Experiential games to teach farmers about weather index insurance

Sarah Janzen[1], Nicholas Magnan[2], Conner Mullally[3], Karl Hughes[4], Judith Oduol[4], Bailey Palmer[5], Soye Shin[6]

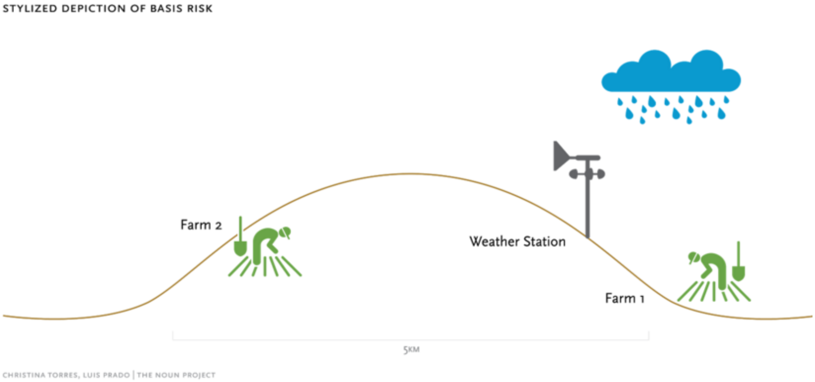
[1]Kansas State University
[2] University of Georgia
[3] University of Florida
[4] World Agroforestry Center
[5]Princeton
[6]Duke-National University Singapore

SEEDEC
May 30, 2019

Motivation

- Agricultural risk is important and can have long term consequences arising from both:
  - *ex ante* investment decisions (low risk, low return activities)
  - *ex post* coping strategies (decrease consumption or sell assets)
- Agricultural insurance, particularly WII, has recently been promoted as a development strategy to protect poor vulnerable households.
  - WII: based on index, low transaction costs, basis risk
  - Some positive impacts have been observed (Karlan et al. 2013, Cai 2016, Janzen & Carter 2018)
  - Pilots have been plagued by low demand (Platteau et al. 2017, Schickele, 2016)

WII and basis risk



Motivation

- Previous experiments show that farmers are sensitive to basis risk (McIntosh et al. 2016, Elabed and Carter 2015).
- Observational (Hill et. al. 2013, Mobarak and Rosenzweig 2012) and experimental (Hill et al. 2016) studies have shown insurance demand to decrease with basis risk, proxied for by distance to weather station.
- Cai and Song (2017) find that experiential games to increase demand for standard indemnity insurance in China.
- We test a game focused on weather index insurance and basis risk in Kenya.

Research questions

- We test two interventions:
  1. an improved high resolution insurance contract
  2. an experiential insurance game highlighting basis risk

- We address the following questions:
  1. Are farmers sensitive to basis risk?
     (Does demand vary by contract quality?)
  2. Does experiential learning affect demand for insurance?
  3. Does experiential learning affect attitudes toward and knowledge of insurance?

Experiment overview

- 2 x 2 experiment where farmers are randomly assigned to:

	Low resolution insurance (LR)	High resolution insurance (HR)
Insurance game (G)	GLR	GHR
Placebo game (C)	CLR	CHR

- HR/LR insurance randomly selected at farmer group level.
- All farmers in group undergo a basic information session on WII before being divided into G/P at individual level.
- Insurance demand elicited using an experimental auction following the games.

Basic information session

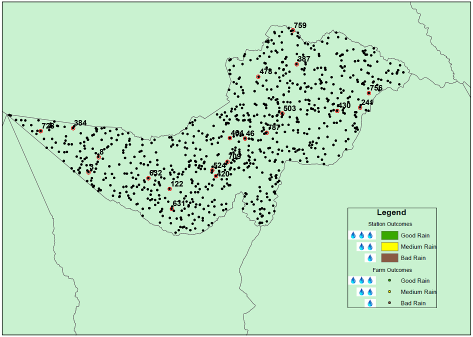
- Farmers generally do not know anything about insurance offered (lenders insure themselves against farmer default).
- Status quo spiel from insurance promoter:
  - "Because you are now producing sorghum as a business, you need to protect that business".
  - "With WII it is possible you will not receive a payout even if you have a poor harvest."
- For the experiment, insurance representatives explain the resolution of the two products (LR **or** HR).
- No explanation of (complicated) trigger system.

