Workshop / *Atelier*

Disaster Risk Financing and Insurance (DRFI)
Financement et Assurance des Risques de Désastres Naturels

Thursday-Friday, June 4-5, 2015
Jeudi-Vendredi 4-5 Juin 2015

Weather-indexed insurance and productivity of small-scale farmers: An impact evaluation of Mexico's CADENA program

By Elizabeth Ramirez Ritchie, UC Berkeley

Weather-indexed insurance and productivity of small-scale farmers: An impact evaluation of Mexico's CADENA program

Elizabeth Ramirez Ritchie, UC Berkeley

Abstract

Farmers in developing countries face substantial weather risk but often have few financial tools to deal with this risk. To address this issue, the Mexican government instituted a program in 2003 called CADENA that currently provides both agricultural and livestock insurance to small farmers. A large portion of the agricultural land that the program covers is insured via weather index insurance. This policy brief summarizes the preliminary results of an evaluation of CADENA's weather index insurance component. A regression discontinuity design using insurance thresholds allows us to determine the impact of receiving payment in the case of a weather shock among the set of insured municipalities. We find that payment results in an increase in the log hectares of maize sowed relative to the previous year. Although we find suggestive evidence of an impact on agricultural income, our preferred point estimates are ultimately not significant. We hope to refine and expand this analysis with additional data in the future.

1 Introduction and program background

Weather shocks are a major source of income fluctuations among rural populations in developing countries, and they can have catastrophic impacts on vulnerable populations. With a rural population of approximately 27 million and approximately two-thirds of Mexico's poor living in rural localities (CONAPO, INEGI), weather risk is an important issue for poverty reduction efforts in Mexico. To address this issue the Mexican Ministry of Agriculture (SAGARPA) began an index insurance program named CADENA in 2003, offering weather index insurance (WII) to small maize farmers in one state in Mexico. As of 2013, CADENA had almost nationwide coverage insuring more than 6 million hectares (FAO, 2014). The program currently offers WII to farmers growing staple crops on less than 20 hectares of rainfed land (SAGARPA, 2014). The insurance provides coverage during three pre-determined phases that cover sowing through harvest. If precipitation falls below (or above in the case flood) the threshold in any of the three phases, the farmers receive indemnity payments. By having the state or federal governments instead of individual farmers pay the insurance premiums, the CADENA program has been able to achieve widespread coverage. Evaluating an existing program with national coverage is an important contribution to the literature on index insurance in developing countries, since much of evidence regarding the effectiveness of WII comes from smaller scale projects. The CADENA program has been previously evaluated in Fuchs and Wolff (2010), which uses the rollout of the program to estimate impacts on income and agricultural yields. They find that the program increases maize yields and rural per capita expenditure and income. The goal of this evaluation is to take advantage of additional data as the program has expanded in geographic scope and has now been existence for over a decade. Furthermore, we hope to disentangle the direct effects of insurance payments and the effects of changes in investment behavior induced by the insurance.

1.1 Preliminary analysis

Providing insurance to previously uninsured farmers has two distinct, although interrelated, effects. Insurance has the direct effect of payment in case of a bad weather realization, which can help smooth consumption or ensure sufficient resources for production in subsequent seasons. The risk reduction that this entails can have indirect effects on economic outcomes by altering farmers' investment decisions. We begin our evaluation of the CADENA program by focusing on the direct effect of providing payment. To identify this effect we limit our sample to municipalities that are insured through index insurance policies between the years of 2007 and 2012 and focus for the time being on drought events only. Using weather data provided by the National Water Commission (CONAGUA), we match policies to their corresponding weather stations and calculate deviations from the threshold specified in the policy for each of the three phases. In a regression discontinuity design, we use the minimum deviation from the threshold over the three phases as our running variable. A municipality should receive payment if its deviation from the drought threshold is negative in any of the three phases. We use this strategy to estimate the impact of payment on agricultural and economic outcomes in the subsequent year.

Following Card and Lee (2008), we use the entire range of data but control for the conditional expectation of the outcome as a function of the running variable using a quadratic polynomial in the running variable. Specifically, we estimate the following equations:

$$Pay_{mct} = \alpha + \beta Z_{mct} + \gamma f(X_{mct}) + \pi f(X_{mct}) \cdot Z_i + \varepsilon_{mct} \tag{1}$$

$$y_{mct+1} = \tilde{\alpha} + \tilde{\beta}\widehat{Pay_{mct}} + \tilde{\gamma} f(X_{mct}) + \tilde{\pi} f(X_{mct}) \cdot Z_{mct} + \tilde{\varepsilon}_{mct} \tag{2}$$

