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Crop Price Indemnified Loans for Farmers

A Pilot Experiment in Rural Ghana

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ABSTRACT

Farmers face a particular set of risks that complicate the decision to borrow. We use a randomized experiment to investigate (1) the role of crop-price risk in reducing demand for credit among famers and (2) how risk mitigation changes farmers' investment decisions. In rural Ghana, we offer farmers loans with an indemnity component that forgives 50 percent of the loan if crop prices drop below a threshold price. A control group is offered a standard loan product at the same interest rate. We find similar rates of loan uptake among all farmers and little significant impact of the indemnity component on uptake or other outcomes of interest, with the exception of higher likelihoods of garden egg cultivation and sales to market traders rather than at farmgate among recipients of indemnified loans.

Key words: agricultural credit, crop prices, crop price insurance, underinvestment, impact evaluation, clustered randomized control trial

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1. INTRODUCTION

Farmers face a particular set of risks that complicate the decision to borrow. Factors that are almost entirely unforeseeable and outside their control, such as crop prices and weather patterns, have an enormous impact on farmers' fortunes—and on their ability to repay any loans they have taken. Therefore, some farmers are believed to be reluctant to take loans to finance seemingly profitable ideas for fear of not being able to repay. Paradoxically, from a bank's perspective, these may be excellent clients. They are so trustworthy that they are not borrowing out of fear of default. Can a loan product with a component that mitigates farmers' risk successfully encourage farmers to take, and benefit from, credit? What types of individuals are more likely to borrow when some of the risk is mitigated? And lastly but equally importantly, how does the mitigation of risk change farmers' investment decisions, such as the purchase of inputs?

Most of the theoretical literature on the impact of credit constraints on productivity focuses on supply-side constraints. In a recent departure, Boucher, Carter, and Guirkinger (2008) argue that in the presence of moral hazard, farmers will prefer not to borrow even though the loan would raise their productivity and expected income. Using panel data from Peru, the authors identify these "risk rationed" (as opposed to quantity rationed) households as households that never tried to access the formal credit market because of the high risk associated with borrowing, due to the consequences of default, and show that risk rationing adversely affects the productivity of these households. Based on this they argue that improvements in the insurance products offered to these households would increase their willingness to participate in formal credit markets and raise household welfare.

As farmers weigh their ability to generate sufficient crop revenue to repay loans, one of the primary risks they face is price variability, which can be very high between and within growing seasons. In terms of price risk management, Morgan (2001) reviews the literature on reducing price risk through support and stabilization measures (e.g., international commodity agreements). Price support—often through marketing boards—has been a common but generally unsustainable policy. Because of the risks and politics involved in maintaining international boards, there has been a broad trend to liberalize agricultural markets, shifting price risk onto producers and traders, and furthermore the boards typically are set up only for dominant export crops.

Due to these difficulties with international commodity agreements, Morgan (2001) and Morgan, Rayner, and Vaillant (1999) outline theoretical justification for the demand for futures markets and other risk-management tools in developing countries but suggest that few systems are implemented successfully in practice, due to frequently unsatisfied infrastructural requirements.

Although in theory the most efficient approach, futures markets are not readily available for many farmers and crops, in particular for farmers in developing countries. Carter (1999) surveys the literature on reducing price variability through derivatives such as futures and options markets. Such markets remain relatively uncommon in developing countries, however, and even where they exist they are primarily accessible to large-volume producers and traders rather than smallholder farmers (Varangis and Larson 1996).

Carter (1999) in particular points to evidence that farmers in developed countries seem to hedge their price risk less than would appear to be optimal and again emphasizes a striking lack of evidence on their counterparts in developing countries. An attempt to begin filling this gap, a comparative study by Woolverton (2007) interviewing U.S. and South African farmers, suggests that in the absence of price supports, farmers do show a higher demand for price-risk-reduction strategies, though Jordaan and Grové (2007) find that demand may be tempered by distrust of the market and insufficient education. These studies seem to focus more on larger-scale farmers who may also be less credit-constrained. There is still very little empirical evidence on how smallholders in particular respond to price-risk-management products.

We are unaware of any crop price insurance offered to smallholder farmers, but recent efforts to sell rainfall insurance are highly instructive. Giné and Yang (2007) study whether the inclusion of rainfall

insurance (at marginal cost) in a loan product induces farmers to borrow. To their surprise, loan take-up was actually lower by 13 percentage points among farmers that had to buy insurance along with the loan. They also find that take-up of the insured loan is positively correlated with education, while take-up of the uninsured loan is not. Thus it is clear that inclusion of insurance in loans (in that case, at actuarially fair prices plus a load to cover insurance company costs) for smallholders is not necessarily an easy task that generates higher demand for these loans.[1]

To investigate whether price risk affected the demand for credit, we conducted a simple social experiment in which some loans included a crop price indemnification clause (a "natural field experiment" in the taxonomy put forward by Harrison and List [2004]). Mumuadu Rural Bank in the Eastern Region of Ghana, in conjunction with Innovations for Poverty Action, offered credit to farmers to invest in their farms. Mumuadu conducted marketing meetings for groups of maize and garden egg (eggplant) farmers. In half (randomly assigned) of the meetings, farmers were offered the opportunity to apply for loans that included crop price indemnification at no additional charge—that is, if crop prices were to fall below a certain floor during the harvest time, 50 percent of their loan would be forgiven. In the other half of the meetings (control), farmers were offered normal loans, with repayment required irrespective of future crop prices. Farmers attending either type of meeting merely knew that the bank was holding a meeting to talk about credit in their community; they were not told that there was variation in the types of loans being offered.[2] By not disclosing to farmers that there was a randomized trial within the lending program, the experiment avoids concerns of "randomization bias," as only certain types of individuals are prone to participate in randomized trials (Heckman 1992). Indeed, this social experiment was entirely "natural" (Harrison and List 2004) in that, aside from the surveying, the individuals interacted with the bank and saw themselves as clients of the bank.

