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

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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 markets

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
- Disentangling the two explanations is crucial to good policymaking
- Needed: exogenous variation in insurance

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 take the uninsured loan if offered, but prefer the status quo (traditional seeds) to the insured loan
 - Basic idea: limited liability provides implicit insurance
 - Insurance premium may exceed benefit from insurance
- Rosenzweig and Wolpin (1993): welfare gain from actuarially-fair weather insurance is minimal

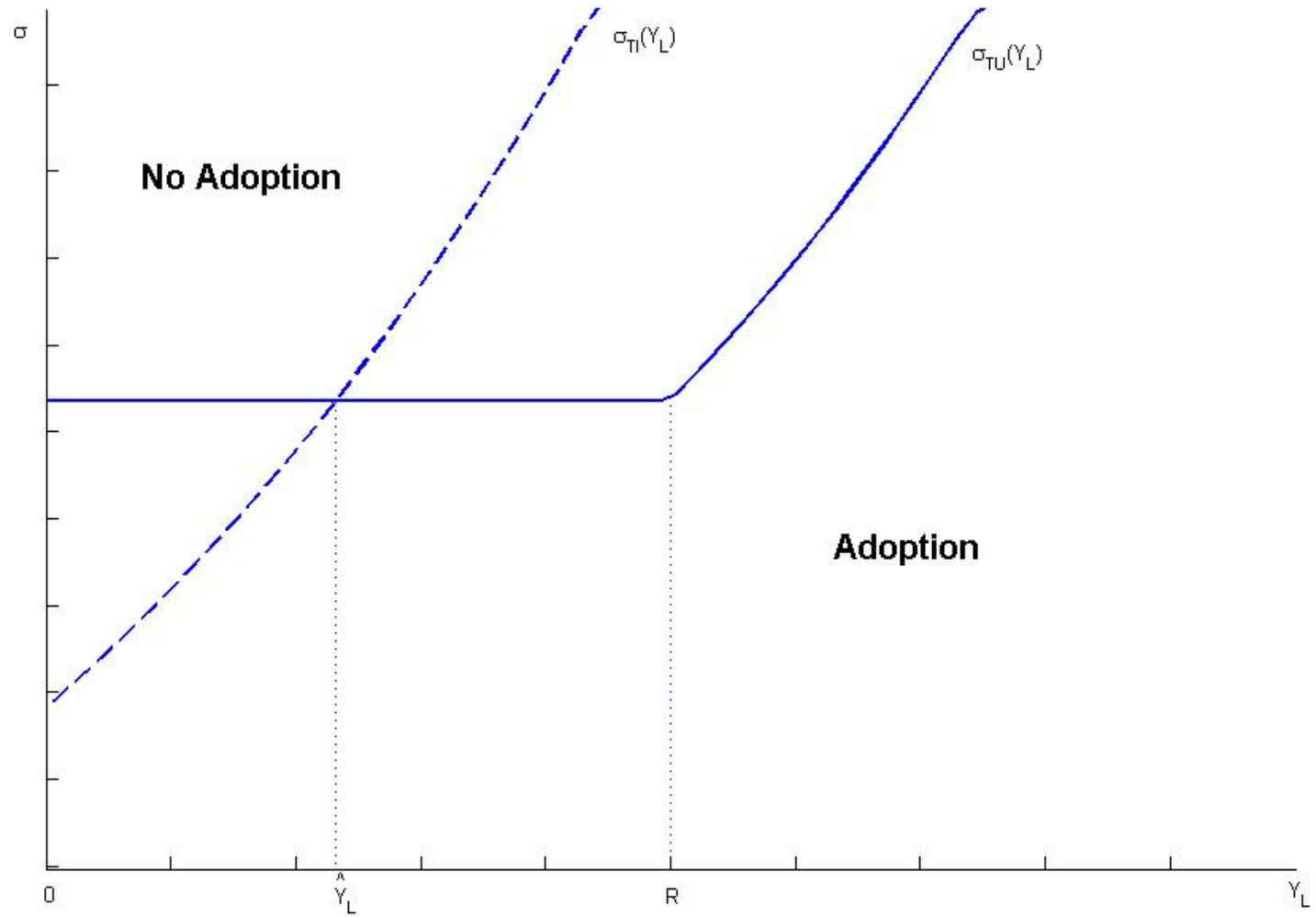
Simple model

- Output from traditional seeds: Y_T
- Output from improved seeds: Y_H, Y_L with probabilities $p, 1-p$
 - Output positively covaries with rainfall
- Farmers are offered loans to purchase improved seeds (repayment R); lender can only confiscate production, but cannot seize assets (so there is a consumption floor)
- CRRA utility: $u(c) = c^{1-\sigma}/(1-\sigma)$
- Farmers are heterogeneous in risk aversion (σ_i) and low-state income from improved seeds ($Y_{L,i}$)
- Some farmers offered loan bundled with actuarially fair rainfall insurance policy (loan forgiven if low state occurs)
- Does rainfall insurance raise loan take-up?

What farmers take up the loan?

- Find coefficient of relative risk aversion $\sigma_{TU}(Y_L)$ such that farmer whose $\sigma_i = \sigma_{TU}$ is indifferent between traditional seeds and uninsured loan for hybrid seeds
 - Farmer takes up the uninsured loan if $\sigma_i < \sigma_{TU}$
- Find analogous cutoff for insured loan, $\sigma_{TI}(Y_L)$
- Cutoffs will be function of income from improved seeds in low state, Y_L
- See Figure 1

Figure 1



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
- World Bank / University of Michigan
 - Technical advice on design of insurance policy
 - Design of randomized evaluation