Where Pay_{mct} is an indicator for payment in municipality m, for crop c, and year t, $\widehat{Pay_{mct}}$ is Pay_{mct} instrumented with Z_{mct}, and y_{mct+1} is our outcome of interest in the following year. X_{mct} is the minimum deviation from the threshold over the three phases ($X_{mct} = \min_{s\in\{1,2,3\}}\{Rain_{mst} - Threshold_{mcst}\}$ where s indexes phases), and Z_{mct} is an indicator for rainfall falling below the threshold in at least one phase $\mathbf{1}\{X_{mct} < 0\}$. The function $f(X_{mct})$ in our case is a quadratic polynomial in X_{mct}. Ultimately, we present the results using only maize crops, which account for the overwhelming majority of our observations, but they are similar to the results using all insured crops, which include sorghum, barley, and beans.

Panel b of figure 1 illustrates the graphical equivalent of equation (1), which is the first stage of our regression discontinuity. While in theory this should be a sharp discontinuity, certain data limitations, some of which we hope to resolve in the future, have resulted in a fuzzy regression discontinuity design. Despite this limitation, we observe a strong first stage. In figure 2, we see the corresponding discontinuities in log maize yields in t+1 and the change in log hectares of maize sowed from t to t+1 (Δ log hectares sowed). While the data is noisy, the graphical analysis seems to suggest that payment results in an increase in the two outcomes, particularly on log hectares sowed. Table 1 provides both the reduced form and the instrumental variables estimation implied by equations (1) and (2). While the graphical analysis suggests effects on both outcomes, we only observe a significant effect, at the 10% level, on Δ log hectares sowed. Turning to the economic outcomes in table 2, we see a large, but imprecisely estimated, effect on agricultural income in the reduced form, which is no longer significant in the instrumental variables estimate. However, we see no effect on total income or expenditures, which may be due to the fact that treatment is assigned at the municipal level, and some municipalities may have only small rural populations.

While this is a preliminary analysis and the data is somewhat noisy, the results suggest that the insurance payments provided by CADENA have positive effects on agricultural outcomes and to a lesser extent on economic outcomes. There are several explanations why our results may differ from those of Fuchs and Wolff (2010). First of all, this is a preliminary analysis, which will benefit from additional data. Secondly, it may be the case that the observed increase in yields in Fuchs and Wolff is due to changes in investment behavior. For example, insured farmers may choose to use more planting season inputs that increase yields under normal conditions but result in larger losses in the case of a negative weather shock. We should observe this effect primarily when comparing insured and uninsured municipalities as they do, instead of when the sample is limited to insured municipalities as is the case for this analysis. Furthermore, they find significant effects on total income and expenditure per capita, while we do not. However, they limit the sample to rural localities, which is probably the more relevant sample, whereas sample size concerns do not allow us to do this. However, we do find some suggestive evidence of increases in agricultural income per capita, which could translate into increases in total income and expenditure per capita when focusing on rural localities.

1.2 Next steps

In the future, we hope to improve this portion of the analysis by adding additional years of data. We will add 2013 data for agricultural production, as well as insurance data for the years 2005 and 2006. We also plan to improve the sharpness of our regression discontinuity design by determining how the insurer (Agroasemex) deals with missing data at weather stations that are linked to policies. Lastly, we plan to expand the scope of our analysis to understand the indirect impacts of the weather index insurance, such as changes in investment decisions.

1.3 Tables

Table 1: Agricultural outcomes, Subsequent year

	(1) First stage: Payment	(2) Reduced form: log yield	(3) 2SLS: log yield	(4) Reduced form: Δ log ha sowed	(5) 2SLS: Δ log ha sowed
Payment			0.160		0.175*
			(0.178)		(0.0935)
Below threshold	0.455***	0.0729		0.0798*	
	(0.0768)	(0.0755)		(0.0409)	
Years insured	-0.00223	0.0208	0.0212	-0.00538	-0.00499
	(0.00700)	(0.0157)	(0.0158)	(0.00748)	(0.00758)
F-statistic	35.11				
N	2366	2366	2366	2366	2366

Standard errors are clustered at the municipality level. All specifications include a quadratic polynomial in the running variable interacted with an indicator for being below the threshold. Hectares sowed and yield is for rainfed maize crops only. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

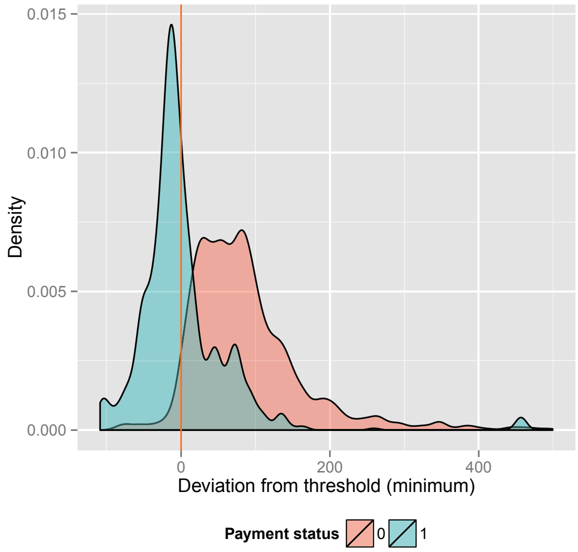
Table 2: Economic outcomes, Subsequent year

