Environment for Development

Discussion Paper Series

March 2017 ■ EfD DP 17-04

Credit, Insurance, and Farmers' Liability

Evidence from a Lab in the Field Experiment with Coffee Farmers in Costa Rica

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Abstract

To cope with losses from extreme hydro-meteorological events, governments typically implement disaster relief programs and offer debt relief to affected parties. Governments in developing countries have made extensive use of total and partial debt coverage as a way to encourage investment in key sectors and in agriculture in particular. In the context of climate change, such practices are not viable because risk is systemic and losses can easily surpass most governments' debt relief budgets. Insurance is an obvious alternative, but insurance uptake in developing countries is typically low, and little is known about the interaction between investment, insurance, and debt relief programs, which effectively reduce borrowers' liability. This paper examines the effect of farmers' liability on demand for credit with and without insurance. We test predictions of a theoretical model in a lab in the field experiment with coffee farmers in Costa Rica. Farmers choose how much to invest in six different settings, described on the one hand by whether the loan is insured or not, and on the other by the probability that the government provides full debt relief. As expected, uptake of loans with insurance is significantly higher than without insurance when farmers are fully liable, and insurance is not relevant for investments if debt relief is guaranteed. Interestingly, uncertainty about liability is enough to trigger the uptake of insured debt. Our results suggest that well-defined rules for disaster relief are needed to support development of insurance markets.

Key Words: credit, insurance, liability, debt relief, agriculture

JEL Codes: Q1, Q18

Contents

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1. Introduction

To cope with losses from extreme hydro-meteorological events, governments typically implement disaster relief programs and offer debt relief to affected parties (The World Bank 2007). For example, agricultural banks in developing countries frequently cooperate with poor agricultural borrowers after they experience a significant loss, restructuring their loans, and sometimes outright cancelling outstanding debts (Carter et al. 2007). However, governments in general and in developing countries in particular have a limited capacity to help. Moreover, in the context of climate change, debt relief practices are becoming less viable because risk is systemic and losses can easily surpass most governments' debt relief budgets. An example of systemic risk is exposure to increasingly frequent, extreme hydro-meteorological events, as predicted under climate change scenarios for Central America.[1] Insurance is an obvious alternative, but insurance uptake in developing countries is typically low, and little is known about the interaction between investment, insurance, and debt relief programs, which effectively reduce borrowers' liability.

Previous research has focused on the combined effects of credit and insurance on investment, and the effects of insurance on credit demand and vice versa.[2] Experimental evidence, however, is mixed. When combining credit and insurance, some studies find credit with insurance increases investment (i.e., fertilizer purchase) (Hill and Viceisza

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[1] It is important to highlight that systemic and highly covariate weather risks can be insured; see Carter et al. (2014) for a review on index-based weather insurance for developing countries.

[2] See Marr et al. (2016) for a review of the most recent literature on index insurance and bundling insurance with credit.

2012), while others find that mandatory insurance actually reduces the demand for credit (Giné and Yang 2009) or has no effect on investment and adoption of new technologies (Brick and Visser 2015). Finally, Karlan et al. (2014) state that crop insurance alone increases farm investment, but when insurance is bundled with credit, it does not necessarily increase investment.

One would expect that governmental debt relief programs are closely linked to the uptake of insurance, since debt relief programs affects farmers' (perceived) liability. However, empirical evidence on how farmers' individual liability affects the uptake of insured credit is scarce. There are studies focusing on joint liability[3] and credit (Ghatak and Guinnane 1999; Chowdhury 2005) and, more recently, on adding collateral requirements to joint liability group lending (Flatnes and Carter 2015). Only Giné and Yang (2009) refer to the existence of limited liability as a possible explanation for lower demand for insured loans compared to uninsured loans. In their model, limited liability provides implicit insurance; thus, when an insurance premium must be paid, this results in a lower demand for loans. Conversely, when farmers are fully liable or face uncertainty about their liability, demand for loans with insurance should increase.

Our objective is to examine the effect of farmers' liability on the uptake of credit with and without mandatory insurance. We believe this is the first empirical study to address this question. We develop a theoretical model, following Giné and Yang (2009), and conduct a lab in the field experiment with coffee farmers in Costa Rica. Each farmer chooses how much to borrow in order to invest in his farm. Credit is offered either with or without mandatory insurance with a premium cost, under three types of government debt relief scenarios. Under these scenarios, farmers have limited liability, uncertainty about their liability, or full liability. A laboratory approach allows us to isolate the impact of limited liability on the demand for loans with and without mandatory insurance. To avoid other factors that are likely determinants of insurance uptake, our design takes into account an actuarially fairly priced insurance premium, with pay-out triggered by weather realization and without any basis risk.

Our results show uptake of loans with insurance is significantly higher than without insurance when farmers are fully liable, but also when there is uncertainty about

[3] Joint liability is when borrowers receive individual loans but form a group in which all members are mutually responsible for the total repayment to the lender (Flatnes and Carter 2015).

their liability. Yet insurance has no effect on credit demand if debt relief is guaranteed. In other words, if a government wants to increase the uptake of insurance as a strategy to reduce the vulnerability of farmers to climate change, it does not have to go to full liability, a very hard to sell public policy and one with hard consequences for the agricultural sector. Our results show already high levels of insured investment in a scenario in which governmental debt relief is uncertain. Through debt relief programs, governments in developing countries have accustomed farmers to enjoy limited liability. In reality, though, there is always uncertainty about the level of governmental resources, and hence about the level of liability that a farmer faces. Our results show that clearly and credibly communicating this level of uncertainty can result in increased uptake of insured credit and hence in farmers being better covered against risk.

The rest of this paper is organized as follows. The second section describes the literature on credit constraints, credit combined with insurance, and the role of limited liability; the third section presents a model on credit, investment and insurance, and develops our hypotheses; section four describes our experimental design and implementation procedures; section five presents the results; and the last section concludes the paper.

2. Literature Review

In this section, we briefly review the relevant literature on credit market imperfections. We then discuss previous evidence on bundling credit with mandatory insurance and the effects on farm investment. Finally, we reflect on the role of limited liability.

Rural households in developing countries face a number of credit constraints and market imperfections that shape investment decisions (Karlan et al. 2014). In the absence of insurance markets, “risk rationing,” as explained by Boucher et al. (2008), suggests that the borrower voluntarily withdraws from taking a loan, due to the risk of losing collateral (Giné and Yang 2009). Traditional formal insurance instruments can be used to manage risks, but such insurance services are basically non-existent in rural areas of developing countries (Carter et al. 2014). This lack of insurance markets might aggravate the effect of risk rationing on credit uptake (Boucher et al. 2008; Giné and Yang 2009). The combination of credit and crop insurance, therefore, could be applied as a mechanism to improve credit markets and encourage investment in the agricultural sector (Carter et al. 2014).

