Weather-indexed insurance and productivity of small-scale farmers:

An impact evaluation of Mexico's CADENA program

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Motivation

- Rural populations in developing countries face substantial weather risk
  - 23% of Mexico's population lives in rural localities (INEGI)
  - 62% of Mexico's poor live in rural areas (CONAPO)
- Weather index insurance (WII) has recently emerged as a potential tool to address this problem
- Mexico instituted a pioneering WII program (CADENA)
- Evaluating WII as a tool for management of weather risk has important policy implications for other developing countries

Related literature and research question

- Fuchs and Wolff find insured municipalities have higher maize yields, income and expenditures p.c.
- Insured farmers invest in riskier, higher-yielding production methods (Cole et al., Mobarak and Rosenzweig, Karlan et al.)
  - Inputs that are complementary with rain
  - Cash crops
  - Larger overall planting-stage investments
- We are interested in disentangling the effects of investment choices vs. payments
  - We begin by focusing on the effect of payment
  - Should be capturing most liquidity effects — could also include some updating of priors on basis risk

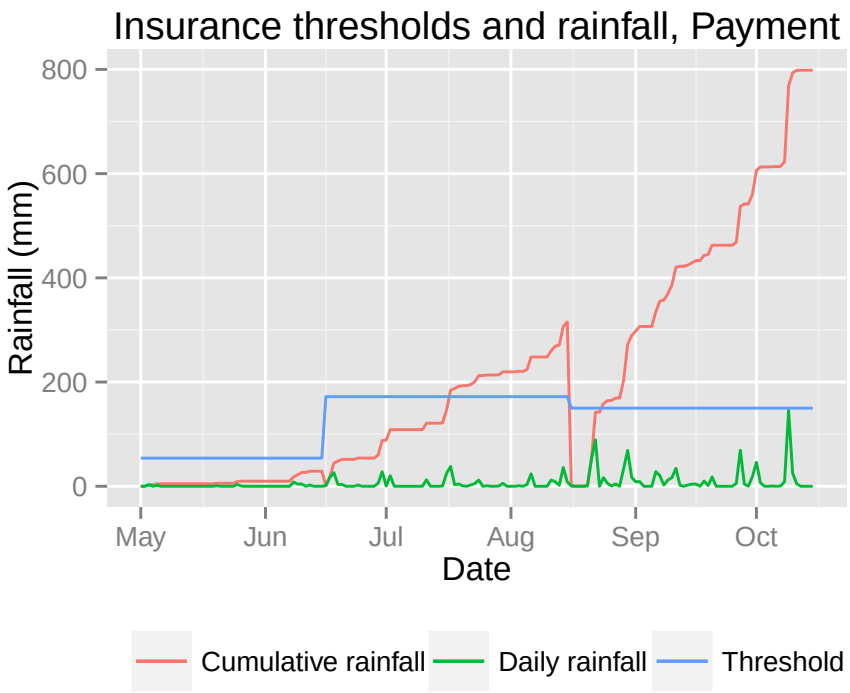
Program details

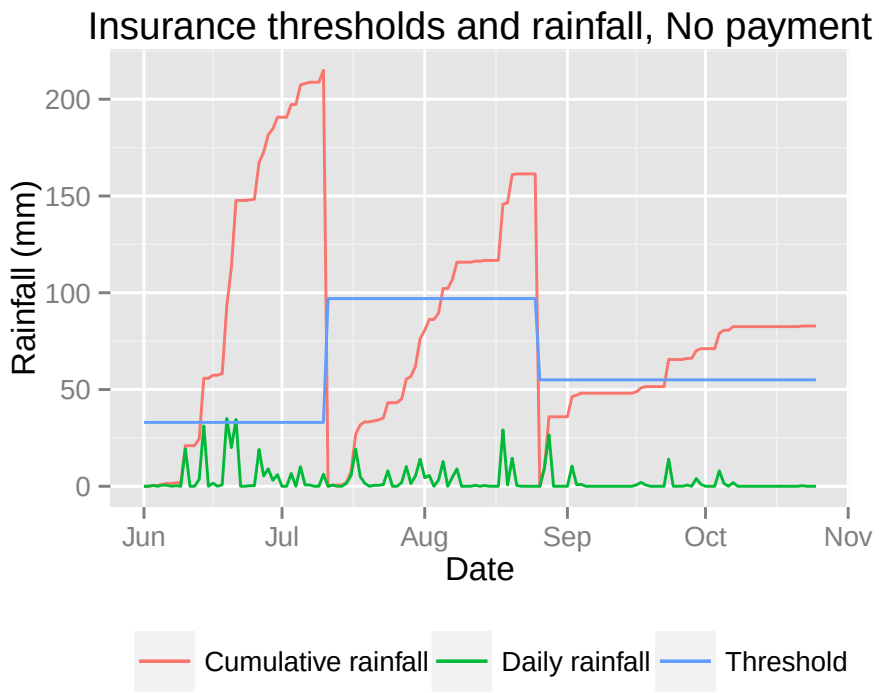
- CADENA began in 2003 and has steadily grown to cover 6 million hectares in 2013 (FAO 2014)
- Offers index insurance for crops and livestock, as well as traditional insurance
  - The focus of this presentation will be agricultural WII
- Premiums are paid by state or federal governments via Ministry of Agriculture (SAGARPA)
- Farmers cultivating insured crops on less than 20 hectares of rainfed land are automatically insured

Insurance design

- WII policies are defined at the weather station-level
- Policies have three defined phases corresponding to sowing through harvest
- Each policy has its own window and threshold corresponding to each of the three phases
  - Phase 1: May/June to June/July
  - Phase 2: June/July to August/Sept
  - Phase 3: August/Sept to Oct/Nov
- If precipitation recorded at corresponding station falls below threshold in any of the three phases, the insurance pays out
  - Payment occurs as soon as rain falls below threshold and insurance is voided for any subsequent periods

Distribution of rainfall by payment status





Data

- Weather station-level precipitation from National Water Commission (CONAGUA)
- Weather station-level insurance policies
  - Dates and threshold for each phase
  - Corresponding municipality
- Municipality-level data of insurance indemnity payments
- National agricultural production data (SIAP)
- Household consumption and expenditure survey (ENIGH - 2008, 2010, 2012)