By conducting this as a randomized control trial, we address two general endogeneity problems. First, those who choose to participate in insurance programs are likely different from those who do not (such as more risk averse, or perhaps more entrepreneurial or resourceful in finding good financial solutions to their problems), and second, those who are approved by lenders are typically different from those who are not. Note that although the take-up rate of the loans was 86 percent in the control group and 92 percent in the treatment group, our analysis of impacts is performed on the intent-to-treat basis, that is, everyone offered treatment loans is analyzed as part of the treatment group (and not just the self-selected sample of those who take up), and the same for the control group.

[1] A more recent rainfall insurance program is under pilot in eastern Kenya. The project, known as Kilimo Salama (or "safe farming"), insures farmers' investments in agricultural inputs against inadequate or excessive rainfall. It is a partnership between Syngenta Foundation (suppliers of agricultural inputs), UAP Insurance, and telecoms operator Safaricom. Premiums are priced at 5 percent of input costs, and claims are paid through mpesa, the mobile-phone payment system.

[2] We cannot, however, rule out the possibility that farmers may have known members of the other groups.

2. LOAN PRODUCT DESCRIPTION AND RATIONALE

Our choice of loan product was initially based on focus group meetings with farmers and bank management. In these meetings, farmers reported that one reason they were not borrowing from Mumuadu Rural Bank was fear of default in the event of a crop price collapse. Opinion from bank management also suggested this was a significant risk. Several further factors made indemnification of crop prices a good candidate for the product. First, more than half of the farmers interviewed in a baseline survey said they would be willing to pay to guarantee a floor for the price of their crop. Furthermore, rainfall, an alternative risk commonly discussed, does not vary enough in this region of Ghana to be considered a substantial risk for most farmers (Keyzer, Molini, and van den Boom 2007), but crop prices do vary considerably. Finally, crop prices are determined in centralized local markets and are thus outside any individual farmer's control or likely influence. Data on these prices are collected by government officials and are easily and quickly verifiable.

The Mumuadu Rural Bank loan product was simple. If the price of the farmer's crop (either maize or garden egg) at the time of harvest fell below a given level (set to be at the 10th percentile of historical garden egg prices during harvest period and at the 7th percentile of historical year-long prices for maize), then Mumuadu Rural Bank would forgive 50 percent of the principal and interest of the farmer's loan. To set the crop price levels and choose the crops, we gathered data from the Ghana Ministry of Agriculture and engaged in conversations with Ministry of Agriculture extension officers, farmers, and Mumuadu Rural Bank managers. We chose the two crops—garden eggs and maize—due to their prevalence in the region, their price volatility, and the availability of historical data. Farmers attended the meetings in groups already designated as either garden egg or maize growers, and there was no opportunity to switch crops afterward depending on prices or other factors.

The loan with crop price indemnification aims to encourage investment, and thus the key outcome measure, beyond take-up of the loan, is whether investment behavior changed for the farmers. We have three sources of data: a baseline survey, the administrative data from the bank with regard to take-up and repayment, and a follow-up survey that focused on the investment decisions of the farmers.

3. EXPERIMENTAL DESIGN

The project launched in August 2007. Mumuadu Rural Bank employees contacted key community members (district assemblyman, storekeepers, farmers) in each of five villages to collect the names of all maize and garden egg farmers in the village. From the listing, farmers were randomly assigned to either the control or the treatment group, and the same community members invited the farmers to separate marketing meetings for treatment and control groups.

At the beginning of each of the marketing meetings, Mumuadu employees explained that the bank was doing marketing research on farmers in the area, and then asked the farmers to participate in a baseline survey. Table 1 presents the summary statistics from this baseline survey for those who were also successfully reached in the follow-up survey one year later. Appendix Table 1 presents the summary statistics from the baseline survey for everyone surveyed in the baseline, and compares those means to those also found for the follow-up, in order to assess whether there was any noticeable attrition pattern. All statistics include farmers who were offered loans, regardless of whether or not they chose to apply later. The aggregate test finds that those who were found for the follow-up survey were systematically different (F-statistic = 1.84, p-value = 0.028). The attrition bias seems driven mostly by those who perceived price risk to be higher, those who preferred to borrow from banks over relatives, and maize farmers (all three groups were more likely to be found for the follow-up survey). Because attrition is nonnegligible in our sample, a series of robustness checks have been added to the estimation section and are presented in Appendix Tables 2, 3, and 4. Results appear to be robust to differing assumptions on attrition.

Once the baseline survey had been completed in the meetings, one of four credit officers from Mumuadu Rural Bank then presented the loan offer to the group of farmers. A total of 169 farmers attended one of the 20 meetings. Of these 169, 91 were maize farmers and 78 were garden egg farmers. Farmers were not informed that the bank was offering two different products; rather, the bank simply made the treatment group its loan offer, and offered the control group the loan without the crop price indemnification.

Farmers then had one month to apply for a loan. Loans were disbursed about one month after application—between September 13 and October 17 for maize farmers, and between November 17 and December 13 for garden egg farmers. Average loan size was 238 GHS ($US159), which represents a large change in cash flow—roughly 13–38 percent of the typical farmer's average annual income. A follow-up survey was conducted after two to three crop cycles (roughly one year), to determine the impact of the indemnified loan on input usage and investment.

