The Impact of Commercial Rainfall Index Insurance: Experimental Evidence from Rural Amhara, Ethiopia

Shukri Ahmed, FAO

Craig McIntosh, UC San Diego

Alexandros Sarris, University of Athens, Greece

In collaboration with the Ethiopian Economic Association (EEA)

Paper presented at the conference "Evidence Advancing Food Security: Lessons from Randomized Controlled Trials" organized by the Center for Effective Global Action (CEGA), the East African Social Science Translation (EASST) Collaborative, and the Agricultural Technology Adoption Initiative (ATAI), held during June 17-19 in Addis Ababa, Ethiopia

Plan of presentation

Nature of natural disasters

Uninsured weather risk and consequences for smallholders.

Weather index insurance: theoretical appeal.

Theory vs reality: Impacts from pilot projects in various developing countries.

The idea of interlinked credit and insurance.

Implementation in Ethiopia and impacts.

Prospects.

Some facts about nature of natural disasters

- Over the last 30 years, data from the International Disaster Database show that an estimated 1,000 natural disasters occurred in Africa, affecting 328 million people with damages estimated at US$24 trillion!!.
- While floods were the most frequent type of natural disaster events (59% of natural disasters in a list that includes droughts, extreme temperatures, storms, earthquakes, and volcano eruptions), droughts were the hazard that has affected the most people and caused the largest damage cost, accounting for 83% of people affected and 40% of total economic damages.
- Together, droughts and floods dominate the African risk landscape, with half of Sub-Saharan Africa countries affected by at least one drought every 7.5 years, and half impacted by at least one flooding event every three years. Relative to other regions of the world, mortality from these events is very high in Africa (Dilley, Chen, and Deichmann, 2005).

Uninsured weather risk and consequences for smallholders.

The largest risk that farming communities cannot manage themselves is covariate, namely affecting all farmers in a location simultaneously, and primary source of this is weather (Christiaensen and Dercon, 2007). This risk is largely uninsured.

This affects negatively investment, innovation, and poverty reduction, as it induces farmers to adopt more diversified production structures, which, however, imply lower average returns and income (Fafchamps and Pender 1997), .

The realization of shocks (production and consumption) induces farmers to adopt consumption smoothing strategies, which, however, do not compensate fully for the random variations in incomes, and this also leads to conservative production structures (Dercon and Christiaensen)

What do farmers do ex-ante?

- Crop diversification (product-wise, area-wise, time-wise). Basically a low expected profit low risk strategy (Dercon, 1996)
- Income diversification through participation in non-farm activities
- Self insurance by accumulating precautionary savings (cash, food stocks, livestock, and other assets that can easily be liquidated such as jewels, etc.). This can distort portfolios, towards accumulating more liquid and less productive assets (Rozensweig and Wolpin, 1993)
- Develop risk sharing or contingent credit networks with relatives, friends, from same or other villages
- Secure access to emergency credit line through patron-client relationships

What do farmers do ex-post?

- Reduce consumption (nutrition, education, health)
- Draw down precautionary savings
- Sell productive or other assets
- Borrow from relatives or friends
- Labor adjustment through migration and child labor
- Informal risk sharing, mutual assistance
- Rely on social safety nets
- All the above imply high cost, and difficulties in saving and investment in productive assets or human capital with risk of irreversibilities and poverty traps

Obvious policy response; access to insurance

- Type of insurance that will work depends on whether realized shocks are **idiosyncratic or covaria**te at the level of the community
- Idiosyncratic shocks can be partially insured through inter-household risk pooling (mutual insurance) and usually do not lead to large reduced consumption. But such mutual insurance is incomplete
- Negative covariate shocks almost always are associated with consumption declines.
- Above implies need for agricultural insurance for covariate shocks.

Why conventional indemnity insurance does not work for small farmers in developing countries?