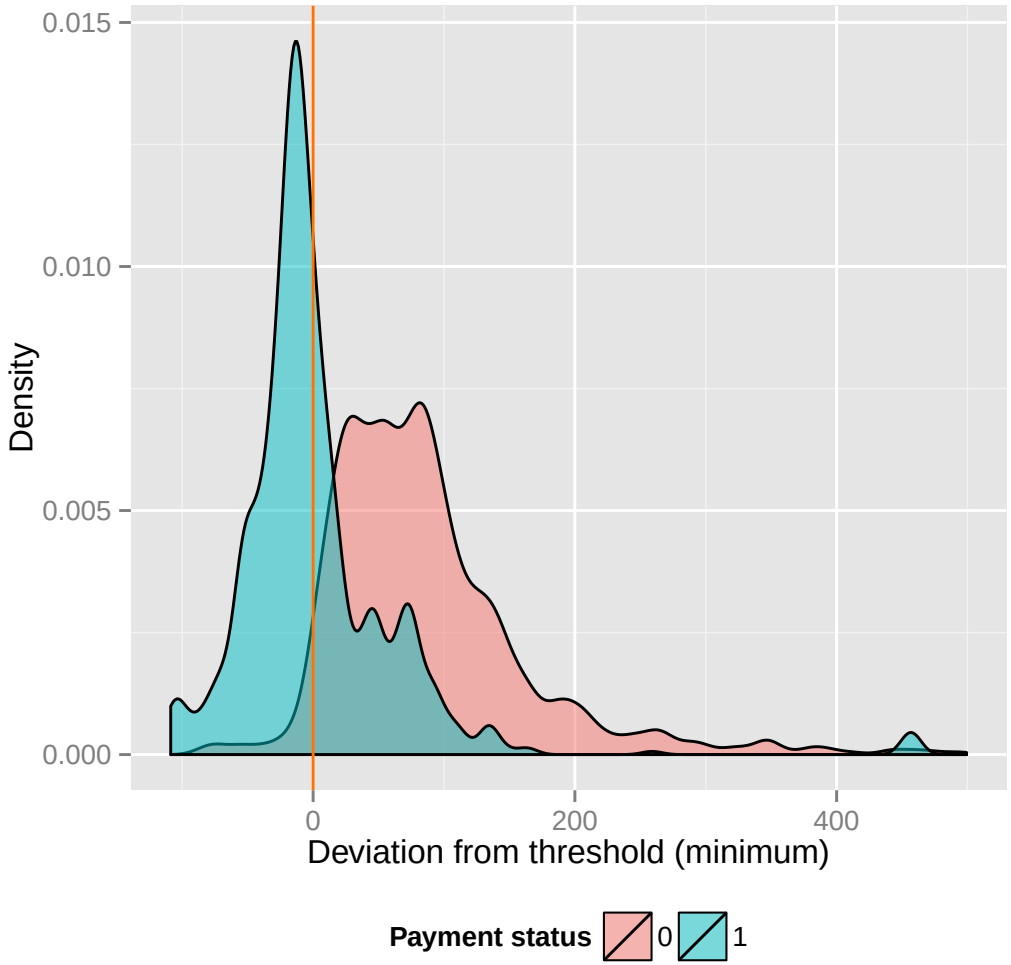
Sample and research design

- WII policies from 2007-2012
- Analyze only drought events
- Policy observations are at the weather station, crop, year, level
- Merged weather station-level policies to municipality-level indemnity payment data
  - Matched on crop, municipality, t+1 year
  - An observation is considered treated (received payment) if the municipality in which it is located receives indemnity payment for the corresponding crop
- We look at impact of payment on agricultural and economic outcomes in t+1 using a regression discontinuity design
- Running variable for RDD is minimum of deviations from threshold across three phases

Summary statistics

Variable	Mean	Std. Dev.	N
CADENA payment = 1	0.135	0.342	2366
Deviation from threshold (mm)	81.265	86.565	2366
Min deviation < 0	0.107	0.31	2366
Δ log maize ha planted	-0.024	0.344	2366
Log maize yield	1.05	0.518	2366
Log ag income p.c.	0.529	1.742	17460
Log income p.c.	8.79	0.875	17460
Log expenditure p.c.	8.76	0.829	17460

Distribution of rainfall by payment status



Reasons for fuzzy RD

- Payments matched at municipality rather than weather station level
- Missing weather data
- Potential misclassification of payment