Table 1. Baseline summary statistics: Orthogonality verification and take-up analysis baseline means and standard errors

		Randomization			Decision to Apply			Decision to Apply: Control			Decision to Apply: Treatment		
	Reached for Follow-up Survey (N=126)	Control (N=66)	Treatment (N=60)	T-stat (2)<>(3)	No (N=14)	Yes (N=112)	T-stat (5)<>(6)	No (N=9)	Yes (N=57)	T-stat (8)<>(9)	No (N=5)	Yes (N=55)	T-stat (11)<>(12)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
General:													
Age	43.413	44.394	42.333	0.903	37.929	44.098	1.716 *	34.111	46.018	2.765 ***	44.800	42.109	0.440
	(1.138)	(1.552)	(1.677)		(3.563)	(1.191)		(2.831)	(1.646)		(8.267)	(1.697)	
Female	0.151	0.121	0.183	0.969	0.143	0.152	0.087	0.111	0.123	0.098	0.200	0.182	0.099
	(0.032)	(0.040)	(0.050)		(0.097)	(0.034)		(0.111)	(0.044)		(0.200)	(0.052)	
Number of dependents	5.992	6.348	5.600	1.422	4.929	6.125	1.431	4.778	6.596	1.582	5.200	5.636	0.358
	(0.264)	(0.399)	(0.335)		(0.715)	(0.282)		(0.969)	(0.430)		(1.114)	(0.353)	
Education score	4.135	4.045	4.233	0.464	4.143	4.134	0.014	4.333	4.000	0.411	3.800	4.273	0.439
(0 = no schooling, 9 = highest)	(0.201)	(0.277)	(0.295)		(0.686)	(0.211)		(0.866)	(0.293)		(1.241)	(0.305)	
Cognitive score	4.643	4.500	4.800	1.240	3.929	4.732	2.114 **	3.889	4.596	1.514	4.000	4.873	1.344
(1 = lowest, 7 = highest)	(0.121)	(0.162)	(0.181)		(0.355)	(0.127)		(0.484)	(0.170)		(0.548)	(0.189)	
Ambiguity aversion score	2.310	2.242	2.383	1.007	1.929	2.357	1.949 *	2.111	2.263	0.512	1.600	2.455	2.595 **
(1 = not averse, 3 = very averse)	(0.070)	(0.101)	(0.095)		(0.322)	(0.067)		(0.423)	(0.099)		(0.510)	(0.089)	
Do you have health insurance?	0.532	0.485	0.583	1.103	0.500	0.536	0.251	0.333	0.509	0.971	0.800	0.564	1.018
	(0.045)	(0.062)	(0.064)		(0.139)	(0.047)		(0.167)	(0.067)		(0.200)	(0.067)	
Lending History:													
Taken any loan	0.595	0.591	0.600	0.103	0.357	0.625	1.938 *	0.444	0.614	0.954	0.200	0.636	1.934 *
	(0.044)	(0.061)	(0.064)		(0.133)	(0.046)		(0.176)	(0.065)		(0.200)	(0.065)	
Taken loan from financial institution	0.325	0.273	0.383	1.322	0.071	0.357	2.174 **	0.111	0.298	1.166	0.000	0.418	1.864 *
	(0.042)	(0.055)	(0.063)		(0.071)	(0.045)		(0.111)	(0.061)		0.000	(0.067)	
Prefer to borrow from bank, not relative	0.841	0.848	0.833	0.231	0.929	0.830	0.944	0.889	0.842	0.359	1.000	0.818	1.036
	(0.033)	(0.044)	(0.049)		(0.071)	(0.036)		(0.111)	(0.049)		0.000	(0.052)	
Would use loan to buy farm inputs	0.952	0.924	0.983	1.558	1.000	0.946	0.883	1.000	0.912	0.916	1.000	0.982	0.299
	(0.019)	(0.033)	(0.017)		0.000	(0.021)		0.000	(0.038)		0.000	(0.018)	
Farming:													
Perceived likelihood of price falling	2.548	2.576	2.517	0.322	2.429	2.563	0.460	2.000	2.667	1.744 *	3.200	2.455	1.678 *
(1=not likely, 6 = very likely)	(0.091)	(0.133)	(0.125)		(0.309)	(0.096)		(0.333)	(0.142)		(0.490)	(0.127)	
Maize farmer (vs. garden egg farmer)	0.579	0.591	0.567	0.273	0.500	0.589	0.634	0.444	0.614	0.954	0.600	0.564	0.154
	(0.044)	(0.061)	(0.065)		(0.139)	(0.047)		(0.176)	(0.065)		(0.245)	(0.067)	
Number of crops planned	1.968	1.970	1.967	0.018	1.786	1.991	0.786	2.111	1.947	0.465	1.200	2.036	2.137 **
	(0.082)	(0.120)	(0.111)		(0.334)	(0.083)		(0.484)	(0.119)		(0.200)	(0.116)	
Planned to grow maize at baseline	0.643	0.682	0.600	0.953	0.643	0.643	0.000	0.667	0.684	0.103	0.600	0.600	0.000
	(0.043)	(0.058)	(0.064)		(0.133)	(0.045)		(0.167)	(0.062)		(0.245)	(0.067)	
Planned to grow gegg at baseline	0.452	0.424	0.483	0.661	0.500	0.446	0.377	0.556	0.404	0.849	0.400	0.491	0.383
	(0.045)	(0.061)	(0.065)		(0.139)	(0.047)		(0.176)	(0.066)		(0.245)	(0.068)	

Note: Joint F-test of significance for selection into the treatment group: 0.75, p-value: 0.740
Standard errors in parentheses. * significant at 10%, ** significant at 5%; *** significant at 1%

4. DATA AND ANALYSIS[3]

The survey instrument for the pilot contains 28 questions and is primarily designed to measure basic demographic information plus data on loan history and plans, cognitive ability, risk perception and aversion, and financial management skills. The survey instrument is available upon request.

We begin with an analysis of differences in means. Our first goal is to verify that the randomization generated observably similar treatment and control groups. Column 4 of Table 1 shows the t-statistics for a series of comparisons of means, which all showed that the treatment assignment was orthogonal to all key observable variables collected in the baseline survey. The joint test of all covariates (F-stat = 0.75, p-value = 0.74 reported in the notes) also shows that the randomization successfully generated observably similar treatment and control groups jointly.