Some studies focus on bundling credit with mandatory insurance and the effects on risk rationality and farm investment. Regarding risk rationality, Cheng (2014) studies the effects of index insurance on risk rationed households in China. In his experiment, providing insurance to risk rationed farmers induced more than half of the farmers to apply for credit, with approximately two-thirds using the loan for productive investment rather than for consumption. Regarding farm investment, Carter et al. (2016) formally model and analyze the conditions under which index-based crop insurance can be most effective. They show that insurance will have no impact on investment and technology adoption when risk is very low and the risk is covered by low collateral or limited liability contracts. When collateral requirements are low, index insurance has low impact, given the implicit insurance of the loan contracts. Insurance also has low impact under high-risk scenarios, when risk aversion reduces adoption and especially when the insurance contract carries high basis risk. For index insurance to have an impact on investment and credit demand, the risk of suffering losses should be high and covariate among farmers. Then the impact of the insurance will depend strongly on the collateral requirements by the lender. Under low collateral requirements, bundling credit and insurance will foremost benefit the lenders by bringing stability to the loan portfolio. In high collateral situations, even stand-alone index insurance, can considerably increase the adoption of new technologies through credit when the risk is covered by a well-designed index contract (Carter et al. 2016).

In an experimental study on the importance of capital constraints and uninsured risk, Karlan et al. (2014) examine if financial market imperfections discourage investment by smallholder farmers. They applied a randomized controlled trial with cash grants, rainfall insurance grants, and rainfall insurance sales in northern Ghana. They find strong responses of agricultural investment to the rainfall insurance grant, but relatively small effects of the cash grants. Hence, uninsured risk limits farmer investment, while farmers with insurance grants manage to find resources to increase investment on their farms. This clearly suggests that agricultural credit market policy alone is not sufficient to increase investment in the agricultural sector.

Brick and Visser (2015) used a lab in the field experiment in South Africa to examine whether provision of index insurance induces farmers to opt for riskier activities. They find that providing a loan with insurance does not increase investment in new technologies. Furthermore, risk-averse farmers are more likely to opt for traditional seeds than for high-yield seeds, regardless of the presence of insurance. Their experimental design reflects the reality of an index insurance product that minimizes the risk of rainfall variability, but the design does not account for other risk factors (i.e., basis risk) that might have affected their results given the high degree of risk aversion.

Giné and Yang (2009) implemented a random field experiment in Malawi to examine whether production risk suppresses the demand for credit. They offered credit to purchase high-yielding seeds to a control group of farmers and credit bundled with index insurance to a treatment group. Their results show that take-up is lower when credit is bundled with insurance. They argue, and show theoretically, that limited liability provides enough implicit insurance, so farmers will prefer loans without mandatory insurance, which are less costly.

To summarize, existing experimental evidence is mixed. On the one hand, providing crop insurance increases farm investments (Hill and Viceisza 2012; Karlan et al. 2014; Elabed and Carter 2014). On the other hand, when credit and insurance are combined, investment does not necessarily increase (Karlan et al. 2014; Brick and Visser 2015) and may even decline (Giné and Yang 2009).

We now turn to a more extensive review of the role of limited liability. When production is low, farmers may be forced to default to maintain a subsistence level of consumption (Miranda and Gonzalez-Vega 2011). Default can occur involuntarily when associated with shocks or other risks that make borrowers unable to repay, but can be voluntary when lack of contract enforcement incentivizes borrowers to default even when they have the means to repay their loans (Ghosh et al. 2000). When contracts are subject to limited liability, borrowers are not forced to repay the bank if returns on investment are less than loan repayment obligations (Ghosh et al. 2000).

Agricultural banks and governments in developing countries often cooperate with poor agricultural borrowers to deal with losses from extreme events, by restructuring loans and through debt relief programs (Carter et al. 2007). Governmental assistance, however, is not always certain, making farmers more or less liable in the process (Miranda and Gonzalez-Vega 2011; Carter et al. 2007). After the strong effects of “El Niño” 1998 in Peru, for example, a government decree forced lenders to reschedule, meaning that farmers in default could pay later. Lenders believed these public sector interventions damaged the credit culture that had been formed in previous years (Trivelli et al. 2006). In Costa Rica, the government applied debt relief six times between 2004 and 2012, to assist borrowers who had received credit from development banks and were struggling to repay their loans (Gutierrez-Vargas 2015). To illustrate the impact of restructuring loans on farmers’ behavior, simulations show that borrowers increase repayment of loans when payment to the bank is reduced, but they default in the period after receiving the loan; this moral hazard effect reduces banks' returns (Miranda and Gonzalez-Vega 2010).

Empirical evidence on the effect of farmers' liability on uptake of credit combined with insurance is scarce. Only Giné and Yang (2009) refer to the existence of limited liability as a possible explanation for lower credit demand when credit is bundled with insurance. They show theoretically that a loan contract with limited liability provides enough implicit insurance, and therefore credit demand will decline with mandatory insurance that increases the price of credit (Giné and Yang 2009). Furthermore, there is evidence that farmers' belief about availability of disaster relief is associated with less participation in insurance programs.

A study by van Asseldonk et al. (2002) explore the producer's belief in disaster relief in the Netherlands. Farmers' willingness to pay to participate in a hypothetical insurance program is negatively and significantly associated with the producer's belief that disaster relief will be available in the future. In addition, a recent study by Deryugina and Kirwan (2016) hypothesizes a similar pattern by estimating whether the Samaritan's dilemma exists in U.S. agriculture.[4] They instrument for disaster payments using political variation at county level and then estimate how expectations of receiving these payments affect farmers' decisions. They find that bailout expectations reduce crop insurance coverage by reducing expenditures on premiums and inducing farmers to choose less generous insurance plans. At the same time, farmers also reduce farm labor and fertilizer use.

The next section will discuss in detail the theory behind farmers' decision-making regarding loans.

3. Theoretical Model

This section describes the theoretical model for credit demand and insurance, building on the model developed by Giné and Yang (2009). We start with the general model setup and then illustrate the simple case of loans without insurance, followed by

[4] First described by Buchanan (1975), the Samaritan's dilemma explain how individuals who expect to be bailed out in times of crisis (e.g., natural disasters and financial crises) take on additional risk in response (Deryugina and Kirwan 2016).

the case of loans with mandatory insurance. Finally, we introduce differences in farmers' liability and discuss the hypotheses.

3.1. General Model Setup

To analyze farmers' demand for credit, we consider a risk-averse farmer who is offered credit under two types of contract (with and without mandatory weather insurance) and three types of government debt relief (limited liability, uncertainty about liability, or full liability for farmers). Farmers use the credit to invest in their agricultural production. Farm output depends on the level of investment, the return on investment, and the state of the weather. We define p and (1-p) as the probability of good (bad) weather. Following Giné and Yang (2009), we assume perfect correlation of investment returns and state of the weather, so that investment returns depend solely on the realization of the weather with a probability p = ½.

Without investment, farmers can realize a base output level Y_B in case of bad weather or $Y_B + a$ in case of good weather, while investment will increase output to the level Y_H in case of good weather and reduce output to the level Y_L in case of bad weather.[5] We assume that expected output is higher when the farmer invests than without investment, so that $p\ (Y_B + a)\ +\ (1 - p)Y_B < p\ Y_H + (1 - p)Y_L$.

Output with investment, Y_H or Y_L, depends on the amount invested, which is equal to the loan size C. In case the weather is good, investment gives the farmer a positive return r, so that $Y_H = Y_b + a + rC$. In case of bad weather, the return is negative r, so that $Y_L = Y_b - rC$.

