**Table 4. Regression Analysis for Risk and Ambiguity Aversion for the Ethiopian Sample**

Explanatory variable	Dependent variable	Risk aversion (Tobit)	Extreme risk aversion (Probit)	Ambiguity aversion (OLS)
Age		-.562 (.573)	-.045 (.031)	-.03 (.026)
Age squared		.004 (.006)	.001 (.001)	.0002 (.0002)
Female		-2.941 (2.557)	-.089 (.142)	-.129 (.146)
Poor Health		5.265* (2.822)	.344** (.133)	.339** (.154)
Married		-3.887 (3.43)	-.174 (.183)	-.433** (.167)
Household size		1.574* (.836)	.102** (.044)	.045 (.062)
# dependent children		-.886 (1.006)	-.029 (.053)	.029 (.045)
Land size		-.192 (1.203)	-.007 (.069)	.092 (.073)
Consumption		.0001 (.002)	.0001 (.0001)	.0001 (.0001)
# observations		84	84	45

#### 4. Cross-Sample Comparison

There has been much interest in cross-cultural differences in attitudes towards uncertainty, and numerous studies have measured attitudes toward prospects with objectively known payoff distributions in developing countries and small scale societies (Binswanger 1980; Bohnet et al. 2008; Kuznar 2001; Yesuf and Bluffstone 2007; Henrich and McElreath 2002; Dillon and Scandizzo 1978; Elamin and Rogers 1992; Weber and Hsee 1998). Most of these studies found a similar degree of risk aversion in student samples from developed countries. Henrich and McElreath (2002) showed that there can be significant differences between

culturally diverse peasant societies, however.<sup>5</sup> These authors also suggested the importance of cross-cultural comparison of attitudes toward ambiguous prospects, when probabilities are unknown. In the real world, ambiguity is ubiquitous, and farmers' preferences between traditional uncertain technologies with well-known payoff distributions and new technologies and crops with unknown risks are relevant to innovation and development.

Our study of risk and ambiguity attitude experimentally in a sample of poor Ethiopian peasants used real incentives and concrete visual representations of prospects (differently colored balls in urns), without reference to probabilities. We compared the Ethiopian data to data from an experiment among Western university students using exactly the same decision task. Holding design features constant between groups is necessary to draw conclusions regarding cross cultural differences, especially when studying potentially volatile ambiguity attitudes (Bohnet et al. 2008; Kocher et al. 2008; Roth et al. 1991; Herrmann et al. 2008).

We found both risk aversion and ambiguity aversion for Ethiopian peasants. Risk aversion was stronger for the peasants than for the comparison student samples, and this effect was driven by extreme risk attitudes among the peasants. Comparing the distribution of risk attitudes with other findings from standard Western student populations shows, however, that this variation is well within the range of the variation expected across different experiments. In any case, the data support the view that strong risk aversion predominates among the farmers.

Ambiguity aversion did not differ between Ethiopian peasants and Dutch university students, and both groups show ambiguity aversion. Ambiguity attitudes in the samples considered in our study are also comparable to those reported in the literature for gains and choice elicitation. Contrasting our results with the results in the literature that use different framing (losses) or a different elicitation method (willingness to pay) showed that slight differences in the experimental design can strongly affect ambiguity attitudes. This illustrates the importance of keeping design features constant when comparing ambiguity attitudes across different participant populations. Otherwise the effects of the elicitation method may wrongly be interpreted as sample differences in attitudes, possibly leading to wrong policy.

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<sup>5</sup> Similarly, Bohnet et al. (2008) found evidence for social risk aversion (betrayal aversion) in the six countries in their study, but they also found clear differences in the strength of the aversion across these countries.

## 5. Effects of Socioeconomic Variables

The finding of relatively high risk aversion for Ethiopian peasants compared to Western university students suggests a possible link between poverty and risk aversion. The explanation is not supported by the analysis of socioeconomic background data, however. Neither land size (wealth) nor consumption (income) had any significant influence on risk attitudes. The absence of wealth effects on risk attitude is consistent with the results in Binswanger (1980), Henrich and McElreath (2002), and Booij and van de Kuilen (2006). Positive effects of wealth and income on risk tolerance have been found in Donkers et al. (2001) and Dohmen et al. (2005), however, and Barsky et al. (1997) found a U-shaped effect of wealth and income with first decreasing and then increasing risk tolerance. We tested for such U-shape relationship in our data set, but did not find evidence for it.

