





Evidence in Agriculture: Risk

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- . Quick Intro: ATAI and RCTs for Policy
- II. Risk as constraint to ag tech adoption
- III. RCT evidence on risk mitigation
- IV. Ethiopia case study with FAO
- V. Conclusion



Motivation

Agricultural technologies exist that can

- boost productivity
- increase profits
- fortify the food supply



We've seen a "Green Revolution," yet agricultural productivity was not transformed everywhere.

- When technology adoption fails -- Why? What policy levers can help?
- How can we improve smallholder farmers' profits and welfare?

Data Source: World Development Indicators, FAO via the World Bank



Q: What helps and what hinders smallholder farmers' **adoption** of technologies and access to markets?

Which approaches **impact** farmer profits and welfare?

- A: ...well, let's tackle this scientifically
 - → Review available evidence: identify key research needs since 2009
 - → Mobilize research networks: "clearinghouse" rather than consultant model, fund competitively-selected, high-quality randomized evaluations
 - → Share findings: inform relevant decisionmaking

Randomized Controlled Trials (RCTs)



RCTs: one type of impact evaluation

Types of Impact Evaluations

Other methods include:

- Pre-post
- Difference in difference
- Matching
- Instrumental Variables
- Regression Discontinuity



Time

These non-experimental methods rely on being able to "mimic" the counterfactual under certain assumptions

Randomization can "construct" a counterfactual with measurable outcomes

Non-random assignment

Randomized evaluations provide a highly rigorous estimate of program impact

Before the program starts, eligible individuals are randomly assigned to two or more groups so that they are statistically identical before the program.

Random assignment

RCTs for Policy

Impact research important to identify "causality"

- Lessons for program and policy design
- Supports results-based management of investments

RCTs have become a widely used methodology

- Not only an academic approach
- Strong demand by development partners (CGIAR, NARS, One Acre Fund, matchmaking exercises)

RCTs in economics help in particular understand the role of behavior and institutions (agricultural systems) in program/policy outcomes.

Inefficiencies constraining ag tech adoption

- 1. Credit markets
- 2. Risk
- 3. Information
- 4. Externalities
- 5. Input and output markets
- 6. Labor markets
- 7. Land markets

Preview: risk

Risk matters

- Most investments in improved inputs increase the financial risks of farming
- Farmers make conservative production decisions to self-insure

Some potential solutions to risk:

- 1. Financial instruments: Weather Index Insurance (WII)
 - Low demand for micro-insurance, in particular weather index insurance
- 2. Technology that structurally decreases risks
 - Risk-mitigating crops, irrigation: Promising early results on risk-mitigating crops
- 3. Credit products with (explicit or implicit) limited liability in case of weather shocks
- 4. Public sector safety nets

How does risk constrain adoption?

- Agriculture is inherently risky activity
 - Weather and disease risks are aggregate, affecting all farmers in geographic area
- Farmers may lose large portion of harvest to extreme weather event
- Without any way to mitigate or insure risks, investment in crops or technologies appears to be an unsafe gamble
 - Higher-value crops may also be more sensitive to weather
- Exacerbated by risk aversion and ambiguity aversion

Protecting farmers through formal insurance

- Agricultural insurance to hedge risk ubiquitous in developed countries
 - Large number of small farmers, poor regulatory environments make most traditional products ill-suited to smallholders
- Weather index insurance as innovation to insure smallholders
 - Payouts made on observable variable (e.g. rainfall)
 - Avoids some disadvantages of conventional insurance: lengthy claims process, adverse selection, moral hazard
 - But has basis risk: official observation does not accurately predict farmers' losses

Stylized index insurance payout schedule

Rainfall (mm)

Major drawback to index insurance: basis risk

STYLIZED DEPICTION OF BASIS RISK

CHRISTINA TORRES, LUIS PRADO | THE NOUN PROJECT

A decade of experimentation on weather index insurance

- 10 randomized evaluations in various contexts
 - India, Ethiopia, Ghana, Malawi
 - Differences in crops insured, conditions that triggered payout, etc.
 - Effects of discounts, other encouragements to purchase insurance
 - Effects on production decisions