Intervention 1: HR Insurance

- Insurance products based on Climate Hazards Group InfraRed Precipitation with Station (CHIRPS) data.
  - 0.05 resolution satellite imagery + in-situ station data to create gridded rainfall data
  - 1981-present time-series available at daily level
- The "status quo" insurance product in the area uses satellite data at 10 x 10 km resolution.
- The "improved" HR contract uses data at 5 x 5 km resolution.
- Farmers generally do not know anything about insurance offered (lenders insure themselves against farmer default).

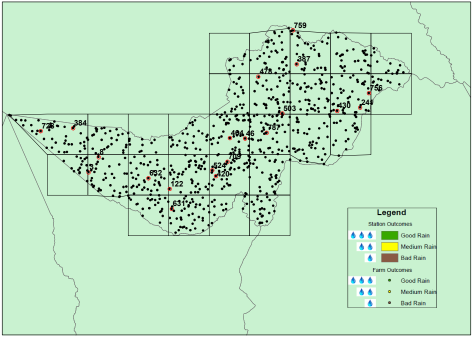
Intervention 2: Experiential insurance game

- The game uses maps consisting of "farms" and grid squares
- Farms randomly assigned to each individual farmer; farmer plays same farm entire game



Intervention 2: Experiential insurance game

- The game uses maps consisting of “farms” and grid squares
- Farms randomly assigned to each individual farmer; farmer plays same farm entire game

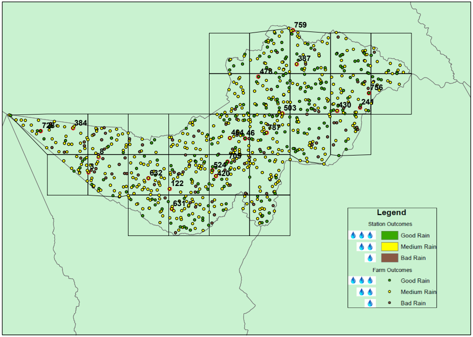


Intervention #2: Experiential insurance game

- The game simulates 8 rounds/seasons of variable weather (calibrated with the CHIRPS weather data)
- A random insurance price is selected each round/season
- In each round/season, farmers can buy 0, 1, or 2 units of insurance at drawn price.
- After each farmer decides how much insurance to purchase, a map reveals the season's weather outcomes, including both farm-level outcomes and insurance payouts.

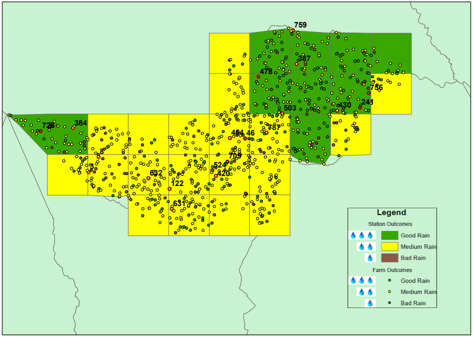
Intervention #2: Experiential insurance game

- Three levels of rainfall depicted in the maps:
  "bad" (brown), "medium" (yellow), and "good" (green).
- Farms and squares each take on one of these three colors,
- Mismatches between farm/square demonstrate basis risk.



Intervention #2: Experiential insurance game

- Three levels of rainfall depicted in the maps: "bad" (brown), "medium" (yellow), and "good" (green).
- Farms and squares each take on one of these three colors,
- Mismatches between farm/square demonstrate basis risk.

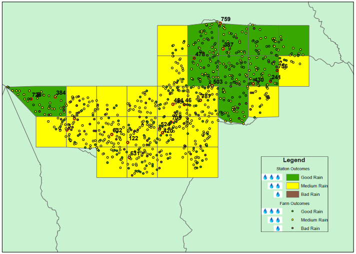


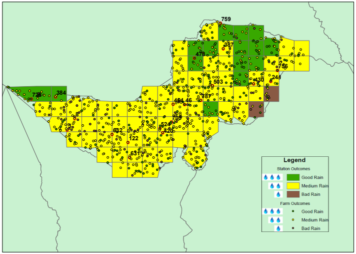
Intervention #2: Experiential insurance game

- Annual farm "profit" is thus contingent upon three factors:
    1. Production value at the farm level
    2. Cost of insurance premium (for those who purchased
    3. Insurance payouts (for those who purchase) determined at the "square" level
- Participants play for real earnings from a randomly chosen season (no dynamic play)
- No competition between farmers

Game x resolution

- G-LR play LR version only, G-HR play HR version only.