- Moral hazard (insured farmers increase risk taking)
- Adverse selection (asymmetrical information on risks leads only farmers with risks above insurance premiums to buy insurance).
- High cost of contracting large number of small farmers
- Costs of assessing damages is large for small farmers adding to premium loadings
- Imperfectly developed legal institutions for enforcement of contracts
- Reinsurance difficult, as international reinsurance companies demand long term risk data, that is normally not available

Index based weather insurance (WII) as alternative to indemnity insurance. Theoretical appeal

- Delinks insurance payments from individual-level losses and links them to an index falling below or above given threshold
- Index is (or should be) objective, publicly verifiable, and non-manipulable by the insurer and insured
- Can be based on climatic data collected at meteorological stations such as rainfall, hail, temperature and wind.
- Can also be based on average outcomes measured over small area (such as crop yield or livestock mortality) or remote sensing (such as NDVI)
- Payments are triggered when index crosses given threshold, signalling disaster.
- Avoids moral hazard and adverse selection, and is cost effective

Problems of WII

- To be viable must be closely correlated with insured losses.
- This gives rise to the main drawback of WII, which is **basis risk**.
- Basis risk arises from the discrepancy between measured risks at the meteorological station and the occurrence of weather shocks at the location of the farm of the insured.
- If weather stations are few, and microclimates locally differentiated, basis risk increases correspondingly, making WII insurance into a cheap and expedient but low quality product (Clarke, 2011).

Basis risk (2)

- Area yield measurements have the advantage of protecting against many unspecified perils (not only rainfall, but also other dimensions of climate, pests, and diseases),
- but discrepancies will similarly occur between area measurement and location specific outcomes.
- All of this could be fixed, with greater density of weather stations and more accurate local yield measurements, but solutions are costly and require entrepreneurial initiative, often as a public good.
- WII is **work in progress.** Around 15 developing countries have introduced index insurance programs at the individual level and some 20 at the institutional level, often on a limited pilot or experimental basis, and there is much to learn from these experiences.
- Generally the take-up of WII by farmers in developing coutnries has been low. This gap between high promise and low take-up creates one of the most fascinating current puzzles in development economics.

Interlinking loans and insurance:

- Interlinking credit with insurance may enhance the willingness of farmers to borrow to invest in inputs, generating a first-order expansion in productivity (Carter et al. 2015).
- However, recent studies on efforts to interlink insurance and credit show demand for credit *fell* when interlinked (Gine & Yang 2009, Banerjee et al. 2014).
  - Requirement to prepay premiums may dampen demand for interlinked products (Casaburi & Willis 2016)
  - Can interlinking play a constructive role on the supply side of the credit market?

