FONDATION POUR LES ÉTUDES ET RECHERCHES SUR LE DÉVELOPPEMENT INTERNATIONAL

Utility, Risk, and Demand for Incomplete Insurance

Craig McIntosh, University of California at San Diego,
ctmcintosh@ucsd.edu

Felix Povel, Kreditanstalt für Wiederaufbau (KfW), Frankfurt,
Felix.Povel@kfw.de

Elisabeth Sadoulet, University of California at Berkeley and Ferdi,
esadoulet@berkeley.edu

Abstract

Index-based weather insurance has had low effective demand in spite of attractiveness of the product in avoiding moral hazard in insurance claims. We use a set of field experiments to assess willingness to pay for index insurance among coffee producers in Guatemala. We show that the probabilistic nature of the insurance is the main reason that makes it unappealing. This is due to a secular dislike of the presence of uninsurable risk that manifests itself even when the actual probability of contract non-performance is minimal, and is consistent with the overweighting of small probabilities in Prospect Theory. This implies that increasing the demand for index insurance needs modifying the product to cover multiple risks. This can be done by more effective indexing and/or by indexing outcomes such as yield instead of indexing the determinants of yields.

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Introduction and Objective

Index insurance, in which payouts are based on a pre-defined index (such as local rainfall), can provide insurance without creating moral hazard. These products appear ideal in that they insure precisely the correlated shock that cannot be smoothed locally. Yet, almost universally these products have met with disappointing demand when introduced in the field (Cole et al., 2013; Carter et al., 2014). In explaining the puzzle of low adoption, the literature has focused primarily on the issues of 'basis risk' in the index (Barnett, Barrett, and Skees, 2008), and on the extent to which ambiguity or compound risk aversion may affect demand (Bryan, 2010; Elabed and Carter, 2015; Barham et al., 2014). In this paper we bring the lens of prospect theory to bear on index insurance demand, and demonstrate that the over-weighting of small probabilities (Tversky and Kahneman, 1992) leads to a decrease in the demand for index insurance in multi-peril environments that is an order of magnitude larger than can be explained by expected utility theory alone.

Our objective is to test two central theoretical propositions in the nature of demand for index insurance. First, that the over-weighting of small probabilities can explain the dramatic decrease in demand that is observed when insurance is probabilistic (may not pay out when a shock occurs) versus partial (may not fully pay out when losses occur). Secondly, an influential paper by Clarke (2011) has suggested that low demand for index insurance can be ascribed to the non-monotonicity of demand with respect to risk aversion in the face of basis risk. If it is possible for the worst state of nature to occur without a payout, then it is possible that insurance moves income from bad states to good states, and the most risk-averse will be most sensitive to this possibility.

Settings and Game Design

We proceed with a set of controlled lab-in-the-field experiments conducted with a very risk-exposed group: cooperative-based smallholder coffee farmers in Guatemala. Yield in the coffee sector is quite variable with excess rainfall and hurricanes posing the primary source of weather risk exposure. In early 2010 we conducted a census of every registered first-tier coffee cooperative in the country. For this exercise, we selected the 71 cooperatives that reported being vulnerable to excess rainfall risk, devised a set of games to understand the nature of index insurance demand, and invited 10 individual members to participate in a day of laboratory experiments.

Subjects in the study were presented with a sequence of scenarios, each featuring a carefully designed graphic illustrating the probability distributions of states of nature that included normal rainfall, heavy rainfall, excess rainfall, or drought. Experiments had quantities that were carefully calibrated based on information about average yields and typical losses from the baseline household survey. Examples are given in Figure 1 (see page 6). The states of nature are represented by columns, with little circles indicating the probability of occurrence. In the 'Risk' game in panel a, for example, normal rainfall occurs with probability 5/7, heavy rainfall with either no loss or Quetzales1,000 loss with probability 1/7, and excessive rainfall with losses of Q3,000, Q5,000, or Q7,000, each with probability 1/21. The 'Severe Drought' game of panel b features a risk of a severe drought entailing a loss of Q8,000 with probability 1/7. We analyze here seven similar "Risk" games in which the intensity and the variance of the excess rainfall losses vary, and six "Drought" games, with constant excess rainfall risk but varying probability and loss intensity from the drought.