Next, we are interested in comparing the characteristics of those who apply for the standard loan to the characteristics of those who apply for the indemnified loan. For instance, are those who are more risk averse more likely to borrow with the indemnified loan? Or perhaps the price indemnification is difficult to understand, and thus those with higher cognitive abilities or education are more likely to take it up, relative to a simple loan. Ideally we would know the riskiness of different farmers (which perhaps is proxied by their risk aversion), in order to test a model of adverse selection versus advantageous selection (note that we employed hypothetical survey questions to measure risk preferences, rather than incentive questions as done in, e.g., Harrison, Steven, and Verschoor [2010]).

Columns 5 through 13 of Table 1 show, via comparison of means, what types of individuals were more likely to take up the loan overall (columns 5–7), under the control condition (columns 8–10), and under the treatment condition (columns 11–13). Overall, farmers who borrowed were roughly six years older than farmers who did not borrow; their cognitive scores were almost one full point (out of seven) higher; they were twice as likely to have borrowed previously, especially from a financial institution; and they were somewhat more ambiguity averse.

Then Table 2 shows similar results using probit econometric specifications:

$$A_i = \gamma + \alpha T_i + X_i \beta + X_i T_i \delta_i + \varepsilon_i , \quad (1)$$

where Ai is an indicator variable equal to 1 if the individual takes up a loan, Ti is an indicator variable for assignment to the treatment group (the farmers to whom the indemnified loan is marketed), Xi is a vector of demographic and other survey responses, and ε i is an error term for farmer i, which allowed for clustering at the group (meaning, meeting) level.

We find very few differences in take-up. Any heterogeneity is likely masked by the large take-up rates for both: 86 percent in the control group and 92 percent in the treatment group (the difference is not statistically significant) took up a loan. We do not find a difference in take-up due to cognitive score or prior experience borrowing, but we do find that those who believed that prices were likely to fall were *less* likely to take up the treatment loan than the control loan.[4] This was significant at the 90 percent level. Our prior was the opposite: the loan protects farmers from prices falling, and thus those who believe prices will fall will show a greater demand for crop price protection. The reversal of this we find interesting and puzzling. We posit one story, ex post: the survey question picked up pessimism[5] in general, not just pessimism with respect to crop prices, and pessimistic individuals were skeptical of the indemnified loan product.

[3] The dataset and estimate code are available on the Innovations for Poverty Action website.

[4] The question asked was, "In your view, what is the likelihood that the price of 27kg of garden eggs will fall below 70,000 between January and April?" Respondents could answer on a scale of 1 to 3, from very unlikely to very likely, and this is summed with the response to the same question asked about the next five years. A similar question was asked of maize farmers.

[5] "Pessimism" is meant here in a layman's sense rather than a formal one.

Table 2. Analysis of loan take-up decision

Probit Results Dependent variable: 1 = Borrowed; 0 = Did not Borrow	Probit (1)	Probit (2)
Treatment (loan included price indemnification)	0.020	0.195
	(0.046)	(0.221)
Age	0.003	0.004
	(0.002)*	(0.002)**
Female	0.031	0.036
	(0.040)	(0.024)
Cognitive score	0.045	0.035
(1 = lowest, 7 = highest)	(0.015)***	(0.017)**
Perceived likelihood of price falling	0.011	0.043
(1 = not likely, 6 = very likely)	(0.023)	(0.032)
Has borrowed previously	0.121	0.04
	(0.072)*	(0.054)
Maize farmer (vs. garden egg farmer)	0.090	0.057
	(0.051)*	(0.039)
Cognitive score* treatment		0.007
		(0.021)
Perceived likelihood of price falling * treatment		-0.088
		(0.045)*
Has borrowed previously * treatment		0.067
		(0.041)
Constant		
Observations	126	126
F test: treat cog*treat likelihood*treat loan*treat		6.79
Prob > F		0.15

Note: Robust standard errors in parentheses. Reported results are marginal effects.
* significant at 10% ** significant at 5%; *** significant at 1%

Next, in Table 3 (summary statistics and mean comparisons) and Table 4 (ordinary least squares [OLS] and probit/Tobit specifications), we estimate the impact of the indemnified loan on investment and profits using the first difference estimator obtained by comparing the levels of the outcome variables between the treatment and control groups. To avoid self-selection bias related to a farmer's decision to apply for a loan, we estimate the intent-to-treat impact—the impact of being offered a price indemnified loan regardless of take-up.

Table 4 uses the following econometric specification:

$$Y_i = \alpha + \beta T_i + X_i \delta_i + \varepsilon_i , \quad (2)$$

where Y_i is the outcome of interest, and X_i is a vector of baseline covariates that are not included in columns 1 and 2 and are included in columns 3 and 4. We use OLS (linear probability) for all outcome

variables in columns 1 and 3; and columns 2 and 4 show the Tobit estimation for nonnegative continuous variables and probit for binary variables. Due to the randomization, the first difference estimator provides an unbiased estimate of the impact of the indemnified loan on investment and profits, without risk of endogeneity with respect to who decided to take up or who was offered credit by the bank.

We find that farmers offered the indemnified loans spent on average 23.1 percentage points (significant at 90 percent, but not significant when not including control variables) more on chemicals for their primary crop as a share of the total spent on chemical inputs. Other than this, there is no indication that the indemnified loan had an impact on investment in inputs.

We also see a shift toward growing garden eggs, by 17.5 percentage points (significant at 95 percent in specifications with baseline control variables, not significant in specifications without baseline controls but the point estimate is similar) and harvesting less maize, resulting in a decrease of 270 kilograms of maize harvested (significant at 95 percent). As garden eggs are the more perishable and thus potentially riskier crop, although both were protected by the indemnification clause, the relative reduction in risk was greater for garden eggs.