Fuzzy RD designs

Following Card and and Lee (2008), I estimate

First stage

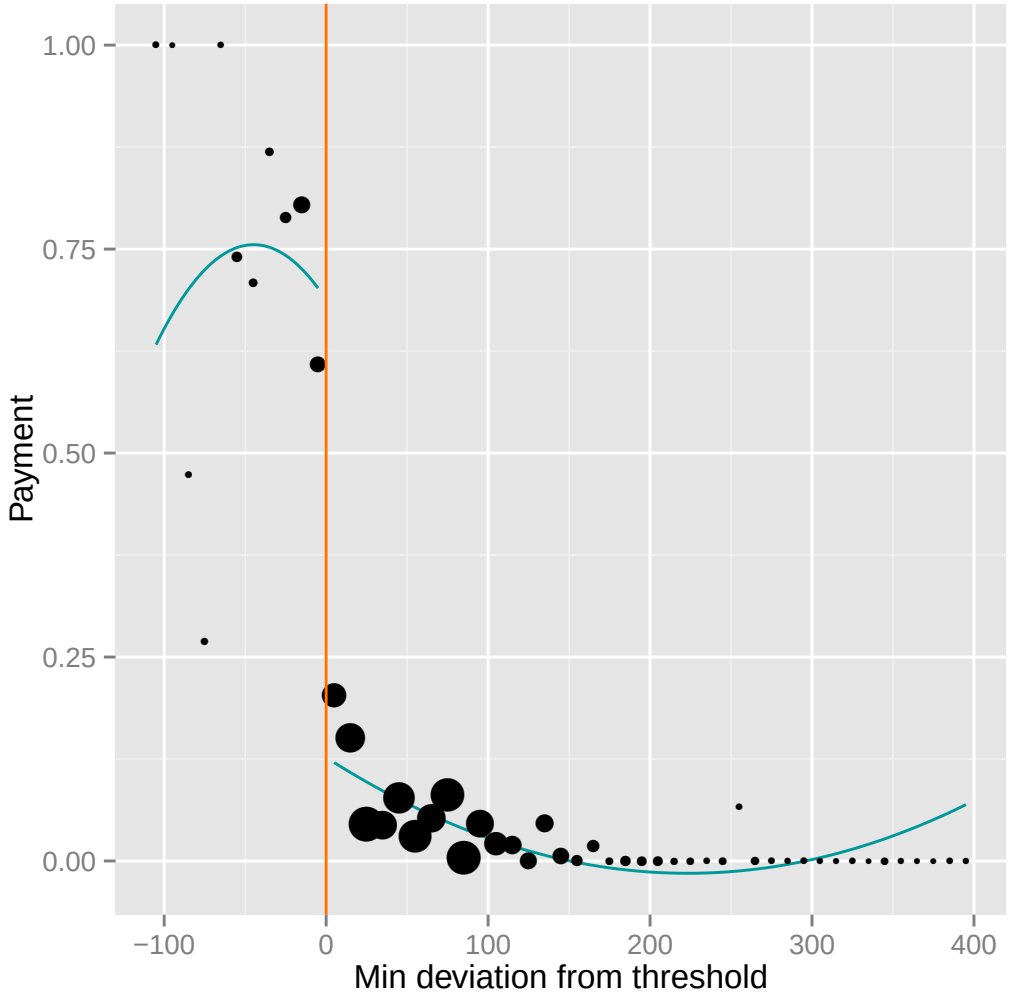
$$Pay_{mct} = \alpha + \beta Z_{mct} + \gamma f(X_{mct}) + \pi f(X_{mct}) \cdot Z_{mct} + \varepsilon_{mct}$$

Second stage

$$y_{mct+1} = \tilde{\alpha} + \tilde{\beta}\widehat{Pay_{mct}} + \tilde{\gamma} f(X_{mct}) + \tilde{\pi} f(X_{mct}) \cdot Z_{mct} + \tilde{\varepsilon}_{mct}$$