All scenarios feature an excess rainfall index insurance product paying out a given amount in case of excess rainfall losses. Hence if the individual is insured, payment of premium (cuota) occurs in all states of nature, and the payout of Q1,400 occurs in states of excess rainfall. For each exercise subjects were asked to record their willingness to pay (WTP) for the product, with the actuarially fair price remaining fixed at 200 Quetzales ($31.73) across all games.

This insurance product is partial for two reasons. First, the rainfall index is imperfectly correlated with yields on farmers' plots, thus providing some risk that is covered by the insurance product and some that is not (often referred to as basis risk in this literature). Furthermore the payout is calibrated to cover average input cost and not losses. For each scenario we hold the basic attributes of the insurance itself constant (likelihood of payout, size of payout), and so all variation in the stated WTP across games arises from variation in the nature of the risk. The demands are incentivized by paying out experimental 'yields' that are 1/100th of the outcomes in in a randomly chosen group of scenarios.

Expected Utility and Demand for Partial Insurance

We begin by analyzing the set of "Risk" games. These games vary the probability and severity of losses while keeping the insurance product fixed, and hence provide a very simple environment in which to understand marginal utility: what is people's willingness to pay to transfer income from good states to bad ones as bad states become worse?

Average WTP are reported in Table 1 (see page 7). Column 1 shows that WTP increases as the severity of the shocks increases across games I1 to I3, indicating an overall risk aversion among all participants. WTP also increases as the variance in losses increases across games I4 to I7, suggesting the presence of an overall prudence in preference (i.e., with third derivative of utility positive). Hence the behavior of participants in the risk games is consistent with risk aversion and prudence under expected utility theory.

We then proceed to use the stated WTP in the seven Risk games to estimate a fairly flexible utility function for each participant. Using these estimated parameters we can compute for each individual predicted utility and all of its derivatives at any level of income. Among all participants 76% exhibit prudence and 10% have an almost quadratic utility function. Furthermore we can compute for any risk scenario the predicted WTP, which is what the player ought to be willing to pay for the insurance under an expected utility behavioral model with the preference expressed in the risk games and the risk profile of the scenario. The predicted WTP is thus a sufficient statistic that summarizes risk and preference. Table 1, column 2 reports the average of these predicted values. For the risk games, they are as expected close to the observed average WTP since these were used to estimate the model.

Demand for Probabilistic Insurance

With these explicit utility functions in hand, we now proceed to the analysis of WTP for probabilistic insurance, where a large behavioral literature has suggested that the possibility of contract non-performance has a larger effect on dampening the level of demand that we would expect. It is difficult to validate these statements without a precise measure of what the WTP 'should' be if agents were standard expected utility maximizers. With a WTP predicted off of individually estimated utility curves, we have a straightforward solution to this problem. The estimated demand is a dollar-value WTP under expected utility theory, and the difference between this amount and the observed WTP provides a monetary estimate of the extent to which decreases in demand for probabilistic insurance are driven by behavioral concerns.

While the index insurance literature has typically referred to all variation in income that is not covered by the index as 'basis risk', there are sharply contrasting theoretical predictions surrounding increases in uncovered risk in insured states versus risk in uninsured states. As the severity of shocks in insured states increases (holding the payout constant), expected utility theory predicts that insurance will become more valuable because its expected marginal utility in the insured states rises. Thus, while the insurance product appears worse in the sense that it covers a smaller fraction of the risk, it should in fact yield a higher WTP. In contrast, when the risk is uninsurable, the demand for insurance decreases with the severity of the risk, as the marginal utility cost of paying the premium increases. This is best seen in Figure 2, (see page 6) which shows predicted WTP as a function of the residual risk. The predicted WTP increases as residual risk increases in Risk games (I1 to I7), while it decreases with residual risk in Drought games (I8 to I13). The dotted lines show non-parametric smooth relationships.

