Behavioral Economics & the Design of Agricultural Index Insurance in Developing Countries

Michael R Carter

Department of Agricultural & Resource Economics
BASIS Assets & Market Access Research Program &
I_4 Index Insurance Innovation Initiative
University of California, Davis
http://basis.ucdavis.edu

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2014 BASIS Technical Committee

November 7, 2014

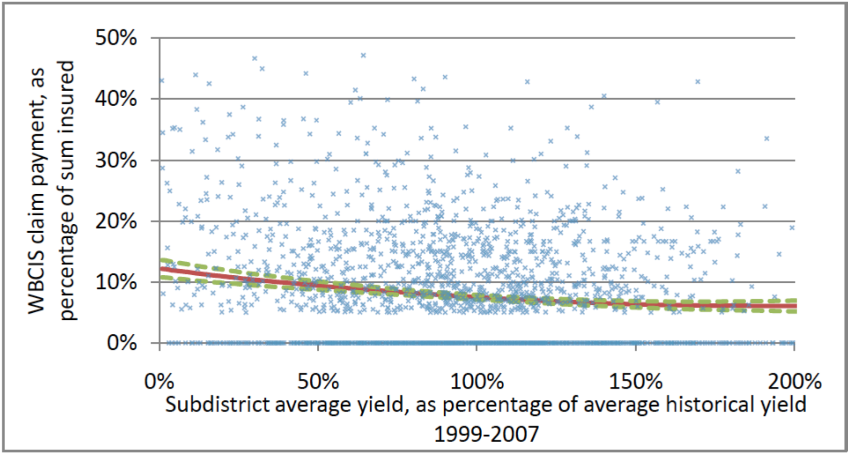
Behavioral Wake-up Call

- Behavioral lab experiments have uncovered a wealth of evidence that people do not approach risk in accord with economics' workhorse theory of "expected utility"
- For example, found that demand tripled with 'simple' contract reformulation in Peru that should not have mattered from a standard expected utility perspective
    - Contract reformulated as a lump sum contract focussed on capital protection rather than income protection
    - Seemingly consistent with insights from behavioral economics (cumulative prospect theory) (see work of Jean Paul Petraud)
- What other insights from behavioral economics may help us understand design of and demand for agricultural index insurance?

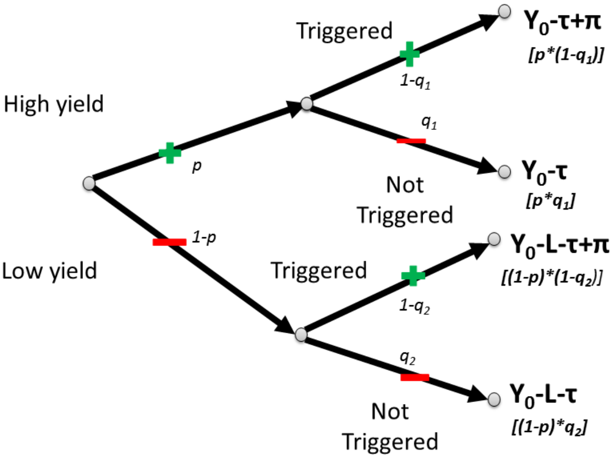
Outline

- Focus here on two areas
- Insights from the behavioral economics of compound risk (~ambiguity) aversion
  - Basis risk is big ... but,
  - Compound risk aversion makes it bigger
  - Measure ambiguity aversion & its impact on insurance demand in Mali
- Certain premium & uncertain payouts: Why this matters more than we think
  - Insights from work on discontinuous preferences (strong preference for certainty)
  - Preference for certainty & insurance demand in Burkina Faso
  - Impact of contract formulation on contract demand

Basis Risk is Big ...



- ... but its behavioral implications may be bigger
- To see this, let's consider index insurance from the farmer's perspective



High yield
Low yield
p
1-p
Triggered
Not Triggered
Triggered
Not Triggered
1-q1
q1
1-q2
q2
Y0-τ+π
[p*(1-q1)]
Y0-τ
[p*q1]
Y0-L-τ+π
[(1-p)*(1-q2)]
Y0-L-τ
[(1-p)*q2]

Index Insurance as a Compound Lottery

- Note that if the contract failure probability $q_2 > 0$, index insurance is a partial insurance
- Expected utility theory explanations (EUT): With $q_2 > 0$, the worst that can happen is worse with insurance than without (Clarke 2011)
- Empirical evidence: people dislike partial insurance even more than the predictions of expected utility theory
  - Wakker et al. (1997): people demand more than 20% reduction in the premium to compensate for $q_2 = 1\%$
- Let's look more into this surprising aversion to basis risk when insurance is a compound lottery

