Utility, Risk, and Demand for Incomplete Insurance: Lab Experiments with Guatemalan Coffee producers

Elisabeth Sadoulet
(with Craig McIntosh and Felix Povel)

FERDI
June 4-5, 2015

OBJECTIVE

- Very large number of projects piloting index insurance in developing world:

  Gine (Malawi, India), Karlan/Udry (Ghana), Carter (Mali/Burkina/Peru), Barrett (Kenya), Hill/Dercon, McIntosh (Ethiopia), Skees (Mongolia), Cai (China) etc.

  Index insurance = insurance with payout triggered by an observed indicator of rainfall, temperature, etc., as opposed to a loss adjustment insurance where payout triggered by observed damage.

- From a Townsend perspective these products seem ideal (Berhane, Clarke, Dercon, Vargas Hill, Taffesse)

  - Little or no MH since indexes built on weather, rainfall, NDVI, etc.
  - Complementary to mutual arrangements, as it insures correlated risk that communities can't cross-insure

- However: with few exceptions demand has been low, products unable to get off the ground without years of large (or complete) subsidies.

- Arguments usually given in the context of index insurance:

  Basis risk associated with the index,

  Ambiguity aversion associated with unknown distribution of payout/outcome (Bryan, Elabed & Carter)

  Very large reaction to the risk of contract failure for very bad shocks, especially by most risk averse (Dercon, Gunning, Zeitlin; Clarke)

- We will see that demand for insurance dramatically decreases in response to **small uninsured risk**, with an order of magnitude larger than cannot be explained by expected utility theory. This conforms with **prospect theory**.

Incomplete insurance:

- Partial insurance

Payout < Loss in states of nature covered by insurance

* Typical of "input" insurance, or insurance with deductible.
* Index insurance, where payout related to weather index not own loss

Demand increases with exposure to risk and with risk aversion
Conforms with standard EU model (Wakker, Thaler, Tversky, 1997).

- Probabilistic insurance

In a world of multiple source of risk, i.e., states of nature with loss that are not insured

* Risk of default from the insurance company
* Insurance for specific risk in multi-peril context ("excess rainfall", but not drought or pest)

In EU theory, the impact on the demand for the insurable risk depends on the correlation between the two risks. In general increases (decreases) if risks are positively (negatively) correlated.

Conforms with Prospect Theory (Kahneman and Tversky, 1979; Wakker et al. 1997), with over-weighting of small probabilities

- **Worst state of nature is not among the insured states**

Particular case of insurance with default risk by Doherty & Schlesinger (1990). Shows complex relationship to risk aversion. Clarke (2011) suggests a U-shaped relationship between risk aversion and demand for insurance, if worst case is sufficiently severe.

Reduces dramatically demand for insurance, but not differentially more for more risk averse people, not as in EU model

APPROACH : Experimental games in the field to test some of the ideas.

- Lab Experiment with coffee producers in Guatemala. 662 players
- Elicitation of Willingness-To-Pay (WTP) for an insurance, for a series of scenarios in which risk and rules for payout distribution are fully specified

Risk scenarios designed to mimic situation faced by coffee producers offered a partial insurance (covering input cost) against one type of risk (excess rainfall) in presence of multiple source of risk (drought).

Use some simple scenarios to estimate a utility function for each and every participant.
Then consider other scenarios with uninsured source of risk.

Having estimated the utility functions allows disentangling the stated demand into:

- what is "pure economic" behavior, i.e., demand for the insurance given the risk that is covered by the insurance and that which remains uncovered in an expected utility framework.