Demand was low at market prices but increased with large discounts

Karlan et al 2013; Mobarak & Rosenzweig 2012; "Make it Rain"

Insured farmers took more risks on their farms

- When given subsidized insurance, farmers took on greater production risks
 - Andhra Pradesh: Fewer subsistence crops, more cash crops
 - Ghana: More land planted to maize, greater fertilizer use
 - Tamil Nadu: Shift from drought-tolerant varieties to high-yield varieties
 - China: Insurance for sows caused farmers to move into this risky but highly profitable crop
 - Mexico (CADENA): insured farmers plant more the year after a shock than non-insured farmers
 - Kenya (IBLI): insurance helps pastoralists avoid decapitalizing livestock in response to drought

<u>Cai et al. 2015; Cai 2013; Cole et al 2014; Karlan et al. 2013; Mobarak & Rosenzweig 2014; de Janvry et al 2016;</u> Janzen & Carter 2013

Can we viably improve demand?

- Marketing & Training?
- Price Subsidies?
- Interlinking with Credit?

Variations on training, marketing, and product design had modest effects on take-up

- Relatively low take-up with video and flyer marketing
- Financial literacy training
 - Increased take-up
 - Not cost-effective
- Trust and experiential learning
 - Mixed results on endorsements
 - Observing payouts over time increased take-up (converse also true)
- Group risk-sharing
 - Some evidence that presence of informal risk-sharing networks increased demand

Cole et al 2014; Dercon et al, 2014; Gaurav et al 2011; Karlan et al 2014; Mobarak & Rosenzweig 2012

Dynamic effects of subsidies

- Lots of evidence from other products that temporary subsidies can have durable effects on demand:
 - Anti-malarial bednets (Dupas 2015)
 - Fertilizer use (Carter et al. 2014)
- Numerous studies have randomized subsidies for WII
 - Some dynamic effect of subsidies, but pronounced only when payouts occur in subsidized products.
 - Interest in designing 'optimal' subsidies to reach adoption target (de Janvry et al. 2015).

Dynamic effects of subsidies

- No evidence that temporary subsidies will 'kick-start' a private market and become unnecessary thereafter.
- So while subsidized insurance appears to have a large effect on farmer behavior, the market won't work without subsidies.
- So: is there a welfare case to be made for perpetual subsidies to WII?

Cash vs. Free Insurance

- Once we start to think of subsidies as a permanent necessity in WII markets,
 - Is it better to simply provide Unconditional Cash Transfers than it is to distribute the same resources in the form of free/subsidized premiums for WII?
- Fortunately, this experiment has been performed by Karlan et al. (2013) in Ghana:
 - Two-armed trial distributes cash for input purchases versus free WII.
 - Provide theoretical justification for why WII might work better: To the extent that risk is the operative constraint for investment, WII can 'unlock' farmers' own capital by giving them the confidence to invest in inputs.

Cash vs. Premiums

- Current debate in social protection about UCTs versus various types of conditional cash transfers.
- Distributing free insurance premiums can be thought of as providing a very specific type of CCT:

'If your crops fail, we will provide you with a cash transfer'

- The underlying logic for this is that the release of risk constraints allow farmers to move toward pure profit maximization as farming decision-makers.
- Links WII to social protection.

- Substantial shift into risky production in several studies when individuals are provided with subsidized WII.
- This means that the agricultural system as a whole has greater sensitivity to rainfall.
- Landless laborers, who are the most vulnerable, see higher wage sensitivity to rainfall when farmers are using WII.

Figure 4: Lowess-Smoothed Relationship Between Log Per-Acre Output Value and Log Rain per Day in the *Khatif* Season, by Insurance Treatment

Crop output in insured villages loses the 'normal is best' curvature and becomes monotonically responsive to rainfall

Mobarak & Rosenzweig 2014

Consequently, the amount of labor hired in insured villages responds strongly to rainfall

Mobarak & Rosenzweig 2014

The figure shows the increase in harvest labor demand among insured cultivators (relative to the uninsured) for different values of the 2011 rainfall shock, as predicted by the Labor Demand equation estimated in Table 4, Column 2. The 2011 rainfall shock in our sample of villages varied between a 3.57 mm per day rain deficit (relative to long-run rainfall average) to a 11 mm per day rain surplus.