Negative basis risk: 0.268
Positive basis risk 0.162

Negative basis risk: 0.177
Positive basis risk 0.157

What we expected

1. Farmers are not sensitive to basis risk without playing the game.
2. Demand for high resolution WII is higher than for low resolution WII for those playing the game.
3. The game could increase or decrease demand for either product relative to the same product without the game.

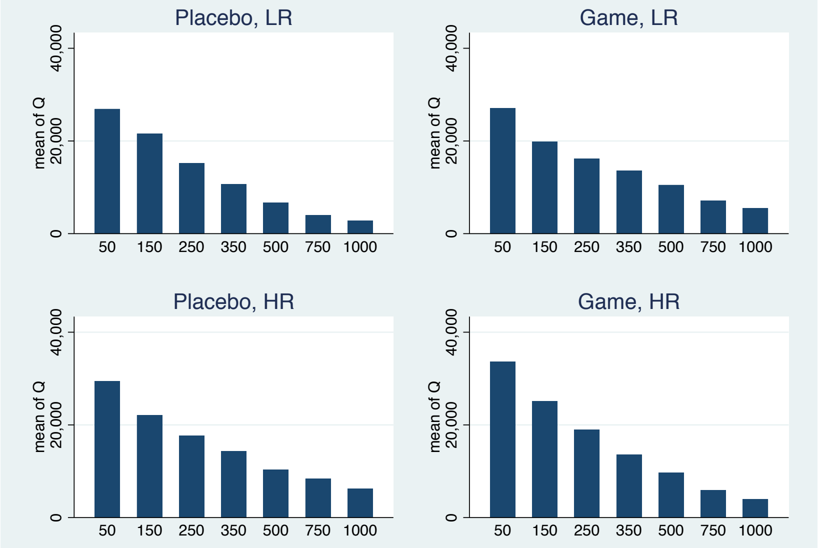
Data

- 487 farmers (in 18 groups) in Kenya's ASALs.
- Insurance demand
  - Multiple price list "binding" auction data
  - Actual purchase data
- Knowledge and attitudes regarding insurance
- Game experience
- Farmer and farm characteristics

Actual insurance purchases

- Commitments to purchase were not enforceable
- **Only six of 487** farmers actually purchased WII after multiple calls and visits.
  - Major contested election and general chaos between auction and purchase window?
  - Overly optimistic about having cash on hand to purchase?
  - Misunderstanding of auction bindingness?
  - Extreme hypothetical bias?
- In any case, we conclude that these farmers will not purchase this WII, even at highly subsidized prices.
- Treatments had zero impact on actual purchases.

Summary visualization of results



Results: quantity demanded (auction)

Intercept shift only:

$$Q_i = \beta_0 + \beta_1 CHR + \beta_2 GLR + \beta_3 GHR + \beta_4 P_i + \mathbf{X_i'}\beta_\mathbf{x} + \varepsilon_i \quad (1)$$

Intercept and slope shift:

$$\begin{aligned} Q_i &= \beta_0 + \beta_1 CHR + \beta_2 GLR + \beta_3 GHR + \beta_4 P_i \\ &+ \beta_5 (CHR \times P_i) + \beta_6 (GLR \times P_i) + \beta_7 (GHR \times P_i) \\ &+ \mathbf{X_i'}\beta_\mathbf{x} + \varepsilon_i \end{aligned} \quad (2)$$

- CLR is omitted category.
- P_i denotes price.
- $\mathbf{X_i}$ is a vector of covariates: age, expected net value, education, literacy, gender, landholdings, past droughts, loan availability, any formal savings, acreage of crop to be insured.
- Standard errors wild bootstrap clustered at farmer group level.

Results: quantity demanded (auction)

Table: Treatment effects on demand over all prices

	(1)		(2)	
	Intercept		Intercept and slope	
	Coverage	p-value	Coverage	p-value
CLR mean	13,269.1		13,269.1	
GLR	4,123.3**	0.015	3,375.1	0.272
CHR	5,093.9***	0.004	4,070.7	0.243
GHR	3,648.8*	0.057	5,258.3	0.133
GLR x P			1.717	0.766
CHR x P			2.348	0.693
GHR x P			-3.694	0.511
N	3409		3409	

Omitted variable is CLR.

