Index Insurance: Promising Institutional Innovation?

AFEPA 2011 Summer School
Thursday Afternoon

Risk and Poverty Traps

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- When insurance markets don't exist, risk can lead to poverty traps via three avenues:
  - Ex-Post asset reduction;
  - Costly ex-ante risk reduction (income smoothing);
  - Negative spillovers to credit markets;
    - Reduced supply;
    - Reduced demand.
- Thus strong insurance markets are critical for poverty reduction.

Asymmetric Information and Insurance

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- Insurance contracts trade resources across states of nature
  - If farmer's harvest fails (bad state of nature), insurer pays farmer;
  - If farmer's harvest succeeds (good state of nature) insurance company keeps the premium.
- Insurer's profitability thus depends on the probability he must pay out a claim;
- This probability depends on:
  - How risky the farmer is (i.e., his risk "type").
  - What the farmer does to reduce risk of harvest failure (i.e., his "actions").
- Problem: Insurer (just like a lender) may not be able to get full information about "types" and "actions".

Moral Hazard

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- Insurer cannot observe farmer's farm management practices (hidden actions).
- Conflict of interest thus exists:
  - More intensive farm management reduces risk of crop failure;
  - But more intensive management is more costly to the farmer.
- Incentive problem:
  - The greater is the insurance coverage;
  - The less incentive the farmer has to intensively manage;
  - Thus probability of crop failure increases;
  - And probability of insurance company making payout increases
- If this incentive problem is severe, insurance companies will be willing to provide only partial – or perhaps no insurance at all.

Adverse Selection

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- Insurer cannot observe the true riskiness (risk profile) of the farmer;
- If insurer charges a premium based on average riskiness across farmers then:
  - Premium will be too low for High Risk farmers;
  - Premium will be too high for Low Risk farmers;
- If both types stay in the market, then we're o.k. (kind of)
  - High risk types are very happy;
  - Low risk types not as happy;
  - Low risk types "cross-subsidize" high risk types.
- BUT: Low risk types may drop out of the market
  - Insurer left with only High risk types…thus lose money
  - May decide not to offer any insurance at all!

Institutional Responses

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- Informal Risk sharing arrangements
- Formal insurance: Deductibles and Co-payments
- Index insurance

Informal Risk Sharing Arrangements (IRSA)

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- Local people (family, friends, villagers) have good information about each others'
  - Types
  - Actions
- Thus they can insure each other:
  - If I've had a good year then I contribute some money into the common "pot"
  - If I've had a bad year then I can withdraw money from the common "pot"
  - Goal is to minimize consumption variability (maximize consumption smoothing).

Limitations to Informal Risk Sharing?

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- Information is not perfect (moral hazard 1);
- Enforcement can be a problem (moral hazard 2);
- Good for *idiosyncratic* risks but not very useful against *covariate* risks

Conventional (formal) Crop Insurance

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- …to blackboard…

Limitations to Conventional Crop Insurance

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- Cost of insuring crops tends to be prohibitively high for a agriculture … especially in developing countries.
- Even with deductibles, requires minimum level of ex-ante information (history of each farmers' yields…)
  - This information tends not to exist in developing countries.
- Ex-post verification of damages is very high cost
  - Agriculture is spatially disperse + Poor road infrastructure → verifying farmers' yields is very expensive.
- Even in developing countries, cost is so high that it requires massive subsidies
  - US government provides 60% subsidy to premium!
  - Developing country governments don't have this type of money.

Verifying crop losses in Ecuador

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Summary thus far…

- In the absence of insurance, risk can be exceptionally damaging…leading to poverty traps.
- Information barriers and transaction costs make formal insurance very expensive and, more often, non-existent.
- Self-insurance and IFRSA's can partially mitigate the adverse consequences of risk…but only partially.
- So we clearly need some major innovations in thinking about insurance!!

Index Insurance to the Rescue?

What is Index Insurance?

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- Start with conventional crop insurance
  - Insurance payout is based on the yields ***on the insured farmer's farm***.
  - If damages are above a certain amount (i.e., individual's yield is low), then the insurance company makes a payout.
- In contrast, in an ***Index Insurance*** contract:
  - Insurance payouts are based on an external index.
  - Index is *correlated* with farmers' yields but *exogenous* to (i.e., independent of) the farmer's characteristics and actions.
  - Indemnity payment made to farmer when the index falls below a critical level (called the "strikepoint").
  - Primary objective is to mitigate *covariate risk* (i.e., risks that simultaneously affect many farmers in a region).