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)
 - 394 farmers

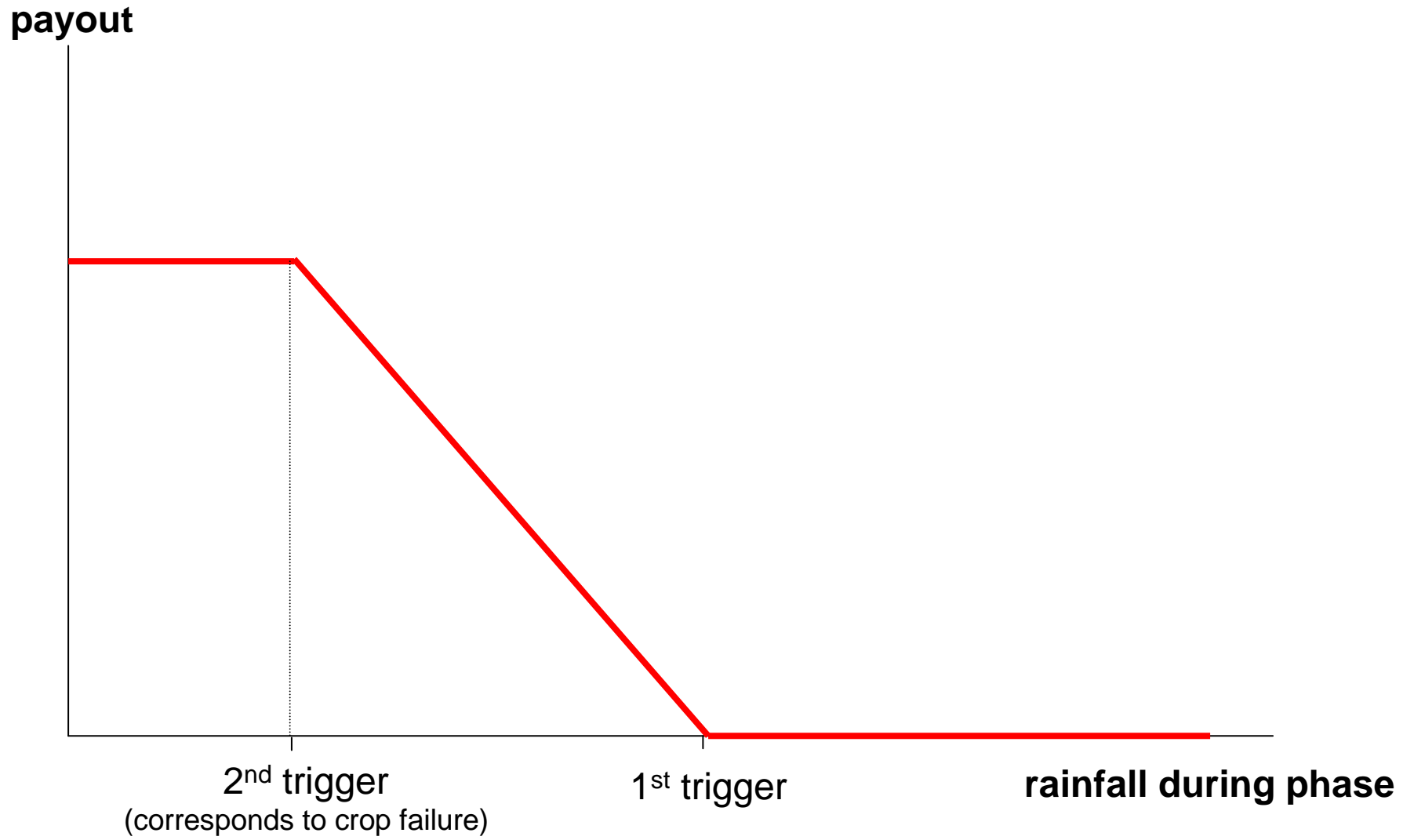
Loan details

- 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
- Groundnut repayment:
 - Uninsured: \$34
 - Insured: \$36-\$38