Looking now at actual WTP observed across the drought games. While the signs of the responses are consistent, the magnitudes display quite a distinct pattern. Actual WTP proves to be very sensitive to small amounts of drought risk (games I8, I9, I11, and I12) and then to display little additional sensitivity to the magnitude or likelihood of risk posed by the most severe droughts (I10 and I13). This indicates that there is a secular dislike of probabilistic insurance that manifests itself even when the actual probability of contract non-performance is minimal.

The clear story emerging from these two ways of analyzing the data is that there is a response to small probabilistic risk that cannot be squared with our expected utility predictions, and if anything the surprise in the response to very large probabilistic risk is that the actual WTP displays less of a decrease than we might expect. Hence, we can conclude very clearly that there is a behavioral puzzle in demand that decreases as the probabilistic nature of the insurance is magnified.

Looking at heterogeneity across producers, we find that the risk averse, for whom insurance is more important overall, are less likely to show large drops in demand as a result of the small drought risk. Similarly, those with a high trust index are less put off by the presence of drought risk and maintain demand. The ambiguity averse, on the other hand show much larger drops in demand when faced with the possibility of mild drought. This latter fact is particularly relevant in that it suggests that the simple survey question eliciting ambiguity aversion does indeed capture meaningful information in predicting economically relevant parameters. On the other hand we find no evidence at all that actual risk exposure of the farmers explain the over-reaction to small drought risks. Consequently, our results show very clearly that this over-response to small risks is driven by the behavioral attributes of the decision-maker and is not driven by the actual exposure to risk.

Risk Aversion and Demand for Insurance Against Severe Risk

We now focus on the response to the 'worst state' drought risk, because the literature on demand for index insurance has paid particular attention to this specific type of contract non-performance as a candidate explanation for low demand. As shown by Clarke (2011), the possibility of the worst state being uninsured can introduce non-monotonicity into the relationship between risk aversion and insurance demand. The drop in WTP for insurance that features this worst possibility should be particularly pronounced among those with high risk aversion. Similarly, the Maximin Expected Utility framework used by Gilboa and Schmeidler (1989) and Bryan (2010) evokes a pessimism in which decision makers fixate on the worst thing that could possibly happen in making insurance purchase decisions, another context in which the effect of these extreme tail risks would be accentuated.

To investigate this, we use data from all the drought games and the risk game with the same insurable risk but no drought, distinguishing among the drought games between the severe drought where the drought loss is worse than the rainfall loss and mild drought for the other cases. We interact dummies for mild drought and severe drought with the measure of risk aversion to study the extent to which WTP drops differentially with the risk of severe drought for the most risk averse.

Consistent with the argument in Clarke (2011), we show that while mild drought risk leads to differentially higher predicted WTP among the more risk averse, this relationship flips over and the 'worst possible' severe drought leads to a substantial and negative differential effect. In sharp contrast to this, the patterns of actual WTP are reversed: WTP in the most risk-exposed uninsured scenarios is highest for the most risk averse, even though the premium must be paid in this state. Thus the non-monotonicity in demand over risk aversion as the severity of probabilistic risk increases is not observed in actual WTP.

In conclusion, while the overall aversion to insurance featuring large probabilistic risk is largely in line with expected utility theory, the mechanism of high risk aversion leading to large drops in WTP does not appear to be the operative one.

Conclusion

Our results have isolated several reasons for the low demand that index insurance products have met in the developing world. Index insurance will struggle to generate demand in environments with multiple risks. Our results indicate that the probabilistic nature of index insurance is the dominant factor making it unattractive, and this is driven both by expected utility issues as well as by behavioral factors. This study therefore reinforces the need to push agricultural insurance products to cover multi-peril risks, as can be achieved with more sophisticated indexes, or to find ways of going directly towards insuring yield.