A bit more formally…

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- …to blackboard…

What are common indices?

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- Weather events:
  - Rainfall
  - Air temperature,
  - Surface-water temperature (El Niño).
- Satellite imagery (vegetative index).
  - Kenya Pilot
- Area yields (avg. yields in a specified area).
- Do these indices meet the criteria for a good index?
  - Correlated with individual farmers' yields
  - Exogenous to individual farmers' yields.

Other Examples of Index Insurance

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- Table from: "Poverty traps and index based risk transfer products" Skees, Barrett and Barnett, *World Development*, 2009.

Advantages of Index Insurance

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- Protects against covariate shocks …which are the major source of risk to farmers.
- No moral hazard or adverse selection: Index is not affected by actions or characteristics of farmers.
- Low-cost: Does not require assessment of individual losses.
- Can work at multiple-levels: Index insurance contracts can be designed for individual farmers, institutions, regional governments, … national governments.

Challenges to Index Insurance

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- **Data availability**
  - Do there exist data of sufficient quantity and quality?
- **Value**
  - Is the index tightly correlated with farmer's yields?
  - If not → "Basis" risk reduces value to farmer
  - **Basis risk**:
    - The risk that a farmer has low yields but the index is high.
    - Thus farmer needs an indemnity payment, but does not receive one.
- **Institutions**
  - Are there any institutions willing and able to market and deliver insurance to small farmers?

Challenges to Index Insurance

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- Data availability
- Value
- Institutions
- **Comprehension**
  - Even if all of the above challenges are met, sustainability requires clear understanding of costs and benefits by the farmer.
  - Under-estimating value → low demand now
  - Over-estimating value → conflict and future collapse
- Rural poverty complicates comprehension
  - Most small farmers have never had insurance (of any type)

Specific Challenges to Comprehension

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- Insurance is a stochastic product
  - Farmer always pays the premium, but infrequently receives an indemnity payment.
  - If farmer does not understand "preventive" nature of insurance she may become disillusioned if she pays but doesn't receive anything.
- Index insurance implies basis risk
  - Farmer may not receive an indemnity payment even though her yields are low.
  - If farmer does not understand this, she will be angry (expects but not receive payment).
- Insurance has inter-temporal benefits
  - Receiving indemnity payment when conditions are bad prevents negative long-term impacts.
    - Selling-off productive assets (land, livestock).
    - Default → loss of future credit access.
  - Farmer will under-estimate value if these benefits are not considered.

A Pilot Research Project in Peru

Pilot Insurance Project in Peru

- UC-Davis and Instituto de Estudios Peruanos (Financed by USAID)
- General Idea:
  - Create a local (pilot) market for area yield insurance;
  - Identify institutional barriers to offering insurance;
  - Evaluate impacts of insurance on farmers' outcomes
    - Credit rationing, investment, assets, …
  - Generate learning that will help decide whether or not to scale up and, if so, how?
- We started in August, 2008…uptake has been quite low.
- Here I'll discuss
  - Design of insurance contract;
  - Design and implementation of research program;
  - Anticipated and unanticipated challenges (and some solutions)

Context: Pisco Valley, Peru

- 25,000 irrigated hectares
- Dominates by small-holder cotton farmers
  - 3,500 cotton growers
  - 13,000 hectares in cotton
- Principal yield risks
  - Drought
  - Excess rain (el niño years)
  - Temperature and pests
- High variability in average yields