WCBS p-vals; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Results: Demand at policy relevant premium levels

Most interested in how each intervention affects demand at the actuarily fair and market price.

$$(Q_i|P_i = 350) = \beta_0 + \beta_1 CHR + \beta_2 GLR + \beta_3 GHR + \mathbf{X_i'}\beta_\mathbf{x} + \varepsilon_i \quad (3a)$$

$$(Q_i|P_i = 750) = \beta_0 + \beta_1 CHR + \beta_2 GLR + \beta_3 GHR + \mathbf{X_i'}\beta_\mathbf{x} + \varepsilon_i \quad (3b)$$

Results: Demand at policy relevant premium levels

Table: Treatment effects on demand over all prices

	(3a) Actually fair (350 KSH)		(3b) Market value (750 KSH)	
	Coverage	p-value	Coverage	p-value
CLR mean	14,431.1		7,207.4	
GLR	5,740.5**	0.017	4,996.4***	0.003
CHR	5,728.0***	0.006	7,346.5***	0.003
GHR	4,670.6	0.104	2,121.1	0.172
N	487		487	

Omitted variable is CLR.

WCBS p-vals; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Results: Probability of *any* insurance uptake

Farmers may initially purchase a small quantity to familiarize themselves with the product before fully insuring.

$$I(Q_i > 0) = \beta_0 + \beta_1 CHR + \beta_2 GLR + \beta_3 GHR + \beta_4 P_i + \mathbf{X_i'}\beta_\mathbf{x} + \varepsilon_i \quad (4)$$

$$I(Q_i > 0 | P = 350) = \beta_0 + \beta_1 CHR + \beta_2 GLR + \beta_3 GHR + \mathbf{X_i'}\beta_\mathbf{x} + \varepsilon_i \quad (5a)$$

$$I(Q_i > 0 | P = 750) = \beta_0 + \beta_1 CHR + \beta_2 GLR + \beta_3 GHR + \mathbf{X_i'}\beta_\mathbf{x} + \varepsilon_i \quad (5b)$$

Results: Probability of *any* insurance uptake

Table: Probability of any insurance uptake

	(4) All	(5a) Actuarily fair	(5b) Market
CLR mean	0.675	0.730	0.418
	(0.468)	(0.446)	(0.495)
GLR	0.0375	0.0853**	0.0361
	(0.031)	(0.040)	(0.072)
CHR	0.0711	0.0231	0.1797**
	(0.042)	(0.054)	(0.067)
GHR	0.0897**	0.1338**	0.1375
	(0.039)	(0.048)	(0.079)
Price	-0.0006***		
	(0.000)		
Observations	3409	487	487

Notes: Clustered standard errors in parentheses.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Results: Knowledge and attitudes

K_i, the number of correct answers on a brief insurance test.

$$K_i = \beta_0 + \beta_1 CHR + \beta_2 GLR + \beta_3 GHR + \mathbf{X_i'}\beta_{\mathbf{x}} + \varepsilon_i \qquad (6)$$

Attitude outcomes are answers to specific question

$$A_i = \beta_0 + \beta_1 CHR + \beta_2 GLR + \beta_3 GHR + \mathbf{X_i'}\beta_{\mathbf{x}} + \varepsilon_i \qquad (7)$$

Results: Knowledge and attitudes

Table: Treatment effects on knowledge and attitudes

	Knowledge		Enough info		WII is valuable		Difficult to understand	
	Score (0-4)	p-val	(0,1)	p-val	(0,1)	p-val	(0,1)	p-val
CLR mean	2.943		0.905		0.975		0.647	
GLR	0.071	0.322	0.009	0.876	0.008	0.745	0.019	0.681
CHR	0.035	0.773	0.023	0.533	0.000	0.999	-0.091	0.313
GHR	0.229**	0.023	0.018	0.670	0.012	0.589	-0.111	0.208
N	487		474		482		477	

Omitted variable is CLR.

WCBS p-vals; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Conclusions and wild speculation

- Quantity demand results are strange:
  - Game increases quantity demanded for low resolution product
  - Game has no effect on quantity demanded for high resolution product (point estimate lower)
  - Without game, demand higher for high resolution product
  - With game, demand for high and low resolution products is the same (point estimate lower)
- Potential reasons why:
  - Imbalance? Results are robust to including or excluding controls.
  - Farmers have a maximum demand reached either through being offered the high resolution product or playing the game?
  - High resolution game is confusing or unappealing? Does not appear that way based on knowledge and attitude results.

Auction process

1. Auction takes place immediately after the games
2. Assistant tells farmer how many units of insurance it would take to insure entire crop value, and how much this would cost, at a very low price
3. Farmer chooses how much insurance to purchase at that price.
4. Process repeats for successively higher prices.
5. Once all prices have been covered, or farmer has zero demand, a single price is randomly selected as the actual price.
6. Enumerator confirms with farmer that she has “committed” to purchase the amount of coverage chosen at that price.

back