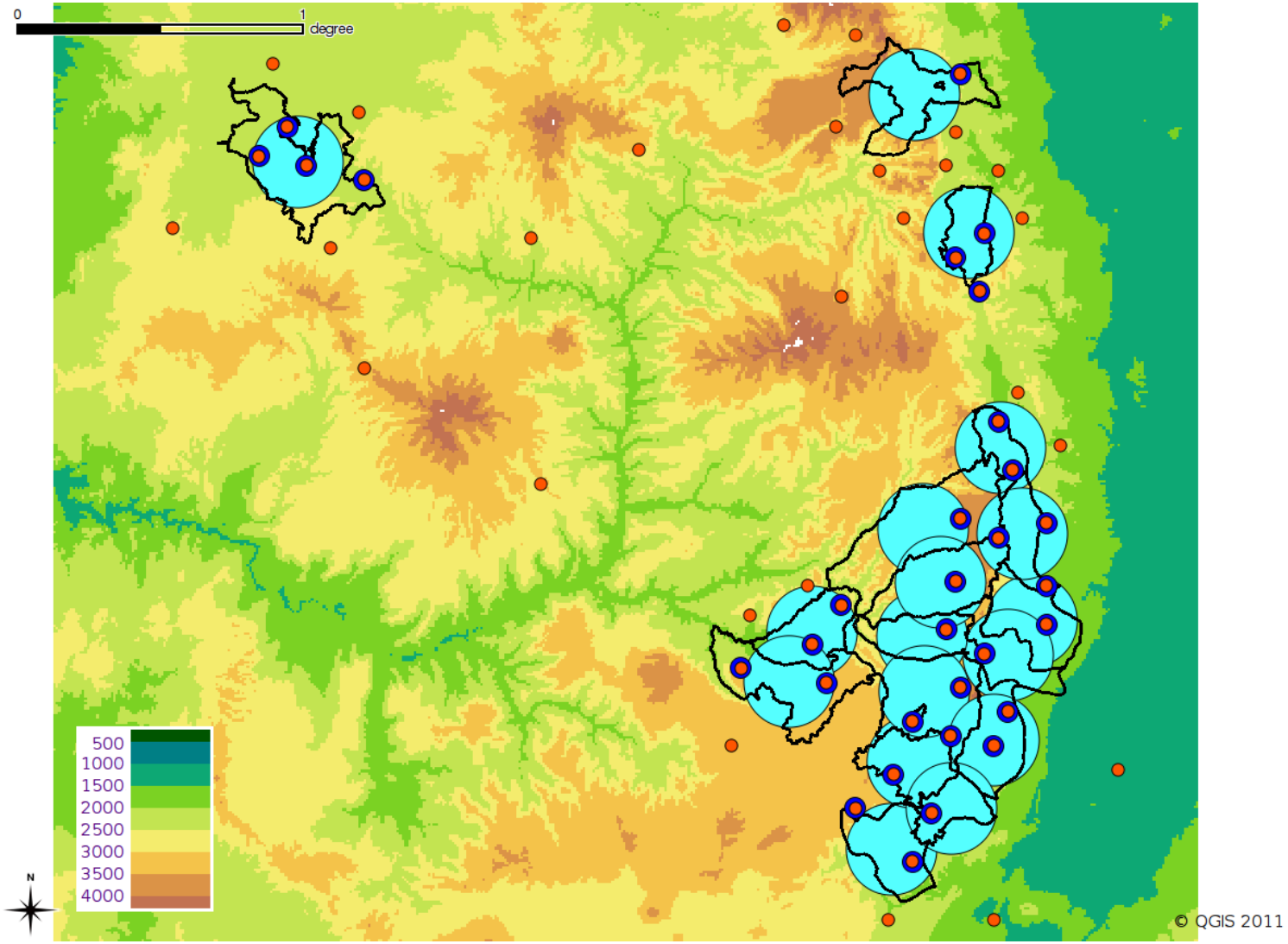
Motivation for EPIICA (Ethiopia Project on Interlinking Insurance with Credit in Agriculture):

- Two ways of thinking about farmer micro-insurance:
  1. A sustainable new financial product that can build a private market mechanism to move weather risk away from farmers.
  2. A way to cover the loss to expected output if farmers are underinvesting in inputs due to risk (Skees & Collier, 2007).
     - May provide a better way of providing transfers than cash (Karlan et al. 2014).
- This study examines both of these premises in Ethiopia, a very weather-exposed farming environment.
  1. Work through large private-sector companies, farmers coops in areas chosen to be strong potential markets.
  2. Experiment at individual level varying transfers provided in the form of risk subsidies to farmers at planting time.
- Ultimate question: can removal of risk generate first-order improvements in inputs, profits?

Ethiopian Project on Interlinking Insurance & Credit for Agriculture (EPIICA):

- Project is a collaboration between researchers and:
  - Nyala Insurance Company (largest insurer in country)
  - Dashen Bank (largest private-sector bank in country)
  - Village-level agricultural cooperatives and their Cooperative Unions.
  - Ethiopian Economics Association (fieldwork/analysis).
- Fielded a commercial index insurance product:
  - Rainfall index built from crop water requirement model.
  - Offered insurance to cooperativized farmers in villages within 25 km of a reinsurable rainfall station.
  - Dashen loans first claimant on Nyala payouts for interlinked.
  - Provided randomized promotion & subsidy vouchers from EEA.