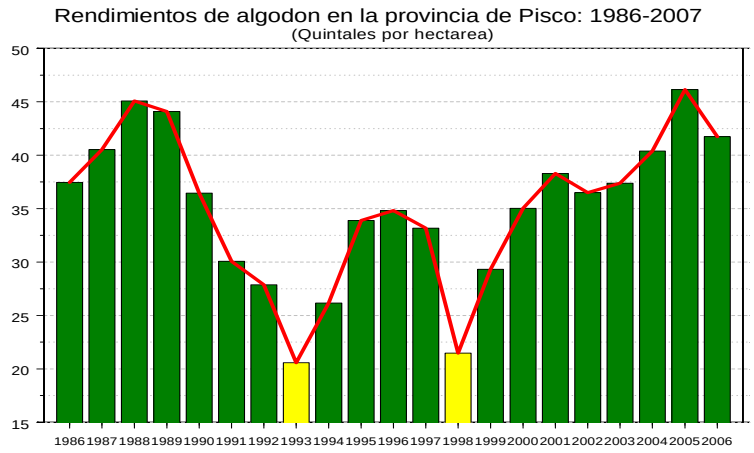
First Step: Choose the Index

- Rainfall?
  - No: There's essentially no rain on Peru's coast
  - Would be insuring low frequency (1 in 13 year) catastrophic event.
  - Hard to start a market with such low frequency payouts.
- Volume of water in river?
  - Hmmm…sounds like a good idea…
  - Surface water in Pisco comes from rainfall & glacial lakes in highlands.
  - Variability in upstream conditions → variability in valley floor yields.
  - Exists 25 years of volumetric river flow measurements on valley floor
  - But correlation between water availability and yields is quite low
  - Why???

- The quality of the data is very low;
- River flows weren't even measured in el Niño years.

- So, we instead decided to use…

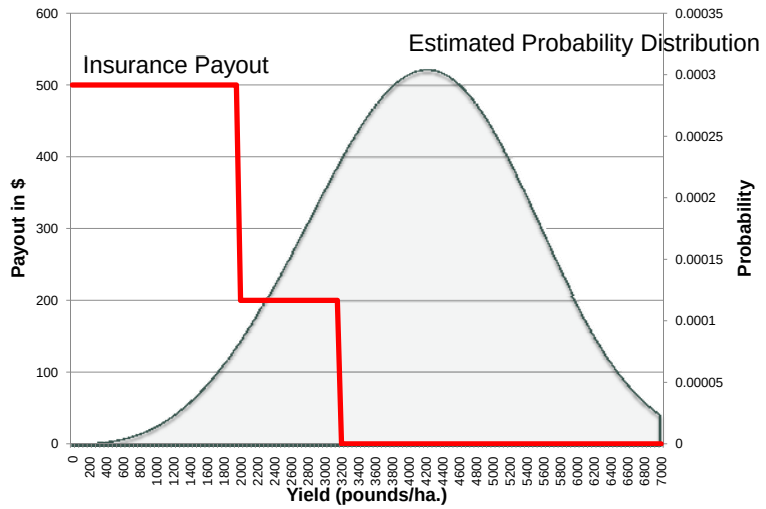
Average Valley Yields



Second Step: Contract Design

- Index is average valley yield;
- Ministry of Agriculture has data from 25 years of annual cotton yield figures for the Province of Pisco
- Use these 25 years of data to statically estimate the pdf (probability distribution function) of area yields for Pisco.
- With pdf, we can calculate the *actuarially fair premium, P,* for any contract.
  - *P* is the premium such that the expected value of payouts made by the insurance company to farmers = the amount of the premium
  - Thus under *P*, insurance company earns zero economic profits.
- Insurance contracts pays:
  - $0 if average valley yield > 3,200 lbs/hectare
  - $200 if average valley yield is between 2,000 – 3,200 lbs/hectare
  - $500 if average valley yield is less than 2,000 lbs/hectare
- Here's what the pdf and contract looks like…

Area Yield Insurance Contract
Pisco, Peru



Index Measurement

- How do we measure yields?
  - Don't want to rely on Ministry of Ag statistics because:
    - Figures released very late (farmers need payout immediately)
    - Farmers may not trust government
- Self-reported yield from random sample of cotton plots throughout the valley.
- Logistics
  - Cotton harvest occurs early May – mid June.
  - 380 plots surveyed between June 15 – June 20
  - Area Yield estimate publicly released on July 1.
  - Indemnities paid by July 15.

Concerns with Area Yield Measure

- Fixed ***Cost*** of Survey
  - $3,000 to run survey and generate yield estimate.
  - For first 4 years cost assumed by researchers.
  - Not prohibitive IF sufficient number of policies sold.
- ***Moral Hazard*** in Reporting
  - Won't farmers intentionally under-report yields to trigger payouts?
  - Perhaps…but not too concerned yet
    - Insured farmers are small portion of surveyed plots (uninsured have no incentive to under-report)
  - As market advances, will need to work more on this
    - Verify with sales receipts from govt. program
- Farmer ***Trust*** in Yield Measurement
  - Worked with Cotton Growers Association and insurer to design survey methodology and choose independent survey firm.