References

- **Barham, B. L.**, **J.-P. Chavas**, **D. Fitz**, **V. Ríos Salas**, and **L. Schechter**. 2014. "The roles of risk and ambiguity in technology adoption." *Journal of Economic Behavior & Organization* 97:204–218.
- **Barnett, B. J.**, **C. B. Barrett**, and **J. R. Skees**. 2008. "Poverty traps and index-based risk transfer products." *World Development* 36 (10):1766–1785.
- **Bryan, G.** 2010. "Ambiguity and insurance." Unpublished manuscript.
- **Carter, M.**, **A. de Janvry**, **E. Sadoulet**, and **A. Sarris**. 2014. "Index-based weather insurance for developing countries: A review of evidence and a set of propositions for up-scaling." *FERDI Working Paper* P112. http://www.ferdi.fr/en/publication/p112-index-based-weather-insurance-developing-countries.
- **Clarke, D. J.** 2011. "A theory of rational demand for index insurance." Department of Economics, University of Oxford. Working paper.
- **Cole, S.**, **X. Giné**, **J.Tobacman**, **R. Townsend**, **P. Topalova**, and **J. Vickery**. 2013. "Barriers to Household Risk Management: Evidence from India." *American Economic Journal: Applied Economics* 5 (1):104–35.
- **Elabed, G.** and **M. R. Carter**. 2015. "Compound-risk aversion, ambiguity and the willingness to pay for microinsurance." forthcoming *Journal of Economic Behavior & Organization*.
- **Gilboa, I.** and **D. Schmeidler**. 1989. "Maxmin Expected Utility with Non-unique Prior." *Journal of Mathematical Economics* 18 (2):141–153.
- **Tversky, A.** and **D. Kahneman**. 1992. "Advances in prospect theory: Cumulative representation of uncertainty." *Journal of Risk and Uncertainty* 5 (4):297–323.