Unlike many studies, we found no gender effect for risk attitude (Borghans et al. 2009; Donkers et al. 2001; Schubert et al. 1999). There is a clear effect of health status, where subjects in poor health are more risk averse. In particular, subjects in poor health show extreme risk aversion and add to the observed differences with student samples. A similar effect was observed for household size, where subjects responsible for larger households were more risk averse.

There is little evidence yet on the effect of socioeconomic variables on ambiguity attitude. Regression analysis of our socioeconomic data shows that, similar to the effect on risk attitude, poor health increases ambiguity aversion. Marriage reduces ambiguity aversion in our sample. No other effects are found. Consistent with findings in Borghans et al. (2009), there is no clear gender effect for ambiguity.

## 6. Poor Health and Uncertainty Attitude

The lack of strong socioeconomic effects on risk and ambiguity attitudes is largely consistent with the literature. Our finding of a strong effect of health is interesting in this respect. Most direct measurements of attitudes toward uncertainty about monetary payoffs in the economics literature do not account for health states or use subject pools with little variation in health status. Viscusi and Evans (1990) estimated utility functions for income explicitly accounting for health state, using the state dependent utility framework proposed by Zeckhauser (1970). They found reduced marginal utility of income in poor health states, compared to full health. Our result for increased risk attitude under poor health can be explained within this framework by relatively flat utility functions under impaired health compared to good health.



Our finding for increased ambiguity aversion for poor health cannot easily be explained within this state dependent utility framework, however.

The result is also consistent with *temperance* (Eeckhoudt et al. 1995; Eeckhoudt and Schlesinger 2006): temperate decision makers dislike assuming more (independent) risks in situation in which they are already confronted with a risk. If poor health indicates situations of high health background risk, participants will be less willing to take an additional financial risk than in situations of low health risk, i.e., in good health. Again, the effects of poor health on ambiguity aversion do not simply follow from this framework either. The ambiguity effect would suggest that the precautionary motive of temperance becomes stronger in the case of risks for which the decision maker feels less competent.

Finally, note that the relatively high degree of risk aversion among the farmers, and especially the occurrence of extreme attitudes, might be driven by negative past experiences. Compared to decision makers in Western societies, poor outcomes resulting from risky decisions are arguably more severe for our Ethiopian small-scale farmers. A poor harvest after switching to a promising new crop that turned out unsuitable for the local soils can threaten the existence of the family, in particular for those household heads in poor health.

## 7. Conclusion

Attitudes toward uncertainty are important factors in the analysis of economic problems and policy in developing countries. Risk-sharing, crop selection, and precautionary saving influence welfare in risky agricultural environments and are influenced by economic actors' attitudes toward risk (Dercon 1996; Jalan and Ravallion 2001; Kochar 1999; Udry 1994). Henrich and McElreath (2002) argue that apart from risk attitude also ambiguity attitude, that is, preferences toward prospects with unknown payoff distributions, may be important to development. Adoption of new technology and crops which involve unknown risks may depend more on ambiguity than on pure risk attitude.

Ambiguity aversion has been widely observed among Western university student samples, and theoretical models of ambiguity aversion have been proposed as explanations for market phenomena in developed economies (e.g., Mukerji and Tallon 2001; Easley and O'Hara 2008; Viscusi and Magat 1992; Zeckhauser 2006). In contrast to most findings in the literature, Henrich and McElreath (2002) reported positive attitudes toward ambiguity in their experiments with Chilean Mapuche peasants. They also found strong risk seeking in prospects with known probabilities. We argue that diverse cultural factors drive uncertainty attitudes and that ambiguity

aversion might be specific to western student populations. In contrast, we found strong ambiguity and risk aversion in experimental decision tasks for our sample of Ethiopian peasants. Although consistent with the view that uncertainty attitudes depend on cultural factors, these results clearly show that ambiguity aversion is also observed in populations deviating on various dimensions from standard university student populations. This suggests that both risk and ambiguity attitude are important for economic decisions in poor agricultural societies, and that both attitudes should be considered in policies regarding the situation of the poor.