Third Step: Find Institutions to Market and Sell the Insurance

- Insurance Company
  - Many exist in Peru, but none have worked in agriculture
  - 18 months of meetings with APESEG (umbrella organization)

Third Step: Find Institutions to Market and Sell the Insurance

- Insurance Company
  - Many exist in Peru, but none have any history of working in agriculture
  - 18 months of meetings with APESEG (umbrella organization)
  - Finally found an innovative manager, willing to experiment with the ag sector from the insurance company "La Positiva"
- Problem: Lack of trust by farmers
  - Since La Positiva has no history in agriculture, how do we establish trust?
  - Trusty Marjorie and Oxfam weren't available…
  - Insurance sold through local MFI/Bank
  - La Caja Rural Señor de Lúren has a long and respected history of offering financial services (including loans) to small holders throughout Pisco.

Final Institutional & Contract Structure

- Triangular Institutional Structure
  - Insurance registered and provided by: La Positiva
  - Insurance sold by: Caja Rural Señor de Luren
  - Re-insurance provided by: HanoverRe\
- Contract
  - Premium = $47/hectare (3 – 5% of production costs)
    - Actuarially fair premium = $35
    - Plus Loading = $32
    - Minus Government subsidy = $20
- Insurance offered by itself or linked with credit
- Borrowers who buy insurance receive interest rate discount (3.25% en vez de 3.5%).

Payoff Structure

Announced average valley yield (qq/ha.)	Indemnity payment per insured hectare (Soles)
More than 31	0
30 – 30.99	61
29-29.99	186
28-28.99	311
27-27.99	436
26-26.99	561
25-25.99	686
24-24.99	811
23-23.99	935
22-22.99	1,060
21-21.99	1,185
20-20.99	1,310
19-19.99	1,435
Less than 19.99	1,435

Research Design

- Insurance introduced in August 2008 (cotton cycle is september – May).
- All cotton growers in the valley are eligible to buy insurance.
- 800 cotton growers randomly selected for surveys.
- Followed for 4 years;
  - Baseline: Agaust 2008 (recall for 07-08 year)
  - Follow-up surveys in: 2009, 2010, 2011
- Primary questions: What is the impact of insurance on…
  - Credit rationing and participation in credit market?
  - Intensiveness of input use, investment and cotton productivity?
  - Income and consumption?
  - Wealth?

Fundamental Challenge of Imapct Evaluation

- Assume we have an intervention (i.e., index insurance) that gives a program (treatment) to some but not others.
- How do we measure the impact of the intervention on the outcome variables of interest (e.g., income)?
- We need to create a valid ***counter-factual***
  - Counter-factual answers the question: "What would income for our treatment group (insured farmers) have been if they had not received the treatment?"
- How can we create a valid counter-factual?
  - Just use non-treated people (i.e., uninsured farmers)?
  - Not if there are systematic differences between treated and non-treated people!! This would give a biased estimate of the true impact.
- Ideally, we would be able to *randomly* assign farmers to treatment (receive insurance) and control (not receive insurance) groups.
  - This is the idea underlying Randomized Control Trials.
  - Great idea…not easy to do in practice.

How do we create Counterfactual?

- Insurance company and lender not willing to to create conventional "control" group by denying access to a randomly chosen group of cotton farmers in Pisco.
- Difficult to use control group in a nearby valley without insurance because conditions are very different.
- Were willing to use "Encouragement Design"
- Randomly distribute two instruments that:
  - Affect farmers' probability of purchasing insurance;
  - No direct effect on outcome variable;
- Instruments
  - Coupons: Random variation in price of insurance;
  - Information/game sessions: Random variation in exposure to information about the insurance.

First Instrument

- Coupons
  - Randomly distributed coupons to 540 cotton growers:
  - Could only be used if the farmer purchased insurance.