We find a potentially interesting result regarding how and when farmers marketed their crop. Note that the indemnified loan was *not* conditional on the price that they received for their crop, but rather on the average price in the area at the time of harvest. Farmers were 15 to 25 percent (depending on specification, and results only significant when including baseline covariates) more likely to sell their crops to market traders rather than to farmgate buyers who come to them and pick up the crop. Anecdotal evidence suggests that the farmgate buyers offer contracts that lock in prices, but at lower levels. Those willing to risk market prices are typically rewarded on average. Two further pieces of information would have helped tell a complete story, but we do not have them. First, if this interpretation is correct, historical prices at the farmgate should be lower and less volatile than historical prices on the market. Second, we should be able to document that farmgate buyers are indeed locking in prices for farmers before harvest.

Lastly, default was large, with 58 percent of borrowers (no difference between treatment and control) in default as of May 2009.

Given the attrition (126 out of 169 farmers successfully surveyed for the follow-up), Appendix Tables 2 and 3 show estimates on borrowing outcomes both for members of the final sample who could be reached for interviews during the follow-up (i.e., same as in the primary tables) and for the full original sample. Appendix Table 4 provides lower-bound estimates for the remaining continuous outcomes by replacing missing control observations with outcome values at the control mean plus 0.25 standard deviation and missing treatment observations with values at the treatment mean minus 0.25 standard deviation. For binary outcomes, the 17 missing control observations are given a value of 1, and the 26 missing treatment observations are given a value of 0.

Table 3. Outcome summary statistics

Mean and Standard Errors				
	Overall (N=126) (1)	**Control (N=66) (2)**	**Treatment (N=60) (3)**	**T-stat (2)<>(3) (4)**
Borrowing:				
Applied for loan	0.889	0.864	0.917	0.942
	(0.028)	(0.043)	(0.036)	
Loan principal (GHS), borrowers only	238.4	239.6	237.2	0.187
	(6.24)	(9.41)	(8.26)	
Loan principal (GHS), all obs	182.94	180.30	185.83	0.272
	(10.11)	(14.40)	(14.27)	
Had overdue balance in May 2009, borrowers only	0.516	0.500	0.533	0.371
	(0.045)	(0.062)	(0.065)	
Had overdue balance in May 2009, all obs	0.586	0.579	0.593	0.145
	(0.047)	(0.066)	(0.067)	

Table 3. Continued

	Overall (N=126) (1)	Control (N=66) (2)	Treatment (N=60) (3)	T-stat (2)<>(3) (4)	
Cultivation and Inputs:					
Cultivated indemnity crop	0.778	0.742	0.817	0.997	
	(0.037)	(0.054)	(0.050)		
Cultivated garden egg	0.254	0.182	0.333	1.966	*
	(0.039)	(0.048)	(0.061)		
Cultivated maize	0.738	0.773	0.700	0.923	
	(0.039)	(0.052)	(0.060)		
Amount of land farmed in minor season (acres)	2.567	2.773	2.342	1.562	
	(0.139)	(0.190)	(0.201)		
Amount of land farmed: indemnity crop (acres)	2.147	2.288	1.992	0.712	
	(0.207)	(0.338)	(0.229)		
Used certified seed on indemnity crop, growers only	0.490	0.449	0.531	0.803	
	(0.051)	(0.072)	(0.072)		
Used certified seed on indemnity crop, all obs	0.381	0.333	0.433	1.151	
	(0.043)	(0.058)	(0.065)		
Total spent on chemicals for indemnity crop (GHS)	54.795	60.670	48.333	0.941	
	(6.546)	(11.451)	(5.513)		
Total spent on chems for indemnity crop, % all crops	0.679	0.604	0.762	1.990	**
	(0.040)	(0.058)	(0.054)		
Total labor days used	36.722	33.833	39.900	0.719	
	(4.208)	(3.947)	(7.719)		
Total labor days used on indemnity crop	26.373	25.742	27.067	0.209	
	(3.160)	(3.954)	(5.045)		
Borrowing:					
Applied for loan	0.889	0.864	0.917	0.942	
Sales and Income:					
Amount harvested from garden egg crop (kg), growers only	424.333	485.909	388.684	0.323	
	(142.709)	(138.181)	(213.247)		
Amount harvested from garden egg crop (kg), all obs	101.032	80.985	123.083	0.563	
	(37.233)	(31.529)	(70.337)		
Amount harvested from maize crop (kg), growers only	464.690	529.441	384.146	1.246	
	(58.135)	(88.593)	(68.969)		
Amount harvested from maize crop (kg), all obs	339.298	409.114	262.500	1.594	
	(46.226)	(73.639)	(52.392)		
Revenue for all crops (GHS), all obs	309.250	346.045	268.775	0.930	
	(41.452)	(65.037)	(49.659)		
Sold indemnity crop, growers only	0.929	0.939	0.918	0.389	
	(0.026)	(0.035)	(0.040)		
Sold indemnity crop, all obs	0.722	0.697	0.750	0.660	
	(0.040)	(0.057)	(0.056)		
Sold indemnity crop to market trader, growers only	0.440	0.348	0.533	1.795	*
	(0.052)	(0.071)	(0.075)		
Sold indemnity crop to market trader, all obs	0.317	0.242	0.400	1.910	*
	(0.042)	(0.053)	(0.064)		

Note: Standard errors in parentheses. * significant at 10%, ** significant at 5%; *** significant at 1%.
"Indemnity crop" refers to maize for the maize group and garden eggs for the garden egg group.