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## Appendixes

### ***Appendix A. Choice List Elicitation of Certainty Equivalents***

The choices were presented to the participants in increasing order of the sure amounts. In the example, the certainty equivalent is calculated as the midpoint between the largest sure amount for which the participant chooses to play the gamble, and the smallest sure amount for which the participants chooses to take the sure cash. That is, the certainty equivalent of the risky prospect is ETB 6.5:

**Table A1**

[1] Bet on a draw from white bag	<input checked="" type="radio"/> <input type="radio"/>	Receive ETB 1 for sure
[2] Bet on a draw from white bag	<input checked="" type="radio"/> <input type="radio"/>	Receive ETB 2 for sure
[3] Bet on a draw from white bag	<input checked="" type="radio"/> <input type="radio"/>	Receive ETB 3 for sure
[4] Bet on a draw from white bag	<input checked="" type="radio"/> <input type="radio"/>	Receive ETB 4 for sure
[5] Bet on a draw from white bag	<input checked="" type="radio"/> <input type="radio"/>	Receive ETB 5 for sure
[6] Bet on a draw from white bag	<input checked="" type="radio"/> <input type="radio"/>	Receive ETB 6 for sure
[7] Bet on a draw from white bag	<input type="radio"/> <input checked="" type="radio"/>	Receive ETB 7 for sure
[8] Bet on a draw from white bag	<input type="radio"/> <input checked="" type="radio"/>	Receive ETB 8 for sure
[9] Bet on a draw from white bag	<input type="radio"/> <input checked="" type="radio"/>	Receive ETB 9 for sure
...		
[19] Bet on a draw from white bag	<input type="radio"/> <input checked="" type="radio"/>	Receive ETB 19 for sure
[20] Bet on a draw from white bag	<input type="radio"/> <input checked="" type="radio"/>	Receive ETB 20 for sure

⊗ = choice made

Participants were presented one choice list for each prospect (risky and ambiguous). One of the choices was randomly selected for payment and played according to the participant's choice.



**Appendix B. Instructions for Ethiopian Participants**

Good morning (Good afternoon)! My name is \_\_\_\_\_. I am here to play a game with you. Before we begin, I will explain the rules of the game. This is an individual exercise, so please do not talk. Please hold your questions until I have finished the explanations. In this game, you can make money. You will get your money tomorrow from your teacher. How much money you make depends to large extent on your decisions. Therefore, it is important that you understand the rules of the game. Please listen carefully.

In the first part of the game, you can choose between drawing a ball from the black bag (*show the bag*) and have a chance to win 20 birr, or just receive a certain amount of money.

The drawing from the black bag will be conducted in the following way. We will fill the bag with 5 yellow and 5 white balls. (*Fill the bag with balls and count aloud.*) When it is my turn to draw a ball from the bag, I will draw one ball without looking. Before I draw a ball, I will pick a color—let us say white. If I pick a white ball from the bag, I will place a white ball on the desk. (*Put a white ball on the desk.*) If I draw a second white ball later, I will get 20 birr. If the ball is yellow, I will not get anything. (*Draw a ball and announce the color.*)

You will each get an answer sheet, which looks like the one on the wall. When you play the game, I would like you, for each choice, to decide if you would like to draw a ball from the black bag (*show the bag*) or if you just want a certain amount of money. Of all the choices you make, only one of them will be played for real. Which choice will be played for real will be randomly determined by rolling a dice. For example, I will decide if I prefer to draw a ball from the black bag (*show the bag*) and have the possibility to win 20 birr or receive 1 birr for sure. If I prefer to draw from the bag (rather than getting 1 birr for sure), then I check this box on the left (*point on the left box*); otherwise, I check this box on the right (*point at the right box*).