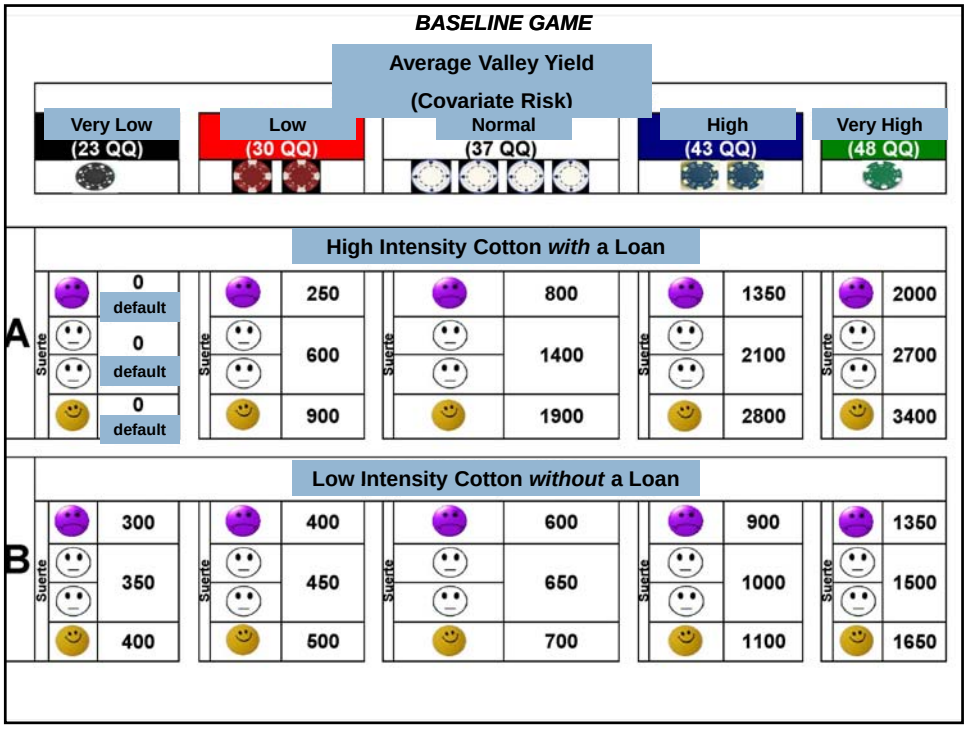
First Instrument

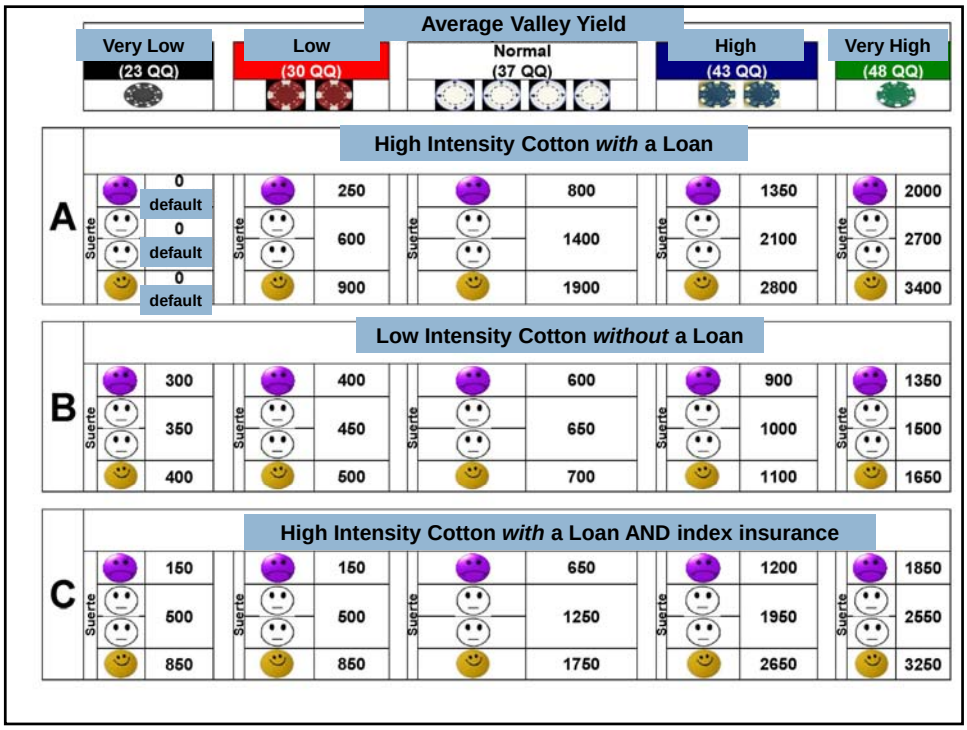
- Coupons
  - We randomly distributed coupons to 540 cotton growers.
  - 4 values: $5, $12, $22, $30 per insured hectare
  - Premium = $47 per hectare
    - Actuarially fair premium (no "loading") = $35
    - $12 coupon → access to actuarially fair insurance
  - We expect (at least in theory) high participation rates for those who receive coupons for $12, $22 y $30.
  - The $22 and $30 coupons actually *increase* expected income.