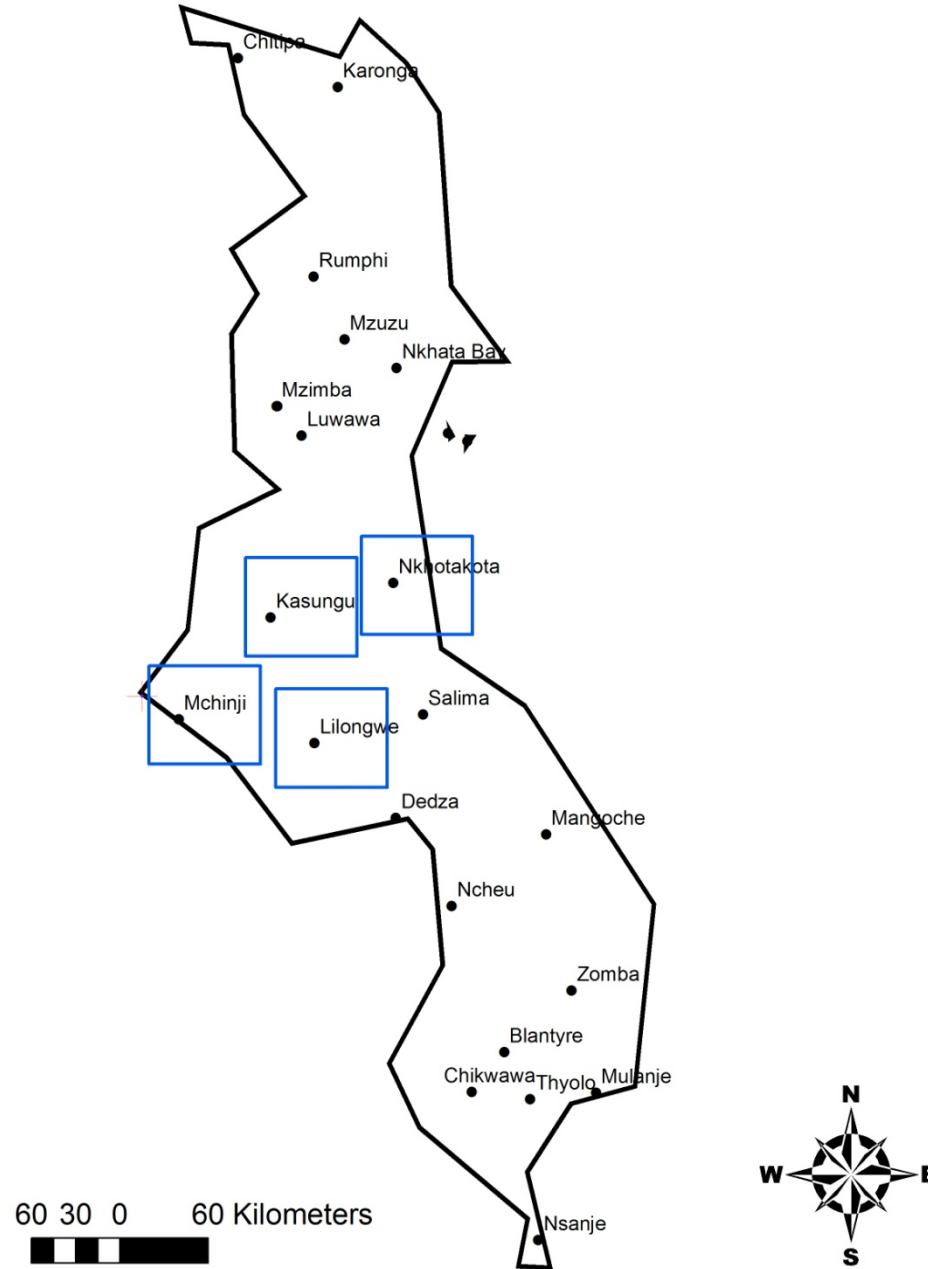
Weather insurance policy

- 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} = takeover indicator
 - I_j = treatment indicator
 - X_{ij} = vector of control variables (collected at baseline)
- Standard errors reported:
 - clustered at locality level
 - bootstrapped

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]*
<i>Clustered s.e. p-value: 0.155</i>		<i>0.085</i>	<i>0.107</i>	<i>0.082</i>
<i>Bootstrapped p-value: 0.198</i>		<i>0.116</i>	<i>0.140</i>	<i>0.120</i>
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%