Map of Rainfall Stations and Study Woredas.



Ethiopian Context.

1. High risk: rain-fed agriculture, large rainfall variation.
   - Risk has been demonstrated to be a constraint in Ethiopian smallholder input use (Dercon and Christiaensen, 2011).
2. Strong state involvement in input and output chains for the cooperative farming sector.
   - This project attempting to bring together public- and private-sector entities in a new way.
3. Large government safety-net program (PSNP) may serve as a substitute for private-sector insurance (Duru 2015).

Raises the question: is it possible for the state to be *too* credible at providing disaster relief, thereby undermining private-sector demand for insurance?

Product fielded 1. Standalone Rainfall Index Insurance:

- Sold through primary (village-level) cooperatives to members at time of purchasing inputs.
- Framed as input insurance, meaning that it would cover cost of inputs if rain fails.
- Payoffs with trigger/exit for each of three crop growth phases, optimized separately for maize, sorghum, teff, and wheat for each insured station.
- Only households in villages whose center is less than 15km from an insured station offered insurance.

Product fielded 2. Interlinked Credit with Rainfall Index Insurance:

- Cooperative Unions (collectives of village-level cooperatives) are used as credit intermediaries.
- Each CU signs single loan contract with Dashen, who is made beneficiary of Nyala insurance policy.
- Can only get the interlinked loan if insurance purchased, but can choose standalone product also in villages where interlinked product is sold.
- Pushes the CUs into new role, asking them to take collateralized loans with collective assets.
- Only successful in achieving real take-off of interlinked insurance in one CU; qualitative study of this case.
- Experimental study is solely on standalone insurance.

Research design, intended and actual:

Original sample:

120 kebeles: 40 control, 40 standalone, 40 interlinked.

However, not all turn out to be deficit-rainfall threatened.

Drought-threatened sample:

84 kebeles: 27 control, 29 standalone, 28 interlinked

However, Swiss Re (Nyala reinsurer) refused all but 7 stations.

Drought-threatened insurable sample 'Experimental':

49 kebeles: 15 control, 17 standalone, 17 interlinked

However, not all kebeles achieved any sales.

'Experimental' sample:

15 control vs. 34 treatment clusters, all standalone

- Despite reduced sample size, balance good across villages and individual voucher experiments.

The Individual-level Voucher Experiment:

To preserve a clean experiment subsequent to attrition:

- We randomized the provision of insurance purchase vouchers at the individual level.
  - The large majority of insurance coverage issued in the project comes from these vouchers rather than from private demand.
- Study provides relatively well-powered experiment on effects of randomizing transfers to households in the form of risk protection.
  - Provides direct test of marginal effect of state-contingent cash transfers.
  - Is there a multiplier effect whereby relaxation of risk constraint increases overall appetite to invest in inputs and productivity?
- Quantity of coverage ~ directly randomized at individual level.

Survey Design:

We ran a four round panel survey.

- Two baseline surveys prior to implementation.
- One survey in each of the years following the first two sales windows.

The household surveys sampled 20 households per village:

- 18 households that were randomly sampled members of the cooperatives.
- 2 households that were randomly sampled from the non-cooperative members in the village.

Our analysis uses only the cooperative members, since they were the only ones with easy access to purchase insurance and inputs.

Organization of the Panel Analysis:

The study features four rounds of household surveys, and two rounds of insurance sales for which we have post-sales outcome data:

Time:	Survey Activities:	Sales Activites:	Payouts:
2011			
Jan – Mar:	Round 1 Survey (baseline)		
2012			
Jan – Mar:	Round 2 Survey (reduced sample in panel)		
July-Aug:		Season 1 sales, standalone only	
2013			
Jan – Mar:	Round 3 Survey (panel)		
Apr:			Season 1 sales payouts.
May-Jul:		Season 2 sales, standalone only	
2014			
Jan – Mar:	Round 4 Survey (panel)		
Apr:			Season 2 sales payouts.
Apr-Jun:		Season 3 sales, takeup only of interlinked in Feres Wega	
2015			
Apr:			Season 3 sales payouts
2016			
Jan – Feb:	Round 5 Survey (Feres Wega village only)		

Baseline Summary Statistics by Region.