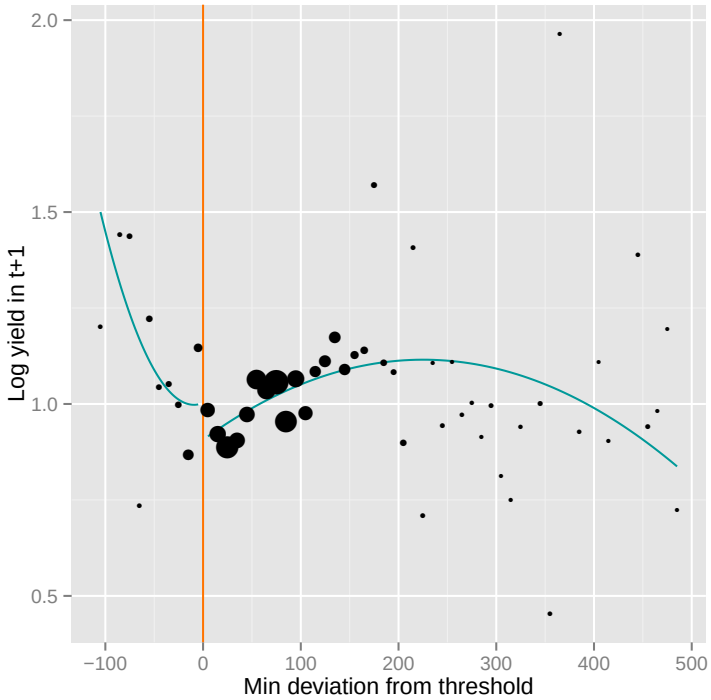
- m = municipality, c=crop, t= year
- $X_{mct} = \min_{s \in \{1,2,3\}} \{Rain_{mst} - Threshold_{mcst}\}$ where s indexes phases
- $Z_{mct} = \mathbf{1}\{X_{mct} < 0\}$
- $Pay_{mct} = \mathbf{1}\{Received\ Payment\}$

Probability of payment by deviation from threshold

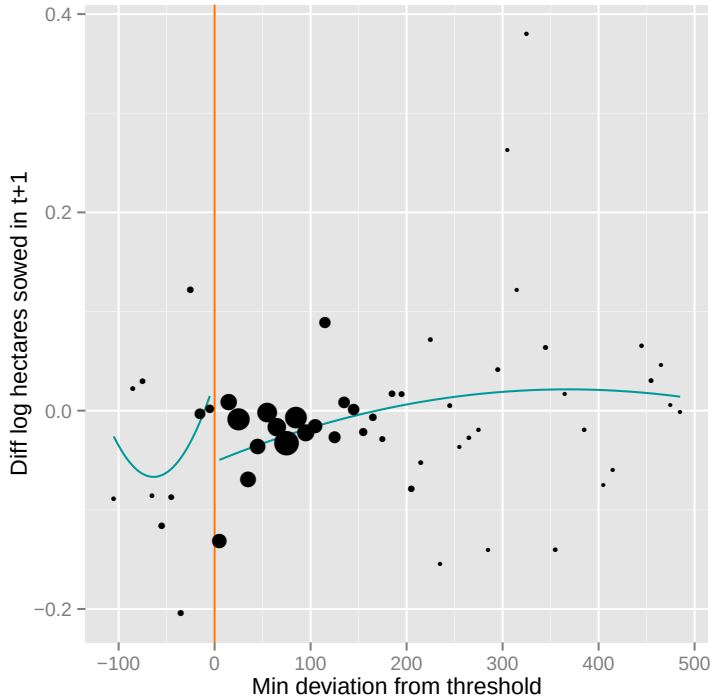


Agricultural outcomes in subsequent year

(a) log maize yield in t+1



(b) Δ log maize ha sowed



Agricultural outcomes in subsequent year, Reduced form

	(1) log maize yield	(2) Δ log ha sowed
Below threshold	0.0729	0.0798*
	(0.0755)	(0.0409)
N	2366	2366

Standard errors are clustered at the municipality level. All specifications include a quadratic polynomial in the running variable.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Agricultural outcomes in subsequent year, 2SLS

	(1) First stage: payment	(2) 2SLS: log maize yield	(3) 2SLS: Δ log ha sowed
Payment		0.160	0.175*
		(0.178)	(0.0935)
Below threshold	0.455***		
	(0.0768)		
F-statistic	18.39		
N	2366	2366	2366

Standard errors are clustered at the municipality level. All specifications include a quadratic polynomial in the running variable. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Agricultural outcomes in subsequent year, Alternate bandwidth