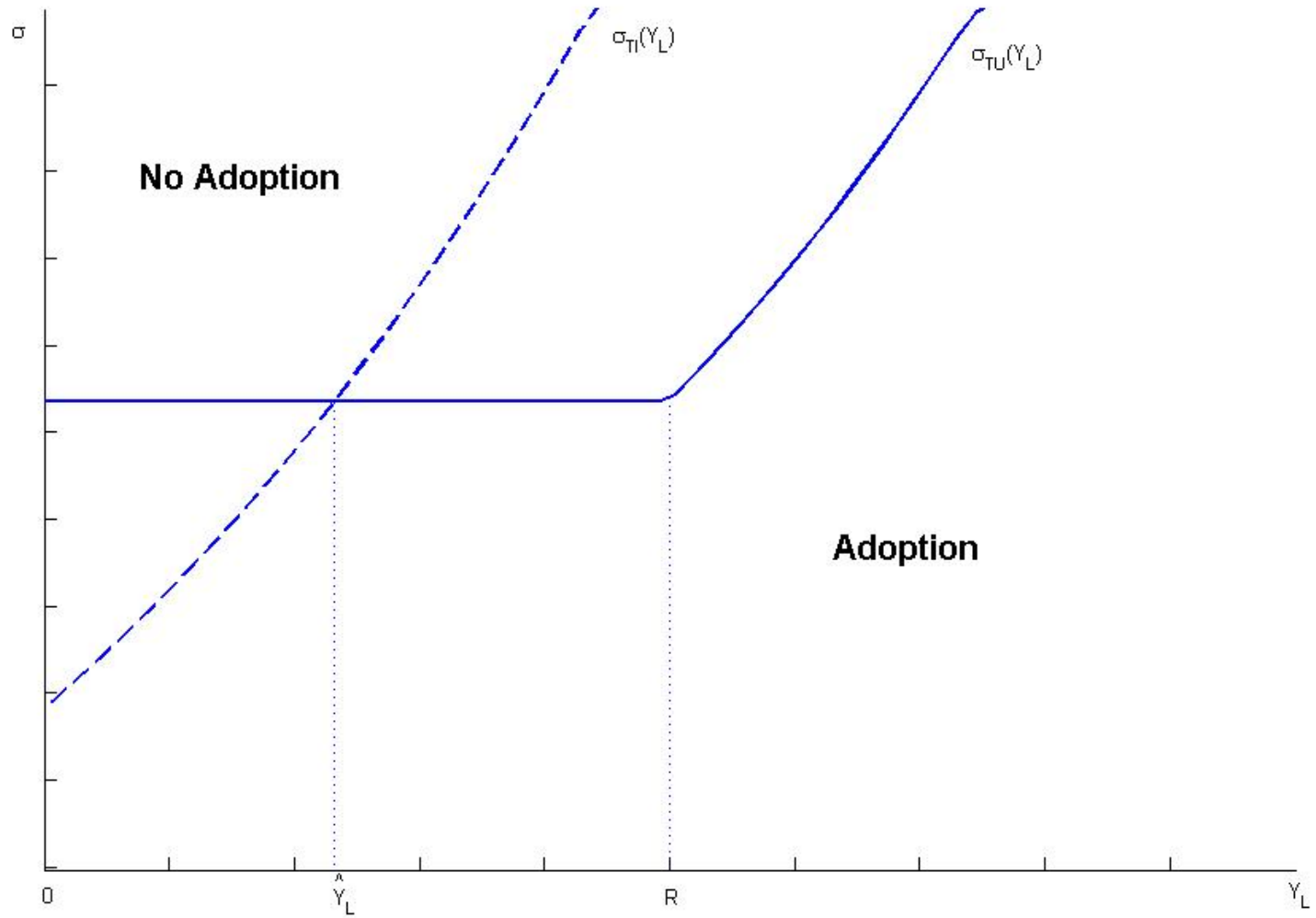
Implied interest rate elasticity

- For a farmer placing zero value on insurance, effective annual interest rates for groundnut loan were:
 - 27.5% for uninsured loan
 - 37.8% to 44.4% for insured loan (varied according to location)
- The 13-percentage-point decline in take-up (from baseline 33.0%) → a 39.4% decline
- Increase in effective interest rate due to insurance: 37.5% to 61.3%
- Implied interest rate elasticity of credit demand ranging from 0.64 to 1.05

Additional testable predictions from theory

- Take-up rates for insured vs. uninsured loan suggest that sample tends to have lower levels of Y_L
- In this range of Y_L , there is another theoretical implication to test:
 - Y_L should be positively correlated with take-up of insured loan
 - But not correlated with take-up of uninsured loan
- But how to measure Y_L ?
 - Assume farmers with higher socio-economic status have higher Y_L
- Regress take-up on education, income, and wealth
 - Separately for farmers offered insured and uninsured loans

Figure 1



Other determinants of take-up

Table 5: Determinants of take-up in treatment and control groups

(Ordinary least-squares estimates)

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