	Total	North Shewa	West Gojam	South Wollo	North Wollo
Number of Households	1150	388	363	260	139
Share of Households in the Zone (%)	100	100	100	100	100
Average Household Size	5.3	5.5	5.8	4.6	4.99
Number of adult equivalents	4.5	4.7	4.8	3.9	4.23
Average age of the head (years)	49	51.2	46.1	48.9	50.53
Sex of household head (%)					
Male	90.7	90	93.7	89.2	87.77
Female	9.3	10.1	6.3	10.8	12.23
Type of hhld head 's education					
No Education	51.4	43	62	46.3	56.82
Formal Education	21.5	22.2	17.1	26.6	21.97
Informal Education	27.1	34.8	20.9	27	21.21
Duration of hhld head's formal education (years), excluding hh heads with no formal education at all	4.8	5	4.5	5	4.14
Hhld head can read and write in local language					
Read only	8.2	11.6	3.6	11.2	5.04
Read and Write	35.3	34.3	32.8	38.6	38.85
Cannot read or write	56.5	54.1	63.6	50.2	56.12

Adequacy of income (percent of households). The years in parentheses refer to the year of realization of the data not the year of the survey

	R1 (2011)	R3 (2013)	R4 (2014)
	All	All	All
Is current household income adequate to meet needs?			
Not enough even for food	27.2	20.5	12.5
Just enough for food	48.4	40.5	43.4
Just enough for food and necessities	20	27.8	37
Enough to meet most of needs	4.4	11.3	7.1

Using the Experimental Design to analyze impact:

- Regressions take the form:

$$y_{ict} = \alpha_i + \delta_t + \beta_1 T_{ct} + \beta_2 V_{ict} + \varepsilon_{ict}$$

  Where outcome y_{ict} is explained by two-way fixed effects, kebele-level treatment status at time *t,* T_{ct} , and individually randomized voucher amounts V_{ict}.

- Most outcomes are not observed in R2, so one pre-treatment period and two post-treatment periods with vouchers independently randomized across these two years.
- Standard errors clustered at the kebele level.

Uptake rates and sum insured

Round 1:	All
Uptake Rate:	0

Round 2:	All
Uptake Rate:	0

		Coop Members:		Non-Coop Members:	
Round 3:	No Voucher:	Standalone Voucher:	Interlinked Voucher	Standalone Voucher:	Interlinked Voucher
Uptake Rate:	0	42,9%	25,0%	29,2%	26,1%
Average Sum Insured:	0	$39,91	$35,90	$24,73	$25,28
Average Own Money Spent:	0	$7,43	$5,41	$4,35	$3,44
Round 4:					
Uptake Rate:	0	43,0%	43,6%	29,4%	45,0%
Average Sum Insured:	0	$37,01	$38,49	$47,19	$50,93
Average Own Money Spent:	0	$2,22	$2,60	$11,42	$1,02

Source. EPIICA surveys

What influences Insurance Uptake

	Bought Insurance	Sum Insured
	(1)	(2)
Any Voucher	0.385***	38.81***
	(0.0389)	(6.309)
Treated Village	-0.00409	-0.780
	(0.0118)	(1.724)
R3	-0.0226	0.0553
	(0.0186)	(2.815)
R4	0.0236	-0.0578
	(0.0195)	(2.942)
Constant	0.000123	0.0206
	(0.00991)	(1.375)
Observations	3,446	3,446
Number of Observations	0.312	0.190

- Strong first-stage impact of individually randomized component on uptake of insurance.
- No uptake outside of voucher group within the study sample.

The impact of year 1 vouchers and payouts on sales in year 2.