	(1) First stage: Payment	(2) 2SLS: Expenditure p.c.	(3) 2SLS: Income p.c.	(4) 2SLS: Ag income p.c.	(5) Red. form: Ag income p.c.
Payment		-0.302	-0.208	1.088	0.504*
		(0.280)	(0.360)	(0.697)	(0.301)
Below threshold	0.463***				
	(0.109)				
Years insured	-0.0266	0.121***	0.0931***	0.0520	0.0230
	(0.0267)	(0.0283)	(0.0293)	(0.0802)	(0.0757)
F-statistic	17.95				
N	17460	17460	17460	17460	17640

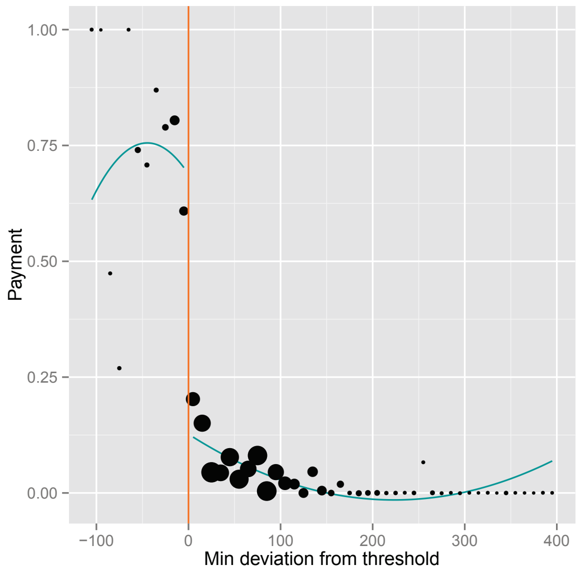
Standard errors are clustered at the municipality level. All specifications include a quadratic polynomial in the running variable interacted with an indicator for being below the threshold. Dependent variables in (2)-(5) are in logs. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