Aversion to Ambiguity & Compound Lotteries

- Long-standing evidence (Ellsberg paradox) that people are averse to ambiguity & act much more conservatively in its presence
- Similar empirical evidence of a similar reaction to compound lotteries
- Psychologically:
  - Complexity
  - If people cannot reduce the lottery, then final probabilities seem unknown –> akin to ambiguity
- Halvey (2007) shows in an experiment a link between ambiguity aversion and compound risk attitudes

Modeling Compound Risk Aversion

- For the simple (binary) compound lottery structure above, adopt the smooth model of ambiguity aversion & write:

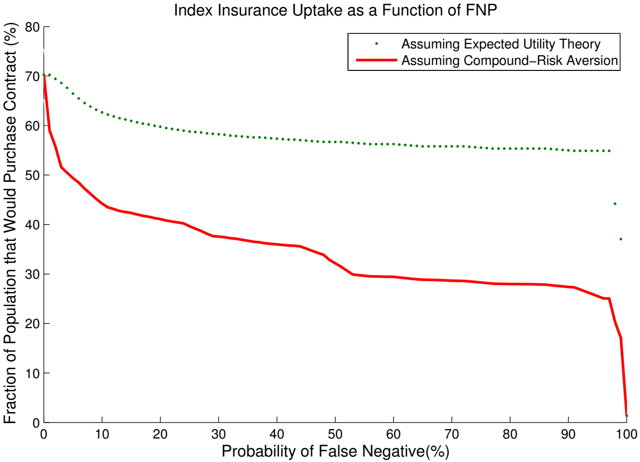
$$p * v[(1 - q_1) * u(a_1) + q_1 * u(a_0)] +$$

$$(1 - p) * v[(1 - q_2) * u(b_1) + q_2 * u(b_0)]$$

where:

- Inner utility function u captures attitudes towards "simple" risk: $u^{'} \geq 0$, $u^{''} \leq 0$
- Outer function v captures attitudes towards "compound" risk: $v^{'} \geq 0$
  - if $v^{''} \leq 0$: compound-risk averse
  - if $v^{''} = 0$: compound-risk neutral & compound reduces to corresponding simple lottery

Predicted Impact of Compound Risk Aversion on Index Insurance Demand



Empirical Measurement of Risk & Compound-risk Aversion

- Framed field experiments with 331 cotton farmers in Bougouni, Mali who were in an area being offered a high quality/low basis risk contract.
- Games were contextualized as cotton insurance and incentivized (mean earnings 1905 CFA (4 USD))
- Game 1: Measured the coefficient of risk aversion through insurance coverage decision with a simple, zero basis risk contract
- Game 2: Added in basis risk (20%) and then elicited Willingness to Pay (WTP) to eliminate this basis risk:
  - Theory says that WTP will be a function of compound-risk aversion and risk aversion
- Combine the findings of Game 1 and Game 2 to derive the coefficient of compound-risk aversion
  - Note that even for compound risk neutral person, there will some WTP to eliminate basis risk
  - Infer this level, and then measure compound risk aversion via

Game 1: Measuring Risk Aversion

- Games framed as cotton production with insurance games
  - Believe that this framing is important
- Historical yield data of the region of Bougouni

- Density of cotton yields discretized into six sections with the following probabilities (in %): 5, 5, 5, 10, 25 and 50%

Game 1: Measuring Risk Aversion

- Here, farmers can choose between 6 coverage levels of *individual insurance* (or to not purchase at all), markup of 20%

$$u(\pi) = \begin{cases} \frac{\pi^{1-r}}{1-r} & \text{if } r \neq 1 \\ \log(\pi) & \text{if } r = 1 \end{cases}$$

Contract #	Trigger (% $\bar{y}$)	r range
0	0	$(\infty; 0.08)$
1	50	$(0.08; 0.16)$
2	60	$(0.16; 0.27)$
3	70	$(0.27; 0.36)$
4	80	$(0.36; 0.55)$
5	100	$(0.55; \infty)$