Second Instrument

- Information/Game Sessions
  - Two objectives
    - Educate farmers so that they make informed demand decisions.
    - Second instrument to help in econometric identification of impacts.
  - Logistics
    - Invitations to "information sessions" distributed to 600 randomly selected farmers.
    - Ran 16 sessions in 16/40 irrigation districts in the valley.
    - First part (90 min.): Farmers played experimental economics games that teach how the contract works (focus on basis risk).
    - Second part (30 min.): Short presentation about the real contract, short marketing video from La Positiva, Q&A session.

Experimental Economics: Willingness to Pay for Index Insurance


BASELINE GAME
Average Valley Yield
(Covariate Risk)
Very Low (23 QQ)
Low (30 QQ)
Normal (37 QQ)
High (43 QQ)
Very High (48 QQ)
High Intensity Cotton with a Loan
A
Suerte
0 default
0 default
0 default
250
600
900
800
1400
1900
1350
2100
2800
2000
2700
3400
Low Intensity Cotton without a Loan
B
300
350
400
400
450
500
600
650
700
900
1000
1100
1350
1500
1650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900
1000
1100
1350
1500
1650
High Intensity Cotton with a Loan AND index insurance
C
150
500
850
150
500
850
650
1250
1750
1200
1950
2650
1850
2550
3250

Covariate Risk Bag

Black chip → Disaster in the valley!!

Everything was ready to go…

- Impact evaluation well thought out and put in place;
- Institutions ready and enthusiastic (Insurer, Lender, Re-insurer);
- Contract formally registered in the Superintendency;
- Product launched on time in August 2008;
- And…
- …Nobody bought it!
  - 2008: 52 policies, 148 hectares
- Made some adjustments to policy and procedures…
  - 2009: 120 policies, 314 hectares
- Further adjustments
  - 2010: 225 policies, 600 hectares
- Why such low takeup initially?? Some hypotheses…

Overlooked key incentive problem with the lender

- Manager of Pisco branch of bank did not fully support the product.
  - Our primary negotiations were with Board of Directors.
  - Board gave vertical order to Pisco manager to implement to insurance.
  - But costs born by Pisco branch;
    - Training of loan agents;
    - Reduction in interest rate reduced (in short run) branch revenues.
- Result:
  - Manager communicated his frustration to the credit agents.
  - Agents – the real face of the product – were very passive in promoting the insurance.

Games & Information Sessions not as Effective as we Hoped?

- Less effective in communicating basic contract structure
  - ~ 25% still thought indemnity depended on individual yields instead of average valley yield (exit survey).
  - Farmers in more productive parts of valley undervalued insurance.
    - Since their yields were very unlikely to fall below strikepoint, they thought that insurance had no value for them.
    - Did not understand that the value of the insurance depends on the degree of *co-movement* between individual and valley (which is high).
- Fundamentally different notion of *average*
  - For us, average yield (*rendimiento promedio*) = statistical mean;
  - For farmers *rendimiento promedio* = potential of their farm (what it should produce in a good year).
  - Result: Farmers under-value the insurance.

Not a Coupon Culture?

- Farmer with largest coupon essentially gets the insurance for free if they take a loan (interest rate discount = premium).
- Why didn't they insure?
- Perhaps they don't understand how the coupon works.
  - In February we will interview all large coupon recipients who did not buy insurance to understand why.

Uncertainty From Public Policy

- Farmers' expectation of public intervention may impede market development.
- During presidential campaign, García pomised that he would provide agricultural insurance;
- Has yet to implement any program but…
- Farmers may prefer not to buy private insurance if there is a possibility that the government will offer a highly subsidies (perhaps even free) insurance program.