This means that agricultural laborers are made more vulnerable if only agricultural producers adopt WII and therefore deepen their structural exposure to weather.

Mobarak & Rosenzweig 2014

Conclusions on WII

- Still clear that risk is a major constraint for smallholder farmers
- However low demand means weather index insurance is unlikely to thrive as a standalone individual commercial product
 - Price, distrust, lack of financial literacy, basis risk
- When farmers have insurance, they take more risks on their farms
 - This is good for average yields but exposes laborers to additional income risk
- So where do we go from here?

Linking WII to Social Safety Nets

- Public-private partnerships for Risk Layering (Carter 2011)
- When not explicitly combined, public-sector programs such as Ethiopia's PSNP crowd out demand for WII (Duru 2015).
 - However, if private sector WII isn't viable, this is not a major downside.
- Safety net programs also expose governments to potentially huge weatherrelated risk.
 - Governments should use reinsurance themselves?
 - Transfer huge and unexpected liabilities into a predictable flow of costs for public sector.
 - Mexico's CADENA program.
- WII appears to be a way of providing safety nets without problems of clientelistic demands & soft budget constraints, but may be hard to achieve this in practice.

An alternative: risk-mitigating crops and technologies

- Agricultural R&D on varieties that tolerate flood, drought, salinity
 - Increasingly important with climate change
- Swarna-Sub1 is a flood-tolerant rice variety
 - No yield penalty in normal conditions
 - Researchers tested effect in reallife conditions in Odisha, India

Flood tolerant rice

JARDSON A., NESTOR ARELLANO, B. AGUSTÍN AMENÁBAR LARRAÍN, LUIS PRADO, NOUNPROJECT.COM

Dar et al 2015

Farmers given Swarna-Sub1 invested more

- More investment...
 - Cultivated more land
 - Used more fertilizer
 - Adopted improved planting techniques
 - Adjusted their savings and credit decisions
- ... led to higher yields and higher revenues.
 - Increased rice yields in years with and without floods
 - Higher yields led to increased revenues and productive investments

Scale-up would benefit marginalized populations the most

Note: Error bars represent 95% confidence intervals. Stars (*) note statistical significance from control group.

Interlinking WII with credit

- Why not address both credit and risk constraints simultaneously?
 - Demand side: Alleviate risk rationing and bring more individuals into the credit market
 - Supply side: Crowd in credit supply if portfolio exposure to weather risk limits lending
- Problematic in practice:
 - 'culture of repayment'; very hard to maintain repayment rates once conditionality of repayment has been introduced.

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 weatherexposed 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.

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.

Virtually no market demand, vouchers work

Round 1:	All				
Uptake Rate:	0				
Round 2:	All				
Uptake Rate:	0				
		Coop M	lembers:	Non-Coop	Members:
	No				
	Vouch	Standalone	Interlinked	Standalone	Interlinked
Round 3:	er:	Voucher:	Voucher	Voucher:	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					

No dynamic benefits of subsidies.

	Covere	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

	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

Very little impact of being insured on input use

- 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.

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 fertilize,r 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.

Impact of EEA Baseline Promotion. 3.

	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. _

Narrative impacts in Feres Wega, where interlinked insurance was sold:

•

					Number
	Number	%	Number	%	with No
Input:	Increasing	Increasing	Decreasing	Decreasing	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

Reported Changes in Input Use:

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

EPIICA 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.

Summary: Risk

- Risk is a constraint for smallholder farmers
- Commercial index insurance targeted directly at farmers unlikely to solve the problem
 - Price, distrust, lack of financial literacy, basis risk
- Alternatives to help farmers manage risk
 - Rethink insurance: provide subsidized policies as an alternative to cash transfers
 - Sell to institutions such as ag lenders
 - Promising preliminary results on risk-mitigating crops

Thank you!

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