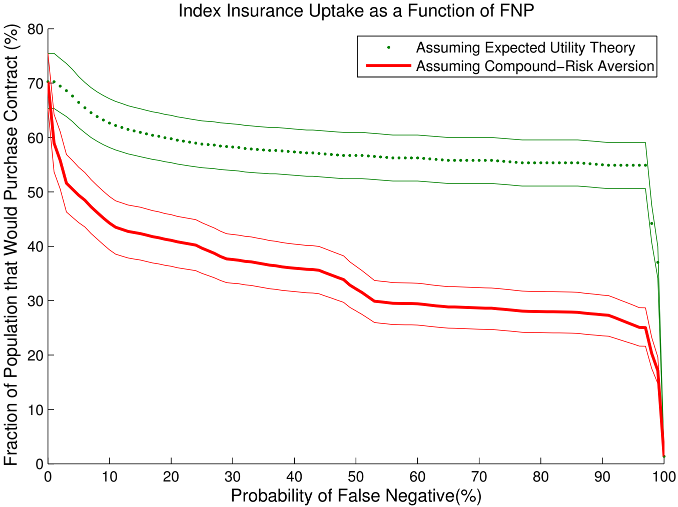
Game 2: Measuring Compound Risk Aversion

- Added basis risk into simple contract used to measure risk aversion
- Offered farmers a choice between the index contract with basis risk & the basis risk free contract
- Kept the price of index insurance constant
- Starting with a really high price for the the basis risk-free contract, slowly lowered the price to see whether and at what point the individual will shifted from the index to the basis risk-free contract
- Those that shift at a higher price are more averse to basis risk
- Using measured simple risk aversion, can then infer additional compound risk aversion

Game 2: Measuring Compound Risk Aversion

- 57 % of the farmers are compound-risk averse to varying degrees
- Willingness to pay to avoid the secondary lottery of those individuals who demand index insurance is on average considerably higher than the predictions of expected utility theory.
- Overall, average willingness to pay to eliminate basis risk is almost 30% of the price of the index contract
- Simulated impact on demand for index insurance (with a 20% mark-up) by a population that has the risk and compound risk aversion characteristics of the Malian population:

Behavioral Impacts of Basis Risk on the Demand for Index Insurance



- Andreoni & Sprenger propose a simple way to account for commonly observed behavioral paradoxes (e.g., Alais paradox):
  - Assuming constant relative risk aversion, hypothesize that individuals value certain outcomes according to:

    $$v(x) = x^{\alpha}$$

    whereas they value risky outcomes according to

    $$u(x) = x^{\alpha-\beta}$$

    where $\alpha > \beta > 0$

- If this 'overvaluation' of outcomes that are certain is correct ($\beta > 0$), implies that individuals undervalue insurance because the bad thing (the premium) is certain and hence overvalued relative to the good thing (payments) which are uncertain and undervalued
- Note that overvaluation is above and beyond what would be expected based on standard risk aversion
- Consistent with farmer complaints in the field about paying premium in bad years

Field Experiment in Burkina Faso

- Working with 577 farmer participants in the area where we are working with Allianz, HannoverRe, EcoBank, Sofitex and PlaNet Guarantee to offer area yield insurance for cotton farmers, played two incentivized behavioral games:
  - Measured risk aversion over uncertain outcomes (α) and extent of certainty preference (β)
  - Measured willingness to pay for insurance under two randomly offered alternative, actuarially equivalent contract framings:
    - Standard framing (certain premium)
    - Novel framing (premium forgiveness in bad years)
- Found that:
  - One-third of farmers exhibit certainty preference
  - Average willingness to pay is 10% higher under novel framing
  - "Certainty Preference Farmers" value the alternative framing by 25%

Identifying Risk Aversion

- Choose between 8 binary lotteries with $p_b = p_g = 1/2$
- Initially A stochastically dominates B, but A becomes riskier
- Where the individual switches from A to B brackets their risk aversion parameter, α.

Pair	Riskier Lottery (A)			Safer Lottery (B)			CRRA if Swi
	Bad outcome	Good outcome	Expected value	Bad outcome	Good outcome	Expected value	$\frac{x^{1-\alpha"}}{1-\alpha"}$
1	90,000	320,000	205,000	80,000	240,000	160,000	–
2	80,000	320,000	200,000	80,000	240,000	160,000	–
3	70,000	320,000	195,000	80,000	240,000	160,000	$1.58 < \alpha"$
4	60,000	320,000	190,000	80,000	240,000	160,000	$0.99 < \alpha"$
5	50,000	320,000	185,000	80,000	240,000	160,000	$0.66 < \alpha"$
6	40,000	320,000	180,000	80,000	240,000	160,000	$0.44 < \alpha"$
7	20,000	320,000	170,000	80,000	240,000	160,000	$0.15 < \alpha"$
8	0	320,000	160,000	80,000	240,000	160,000	$0 < \alpha" <$