Figure 1: Examples of Representations Used in Games

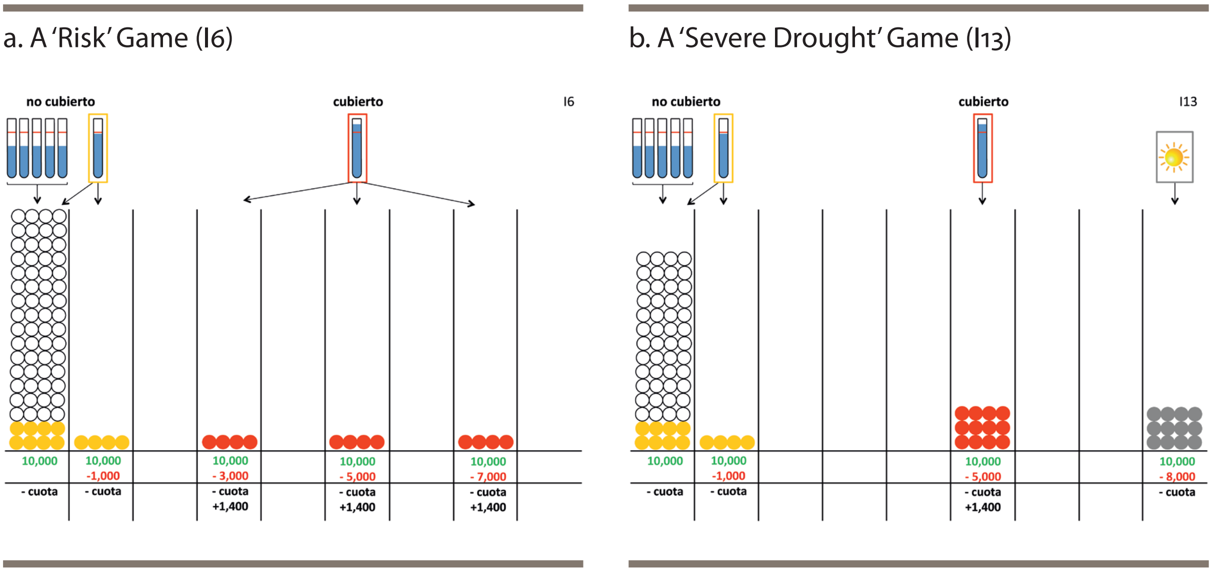

Figure 2: Actual versus Predicted WTP in Risk and Drought Games

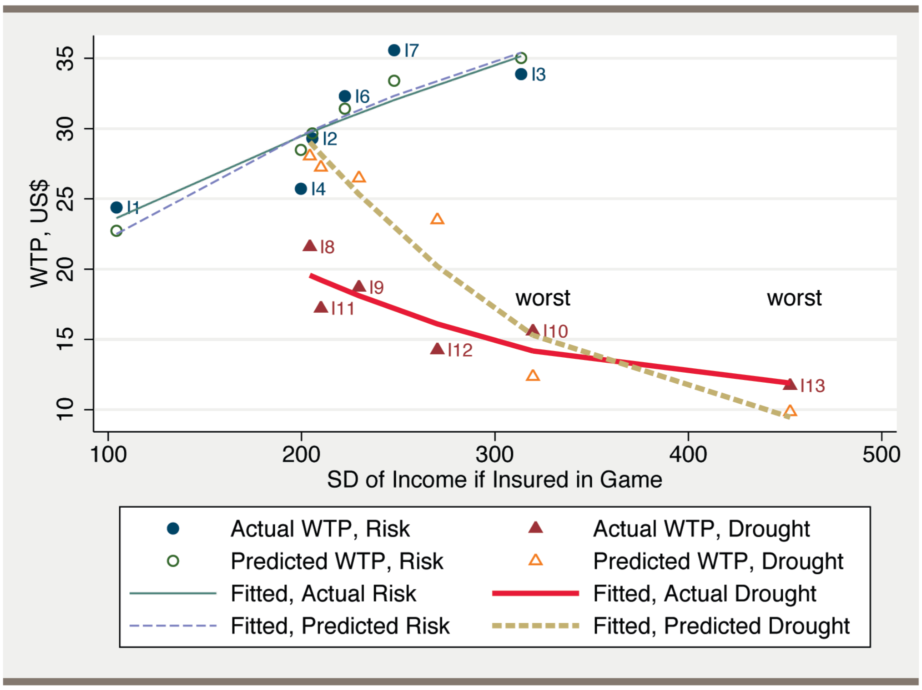

Table 1: Actual and Predicted WTP in Risk and Drought Games

Game	Description	Actual Willingness to Pay (1)	Predicted EU Willingness to Pay (2)
Panel A: Variation in Insured Risk			
I1	Risk, small shock	24.38	22.73
I2	Risk, med shock	29.51	29.92
I3	Risk, large shock	33.87	35.02
I4	Risk, base (no variability)	25.72	28.49
I5	Risk, some variability	29.10	29.41
I6	Risk, med variability	32.31	31.42
I7	Risk, large variability	35.58	33.40
Panel B: Variation in Uninsured Risk			
I4	No drought	25.72	28.49
I8	Drought, rare & small	21.59	28.05
I9	Drought, rare & med	18.71	26.48
I10	Drought, rare & worst	15.58	12.36
I11	Drought, freq & small	17.22	27.24
I12	Drought, freq & med	14.26	23.50
I13	Drought, freq & worst	11.72	9.86

All figures are in US Dollars.

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Contact
www.ferdi.fr
contact@ferdi.fr
+33 (0)4 73 17 75 30

n° ISSN : 2275-5055

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