In next choice, I also decide if I would like to draw a ball from the black bag or get a certain amount of money for sure. But, this time I will receive 2 birr for sure. As you can see, the amount of birr increases in the right column (*point at the right column*). As long as I want to draw a ball from the black bag instead of getting a certain amount of money for sure, I check the left box (*point at the left box*). Assume that I prefer to draw a ball from the black bag, then I check here (*point at the left boxes in the second to last choice*). But, in the last choice, I will always check the right box (*point*) because it is better to get 20 birr for sure than draw a ball from the black bag which might give me 20 birr or might give me nothing.

Assume that I do not want to draw from the black bag at all, then in the first choice I choose to get the money for sure and continue with that for all choices (*point at the right*

*column*). But, most likely, I will begin by choosing to draw from the black bag until the choice situation comes when I prefer to choose the for sure amount (*show with a sweeping motion*). When I have chosen the for sure amount, then I continue with that choice for the rest of the choice situations. If I prefer 1 birr for sure in the first choice situation, rather than drawing a ball from the black bag, then it is clear that in next choice situation I will prefer 2 birr for sure over drawing a ball from the black bag.

Has everyone understood the rules of the game? (*Leave time for questions.*)

The second part of our game is similar to the first, but there is one important difference. The black bag is now replaced by the white bag (*show the bag*). Now you will decide if you would like to draw a ball from the white bag and have a chance to win 20 birr or if you would like to get a certain amount of money for sure.

The drawing from the white bag is conducted in the following way. We have filled the white bag with 10 white and yellow balls. However, how many of each color is secret. Before I draw a ball, I will pick a color, exactly as before, and put the ball with the selected color on the desk. When it is my turn to draw a ball from the bag, I will draw one ball without looking. The only thing that differs from the first part is that the black bag contains 5 white and 5 yellow balls (*show the bag*), while the white bag contains 10 balls, but the number of balls of each color is secret.

You will all get a second answer sheet, which looks like the poster on the wall. When you play the game, I would like you to decide, for each choice, if you want to draw a ball from the white bag or if you would like a certain amount of money for sure.

Have everyone understood the rules of the game? (*Leave time for questions.*)

Now I will explain how you will get your money. When everybody has made all their 20 choices (*point at all choices*), each of you will roll a 6-edged dice to decide whether the answer sheet with the black or white bag will be used. If the dice shows the numbers 1, 2, or 3, then the answer sheet with the black bag will be used. If the dice shows the numbers 4, 5, or 6, then the white bag will be used (*show the dice*). Then, you will roll a 20-edged dice to decide which of the 20 alternatives will be played (*show the dice*). The number shown will be the choice situation played for real.

First, I will throw the 6-edged dice (*throw the dice*). If I roll number 3, the answer sheet with the black bag is in play (*point at poster with a black bag*). Then, I will roll the 20-edged dice to decide which choice situation on the answer sheet will played for real (*throw the dice*). If

I roll number 5, the choice situation 5 in the black bag will be played for real (*point at poster with a black bag and at choice situation 5*). Now comes the most important part: if, in choice situation 5, I have chosen to draw from the black bag, then I must draw a ball from the black bag. If I guessed the correct color, I will win 20 birr, otherwise I will get nothing. Remember that the black bag contains 5 white and 5 yellow balls. If I have chosen to get a certain amount of money for sure, I will get 5 birr. If, for example, I roll number 5 when I roll the 6-edged dice, then the white bag is the valid one. If I then roll the 20-edged dice and get number 11, choice situation 11 will be played (*point at white bag and choice situation 11 on the poster*). If I then draw a ball with the same color as I have guessed, I win 20 birr; otherwise I will get nothing. Remember that the white bag contains 10 balls, but you do not know how many balls are white and yellow. If I have chosen to get a certain amount of money for sure, I will get 11 birr.

When you roll the two dice, you can get either of the 2 bags and any of the 20 choice situations. Therefore, you should carefully think about each choice: whether you would like to draw a ball from the bag or for sure get a certain amount of money.

Have everyone understood the rules of the game? (*Leave time for questions.*)