1.4 Figures

Figure 1: Probability of payment status by deviations from threshold

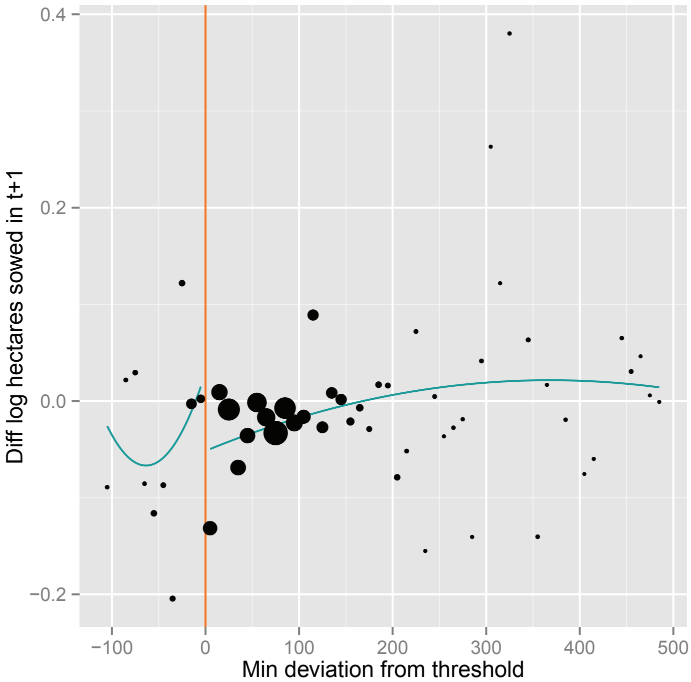


(a) Distribution of deviations from threshold

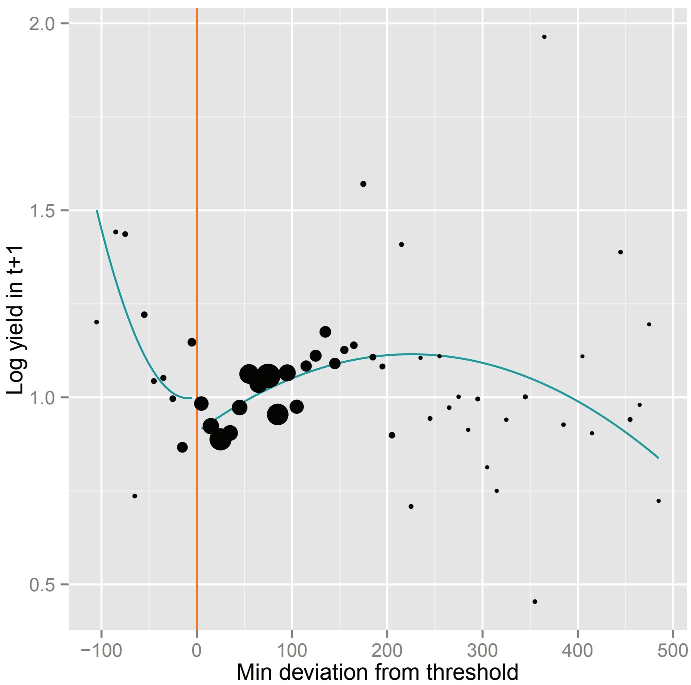


(b) Probability of payment

Figure 2: Discontinuity in agricultural outcomes at payment threshold

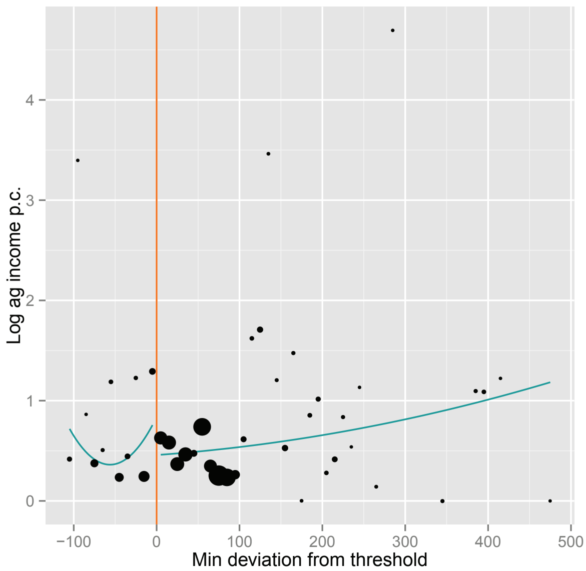


(a) Δ log maize sowed (ha) in t+1

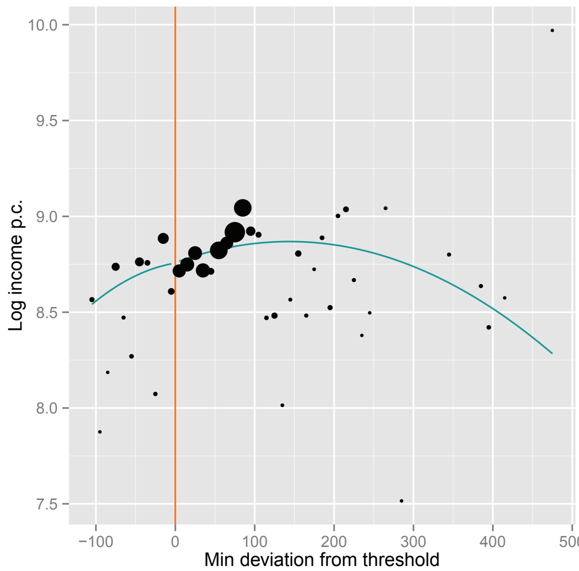


(b) Log maize yield in t+1

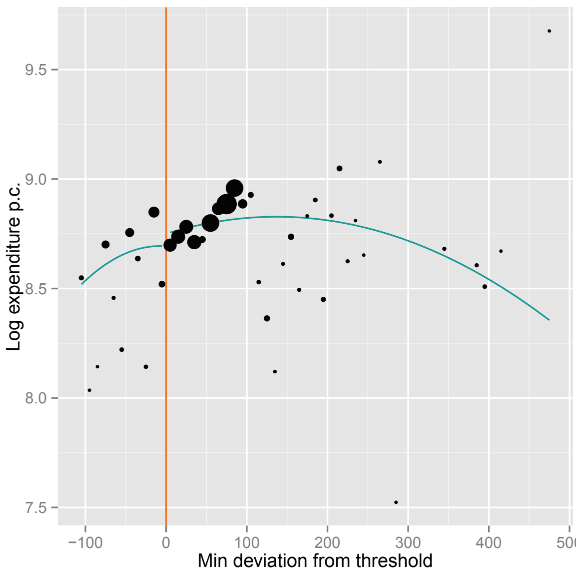
Figure 3: Discontinuity in economic outcomes at payment threshold



(a) Log agricultural income per capita in t+1



(b) Log total income per capita in t+1



(c) Log expenditures per capita in t+1