We define i as the interest rate, W as the value of famers' assets required as collateral for a loan of any given size, and R as the repayment of the loan, consisting of the amount borrowed and the interest due. We assume that the value of the collateral is enough to cover the repayment of the loan: $W > (1 + i)C = R$, and that output in the low state is not sufficient to repay the bank ($Y_L < R$). The lender can always seize up to the full value of farm output Y_L or Y_H in order to secure repayment of the loan, but only seizes other assets W with a probability ϕ. The three scenarios we analyze are limited liability ($\phi = 0$), uncertain liability ($0 < \phi < 1$), and full liability ($\phi = 1$).

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[5] We give farmers the example of investing in new coffee trees (see Annex 2), when indeed a bad weather shock can lead to negative returns on investment.

3.2. Credit Without Insurance

First, consider the case when credit is offered without insurance and farmers decide whether to borrow and invest amount C. When the farmer chooses not to invest, expected utility is defined as

$$U_B = \frac{1}{2}u(Y_B + a + W) + \frac{1}{2}u(Y_B + W) \quad (1)$$

When the farmer chooses to invest, output can be high or low, depending on the weather. Consumption in the high output state is $c_H = Y_H - R + W$. In the low output state, consumption depends on whether the bank seizes (part of) the collateral to recover repayment, which it does with probability ϕ. Hence, expected utility with investment in the case of credit without insurance is given by:

$$U_U = \frac{1}{2}u(Y_H - R + W) + \frac{1}{2}[\phi\, u(Y_L - R + W) + (1 - \phi)u(W)] \quad (2)$$

3.3. Credit With Mandatory Insurance

Second, consider the case when credit is offered only in combination with weather insurance provided by the bank. The insurance premium π is set at an actuarially fair price (following Giné and Yang 2009), so that, in order to invest level C, farmers need to borrow an amount $C + \pi$. The total repayment to the bank for a loan with insurance is therefore $R^I = (1 + i)(C + \pi)$. In states of bad weather, the insurance pays out the total amount R^I. Given the actuarially fairly priced insurance, the premium can be written as a function of repayment without insurance (as in Giné and Yang 2009), which gives $R^I = \frac{R}{\mathrm{p}} = 2R$. Hence, expected utility of investment when credit is combined with insurance is:

$$U_I = \frac{1}{2}u(Y_H - 2R + W) + \frac{1}{2}u(Y_L + W) \quad (3)$$

3.4. Differences in Farmers' Liability

We evaluate three different liability scenarios: limited liability ($\phi = 0$), uncertain liability ($\phi = \frac{1}{2}$), and full liability ($\phi = 1$). In general, utility of credit demand with actuarially fairly priced insurance depends on the level of output in case of bad weather, Y_L, and on farmers' risk aversion. In the next section, we use a constant relative risk aversion utility function (CRRA)[6] and show the predictions of the theoretical model under the distinct features of our experimental design.

Intuitively, when farmers have limited liability and income in the low state is lower than repayment with insurance $Y_L < R$, loans without insurance should provide sufficient implicit insurance. Thus, utility of uninsured credit should be higher than utility of insured credit. Then, when farmers are uncertain about their liability or are fully liable, low values of Y_L and a contract without insurance still provide implicit insurance and thus higher expected utility for uninsured loans. However, when Y_L increases, farmers' default costs also increase and expected utility is higher for loans with insurance (Giné and Yang 2009, p4). Table 1 summarizes expected utility in each of the scenarios, assuming that $Y_L < R$ and that the coefficient of risk aversion $\sigma = 0.5$.

Table 1. Expected Utility in Each Experimental Treatment and Testable Hypothesis

	Limited liability ($\phi = 0$)	**Uncertain liability ($\phi = \frac{1}{2}$)**	**Full liability ($\phi = 1$)**
Credit without insurance (U_U)	$\frac{1}{2}u(Y_H - R + W) + \frac{1}{2}u(W)$	$\frac{1}{2}u(Y_H - R + W) + \frac{1}{2}\left[\frac{1}{2}u(Y_L - R + W) + \frac{1}{2}u(W)\right]$	$\frac{1}{2}u(Y_H - R + W) + \frac{1}{2}u(\boldsymbol{Y_L} - R + W)$
Credit with insurance (U_I)	$\frac{1}{2}u(Y_H - 2R + W) + \frac{1}{2}u(\boldsymbol{Y_L} + W)$	$\frac{1}{2}u(Y_H - 2R + W) + \frac{1}{2}u(\boldsymbol{Y_L} + W)$	$\frac{1}{2}u(Y_H - 2R + W) + \frac{1}{2}u(\boldsymbol{Y_L} + W)$
Testable hypothesis	$U_U \succ U_I$	$U_U \prec U_I$	$U_U \prec U_I$

Note: Expected utility based on the model outlined in the main text, when $Y_L < R$ and $\sigma = 0.5$.

4. Experimental Design and Implementation

To test our hypotheses in a controlled environment, we implemented a lab in the field experiment with coffee farmers in Costa Rica. The experiment is set up as a within-subject design in which each farmer faces six different treatments. In each treatment, the farmer chooses how much to borrow for investment in her farm, while facing ex-ante uncertainty about the weather, which can be good or bad. In the treatments, credit is offered either with or without mandatory insurance, and with farmers having limited liability ($\phi = 0$), uncertainty about their liability ($\phi = ½$), or full liability ($\phi = 1$). We explain that farmers' liability is the result of whether or not there will be debt relief by the

[6] Constant relative risk aversion utility function: $u(c) = \frac{c^{1-\sigma}}{1-\sigma}$; $0 < \sigma < 1$. $\sigma = 0$ indicates risk neutrality and $\sigma > 0$ indicates risk aversion.

government in case of bad weather. Each treatment is presented as a one-period decision making game, independent from the other treatments.