Macro Shocks

- 2008: Oil shock
  - Fertilizer prices spiked in august/september 2008
  - Precisely when farmers taking planting decisions
  - Cotton highly dependent on chemical fertilizers
- New trade policy reduced protection for cotton farmers
  - Large increase in textile imports from India;
  - Cotton prices fell 33%
- Implications
  - Farmers focused more on price risk instead of yield risk;
  - Profitability dropped
  - Many farmers switched out of cotton
    - In our sample, 40% did NOT plant cotton last year.
- Chose wrong crop at the wrong time to carry out impact evaluation?

Final Thoughts

- Is the insurance cup half empty or half full?
  - Half Empty: Frustrating Low Takeup
    - Covariate yield risk is a real issue in Pisco
    - 25% of cotton farmers risk rationed
    - Yet farmers reluctant to purchase insurance
    - Many hypotheses about low takeup…much more work needed to separate among them
    - Matthieu (Interaction with Informal Risk Sharing networks).
  - Half Full:
    - Encouraged that private actors (insurer, bank) willing to participate and market was created.
    - Perhaps just need more time and adjustments?

Another empirical study (time permitting)

Insurance, Credit and Technology Adoption: Field Experimental Evidence from Malawi

Xavier Gine
World Bank

Dean Yang
University of Michigan

Technology adoption, risk, and credit

- Key question: Does risk inhibit adoption of new technologies?
- High-yielding varieties have higher yields but may also be riskier
  - So households unwilling to bear fluctuations in their consumption may decide not to adopt
  - Downside risk of adoption may be exacerbated when adoption requires credit
    - Failure of crop is compounded by the consequences of default
- Problem: absent or imperfect insurance

Credit or insurance as the key barrier?

- In observational data, the relative importance of credit constraints and imperfect insurance may be confounded
- Example: widely-observed correlation between wealth and adoption of new technology
  - May be because wealthier farmers have better access to credit
  - But wealthier households may also have better access to (formal and informal) insurance mechanisms

This paper

- A field experiment where insurance was allocated randomly
- Question of interest:

  Does providing insurance against a major source of risk increase farmers' willingness to take out a loan to adopt a new technology?
- Adoption decision: whether or not to take out a loan for improved groundnut and maize seeds

Weather insurance and loan take-up in theory

- Risk-averse farmers choose between traditional seeds, and taking out loan for improved seeds
  - Improved seeds have higher mean yield, but are riskier
  - Consider attractiveness of bundling loan with weather insurance (at actuarially fair rate)
- Loans subject to limited liability: in case of default, lender can only seize the value of production
- Under certain conditions, farmers might

Key partners in project

- Rural lenders
  - Malawi Rural Finance Company (MRFC)
  - Opportunity International Bank of Malawi (OIBM)
- National Smallholder Farmers Association of Malawi (NASFAM)
  - Contact with farmers
- Insurance Association of Malawi
  - Underwrites insurance

Experimental design

- Joint liability loans for “clubs” of 10-15 farmers
  - Participation is individual farmer decision
- Randomization across 32 localities
- **Treatment**: farmers offered hybrid seed loan with insurance against poor rainfall
  - 393 farmers
- **Control**: farmers offered hybrid seed loan only (no insurance)