	Covered by Insurance Year 2			Sum Insured Year 2		
	(1)	(2)	(3)	(4)	(5)	(6)
Any Voucher Year 1	0.00683	0.0364	0.0290	18.41	80.95	33.35
	(0.0220)	(0.0423)	(0.0495)	(35.52)	(91.24)	(88.13)
Voucher Amount Year 1		-0.00164	-0.00154		-3.551	-3.218
		(0.00222)	(0.00221)		(4.468)	(4.273)
Any Voucher Year 2	0.429***	0.419***	0.406***	533.5***	129.8	109.9
	(0.0519)	(0.0845)	(0.0857)	(124.2)	(101.1)	(96.84)
Voucher Amount Year 2		0.000635	0.000867		28.66***	28.97***
		(0.00520)	(0.00521)		(9.146)	(9.252)
Insurance would have paid out Y1			0.0923			120.3
			(0.0651)			(117.9)
Voucher Y1 * Insurance would pay Y1			-0.0445			23.75
			(0.0802)			(122.8)
Constant	-0.00255	-0.00241	-0.0113	-6.865	-5.945	-17.13
	(0.00824)	(0.00830)	(0.00935)	(13.34)	(13.18)	(13.64)
Observations	841	841	841	841	841	841
Number of Observations	0.296	0.297	0.301	0.150	0.175	0.182

Regressions run at the household level among all cooperative members; dependent variable is the insurance purchase decision observed in the second sales season. Robust standard errors are reported in parentheses, clustered at the village level to account for the design effect.
*** p<0.01, ** p<0.05, * p<0.1

Panel Impacts on Ag Input Use

	Any Chemical Fertilizer	KGs of Chemical Fertilizer	Number of crops using Chemical Fertilizer	Uses any Improved Seeds	Uses any Input Credit
	(3)	(4)	(5)	(6)	(7)
Any Voucher	0.0203	-1.761	-0.0319	0.0607*	0.0127
	(0.0381)	(4.862)	(0.0826)	(0.0329)	(0.0339)
Treated Village	-0.0615	1.153	-0.0691	-0.124*	0.0374
	(0.0983)	(6.279)	(0.182)	(0.0689)	(0.0393)
R3	0.232**	15.99***	0.497***	0.0677	0.0432
	(0.0920)	(3.735)	(0.176)	(0.0532)	(0.0292)
R4	0.189**	17.09***	0.359**	0.0570	-0.0317
	(0.0831)	(4.038)	(0.150)	(0.0522)	(0.0295)
Constant	0.556***	91.02***	1.196***	0.372***	0.153***
	(0.0272)	(1.300)	(0.0482)	(0.0198)	(0.00680)
Observations	2,544	3,280	2,571	2,544	3,416
Number of Observations	0.084	0.025	0.069	0.006	0.014

- No evidence of any meaningful increase in input use due to standalone WII.

Panel Impacts on Ag Output, Income

	Total Value of Inputs Used	Index of Agricultural Yields	HH Income per Capita
	(8)	(9)	(10)
Any Voucher	1.567	0.00158	47.79
	(14.31)	(0.0438)	(55.18)
Treated Village	-6.093	-0.0848	-190.8**
	(19.63)	(0.0932)	(89.90)
R3	3.940	-0.0397	101.0**
	(12.02)	(0.0791)	(39.62)
R4	11.35	0.0903	137.0***
	(16.28)	(0.0801)	(39.08)
Constant	128.3***	-0.105***	246.5***
	(4.802)	(0.0166)	(22.91)
Observations	3,416	3,191	2,561
Number of Observations	0.000	0.014	0.004

- No evidence of any meaningful increase in input use.

Why the year dummies are significant?

- The use of chemical fertilizer surged overall during the course of the 2012 (R3) and 2013 (R4) seasons, the fraction of farmers using fertilizers rose from a control average of 54% in 2010-2011 to 77% in 2012 and 73% in 2013. The average number of kilograms used went from 91 to 107 in 2012 and 108 in 2013.
- Correspondingly, average household income was 55% higher in the endline than it was in the baseline. So it is important to recognize that lack of insurance impacts is measured during an interval when the target outcomes of the study were strongly improving overall.