Playing the Game

Identifying Certainty Preference

- Replaced the safer lottery with a degenerate (sure thing) lottery
- The value of the degenerate lottery (D) for each pair equals the certainty equivalent of safe lottery B for an individual who would have switched at that point (i.e., an expected utility maximizer should switch at the same point)

Pair	Risky Lottery (A)			Certain 'Lottery' (D)
	Bad outcome	Good outcome	Expected Value	
1	90,000	320,000	205,000	60,000
2	80,000	320,000	200,000	80,000
3	70,000	320,000	195,000	127,200
4	60,000	320,000	190,000	139,000
5	50,000	320,000	185,000	146,000
6	40,000	320,000	180,000	150,700
7	20,000	320,000	170,000	157,400
8	0	320,000	160,000	160,000

Identifying Certainty Preference

- Main diagonal (in bold) are expected utility maximizers who switch at same point
- Upper triangle (in italics) have a 'certainty preference' with $\beta > 0$

	Switch Point with Risky Alternatives							
	2 Percent	3 Percent	4 Percent	5 Percent	6 Percent	7 Percent	8 Percent	9 Percent
2	**51**	*18*	*10*	*4*	*3*	*10*	*13*	*12*
3	12	**27**	*22*	*12*	*10*	*10*	*3*	*4*
4	12	24	**32**	*21*	*15*	*10*	*8*	*4*
5	3	12	18	**32**	*31*	*8*	*11*	*7*
6	2	10	4	8	**21**	*19*	*11*	*7*
7	3	4	3	7	13	**15**	*13*	*7*
8	8	3	7	11	5	2	**31**	*9*
9	9	3	3	5	2	5	11	**51**
Total Number	65	78	90	84	61	59	64	76

Identifying Certainty Preference

Agent Type	Number	%
Expected Utility ($\beta = 0$)	191	33
Certainty Pref. ($\beta > 0$)	168	29
Others ($\beta < 0$)	218	38

- Given that about one-third of farmers appear to have a strong preference for certainty, the key question then becomes if these farmers are sensitive to contract design and framing
- Specifically, will these farmers
  - undervalue conventionally framed insurance relative to Expected Utility types
  - respond positively to an insurance contract in which payment of the premium is uncertain (rebated)

Insurance Demand Experiment

An insurance on cotton production is something you buy before you know your yield. The insurance gives you some money after the harvest, but only in case of bad yield. Let me explain how the insurance works.

- Frame A

The amount of your savings is 50.000 CFA. You decide to buy an insurance before you know your yield. The insurance price is 20.000 CFA.You pay the insurance with your savings. Therefore you remain with 30.000 CFA. In case of bad yield, the insurance gives you 50.000 CFA. In case of good yield the insurance gives you 0 CFA.

- Frame B

The amount of your savings is 50.000 CFA. You decide to buy an insurance before you know your yield. The insurance price is 20.00 CFA.You pay the insurance with your savings, **BUT only in case of good yield.**Therefore you remain with 30.000 CFA in case of good yield and 50.000 CFA in case of bad yield. In case of bad yield the insurance gives you 30.000 CFA. In case of good yield the insurance gives you 0 CFA.

Willingness to Pay for insurance

- Randomly offered some farmers Frame A, and others Frame B
- Under both frames, explore farmer's willingness to buy insurance as we slowly decreased the price from a very high 30,000 CFA (3-times the actuarially fair price) to 0 CFA
- Price was decreased in 5000 CFA increments
- Price at which farmers switches identifies willingness to pay (WTP)

Willingness to Pay for insurance

	All	Certainty Preference	Others	Expected Utility
Average WTP (both frames)	15,771	15,208	15,573	16,492
Frame A WTP	15,051	13,526	15,631	15,989
Frame B WTP	16,493	17,397	15,521	16,950
T-test (p-value)	0.09	0.01	0.9	0.5

- Regression analysis (controlling for covariates, clustering standard errors, etc.) confirms these findings that Frame B has a large & significant impact on demand for the 30% of the population that exhibits a strong preference for certainty

Conclusions

- Behavioral economics has offered a number of insights on how people 'really' behave (as opposed to how economists believe they behave)
- Insights especially rich in the area of behavior in face of risk
- Behavioral economic games with West Africa cotton farmers reveal two things:
  1. Basis risk not only lessens value of insurance, but farmers' ambiguity aversion depresses demand even more than would be expected (meaning that insurance can have none of its hypothesized development impacts)
  2. Farmers surprisingly overvalue "sure things" relative to unsure things–writing contracts with unsure premium enhances farmers willingness to pay for insurance significantly
- Given continuing problems of sluggish demand for agricultural index insurance in many places, these insights suggest important new ways of designing contracts