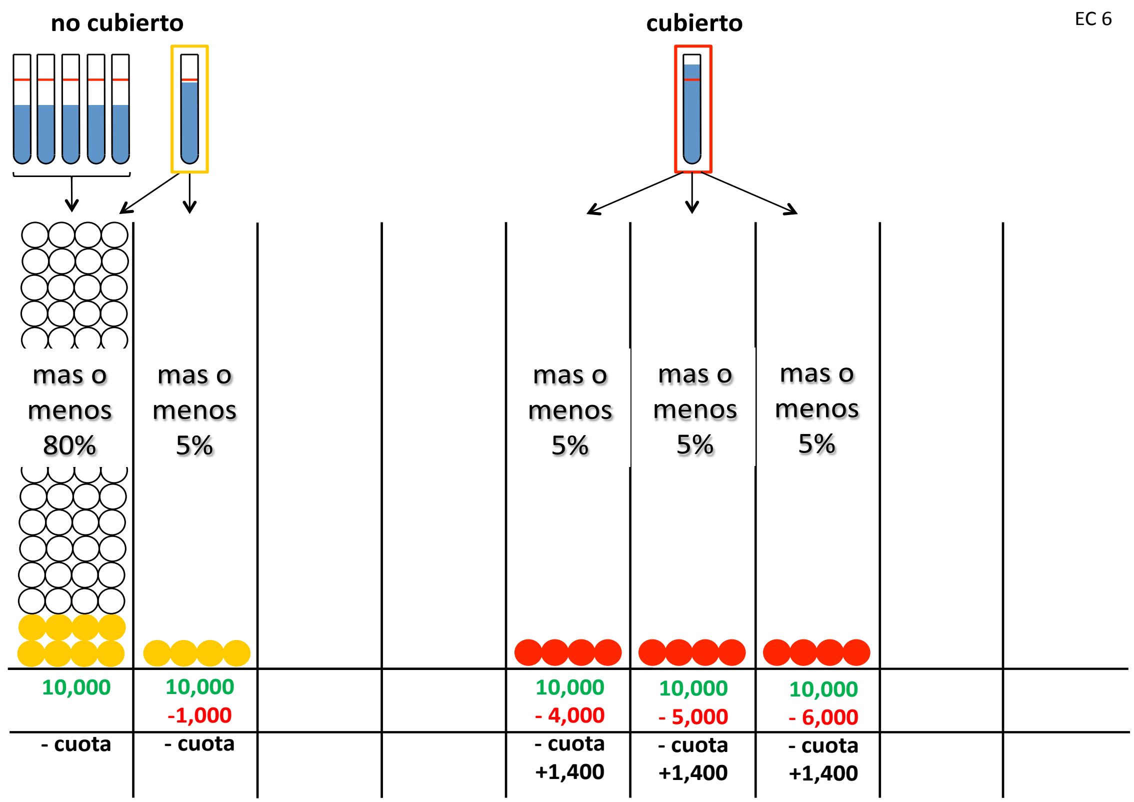
- what is more "behavioral economics", imperfect information, over-estimation of low probability events, trust, etc.

Lab experiment set-up – Mimicking an excess rainfall insurance

- Climate: 5 good years, 1 year with heavy rainfall, 1 year with excess rainfall
- Income in normal years: Q 10,000 ($1,600)
- Game losses: Q 0 with normal rainfall, possibly Q 1,000 with heavy rainfall, Q 2,000-8,000 with excess rainfall
- Payout when excess rainfall only: Q 1,400, whatever the loss

Payout<loss
Payout independent of loss
Uninsured states (1,000 in example)

(12 circles per year)



- We do not play insurance games (with random drawing of rainfall and loss), except twice to learn and once at the end to compute payments.
- Respondents record their WTP on a sheet for each scenario presented to them:

Fila:	Precio más alto	Quetzales:															Precio más alto
I4		80	100	120	140	160	180	200	220	240	260	280	300	320	340	360	

(Actuarially fair price is Q 200)

- Games are incentivized by payment for the day proportional to the outcome of one of the games being played at the end (Q 10000 in game = Q 70; participants receive Q 10 for attendance)

- 13 individual games + 4 validation games

- Randomization (16 cells: two price brackets x 8 different orders of experiments per bracket)

FOUR RESULTS

1. Expected Utility and Demand for Partial Insurance

Risk games: 7 scenarios with 3 excess rainfall states with loss

R - s, R, R+s

and payout C constant and <R

Increasing R keeping s constant; increasing s keeping R constant

Strong demand, and evidence of risk aversion and prudence (3rd derivative of u positive, i.e., stronger curvature of u at lower income)

Panel A: Variation in Insured Risk		WTP (in $)
I1	Risk, small shock	24.38
I2	Risk, med shock	29.51
I3	Risk, large shock	33.87
I4	Risk, base (no variability)	25.72
I5	Risk, some variability	29.10
I6	Risk, med variability	32.31
I7	Risk, large variability	35.58

Fair price **$32**

Increasing WTP from I1 to I3 → Risk aversion
Increasing WTP from I4 to I7 →Prudence