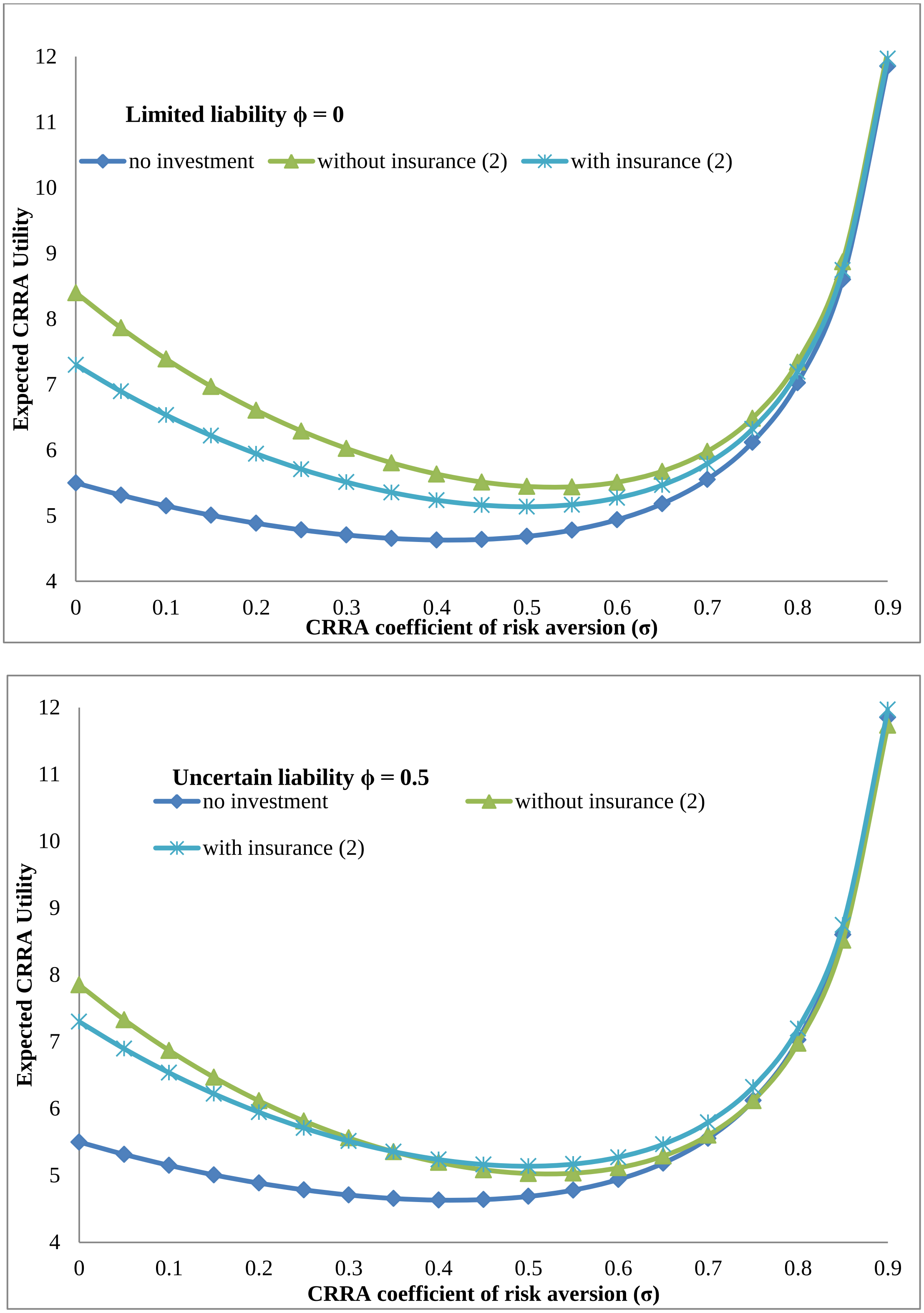
The experimental design is developed in line with the previous model, in which good and bad weather occur with equal probability ($p = ½$) and we assume a CRRA risk aversion parameter ($\sigma = ½$). Base output (without any investment) is $\mathrm{Y_b} = 2$ in case of bad weather, while good weather will result in additional output over base output equal to $a = 1$ (Hill and Viceisza 2012). Farmers can choose to invest zero, one or two units of capital C. If the weather is good, investment gives the farmer a positive return over the capital $(r = 5)$: $Y_H = Y_b + a + rC$. In case of bad weather, the return is negative $(r = -1)$ and: $Y_L = Y_b - C$.

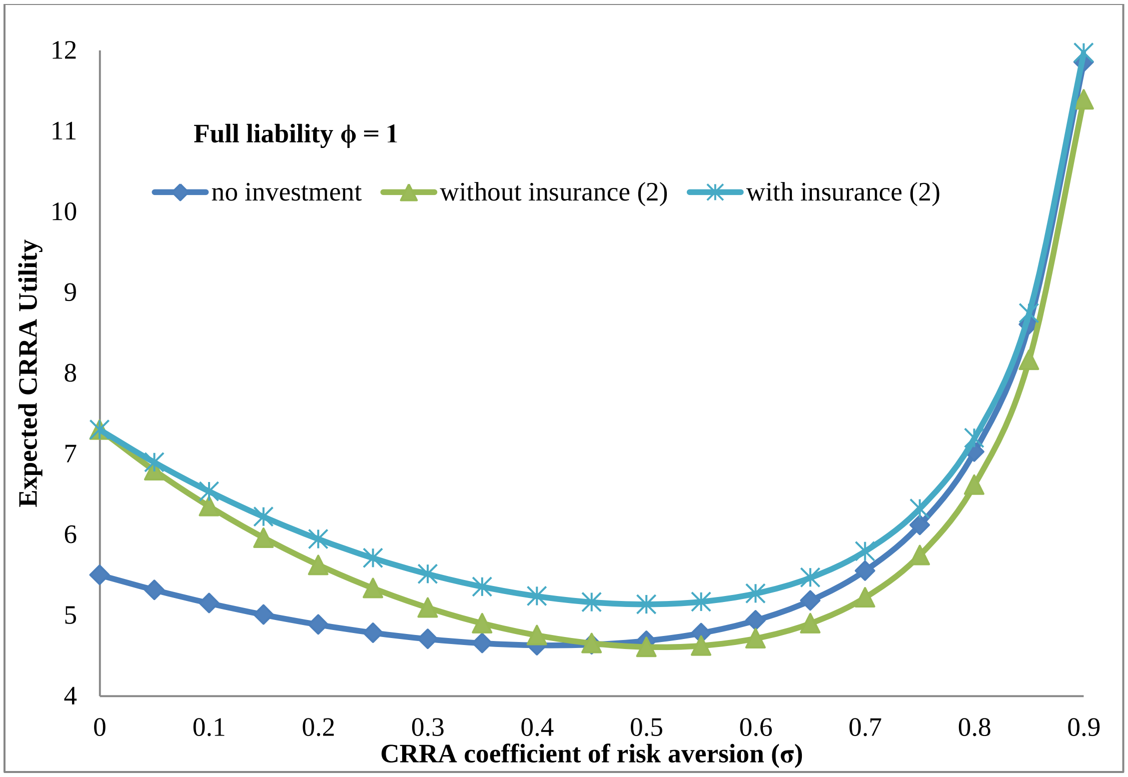
In each of the six treatments, farmers are given an endowment (W = 3) that can serve as collateral. This endowment is sufficient to guarantee the maximum uninsured repayment amount (W > R), with the interest rate fixed at $i = 0.10$ throughout the experiment. Farmers are told that their asset endowment can be seen as farmland, housing, or other properties that the lender can take in case of default. Farmers' consumption will depend on the amount invested C, the weather draw, and whether or not their collateral is seized by the bank. One unit of income or consumption in the experiment is set equal to 1,000 Costa Rican Colones (CRC).[7]

Figure 1 shows expected utility without credit (zero investment) and with maximum investment (C=2), with or without insurance, for different risk aversion parameter values and while holding the expected returns constant. As Figure 1 shows, for low levels of risk aversion, the expected utility associated with maximum investment is always higher than the expected utility without investment, whether or not credit comes with insurance.

[7] 1000 CRC equals approximately two US dollars.

Figure 1. Expected CRRA Utility Varying the Risk Aversion Parameter





When risk aversion increases, maximum investment is still preferred in the case of limited liability (top panel), except for very high levels of risk aversion, where no differences are clearly displayed. When farmers are uncertain about their liability (middle panel), maximum investment is still preferred over no investment if credit is bundled with insurance. If credit is uninsured, the very risk-averse farmers are indifferent between maximum investment and no investment. Finally, when farmers are fully liable (bottom panel) and risk aversion increases above 0.4, they prefer zero investment over uninsured investment.