So, why this lack of impacts?

Statistical power strong

Different attrition by voucher status does not change results

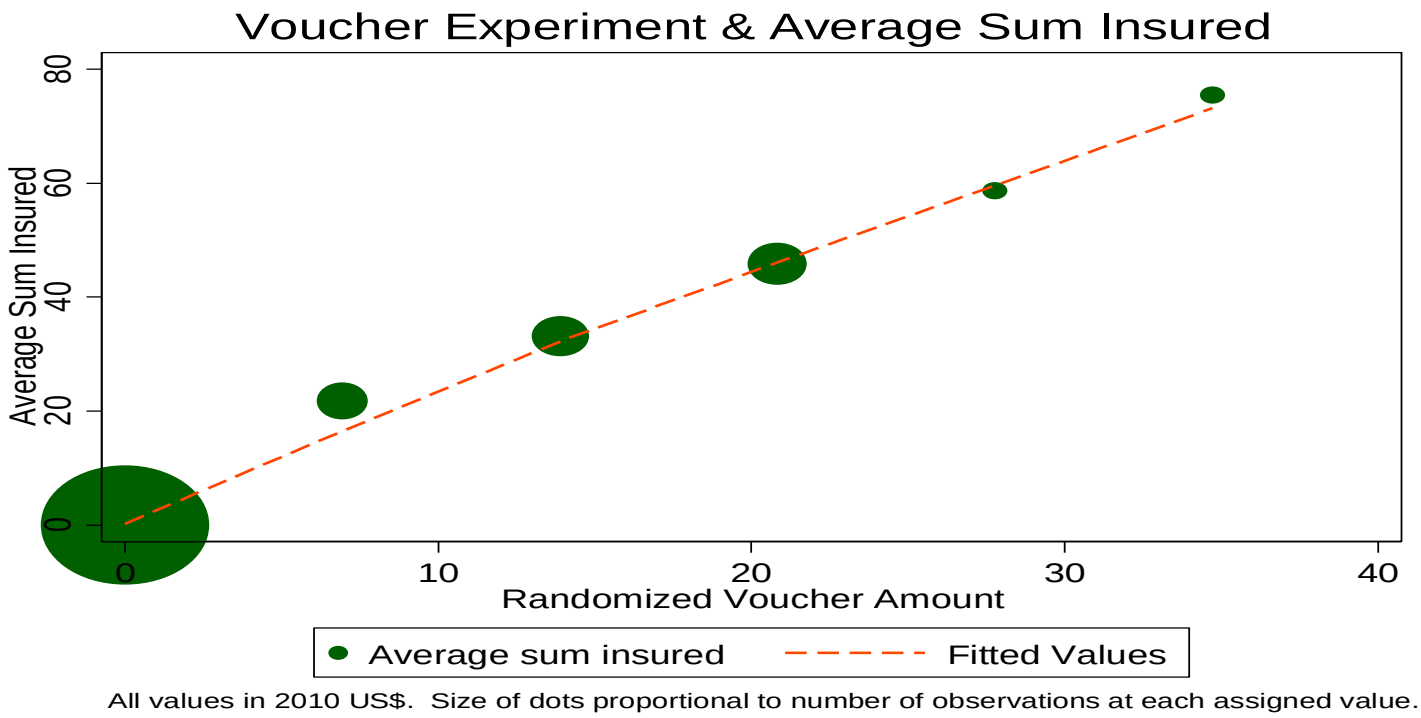
No strong impacts within sub-groups of the treatment.

A set of other possible explanations:

1. Voucher amounts too small?
   - IV analysis to estimating the slope term on actual sum insured.
2. Few are actually risk constrained in investment?
   - Interaction by baseline measure of risk rationing.
3. Insurance not properly promoted or understood?
   - Independent randomized promotion experiment conducted by EEA at baseline.