2. Estimation of Individual Utility Functions from Observed WTP

Preferences are characterized by the following utility function:

$$u(y; k, \beta) = -\frac{1}{k} e^{-k \frac{y^{1-\beta}}{1-\beta}}$$

Each risk experiment g characterized by: p_x^g probability of state x and C_x^g payout if insured

Expected utilities without and with insurance are:

$$\begin{aligned} EU_0^g(k, \beta) &= \sum_x p_x^g u(x; k, \beta) \\ EU_I^g(k, \beta, \delta) &= \sum_{x=2}^{10} p_x^g u(x - wtp + \delta C_x^g; k, \beta) \end{aligned}$$

where *wtp* is the premium for the insurance and δ ∈ [0,1] is a trust parameter that the agent places on the insurance payout.

The willingness to pay for the insurance is defined by:

$$wtp(g, \theta) = (wtp : EU_I^g - EU_0^g = 0) \qquad \text{where } \theta = (k, \beta, \delta)$$

We use the observed wtp_g of the first seven games, and assume some additive errors on the willingness to pay:

$$wtp_g = wtp(g, \theta) + \epsilon_g \qquad g = 1, \ldots, 7$$

For each individual *i* we use a non-linear least square estimator

$$\widehat{\theta}_i = \arg\min_{\theta \in \Theta} \sum_{g=1}^{G} \left(wtp_g - wtp(g, \theta)\right)^2$$

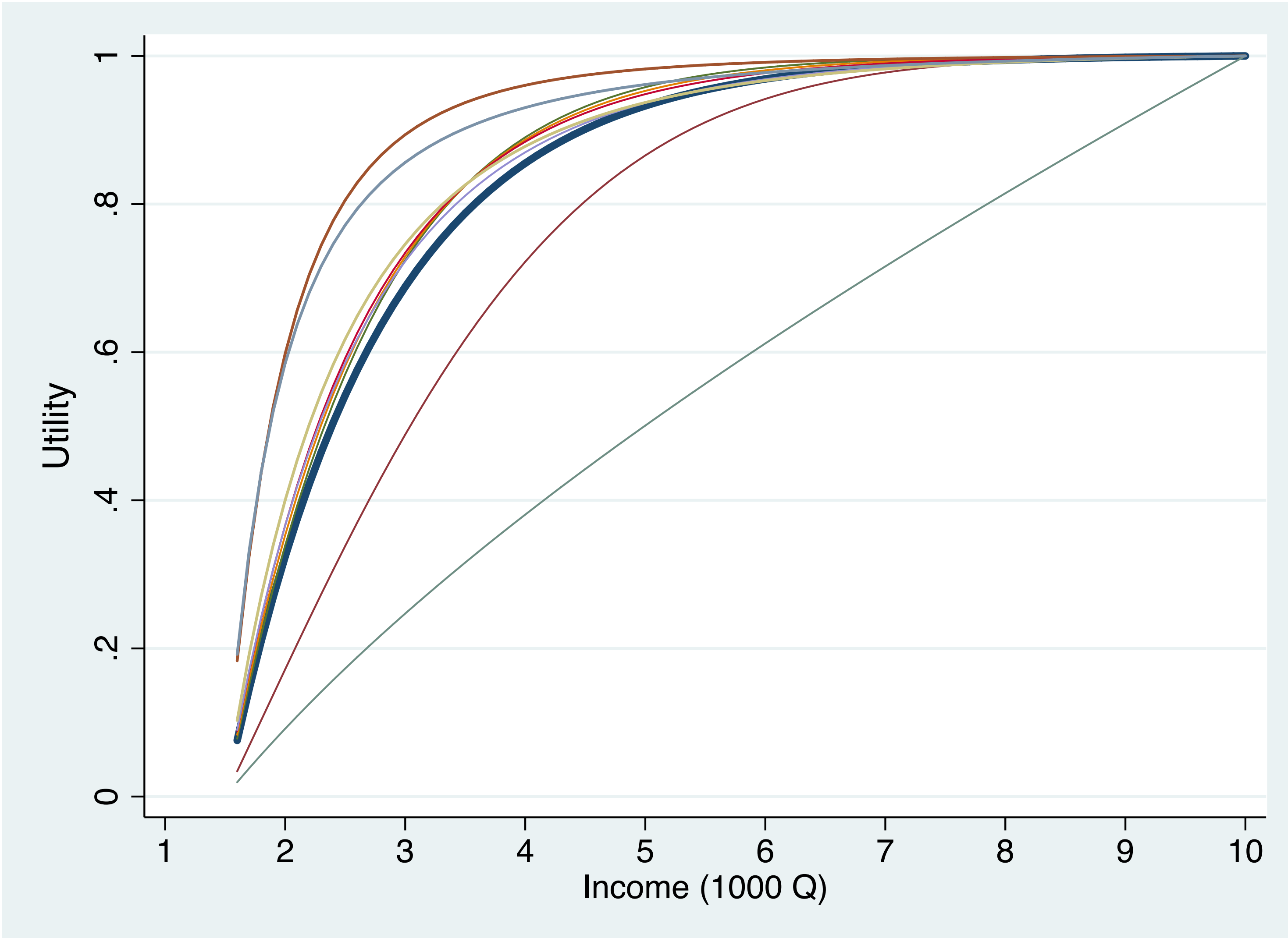
Difficult task because $wtp(g, \theta)$ is only defined implicitly, but ... feasible.