Table 4. Treatment effects

Dependent variables: Each row represents a different dependent variable								
Specification:	**OLS**		**Probit/Tobit+**		**OLS**		**Probit/Tobit**	
Includes baseline covariates:	**No**		**No**		**Yes**		**Yes**	
	(1)		**(2)**		**(3)**		**(4)**	
Borrowing:								
Applied for loan	0.053		0.053		0.042		0.030	
	(0.061)		(0.061)		(0.062)		(0.048)	
Loan principal (GHS)	5.530		7.667		5.295		6.644	
	(24.981)		(30.673)		(21.657)		(26.762)	
Had overdue balance in May 2009, borrowers only	0.014		0.014		0.035		0.034	
	(0.126)		(0.125)		(0.137)		(0.137)	
Had overdue balance in May 2009, all obs	0.033		0.033		0.052		0.052	
	(0.126)		(0.126)		(0.133)		(0.131)	
Cultivation and Inputs:								
Cultivated indemnity crop	0.074		0.074		0.092		0.088	
	(0.143)		(0.142)		(0.078)		(0.072)	
Cultivated garden egg	0.152		0.152		0.156	**	0.175	**
	(0.148)		(0.147)		(0.071)		(0.081)	
Cultivated maize	-0.073		-0.073		-0.070		-0.070	
	(0.147)		(0.146)		(0.077)		(0.074)	
Amount of land farmed in minor season (acres)	-0.431		-0.423		-0.428		-0.422	
	(0.325)		(0.332)		(0.345)		(0.350)	
Amount of land farmed: indemnity crop (acres)	-0.296		-0.179		-0.257		-0.075	
	(0.447)		(0.683)		(0.388)		(0.489)	
Used certified seed on indemnity crop, growers only	0.082		0.082		0.082		0.086	
	(0.111)		(0.110)		(0.117)		(0.118)	
Used certified seed on indemnity crop, all obs	0.100		0.100		0.109		0.115	
	(0.103)		(0.102)		(0.090)		(0.091)	
Total spent on chemicals for indemnity crop (GHS)	-12.34		-4.35		-12.50		-4.17	
	(19.07)		(28.72)		(18.37)		(24.44)	
Total spent on chems for indemnity crop, % all crops	0.158		0.212		0.179	**	0.231	*
	(0.157)		(0.220)		(0.080)		(0.118)	
Total labor days used	6.067		6.918		4.990		5.587	
	(10.493)		(10.709)		(9.653)		(9.690)	
Total labor days used on indemnity crop	1.862		5.025		1.456		5.370	
	(9.155)		12.655		(7.273)		(9.408)	
Sales and Income:								
Amount harvested from garden egg crop (kg)	42.10		282.28		28.87		417.62	
	-112.12		-662.35		-92.36		-560.28	
Amount harvested from maize crop (kg)	-146.61	*	-257.30	**	-147.45		-270.35	**
	(72.85)		128.40		(74.97)		(121.70)	
Revenue for all crops (GHS)	-77.27		-97.99		-85.98		-106.16	
	(89.83)		(104.97)		(70.74)		(82.00)	
Sold indemnity crop	-0.020		-0.020		-0.035		-0.061	
	(0.075)		(0.074)		(0.079)		(0.102)	
Sold indemnity crop to market trader, growers only	0.186		0.186		0.250		0.254	**
	(0.118)		(0.117)		(0.121)		(0.115)	
Sold indemnity crop to market trader, all obs	0.158		0.158		0.176		0.185	*
	(0.111)		(0.111)		(0.106)		(0.103)	

Note: +Marginal effects presented for probit and Tobit results. Probits used for binary indicators and Tobits for non-negative continuous variables. Robust standard errors in parentheses. * significant at 10%, ** signicant at 5%, *** significant at 1%. Control variables for column (2) are age, female, education, cognitive score, ambiguity aversion, perceived likelihood of price drop, and maize farmer (vs. garden egg group). 'Indemnity crop' is maize for the maize farmer group and garden eggs for the garden egg group.

5. DISCUSSION AND DIRECTIONS FOR FUTURE RESEARCH

Ironically, the surprisingly high take-up rate of credit made it difficult to assess the heterogeneity in take-up that the study aimed to test. We specifically designed this product to be built in to the loan, rather than as add-on insurance. This, combined with the fact that the triggering event was measured by the Ministry of Agriculture, reduced the processing costs for the bank. We also integrated the insurance with the loan to avoid potential choice overload problems (i.e., when too many choices cause stagnation in decisionmaking; see Bertrand et al. [2010] and Iyengar and Lepper [2000]). Giné and Yang (2007) also discuss this issue (and related issues of confusion that the insurance may generate among those unfamiliar with insurance) in a working-paper version of their rainfall insurance experiment, in which take-up rates for credit plus rainfall insurance were lower than take-up rates for credit alone (in their case, the rainfall insurance was priced at actuarially fair prices plus a load).[6] How to ensure that farmers truly understand such a product is a larger question that can be explored through further empirical research.

Due to the high take-up rates and thus little room for heterogeneity in take-up, we focus our attention on the impact, or lack thereof in significant ways, on farmer decisions. Several factors may be at work to generate few impacts. First, did farmers fully understand the indemnity clause? Priced fairly, the product undoubtedly makes financial sense for many farmers; by investing more in their crops they are more likely to earn increased farm income, and this product lowered the risk they faced with such investments. Second, perhaps one year is not enough time. The farmers needed to believe that the crop price indemnification loans would be offered for years to come in order to start making large investment changes. Third, the high rates of default we observe may indicate that the bank already effectively had a flexible "loan forgiveness" program in place, so the additional indemnification had little impact on behavior. Fourth, it could be that crop prices were simply not causing that much volatility for farmers. Observed crop prices may have been volatile, and may have been the focus of much attention, but through storage and optimal timing of sales farmers are able to mitigate this risk at least partially on their own. Related to this, a study by Mahul (2000) suggests that farmers may jointly consider price and yield risk. It is possible that the impact of reducing price risk may be muted in the presence of unmitigated yield risk. Lastly, the sample size of the study was small, and thus many of the results are positive but not significant statistically. In many of the cases, we are not able to rule out large and meaningful results.