Farmers in our experiment choose their level of credit under each type of loan (insured or uninsured) and liability scenario, rather than choosing between an insured and uninsured loan. Hence, our theoretical model predicts that, when farmers have limited liability, credit demand should be higher if credit is not bundled with insurance than if credit is bundled with insurance. When farmers are uncertain about their liability and have relatively low risk aversion, credit demand should also be higher if credit is not bundled with insurance. With uncertain liability and high levels of risk aversion, credit demand should be higher if credit is bundled with insurance. When farmers are fully liable, credit demand should be higher if credit is bundled with insurance. In the same scenario, for risk aversion below 0.45, expected utility without insurance is still higher than without investment, but, for risk aversion above 0.45, the expected utility of not investing is higher than that of investing without insurance.

Each of the six treatments was repeated three times to be able to perform several robustness tests. We explain that rounds are independent from each other, and that one round will be randomly selected for payment at the end of the experiment. The draw of the round for payment and weather is determined in private for each farmer. Selection of the payment round was done by taking one chip out of a bag with 18 chips numbered 1-18, while the weather draw was determined with the toss of a coin. Final payment consisted of a show-up fee of 2000 CRC plus the level of consumption the farmer reached in the selected round. Detailed instructions are included in the complete experimental protocol in Annex 4.

Farmers participating in the experiment were selected from two coffee regions, Perez Zeledon and Los Santos, using stratified random sampling according to the density of coffee plots. Regions were selected to capture the variety in altitude and effects of a coffee rust epidemic in 2012-13; all farmers were surveyed in 2014 as part of a different study (Alpízar et al. 2016). We contacted all surveyed farmers and conducted thirteen experimental sessions at local primary schools during the second and third week of October 2015.[8] Sessions were organized one per day during the afternoon, with on average 10 farmers per session, who were assigned randomly to individual desks around the classroom. The order of treatments was selected randomly in the first two sessions, and repeated in subsequent sessions.

In total, 134 (46 percent of the 2014 survey participants) farmers participated in the experiment. Two farmers had incomplete responses for the experiment; these are excluded from the analyses. Table 2 presents farmers' characteristics for the survey and experimental participants. Differences in means (t-test) show no differences between the two groups for most of the variables, except that farmers participating in the experimental sessions have on average a smaller total area planted with coffee. We show in the next section that this has no effect on the outcomes of the experiment. Hence, our results can be seen as representative for the two coffee regions.

[8] Farmers were offered two possible dates to attend a workshop session at two nearby villages.

Table 2. Variables and Sample Means for Survey and Experimental Sample

	Survey 2014		Experiment 2015		t-test	
	n	***Mean***	***n***	***Mean***	***Difference***	***p-value***
Age (years)	294	51.76	132	51.52	0.25	0.828
Women	294	0.10	132	0.11	-0.01	0.783
Education (years)	294	5.79	132	5.79	0.00	0.993
Region (% from Perez Zeledon)	294	0.47	132	0.39	0.08*	0.053
% income from coffee	279	56.94	126	57.83	-0.89	0.780
Total coffee area (ha)	294	3.48	132	2.53	0.96***	0.000
Affected by leaf rust	294	0.81	132	0.81	0.00	0.975

Source: (Alpízar et al. 2016). Note: *** p<0.01, ** p<0.05, * p<0.1

5. Empirical Strategy and Results

To analyze the effect of farmers' liability on demand for credit with and without insurance, our main dependent variable is the average amount borrowed across the three repeated rounds within each treatment. Figure 2 presents the distribution of farmers' credit demand across the six experimental treatments. Credit demand varies considerably across treatments. Farmers are more likely to demand the highest level of credit (2000 CRC) when governmental debt relief ensures limited liability for the two types of loans, with insurance (52 percent) and without insurance (58 percent). Comparing Figures 2a and 2b, there appears to be little impact of mandatory insurance on farmers' credit demand when farmers are not liable, in line with theoretical predictions (see Figure 1). Compared to limited liability, credit demand is lower when farmers are uncertain about their liability and especially when they are fully liable. Comparing Figures 2c and 2d, as well as Figures 2e and 2f, we see that, with uncertain or full liability, mandatory insurance increases demand for credit. Again, this is in line with predictions from the model, and suggests the farmers in our sample have intermediate to high levels of risk aversion.