For each individual with parameter $\hat{\theta}$, we can compute:

- Any characteristic of the utility function, notably Risk Aversion.

- $\widehat{wtp_{g'}}$, that the player ought to have for any game g'.

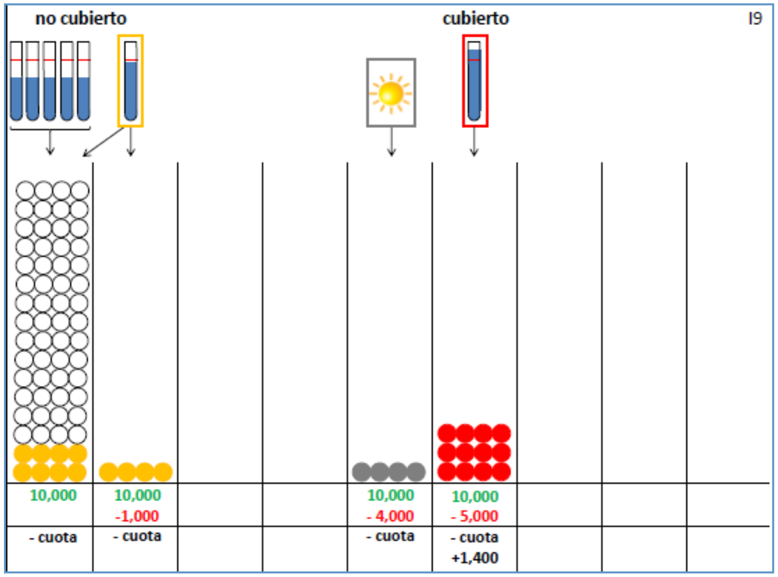
  Interesting in its own right
  Sufficient statistic for the economic benefit of the insurance given the "preference" of the individual and the riskiness of the environment