This experiment tried to address a key question for development: does risk inhibit investment? Although many interventions try to mitigate risk by selling insurance or loans at market prices, the even simpler question remains: if the risk were removed, without any selection effects, how would behavior change? We tried to answer this in the simplest way possible: by giving away the crop price indemnification rather than selling it, and thus observing only the intent-to-treat effect on those who want their crop price risk mitigated. We see this approach as enlightening, to in a sense know how high the bar can be for the impact of insurance on investment. Further research needs to be done on other risks (e.g., rainfall), with larger sample sizes, and perhaps with training and longer-term commitments to maintain a presence in a market.

[6] Giné and Yang (2007) is the working-paper version of Giné and Yang (2009).

APPENDIX: SUPPLEMENTARY TABLES

Table A.1. Analysis of attrition

	Full Sample Interviewed at Baseline (N=169) (1)	Interviewed at Baseline Only (N=43) (2)	Reached for Follow-up Survey (N=126) (3)	T-stat (2)<>(3) (4)	
General:					
Treatment: Selected for crop price indemnity	0.509	0.605	0.476	1.455	
	(0.039)	(0.075)	(0.045)		
Age	42.905	41.419	43.413	0.908	
	(0.957)	(1.735)	(1.138)		
Female	0.166	0.209	0.151	0.888	
	(0.029)	(0.063)	(0.032)		
Number of dependents	5.840	5.395	5.992	1.156	
	(0.225)	(0.428)	(0.264)		
Education score	4.254	4.605	4.135	1.219	
(0 = no schooling, 9 = highest)	(0.168)	(0.294)	(0.201)		
Cognitive score	4.609	4.512	4.643	0.547	
(1 = lowest, 7 = highest)	(0.104)	(0.206)	(0.121)		
Ambiguity aversion score	2.260	2.116	2.310	1.365	
(1 = not averse, 3 = very averse)	(0.062)	(0.130)	(0.070)		
Do you have health insurance?	0.538	0.558	0.532	0.298	
	(0.038)	(0.077)	(0.045)		
Lending History:					
Taken any loan	0.592	0.581	0.595	0.159	
	(0.038)	(0.076)	(0.044)		
Taken loan from financial institution	0.325	0.326	0.325	0.002	
	(0.036)	(0.072)	(0.042)		
Prefer to borrow from bank, not relative	0.811	0.721	0.841	1.745	*
	(0.030)	(0.069)	(0.033)		
Would use loan to buy farm inputs	0.964	1.000	0.952	1.458	
	(0.014)	0.000	(0.019)		
Farming:					
Perceived likelihood of price falling	2.414	2.023	2.548	2.941	***
(1=not likely, 6 = very likely)	(0.079)	(0.147)	(0.091)		
Maize farmer (vs. garden egg farmer)	0.538	0.419	0.579	1.833	*
	(0.038)	(0.076)	(0.044)		
Number of crops planned	2.030	2.209	1.968	1.496	
	(0.070)	(0.135)	(0.082)		
Planned to grow maize at baseline	0.627	0.581	0.643	0.717	
	(0.037)	(0.076)	(0.043)		
Planned to grow gegg at baseline	0.485	0.581	0.452	1.462	
	(0.039)	(0.076)	(0.045)		

Note: Joint F-test of significance on being surveyed at follow-up: 1.84, p-value: 0.028

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

Table A.2. Analysis of loan take-up decision

Table 2, Repeated with Original Full Sample Dependent variable: 1 = Borrowed; 0 = Did not Borrow Specification: Probit				
Sample:	**Follow-up only (N=126) Same as Table 2, Col. 1**	**Follow-up only (N=126) Same as Table 2, Col. 2**	**Full (N=169)**	**Full (N=169)**
	(1)	**(2)**	**(3)**	**(4)**
Treatment (loan included price indemnification)	0.020	0.195	-0.063	0.149
	(0.046)	(0.221)	(0.067)	(0.218)
Age	0.003	0.004	0.002	0.002
	(0.002)*	(0.002)**	(0.002)	(0.002)
Female	0.031	0.036	0.033	0.041
	(0.040)	(0.024)	(0.069)	(0.059)
Cognitive score	0.045	0.035	0.064	0.067
(1 = lowest, 7 = highest)	(0.015)***	(0.017)**	(0.017)***	(0.029)**
Perceived likelihood of price falling	0.011	0.043	0.028	0.059
(1 = not likely, 6 = very likely)	(0.023)	(0.032)	(0.022)	(0.034)*
Has borrowed previously	0.121	0.04	0.119	0.108
	(0.072)*	(0.054)	(0.077)	(0.099)
Maize farmer (vs. garden egg farmer)	0.090	0.057	0.056	0.055
	(0.051)*	(0.039)	(0.058)	(0.059)
Cognitive score* treatment		0.007		-0.01
		(0.021)		(0.037)
Perceived likelihood of price falling * treatment		-0.088		-0.073
		(0.045)*		(0.043)*
Has borrowed previously * treatment		0.067		0.008
		(0.041)		(0.119)
Observations	126	126	169	169
F test: treat cog*treat likelihood*treat loan*treat		6.79		3.97
Prob > F		0.15		0.41

Note: Robust standard errors in parentheses. Reported results are marginal effects.