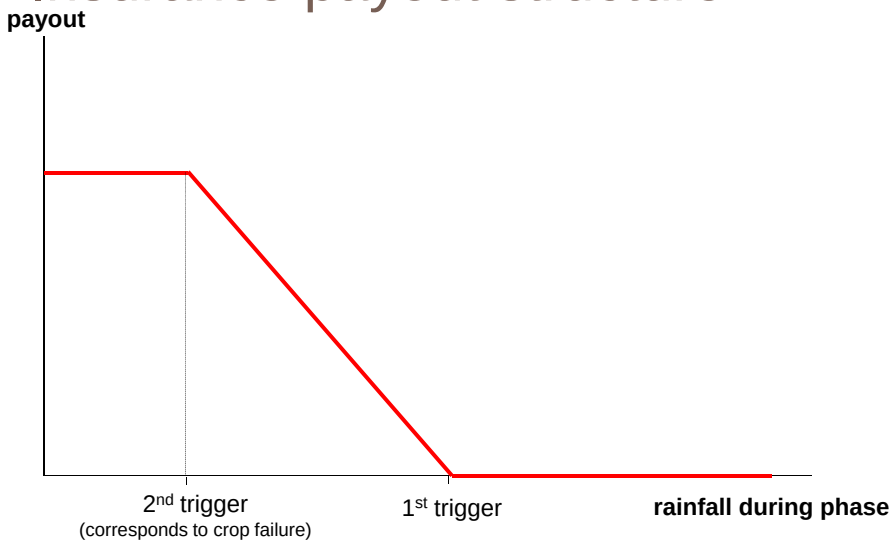
Loan details

- Farmers given option to purchase either groundnut package only, or both groundnut and maize
  - Seeds and fertilizer for planting 1 acre (groundnut) or ½ acre (maize)
  - Initial deposit of 12.5% of principal
  - Repayment due in 10 months
  - 27.5% interest rate (33% annual interest rate x 10/12)
- Maize repayment:
  - Uninsured: $36
  - Insured: $40-$43

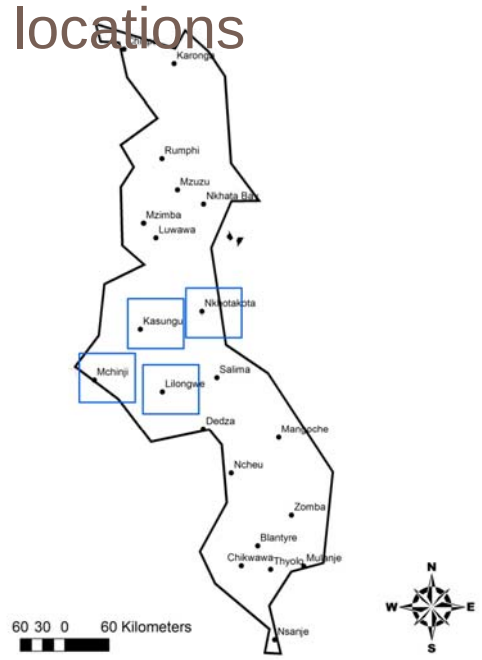
Weather insurance policy

- Farmers insured against poor rainfall as measured at nearest weather station
- Paid continuous amount depending on shortfall below "1st trigger", up to maximum amount for rainfall at or below "2nd trigger"
- Insurance premium = actuarially fair price + 17.5% surtax

Insurance payout structure



Project locations



Simple treatment-control comparison

- Take-up rate for uninsured loan: 33.0%
- Take-up rate for insured loan: 17.6%

Regression specification

- For farmer *i* in group *j*:

$$Y_{ij} = a + bI_j + fX_{ij} + \varepsilon_{ij}$$

  - Y_{ij} = takeup indicator
  - I_j = treatment indicator
  - X_{ij} = vector of control variables (collected at baseline)

- Standard errors reported:
  - clustered at locality level

Impact of insurance on take-up

Table 3: Impact of insurance on take-up of loan for hybrid seeds
(Ordinary least-squares estimates)

Dependent variable: Respondent took up loan for November 2006 planting season

	(1)	(2)	(3)	(4)
Treatment indicator	-0.154	-0.141	-0.132	-0.128
	[0.109]	[0.082]*	[0.082]	[0.074]*
Clustered s.e. p-value:	*0.155*	*0.085*	*0.107*	*0.082*
Bootstrapped p-value:	*0.198*	*0.116*	*0.140*	*0.120*
Region fixed effects		Y	Y	Y
Linear control variables			Y	
Indicators for 5-year age categories				Y
Land quintile indicators				Y
Income quintile indicators				Y
Education quintile indicators				Y
Mean dependent variable	0.253	0.253	0.253	0.253
Observations	787	787	787	787
R-squared	0.03	0.13	0.15	0.17

* significant at 10%; ** significant at 5%; *** significant at 1%

Other potential explanations

- Complexity
- Risk priming
- Differential default cost perceptions

In sum

- Take-up is lower for loans bundled with insurance against poor rainfall (priced actuarially fairly)
  - Compared with identical loans that are uninsured
- Potential explanation:
  - Farmers already implicitly insured by limited liability inherent in loan contract
  - Reduces value of the formal, explicit insurance
- Among farmers offered the insured loan, take-