Very high risk aversion, although with large variation across individuals

3. Demand for Probabilistic Insurance

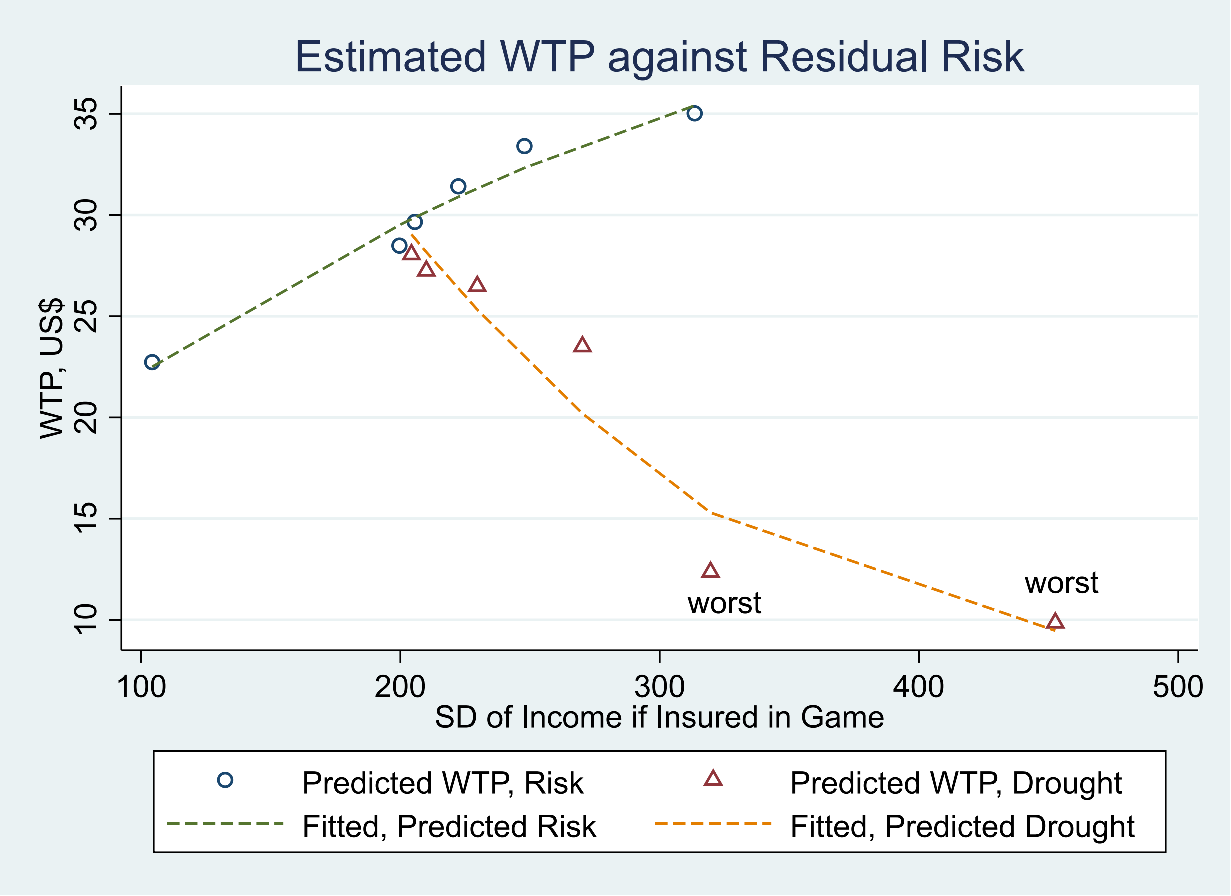
Add 6 scenarios with an uninsurable risk (drought) with varying probability and varying severity