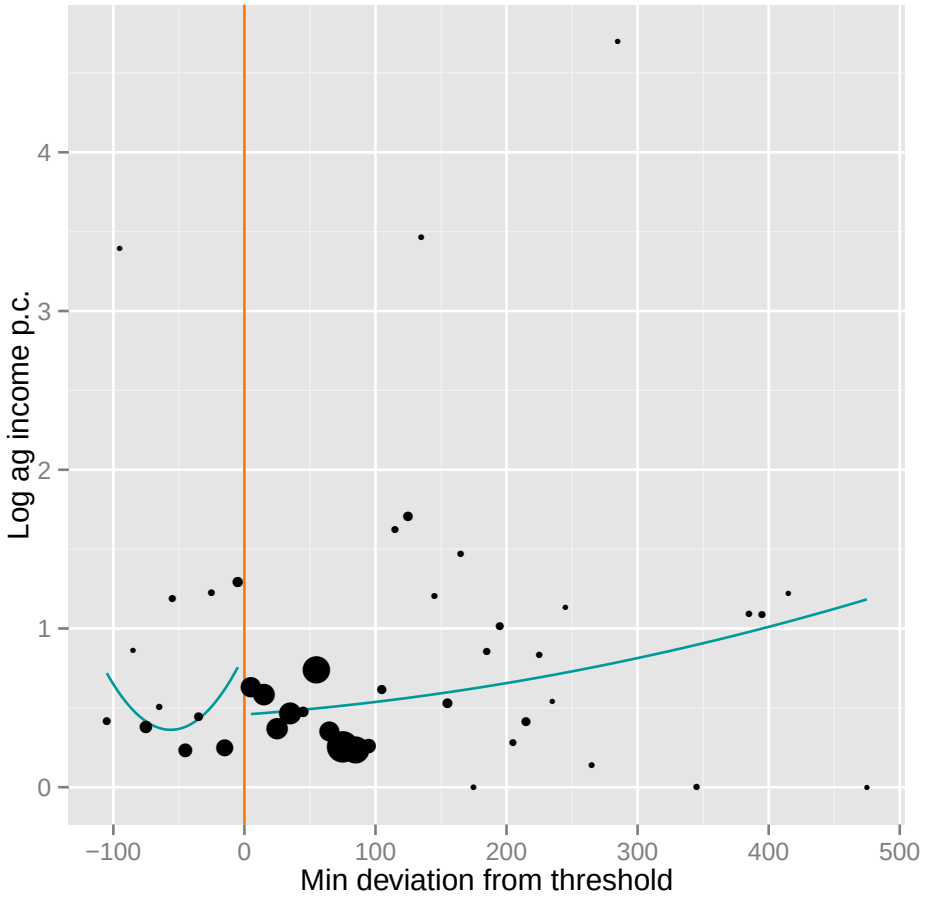
Table : Agricultural outcomes, 2SLS

	(1) BW = 50 Δ log ha sowed	(2) BW = 65 Δ log ha sowed	(3) BW = 80 Δ log ha sowed
Payment	0.538**	0.321**	0.124
	(0.241)	(0.140)	(0.0848)
N	779	1028	1314

Standard errors are clustered at the municipality level. All specifications include a linear function of the running variable. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