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

Table A.3. Treatment effects

Table 4, Panel A: Repeated with original full sample Specifications: OLS and Probit/Tobit with baseline covariates				
Specification:	**OLS**	**OLS**	**Probit/Tobit**	**Probit/Tobit**
Sample:	**Follow-up only (N=126) Same as Table 4, Col. 3**	**Full (N=169)**	**Follow-up only (N=126) Same as Table 4, Col. 4**	**Full (N=169)**
	(1)	**(2)**	**(3)**	**(4)**
Borrowing:				
Applied for loan	0.042	-0.052	0.030	-0.059
	(0.062)	(0.064)	(0.048)	(0.061)
Loan principal (GHS)	5.295	21.245	6.644	29.180
	(21.657)	(22.757)	(26.762)	(28.951)
Had overdue balance in May 2009, borrowers only	0.035	0.040	0.034	0.038
	(0.137)	(0.091)	(0.137)	(0.092)
Had overdue balance in May 2009, all obs	0.052	0.068	0.052	0.069
	(0.133)	(0.100)	(0.131)	(0.098)

Note: Borrowing and repayment information were collected as part of Mumuadu's administrative data, so data were available for all 169 individuals. The results with the final sample of 126 are presented to keep a sample consisent with the follow-up outcomes. Control variables for column (2) are age, female, education, cognitive score, ambiguity aversion, perceived likelihood of price drop, and maize farmer (vs. garden egg group). Robust standard errors in parentheses. * significant at 10%, ** signicant at 5%, *** significant at 1% (No results are significant).

Table A.4. Bounded treatment effects

Table 4, Panel B: Repeated with attriters imputed for lower bound estimate~ Specifications: OLS and Probit/Tobit with baseline covariates Dependent Variables: Each row represents a different dependent variable								
Specification:	**OLS**		**OLS**		**Probit/Tobit**		**Probit/Tobit**	
Sample:	**Follow-up only (N=126)**		**Full (imputed) (N=169)**		**Follow-up only (N=126)**		**Full (imputed) (N=169)**	
	Same as Table 4, Col. 3				**Same as Table 4, Col. 4**			
	(1)		**(2)**		**(3)**		**(4)**	
Cultivation and Inputs:								
Cultivated indemnity crop	0.092		-0.215	**	0.088		-0.251	***
	(0.078)		(0.081)		(0.072)		(0.083)	
Cultivated garden egg	0.156	**	-0.119	*	0.175	**	-0.137	*
	(0.071)		(0.061)		(0.081)		(0.071)	
Cultivated maize	-0.070		-0.326	***	-0.070		-0.404	***
	(0.077)		(0.091)		(0.074)		(0.091)	
Amount of land farmed in minor season (acres)	-0.428		-0.646	**	-0.422		-0.643	**
	(0.345)		(0.278)		(0.350)		(0.282)	
Amount of land farmed: indemnity crop (acres)	-0.257		-0.577	*	-0.075		-0.474	
	(0.388)		(0.318)		(0.489)		(0.367)	
Used certified seed on indemnity crop, growers only	0.082		-0.252	*	0.086		-0.259	*
	(0.117)		(0.128)		(0.118)		(0.127)	
Used certified seed on indemnity crop, all obs	0.109		-0.162		0.115		-0.166	*
	(0.090)		(0.096)		(0.091)		(0.094)	
Total spent on chemicals for indemnity crop (GHS)	-12.50		-21.71		-4.17		-16.80	
	(18.37)		(15.56)		(24.44)		(18.81)	
Total spent on chems for indemnity crop, % all crops	0.179	**	0.112		0.231	*	0.143	*
	(0.080)		(0.066)		(0.118)		(0.086)	
Total labor days used, all obs	4.990		-0.948		5.587		-0.597	
	(9.653)		(7.188)		(9.690)		(7.297)	
Total labor days used on indemnity crop, all obs	1.067		-3.593		4.358		-1.590	
	(7.322)		(5.481)		(9.573)		(6.968)	
Sales and Income:								
Amount harvested from garden egg crop (kg), all obs	28.87		-30.41		417.62		-123.56	***
	(92.36)		(58.08)		(560.28)		(46.64)	
Amount harvested from maize crop (kg), all obs	-147.45	*	-215.46	***	-270.35	**	-270.48	***
	(74.97)		(59.65)		(121.70)		(80.67)	
Revenue for all crops (GHS), all obs	-85.98		-150.16	**	-106.16		-162.39	***
	(70.74)		(53.87)		(82.00)		(59.91)	

Table A.4. Continued

Specification:	OLS		OLS		Probit/Tobit		Probit/Tobit	
Sample:	Follow-up only (N=126) Same as Table 4, Col. 3		Full (imputed) (N=169)		Follow-up only (N=126) Same as Table 4, Col. 4		Full (imputed) (N=169)	
	(1)		(2)		(3)		(4)	
Sold indemnity crop, growers only	-0.035		-0.356	***	-0.061		-0.356	***
	(0.079)		(0.068)		(0.102)		(0.067)	
Sold indemnity crop, all obs	0.065		-0.227	***	0.056		-0.248	***
	(0.094)		(0.074)		(0.097)		(0.076)	
Sold indemnity crop to market trader, growers only	0.250	*	-0.176	*	0.254	**	-0.177	*
	(0.121)		(0.100)		(0.115)		(0.096)	
Sold indemnity crop to market trader, all obs	0.176		-0.108		0.185	*	-0.109	
	(0.106)		(0.079)		(0.103)		(0.076)	

Note: Missing continuous values imputed at treatment mean minus .25* treatment standard deviation for treatment observations and control mean plus .25*control standard deviation for control observations. Missing binary values replaced at 0 for treatment and 1 for control. Marginal effects presented for probit and tobit results. Probits used for binary indicators and tobits for non-negative continuous variables. Robust standard errors in parentheses. * significant at 10%, ** signicant at 5%, *** significant at 1%. Control variables for all columns are age, female, education, cognitive score, ambiguity aversion, perceived likelihood of price drop, and maize farmer (vs. garden egg group). 'Indemnity crop' is maize for the maize farmer group and garden eggs for the garden egg group.

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