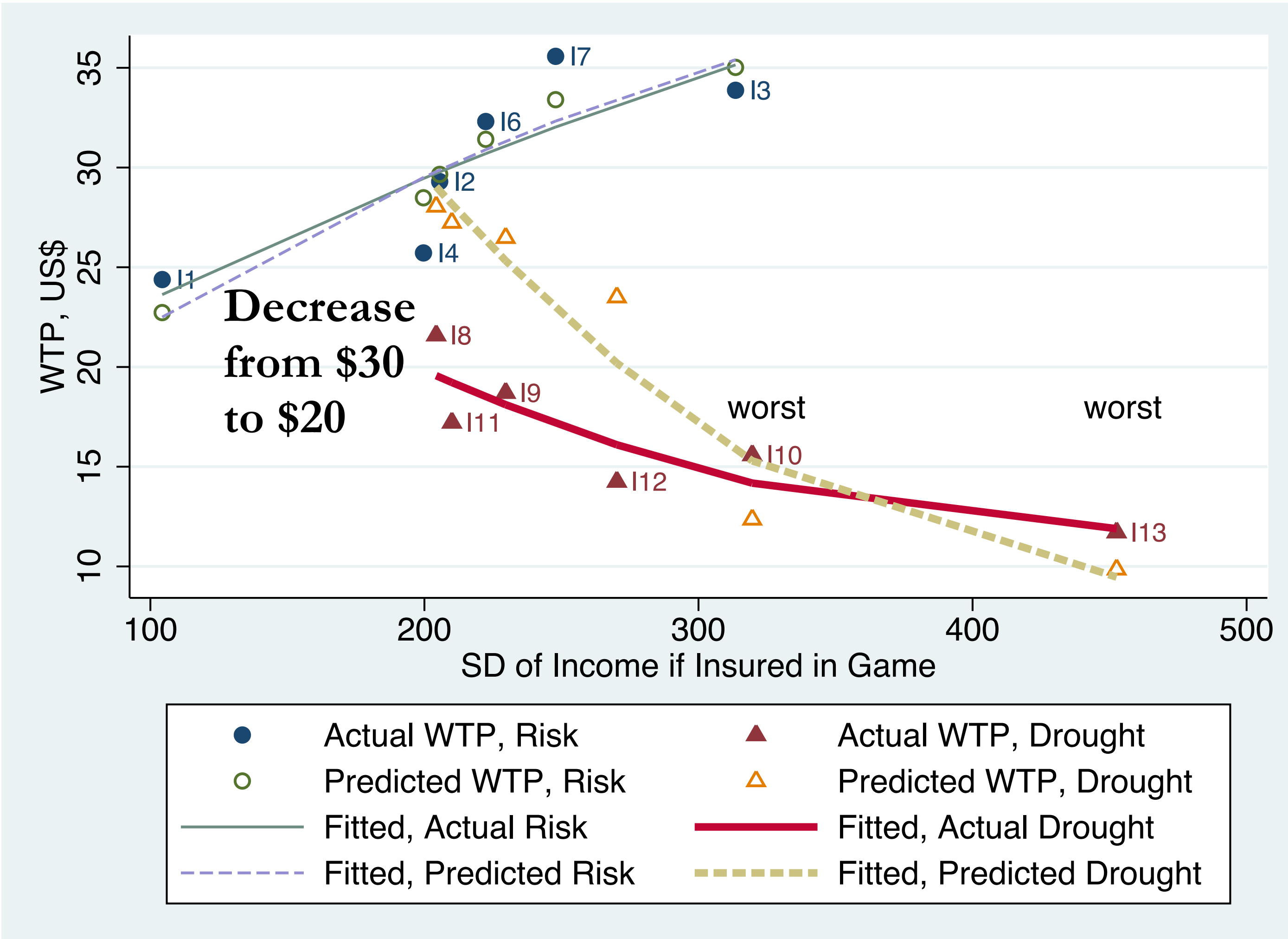
Comparing the demand for probabilistic and partial insurance

Using the estimated U, predict WTP

- If losses increase in states of nature where the insurance pays (Partial rainfall insurance), predicted WTP increases – Games I1-I7
- If losses increase in states of nature where the insurance does not pay (drought), predicted WTP decreases – Games I8-I13. The decline is extremely steep for the games where the worst case is uninsured