Figure 2. Credit Demand by Treatment

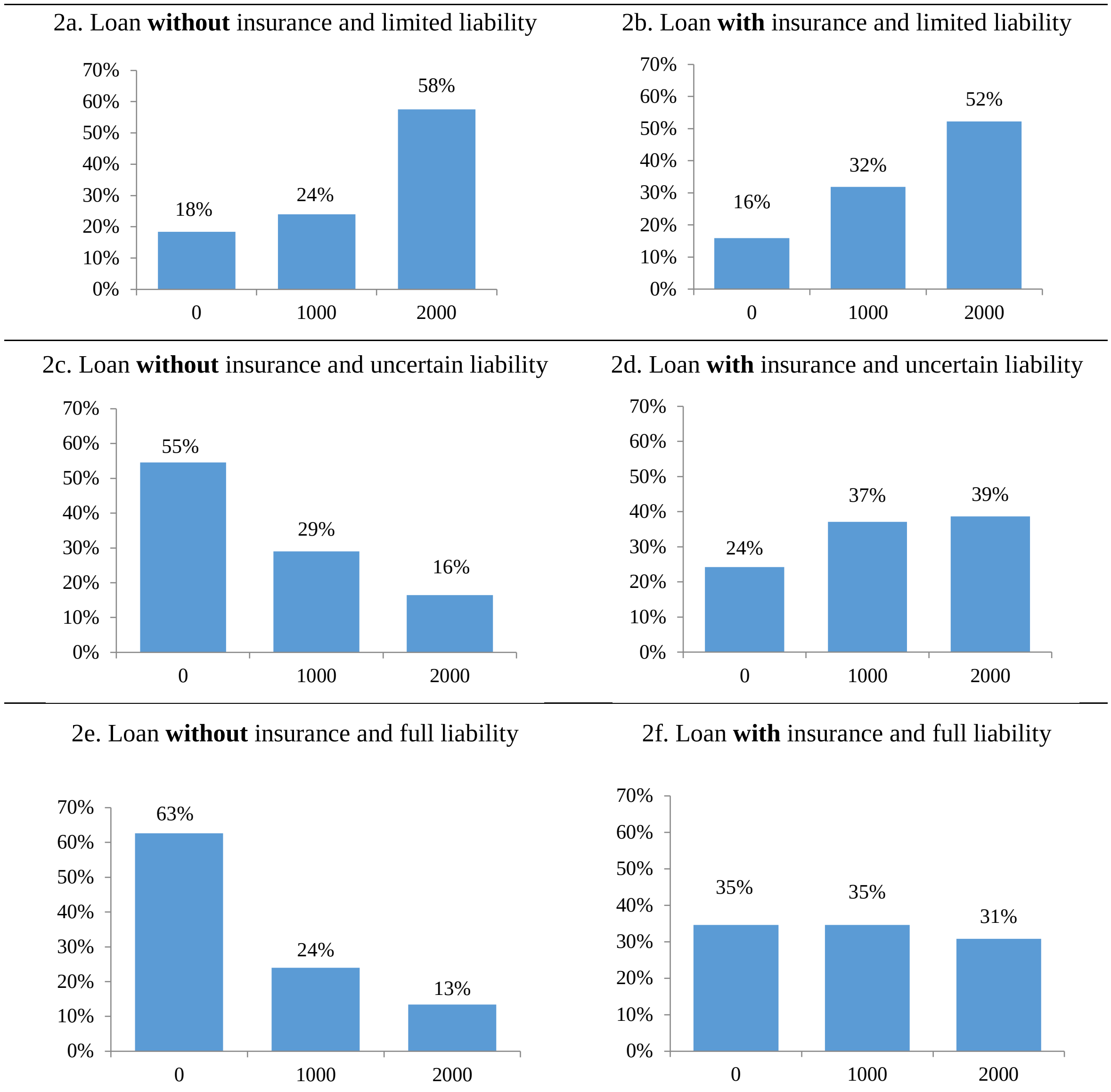


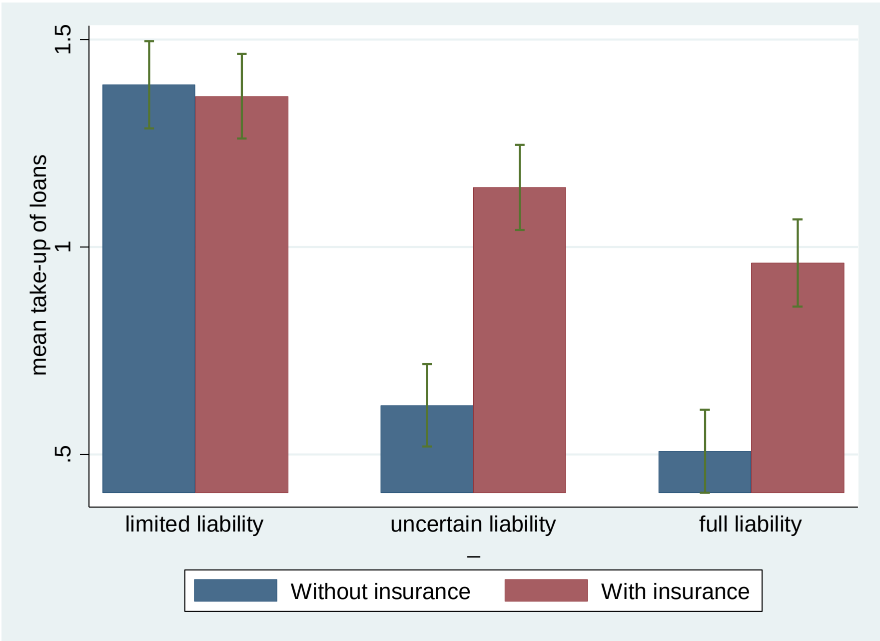
Table 3 and Figure 3 explore differences in means between treatments using a paired t-test. Comparing means across the rows of Table 4 again shows that liability decreases total credit demand. We also confirm that uptake of loans with insurance is significantly higher than without insurance when farmers are liable or when there is uncertainty about their liability. We find no significant differences between demand for loans with and without insurance in case of limited liability.

Table 3. Paired t-test for Differences in Credit Demand Means Across Treatments

	Without insurance		With insurance		t-test		N
	Mean	*Std. Error*	*Mean*	*Std. Error*	*Difference*	*p-value*	
Limited liability	1.39	0.053	1.36	0.052	-0.03	0.593	132
Uncertainty	0.62	0.050	1.14	0.052	0.53***	0.000	132
Full liability	0.51	0.051	0.96	0.053	0.45***	0.000	132

Note: *** p<0.01, ** p<0.05, * p<0.1.

Figure 3. Differences in Credit Demand Across Treatments



To formally analyze the effect of mandatory insurance and liability, we estimate the following equation:

$$Y_{ijk} = \alpha + \beta_1 Insurance_j + \beta_2\, Uncertain\_liability_{\,k} + \beta_3\, Full\_liability_{\,k} + \beta_4\, Insurance_j \times Uncertain\_liability_{\,k} + \beta_5\, Insurance_j \times Full\_liability_{\,k} + \gamma_i + \varepsilon_{ij} \quad (4)$$

Our dependent variable Y_{ijk} is the average amount borrowed by farmer *i* in insurance treatment *j* and under liability treatment *k*, γ_i are farmer fixed effects, and ε_{ij} is the error term. The average amount borrowed is measured as the average of all three rounds within a treatment. The treatment with no insurance and limited liability is taken as the reference. Standard errors are clustered by farmer.

Table 4. Impact of Insurance and Liability on Credit Demand

Dependent variable: average amount borrowed	Full sample	First round per treatment dropped	Subsample treatment order 1	Subsample treatment order 2
Insurance	-0.03	0.00	-0.02	-0.03
	[0.05]	[0.06]	[0.07]	[0.08]
Uncertain liability	-0.77***	-0.83***	-0.88***	-0.66***
	[0.06]	[0.07]	[0.08]	[0.09]
Full liability	-0.88***	-0.95***	-0.97***	-0.79***
	[0.06]	[0.07]	[0.08]	[0.10]
Insurance * Uncertain liability	0.55***	0.52***	0.58***	0.52***
	[0.06]	[0.07]	[0.09]	[0.09]
Insurance * Full liability	0.48***	0.47***	0.53***	0.43***
	[0.06]	[0.07]	[0.09]	[0.08]
Constant	1.39***	1.41***	1.41***	1.38***
	[0.04]	[0.05]	[0.05]	[0.06]
Fixed effects	Y	Y	Y	Y
Mean dependent variable	1.38	1.41	1.39	1.36
Observations	792	792	414	378
R-squared within subjects	0.417	0.385	0.487	0.348
Number of subjects	132	132	69	63

Note: Clustered standard errors in brackets, *** p<0.01, ** p<0.05, * p<0.1.

In Table 4, the first column shows that the introduction of mandatory insurance has no significant effect on credit demand when liability is limited. This is not surprising, and confirms the reality of developing countries, where limited liability is ubiquitous and insurance virtually nonexistent. On the other hand, the coefficients on the interaction terms show that, when there is uncertainty about liability or full liability, the effect of mandatory insurance is positive and highly significant. Moreover, the effect is large: insurance increases credit demand by around 0.5 (or 500 CRC), which is more than one-third of the sample average (1.38), and close to one standard deviation (0.60).

We perform a number of robustness checks. First, we drop the first observation of each round, as this may be considered a practice round, after which farmers are better able to determine their preferred level of credit. Hence, the dependent variable is the average amount borrowed across the second and third round of the respective treatment (results in the second column of Table 4). Second, to ensure results are not driven by the order of the rounds in the experiment, we split the sample according to the order of treatments: each session followed one of two possible (randomly determined) treatment orders, so we analyze whether results differ between the two groups of experiment sessions (third and fourth columns of Table 4). In all estimations, we find very similar results.

5.1. Heterogeneous Treatment Effect

In this section, we present results for heterogeneous effects of treatment. We start with verifying whether treatment effects depend on farmers' total area planted with coffee. Recall from Table 2 that coffee area is significantly smaller for famers in the experiment sample, compared to the total random sample of farmers that were invited to participate. Results in Table 5 show there are no differences by farmers' total coffee area. This suggests our results are representative of farmers in the two regions, even though our sample is not representative in terms of coffee area planted.