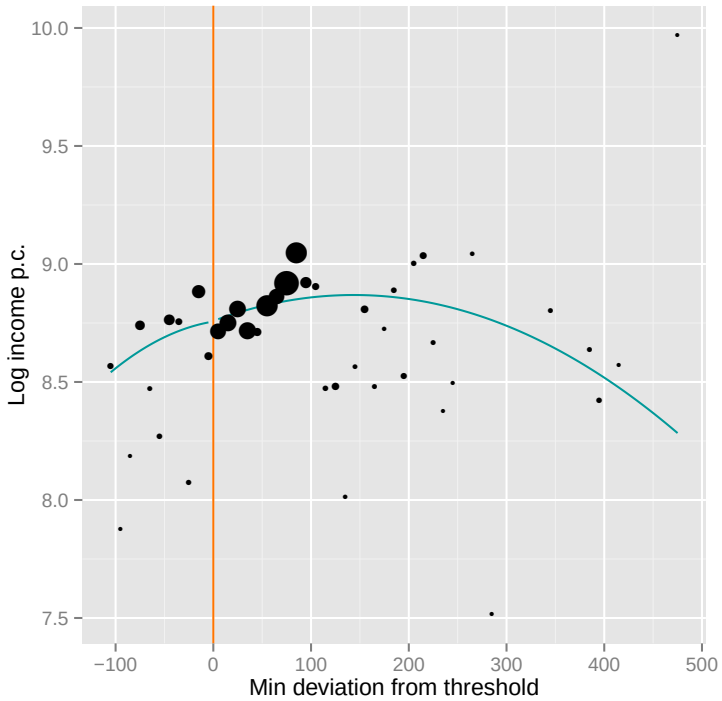
Economic outcomes in subsequent year

Figure : Log agricultural income per capita in t+1

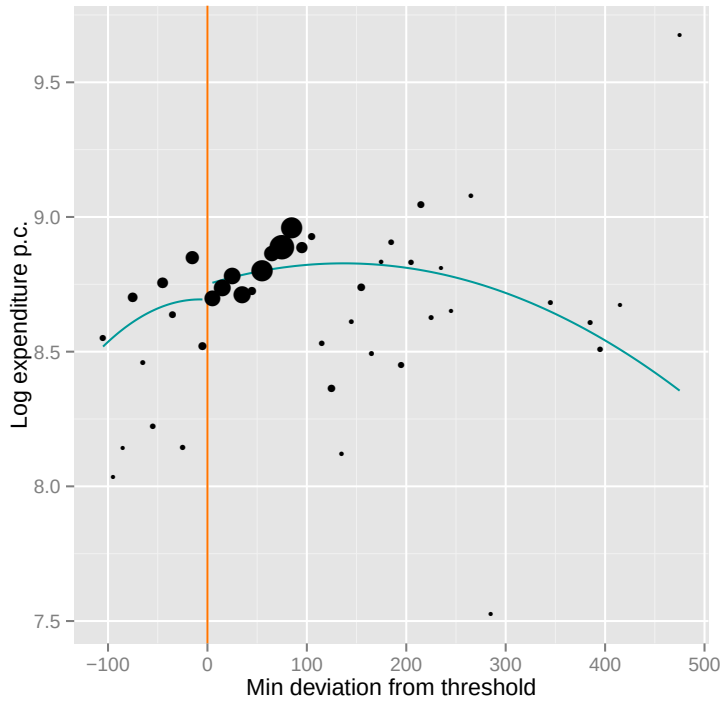


Economic outcomes in subsequent year

(a) Log income per capita in t+1



(b) Log expenditure p.c. in t+1



Economic outcomes in subsequent year, Reduced form

	(1) 2SLS: Expenditure p.c.	(2) 2SLS: Income p.c.	(3) 2SLS: Ag income p.c.
Below threshold	-0.140	-0.0964	0.504*
	(0.130)	(0.168)	(0.301)
N	17460	17460	17460

Standard errors are clustered at the municipality level. All specifications include a quadratic polynomial in the running variable. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Economic outcomes in subsequent year, 2SLS

	(1) First stage: Payment	(2) 2SLS: Expenditure p.c.	(3) 2SLS: Income p.c.	(4) 2SLS: Ag income p.c.
Payment		-0.302	-0.208	1.088
		(0.280)	(0.360)	(0.697)
Below threshold	0.463***			
	(0.109)			
F-statistic	17.95			
N	17460	17460	17460	17460

Standard errors are clustered at the municipality level. All specifications include a quadratic polynomial in the running variable. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Next Steps

- We plan to add policy data from 2005 and 2006, as well as agricultural production data for 2013
- Determine how insurer (Agroasemex) handles missing weather data for stations linked to policies
- Apply regression discontinuity design to flood events
- Estimate behavioral impact of policy on investment using agricultural census data