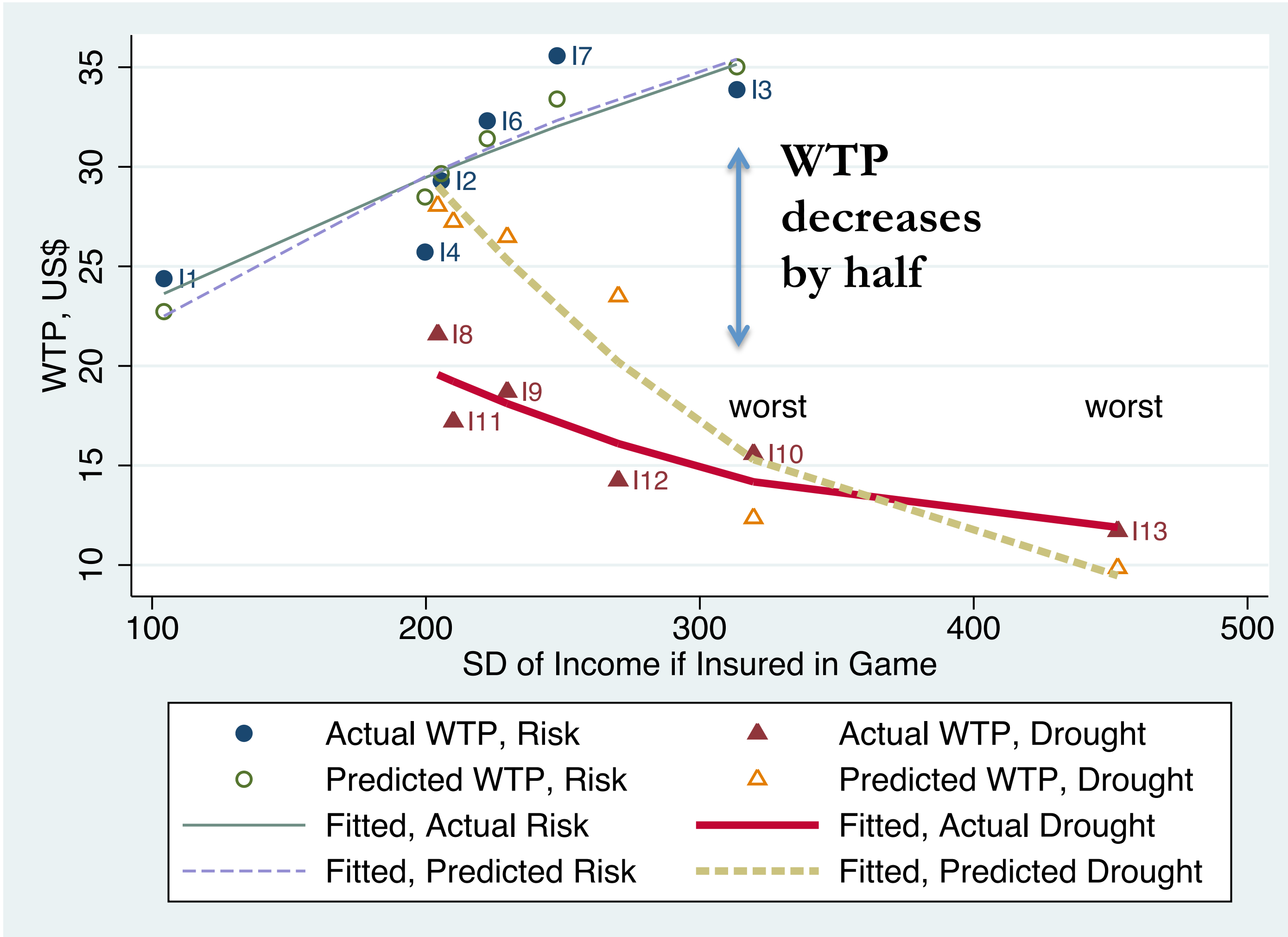
- Actual similar to Predicted in Games I1-I7 (used for the estimation)
- **Very large over-reaction to the mild risk of drought** (I8, I9, I11, I12), **conforming with prospect theory**



“PROSPECT BEHAVIOR” (over-reaction to small uninsured risk) associated with higher ambiguity aversion, lower trust, and lower risk aversion, not with exposure to risk

	Mean value of (Predicted WTP - Actual WTP) in USD	
	(2)	(3)
Behavioral characteristics		
Risk Aversion	-0.88***	-0.81**
	(0.34)	(0.35)
Ambiguity Aversion	0.83***	0.85***
	(0.32)	(0.32)
Trust Index	-1.00***	-0.95***
	(0.31)	(0.32)
Perceived Risk Exposure		(Some risk)
Excess Rainfall		-0.10
		(1.15)
Drought		-0.04
		(0.89)
Strong Wind		1.52*
		(0.79)
Disease		-0.94
		(0.71)
Constant	11.65***	11.50***
	(2.47)	(2.68)