Table 5. Heterogeneous Effects for Coffee Area

Dependent variable: average amount borrowed	(1)
Insurance	-0.06
	[0.07]
Uncertain liability	-0.70***
	[0.08]
Full liability	-0.77***
	[0.09]
Insurance*Uncertain liability	0.52***
	[0.09]
Insurance*Full liability	0.46***
	[0.09]
Coffee area*Insurance	0.01
	[0.02]
Coffee area*Uncertain liability	-0.03
	[0.02]
Coffee area*Full liability	-0.04*
	[0.02]
Coffee area*Insurance*Uncertain liability	0.01
	[0.02]
Coffee area*Insurance*Full liability	0.01
	[0.02]
Fix effects	Y
Mean dependent variable	1.38
Observations	792
R-squared with-in subjects	0.425
Number of subjects	132

Note: Clustered standard errors in brackets, *** p<0.01, ** p<0.05, * p<0.1.

We analyze other heterogeneous effects across farmers' social and financial indicators (Annex 1). Evidence from previous studies suggests there is a positive relationship between credit take-up and farmer's education and income (Giné and Yang 2009), and that previous exposure to weather shocks can affect the take-up of credit bundled with insurance (Hill and Viceisza 2012). We analyze heterogeneity by farmers' age, gender, years of schooling, percentage of income coming from coffee harvest, and having been affected by other shocks in the past, including their experience with the recent coffee leaf rust epidemic in 2012-13. However, we do not find significant effects of these variables in interaction with treatments (Annex 1, Table A1).

We believe that our lab in the field experiment design was well-explained and easier to understand for farmers, compared to other field experiments evaluating existing insurance programs. Existing insurance schemes can carry basis risk and trust concerns due to lack of information, which can lead to differences based on education, income, and previous experience with shocks. Furthermore, our experimental sample and the farmers' population in general is very homogeneous in their socioeconomic characteristics. Therefore, we don't have sufficient variability in the data to find significant heterogeneous effects.

6. Conclusions

Governments in developing countries have made extensive use of total and partial debt relief as a way to encourage investment in key sectors and in agriculture in particular. In a context of climate change, such practices are most likely not viable because risk is systemic and losses can easily surpass most governments' debt relief budgets. Insurance is an obvious alternative, but what is the interaction between insurance and debt relief programs?

We test the predictions by Giné and Yang (2009) that insurance will not increase credit demand if farmers are not liable. Using their conceptual model, we explore the effect on the credit demand of interacting mandatory insurance with different degrees of liability. The model is tested using a lab in the field experiment with coffee farmers in Costa Rica.

Our results show that uptake of loans bundled with insurance is significantly higher than uptake of loans that are not bundled with insurance, both when farmers are fully liable and when there is uncertainty about their liability. Yet, insurance has no effect on credit demand if debt relief is guaranteed. In other words, if a government wants to increase the uptake of insurance as a strategy to reduce the vulnerability of farmers to climate change, it does not have to impose full liability, a very hard to sell public policy and one with hard consequences for the agricultural sector. Our results show already high levels of insured investment in a scenario in which governmental debt relief is uncertain. Through debt relief programs, governments in developing countries have accustomed farmers to enjoying limited liability. In reality, though, there is always uncertainty about the level of governmental resources, and hence about the level of liability that a farmer faces. Our results show that clearly and credibly communicating this level of uncertainty can result in increased uptake of insured credit and hence in farmers being better covered against risk.

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Annex 1. Additional Results

Table A1. Heterogeneous Effects by Farmers' Characteristics

Dependent variable: average amount borrowed	(1)	(2)	(3)	(4)	(5)
Insurance	0.18	-0.03	-0.07	-0.03	-0.01
	[0.20]	[0.05]	[0.15]	[0.11]	[0.13]
Uncertainty	-1.33***	-0.77***	-0.47***	-0.70***	-0.94***
	[0.22]	[0.06]	[0.14]	[0.11]	[0.12]
Full liability	-1.85***	-0.89***	-0.51***	-0.75***	-1.00***
	[0.23]	[0.06]	[0.16]	[0.13]	[0.14]
Insurance*Uncertain liability	0.47*	0.57***	0.56***	0.52***	0.64***
	[0.25]	[0.06]	[0.15]	[0.13]	[0.17]
Insurance*Full liability	0.82***	0.48***	0.27*	0.33***	0.43***
	[0.23]	[0.06]	[0.15]	[0.12]	[0.14]
Age*insurance	-0.00				
	[0.00]				
Age*Uncertain liability	0.01**				
	[0.00]				
Age*Full liability	0.02***				
	[0.00]				
Age*Insurance*Uncertain liability	0.00				
	[0.00]				
Age*Insurance*Full liability	-0.01				
	[0.00]				
Female*Insurance		0.06			
		[0.20]			
Women* Uncertain liability		-0.04			
		[0.26]			
Women*Full liability		0.03			
		[0.24]			
Women*Insurance*Uncertain liability		-0.17			
		[0.25]			
Women*Insurance*Full liability		0.02			
		[0.24]			
Schooling[1]*Insurance			0.01		
			[0.03]		
Schooling* Uncertain liability			-0.05**		
			[0.02]		
Schooling*Full liability			-0.07**		
			[0.03]		
Schooling *Insurance*Uncertain liability			-0.00		
			[0.02]		
Schooling *Insurance*Full liability			0.04		
			[0.02]		

Dependent variable: average amount borrowed	(1)	(2)	(3)	(4)	(5)
Income[2]*Insurance				-0.00	
				[0.00]	
Income* Uncertain liability				-0.00	
				[0.00]	
Income*Full liability				-0.00	
				[0.00]	
Income*Insurance*Uncertain liability				0.00	
				[0.00]	
Income*Insurance*Full liability				0.00	
				[0.00]	
Shocks[3]*Insurance					-0.02
					[0.14]
Shocks* Uncertain liability					0.21
					[0.14]
Shocks*Full liability					0.14
					[0.16]
Shocks*Insurance* Uncertain liability					-0.10
					[0.19]
Shocks*Insurance*Full liability					0.06
					[0.16]
Constant	1.39***	1.39***	1.39***	1.39***	1.39***
	[0.04]	[0.04]	[0.04]	[0.04]	[0.04]
Fix effects	Y	Y	Y	Y	Y
Mean dependent variable	1.38	1.38	1.38	1.38	1.38
Observations	792	792	792	756	792
R-squared within subjects	0.451	0.420	0.438	0.411	0.421
Number of subjects	132	132	132	126	132

Note: Clustered standard errors in brackets, *** p<0.01, ** p<0.05, * p<0.1.
[1] Years of schooling.
[2] Percentage of the total household income coming from coffee farming.
[3] Dummy variable of being affected by shocks in the past including their experience with the recent coffee leaf rust epidemic in 2012-13.

Annex 2. General Experimental Instructions

I. Welcome procedures

1. *Meet people at door; request ID.*
2. *Match ID with survey ID.*
3. *Write the ID survey number in the decision sheet booklet.*
4. *Give them the closed decision sheet booklet. Stress that they can't open the booklet until indicated by the coordinator.*
5. *Invite them to sit, assigning them randomly across the room.*

II. General instructions for farmers and experimenters

[START POWER POINT PRESENTATION]

☼ **[Slide 1]** *Good afternoon. Today you will participate in a decision-making workshop. You are invited as a follow-up to a survey conducted last year. The exercises are based on real-life decisions that will allow us to learn from your experience, according to the decisions made during the workshop. The workshop will last about two hours and we need to stay together until the end. At the end of the workshop, you will be compensated with real money, the amount of which will depend on the decisions made and on chance. You will receive a minimum payment of 2,000 colones, plus the result of your decisions in the workshop exercises.*

We are going to read the instructions together. First the general instructions and then gradually through the decision game rounds. Listen carefully to the instructions for each choice. Look carefully at the possible payments and the probabilities associated with each choice before making a decision. Remember that your final earnings will depend on the decisions you make and on chance.