	Treatment group (insured loan)						Control group (uninsured loan)					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Years of schooling	0.014**					0.011*	-0.001					-0.002
	[0.005]					[0.005]	[0.008]					[0.009]
Net income (MK 100,000)		0.098				0.075		0.004				0.003
		[0.059]				[0.053]		[0.010]				[0.010]
House quality			0.041			0.027			0.011			0.011
			[0.027]			[0.030]			[0.022]			[0.022]
Land owned				0.001		0.001				0.001		0.001
				[0.003]		[0.003]				[0.002]		[0.002]
Risk aversion (self-reported)					-0.008	-0.008					-0.015***	-0.015***
					[0.006]	[0.006]					[0.004]	[0.004]
Region fixed effects	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Mean dependent variable	0.176	0.176	0.176	0.176	0.176	1.176	0.330	0.330	0.330	0.330	0.330	0.330
Observations	393	393	393	393	393	393	394	394	394	394	394	394
R-squared	0.074	0.078	0.073	0.058	0.061	0.101	0.274	0.274	0.274	0.274	0.286	0.287

F-stat: Joint signif. of first 4 indep. variables: 3.446

P-value: 0.03

F-stat: Joint signif. of first 4 indep. variables: 0.113

P-value: 0.98

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

Notes -- Standard errors clustered by localities in square brackets. Dependent variable equal to 1 if respondent took up loan for November 2006 planting season, and 0 otherwise. Omitted region indicator is for Kasungu. See Appendix for variable definitions.