The Individual-level Voucher Experiment:

- Only 21% of farmers put any of their own money into purchase; most took the voucher and purchased only that much coverage.



All values in 2010 US$. Size of dots proportional to number of observations at each assigned value.

- Individually randomized reduction in risk exposure.

Implications of risk constrained farmers

- Based on baseline survey 54.6% of our sample are credit unconstrained, 18.8% are quantity constrained, 6.8% are price constrained, and 19.8% are risk constrained. Standard agricultural investment models such as Bardhan and Udry (1999), Boucher et al. (2008), and Carter et al. (2015) would all predict that the first-order impacts of insurance on expanding the willingness to borrow and invest in inputs will be strongest in the risk-constrained group.

- Those identified as credit rationed at baseline have sharply lower input use. They are 12.5 percentage points less likely to use any fertilizer than the unconstrained, they use 40 Kgs less fertilizer and use it on roughly half the number of crops.

- Despite these large cross-sectional differences, there are no signs of significant differential impacts of the provision of vouchers on the risk constrained.

3. Impact of EEA Baseline Promotion.

	First Sales Season		Second Sales Season		Endline Survey
	Sum Insured	Total Own Money Paid	Sum Insured	Total Own Money Paid	Knowledge of Product
	(2)	(3)	(6)	(7)	(9)
Received Product Promotion at Baseline	194.8***	2.810***	-28.27	0.852*	-0.00437
	(69.49)	(0.720)	(33.42)	(0.444)	(0.0189)
Any Voucher in Corresponding Season	428.8***	4.745***	551.4***	2.108**	-0.0325
	(93.30)	(0.923)	(127.3)	(0.891)	(0.0249)
Constant	-20.97**	-0.303***	9.135	-0.275*	0.0884**
	(9.089)	(0.109)	(10.88)	(0.154)	(0.0360)
Observations	847	847	835	835	588
R-squared	0.121	0.162	0.150	0.015	0.004

- Nyala attempted to promote by training coop heads, extension officials as recruiters to solicit individual demand.
- Results suggest that lack of promotion was a barrier to overall uptake.

Indicative impacts in Feres Wega. Reported changes in input use as a result of the interlinked insurance loan

Reported Changes in Input Use:

Input:	Number Increasing	% Increasing	Number Decreasing	% Decreasing	Number with No Change
Local Seeds	20	18.5%	3	2.8%	85
Improved Seeds	28	25.9%	5	4.6%	75
Organic Fertilizer	28	25.9%	5	4.6%	75
UREA	72	66.7%	9	8.3%	27
DAP	70	64.8%	9	8.3%	29
Insecticides/Herbicides	17	15.7%	2	1.9%	89
Veterinary Services	7	6.5%	0	0.0%	101
Other Livestock Inputs	4	3.7%	1	0.9%	103

Data come from the Round 5 survey conducted only in the village of Feres Wega where interlinked insurance was successfully sold.

Conclusions.

1. **Commercial:**
   - No evidence of solid demand for standalone WII at market prices.
   - Temporary subsidies are not an effective way to kick-start the market.
   - Interlinking insurance & credit is a complex undertaking but shows promise.
     - Ultimately more effective to provide index insurance to banks than to their borrowers?
2. **The productive potential of transfers via risk reduction:**
   - Substantial individually-randomized variation in the extent of standalone WII coverage, but no evidence of meaningful changes in agricultural behavior. Not enough time for learning
   - No evidence from this study that making transfers via risk reduction generate a first-order improvement in income.
   - Interlinking WII with credit seems to have potential to increase production inputs and shift risk, but it is a time consuming process. Promising way to go.

- **Insurance, like credit, is a time-inconsistent contract.**
  - Building trust and explaining a complex product clearly are difficult, but necessary.
  - The only evidence in our data of actual willingness to pay for insurance is in the group that had it directly explained to them face-to-face.
  - Outreach & training are under-appreciated pieces of the index insurance puzzle.