If you have any questions, please raise your hand and I or one of my colleagues will come to help you! Please do not hesitate to ask a question if you do not understand. There are no right or wrong answers. Your decisions are personal and depend on your own preferences. Your decisions are also anonymous. This means the decisions can only be yours and your choices will remain private. So, please remain quiet and do not share your decisions or talk to the person sitting next to you. ***This is very important!***

[GO THROUGH INSTRUCTIONS WITHOUT INVITING QUESTIONS. AVOID PUBLIC QUESTIONS]

☼ **[Slide 2]** **<u>To borrow or not to borrow money from the bank</u>**

You choices today consist of deciding whether or not to take a loan to invest in your farm. If you decide to invest, just like any loan contract, you must have illiquid assets as a guarantee in case you cannot pay the loan. These assets can be your own farmland, *house or other properties that are taken by the lender if you can´t pay back what you borrowed.*

*Since we cannot quantify what you possess, today you all have the same value of wealth as a guarantee, equal to **3,000 colones,** before you make your decision.*

☼ **[Slide 3] <u>You pay an interest rate</u>**

You decide how much to borrow. You can borrow nothing, 1,000, 2,000 or 3,000 colones. The decision is yours. Remember there are no right or wrong answers.
Like any credit, you must pay an interest rate to the Bank**. The interest rate is **10%** of the amount you decide to borrow. This means that, according to the table below, if you decide to invest and borrow **1,000 colones** from the bank, you have to pay back **1,100 colones**. If you invest and borrow **2,000 colones**, you have to pay back **2,200 colones**. If you decide **not to borrow**, then you pay nothing back to the bank. **Do you have any questions?


You invest and borrow	You pay back to the bank
₡0	₡0
₡1,000	₡1,100
₡2,000	₡2,200

☼ **[Slide 4] <u>Your investment is risky and depends on the weather</u>**

Note that the result depends on the weather. For example, consider renewing your farm with a new variety of coffee. If things go well and the weather conditions are favorable, you get a profit. However, if things go wrong and there is a lack of rain, or a hurricane to damage your new coffee plantation, then you will have a much lower output than if you had not invested.

The probability of a good or bad result is 50/50. That is, after deciding how much to borrow to invest, you have to throw a coin. If the coin marks "Crown," that means there will be good weather and if the coin marks "Shield," that means there will be bad weather. If you choose not to invest, you will have an output of 3,000 colones if there is good weather and production of 2,000 colones if weather conditions are not favorable and affect the harvest.

On the other hand, if you decide to borrow and invest, there is a chance that things will go well and that you will earn more money, or that things will go badly and you will be worse off than without investing. If you borrow and invest 1,000 colones and there is good weather, you might get 8,000 colones and if bad weather 1,000 colones. If you borrow and invest 2,000 colones and there is good weather, you might get 13,000 *colones, and if bad weather zero colones.* ***Do you have any questions?***

		
You invest and borrow	Good weather	Bad weather
₡0	₡3,000	₡2,000
₡1,000	₡8,000	₡1,000
₡2,000	₡13,000	₡0

Do you have any questions? [WAIT AND EXPLAIN AGAIN IF NECESSARY]

☼ **[Slide 4] <u>Production + Capital – Payment to the bank</u>**

After the good or bad weather determines the outcome of your investment, you will still have to pay the Bank according to your loan. Remember that everyone has the same initial capital as collateral, which is equal to ₡ 3,000. Therefore, your final output is production + capital – what you have to pay the bank.

		
You invest and borrow	Good weather	Bad weather
₡0	₡3,000 + ₡3,000 – ₡0 = **₡6,000**	₡2,000 + 3,000 – ₡0 = **₡5,000**
₡1.000	₡8,000 + ₡3,000 – 1,100 = **₡9,900**	₡1,000 + ₡3,000 – 1,100 = **₡2,900**
₡2.000	₡13,000 + ₡3,000 – 2,200 = **₡13,800**	₡0 +₡3,000 – 2,200 = **₡800**

Any questions? [WAIT AND EXPLAIN AGAIN IF NECESSARY]

☼ **[Slide 5] <u>Weather insurance</u>**

Pay attention to the instructions. Sometimes the loan offered is bundled with insurance. This means that, when you take the loan, it includes ***mandatory insurance****. The benefits from the insurance are that it takes care of repaying the bank when bad weather events occur, securing your assets. However, the insurance is costly. Therefore, when the weather is good, there is a cost reflected by the amount to repay to the bank.*

You invest and borrow	You pay back the bank with NO insurance	You pay back to the bank with insurance
₡0	₡0	₡0
₡1.000	₡1,100	₡2,200
₡2.000	₡2,200	₡4,400

Do you have any questions? [WAIT AND EXPLAIN AGAIN IF NECESSARY]
☼ **[Slide 6] Government help in case of bad weather**

Sometimes when a bad weather event occurs, and affects an entire sector, for example coffee production, the government takes action to relieve the consequences of the shock. In the past, the government has applied debt forgiveness on credit loans when farmers affected by shocks can´t pay back the banks. Please pay attention to the instructions, since in some rounds the government will apply debt forgiveness when bad weather events occur and sometimes it might help according to a probability. ***Do you have any questions?***

[WAIT AND EXPLAIN AGAIN IF NECESSARY]

<table>
<tr><th colspan="2">Debt forgiveness when bad weather events occur</th></tr>
<tr><td></td><td>

No help ➔ You have to pay the bank
Debt forgiveness ➔ You don’t have to pay the bank
Depends on a probability ➔
- You have to pay the bank
- You don’t have to pay the bank


</td></tr>
</table>

☼ **[Slide 7] Payment procedure**
You will take ***18 decision tasks.*** *After you have taken all the decisions, one of your decisions will be drawn for real payment. This mean the amounts indicated in the decision problem will be paid out for real.*

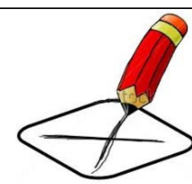
At the end of this workshop, one of the ***18 decision tasks*** *will be drawn at random by each of you, by taking one chip out of this bag with equal probability for each decision task to be extracted for payment. You can check that in the bag there will be exactly* ***18 numbered chips,*** *one for each decision previously taken. Then, you will draw a coin to pay you according to the good weather or bad weather.* ***Do you have any questions?***

[WAIT AND EXPLAIN AGAIN IF NECESSARY]

Annex 3. Example of Decision Sheet

EXAMPLE

- ✓ Credit does not require insurance
- ✓ The government cannot help and the Bank will seize your properties if no payment

POSSIBLE RESULTS			
Amount borrowed	Good weather	Bad weather	Mark your answer
			
₡ 0	₡ 6,000	₡ 5,000	
₡ 1,000	₡ 9,900	₡ 2,900	
₡ 2,000	₡ 13,800	₡ 800	