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-up is higher among farmers with higher education, income, and wealth
 - But not among farmers offered the uninsured loan
 - Perhaps because higher-status farmers have higher default costs

Ongoing related research

- Current projects continue to examine the nature of constraints that Malawian farmers face in financial markets
- Credit
 - How important are difficulties in enforcement in limiting credit supply in rural areas?
 - In particular, can improvements in identification technology raise loan repayment rates?
- Savings
 - How important are imperfect savings mechanisms in explaining low input use on farms?
 - How important are transactions costs in explaining low utilization of formal savings mechanisms?

Extra slides

Summary statistics

Table 1: Summary statistics

September - October 2006

<u>Variable</u>	<u>Mean</u>	<u>Std. Dev.</u>	<u>Min.</u>	<u>10th pct.</u>	<u>Median</u>	<u>90th pct.</u>	<u>Max.</u>	<u>Num. Obs.</u>
Take-up (indicator)	0.25	0.43	0	0	0	1	1	787
Treatment (indicator)	0.50	0.50	0	0	0	1	1	787
Female (indicator)	0.44	0.50	0	0	0	1	1	787
Household is female headed (indicator)	0.12	0.33	0	0	0	1	1	787
Years of schooling	5.34	3.50	0	0	5	10	12	787
Risk aversion (self-reported)	2.59	3.29	0	0	0	10	10	787
Age	40.64	12.50	13	26	39	58	86	787
Land owned (acres)	7.10	8.32	0	2	5	13	108	787
House quality	-0.03	1.27	-0.91	-0.85	-0.73	2.59	3.10	787
Net income (MK 100,000)	0.26	1.50	-2.15	-0.01	0.09	0.45	37.12	787

Notes -- Data are from the Malawi Technology Adoption and Risk Initiative (MTARI) farm household survey in September - October 2006. All variables refer to respondent or respondent's household. See Appendix for variable definitions.

Comparison of baseline characteristics

Table 2: Differences in means, treatment vs. control group
September - October 2006

<u>Variable</u>	<u>Treatment mean</u>	<u>Control mean</u>	<u>Difference</u>	<u>p-value</u>
Female (indicator)	0.443	0.445	-0.002	0.975
Household is female headed (indicator)	0.125	0.119	0.006	0.852
Years of schooling	4.919	5.760	-0.841*	0.062
Risk aversion (self-reported)	2.632	2.564	0.068	0.779
Age	40.936	40.357	0.579	0.759
Land owned	6.440	7.759	-1.319	0.117
House quality	-0.144	0.087	-0.231	0.228
Net income (MK 100,000)	0.202	0.316	-0.114	0.364

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

Notes -- Table presents means of key variables for treatment group (farmers offered insured loan) and control group (farmers offered uninsured loan) in September - October 2006, prior to treatment. P-value is for F-test of difference in means across treatment and control groups, and accounts for clustering at level of 32 localities. See Appendix for variable definitions.

Alternative null hypotheses

Table 4: Testing against alternative null hypotheses

P-values from test of significance of "Treatment" coefficient vs. alternative null hypotheses

	<u>Regression</u> (coefficient estimates in Table 3)				
	(1)	(2)	(3)	(4)	(5)
<i>Null = 0.05</i>					
<i>Clustered s.e. p-value:</i>	0.060	0.020	0.026	0.016	0.015
<i>Bootstrapped p-value:</i>	0.068	0.056	0.066	0.048	0.048
<i>Null = 0.10</i>					
<i>Clustered s.e. p-value:</i>	0.019	0.003	0.005	0.002	0.002
<i>Bootstrapped p-value:</i>	0.044	0.016	0.024	0.014	0.016

Farmer locations