4. Reaction to the possibility of worst-case scenario



- Reduction not larger than predicted from preference and risk

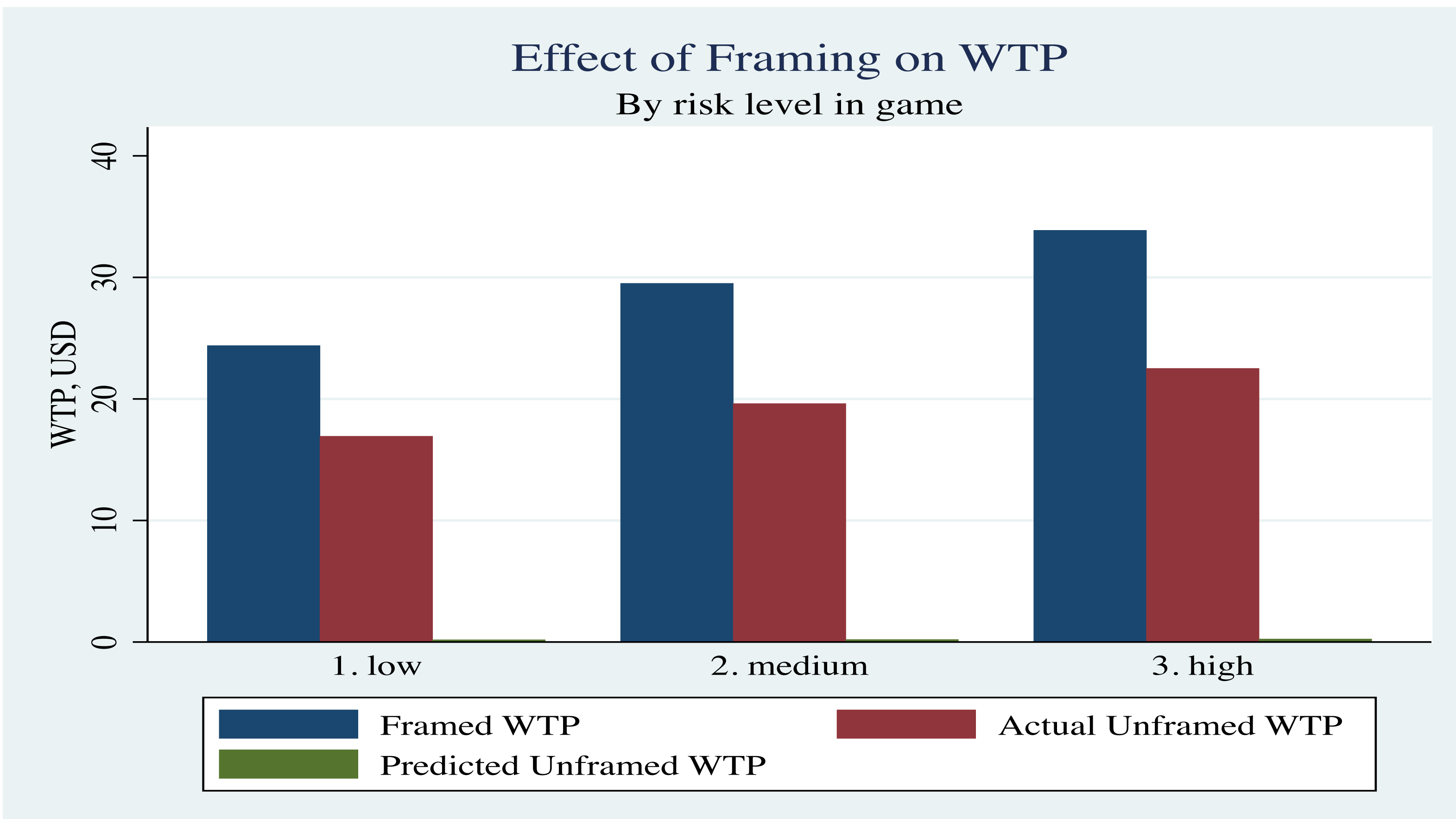
- Demand <u>increases</u> with risk aversion

Dependent Variable: Willingness to Pay, US$	Predicted WTP	Actual WTP
	(1)	(2)
Risk aversion * Mild Drought	0.15*	0.33
	(0.10)	(0.54)
Risk aversion * Severe Drought	-6.83***	0.7
	(0.93)	(0.61)
Risk Aversion	0.99	1.73**
	(0.67)	(0.70)
Mild Drought	-3.01***	-9.69***
	(0.58)	(3.20)
Severe Drought	21.95***	-16.12***
	(5.46)	(3.61)
Constant	22.80***	15.75***
	(3.90)	(3.85)

Can we learn about insurance demand from lab experiments?

Full day of experiments framed around insurance and (large) losses.
At one point in the day we play a round of games unframed, meaning we discuss the actual (small) winnings that are at risk.

Conclusion: both mean WTP and the marginal effect of risk are strongly affected by the framing; consistent with the idea that players are responding to narrative of large downside risk.



CONCLUSION

1. There is a strong demand for **partial** risk insurance. It increases with risk exposure and with risk aversion.

2. There is a weak demand for **probabilistic** insurance: the presence of a negatively correlated other source of risk reduces the demand for insurance

With a very strong overly negative reaction to small risk (by 30%)

Particularly by ambiguity averse, less risk averse, and people with lower level of trust,

3. The possibility that the worst possible state occurs without a payout is a major drag on demand (reduction by 50%). This is of the order of magnitude predicted by EU, but it does not affect risk averse more than the others

Recommendations:

Partial coverage and index feature are fine, but insurance should be multi-peril.