Ex-ante Impacts of Agricultural Insurance:

Evidence from a Field Experiment in Mali

Ghada Elabed and Michael Carter

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Abstract

Anticipating a negative income shock, uninsured households may refrain from undertaking profitable, but risky activities. This ex-ante risk coping strategy is costly in terms of forgone income. Therefore, insuring households so that they are objectively (and subjectively) less exposed to risk can prevent them from adopting these welfare decreasing ex-ante behaviors. To test this hypothesis, we randomly distributed the possibility of being insured and feeling insured to a group of cotton cooperatives in Mali by giving them access to a microinsurance contract. In a first step, we estimate the average treatment effect of the intervention by comparing the outcomes of households belonging to treated cooperatives to their counterparts in the control group. We find that our randomization instrument had a significant impact on households' ex-ante behaviors at the extensive margin. These intention to treat estimates show that offering insurance resulted in a 15% increase in the area in cotton, and a 14% increase in the expenditure on seeds per ha. In addition, as a result of our randomization 22.5% of the treated farmers and 10% of the non-treated farmers knew that they are insured. We measured the impacts of perceived risk reduction and objective risk reduction at the individual level using two instrumental variable strategies. We find that households who felt insured increased their area in cotton by more than 60%.

1 Introduction

Uninsured risk remains a serious impediment to poverty reduction in developing countries. It disproportionally affects the poorest within a population, potentially impeding their ability to benefit from growth. When facing a negative income shock, uninsured poor households tend to protect their assets at the cost of reduced consumption, with potentially irreversible losses in child human capital. In addition to this ex-post effect of shocks, uninsured shocks might also have ex ante effects. Anticipating a negative shock, uninsured households refrain from undertaking profitable, but risky activities. They instead invest in traditional technologies that have a low rate of return, which makes them even poorer.

In some developing countries, policy makers have promoted microinsurance as a tool to stabilize households 'incomes, mitigating the pernicious ex-post and ex-ante effects of uninsured risk. Despite the rapid spread of microinsurance pilots around developing countries, there is little empirical evidence on their effectiveness as a tool to reduce poverty. The goal of this paper is to remedy this gap in the literature by evaluating the efficacy of a microinsurance intervention that targeted cotton farmers in Mali. The focus of the study is to specifically analyze the ex-ante impacts of insurance, namely agricultural production decisions.

We designed the pilot project on which we base the analysis around cotton cooperatives since the cotton industry in Mali takes place in cooperatives. The research strategy we adopted was a randomized intervention that involved 87 cooperatives. We allocated two thirds (59) of the cooperatives into treatment group and we maintained one third (28) of the cooperatives as a control group. The treatment cooperatives were then offered the option of purchasing a microinsurance contract.

The microinsurance contract is an index insurance contract. Unlike conventional indemnity insurance in which payouts are based on individual outcomes, index insurance insures an index. The index is measured objectively and is designed to be highly correlated but not identical to individual outcomes (for example rainfall insurance or area-yield insurance).We focus on the ex-ante impacts of insurance, including agricultural production decisions.

To increase the likelihood of substantial take-up, we adopted an encouragement design: treatment cooperatives randomly received randomly distributed discounts that reduced the price to 50%, 75%, or 100% of the actuarially fair premium.

In the first year of the program, 16 out of the 59 treatment cooperatives (30%) agreed to purchase the index insurance contract. This uptake rate is well above up-take rates in some other pilot projects. We estimate the average treatment effect of the intervention by comparing the outcomes of households belonging to treated cooperatives to their counterparts in the control group. We find that our randomization instrument had a significant impact on households' ex-ante behaviors at the extensive margin. These intention to treat estimates show that offering insurance resulted in a 15% increase in the area in cotton, and a 14% increase in the expenditure on seeds per ha. In addition, as a result of our randomization 22.5% of the treated farmers and 10% of the non-treated farmers felt that they are insured. We measured the impacts of perceived risk reduction and objective risk reduction at the individual level using two instrumental variable strategies. We find that households who felt insured increased their area in cotton by more than 60%, and significantly increased the area of land they own and their expenditures on cotton inputs.

The remainder of the paper is structured as follows. In Section 2, we present a literature review of the studies of the impact of insurance. We then present the context of the intervention in Section 3. In Section 4 we describe the sample. In Section 5 we present our main findings. We conclude with policy implications.

2 Impact of microinsurance on risk coping and risk mitigation mechanisms

To set the stage for the impact of insurance on welfare, let us examine household behavior in the absence of insurance. The literature has established two main channels through which uninsured risk affects a poor household. The first channel takes place after the shock occurs (ex post), and consists of two complementary smoothing mechanisms. Consumption smoothing consists in liquidating the household's assets such as livestock to maintain a critical level of consumption. It is the most common type of coping strategy among the rural poor. It leads to a suboptimal accumulation of capital, and therefore a lower level of long-term income. Asset smoothing, which complements consumption smoothing, consists in destabilizing the households' consumption to protect their assets (Hoddinott 2006, Carter et al. 2007, Carter and Lybbert 2012,Kazianga and Udry 2006Jalan and Ravallion 1997Townsend 1994). Not only does this type of behavior have immediate short term impact on households 'nutritional status, but it can also lead to potentially irreversible losses in child health, nutrition and education [Carter et al., 2007]).

The second channel through which uninsured risk affects households' well-being occurs before the realization of the shock or ex ante. For an agricultural household, this channel takes place primarily through their production decisions. Anticipating a negative income shock, a household chooses to adopt a risk averse production behavior by investing in lower risk and lower return production method, instead of profitable but riskier alternatives [Rosenzweig and Binswanger, 1993]; [Carter et al., 2007]).

Empirical studies of the impact of microinsurance[1] on household production decisions in developing countries are scarce, mainly because of a low level of uptake of these products. Earlier studies have reported liquidity constraints [Cole et al., 2013a, Giné and Yang, 2009], lack of trust poor understanding ([Cai et al., 2009, Dercon et al., 2011, Cole et al., 2013a] as a possible explanation for the low uptake problem of microinsurance. More recent literature used insights from behavioral economics such as ambiguity aversion [Bryan, 2010], compound risk aversion ([Elabed and Carter, 2014]), and prospect theory considerations ([Petraud, 2014] to shed light on the problem of low insurance demand.

In theory, by protecting households against shocks and therefore reducing income variability, microinsurance allows households to avoid the costly asset smoothing and consumption smoothing behaviors. To date, only Janzen and Carter [2013] study the ex post impact of micro insurance on households' welfare. Their study is based on a drought induced insurance intervention in Kenya. Using households' reported risk coping strategies they find that insured farmers were less likely to smooth their consumption and their assets.

The main finding of the ex-ante impacts of microinsurance is that it induces farmers to take more profitable but riskier activities. When studying agricultural decisions in Ghana, Karlan et al. [2012] show that uninsured risk is the binding constraint to farmer's investment decisions. They randomly distributed cash grants, the possibility of purchasing insurance, or both. They showed that insuring against the main pro-

[1] Cole et al. [2012] and [De Bock and Darwin Ugarte, 2013] do a systematic review of the effectiveness of index insurance in developing countries.

duction risk enables farmers to spend more resources on their farm. Cole et al. [2013b] randomly distributed insurance contracts to a sample of Indian farmers. They find that farmers intensify the production of their main cash crop, which is risky relative to other land and labor uses. They do so by allocating more fertilizers, seeds and land to that crop. Mobarak and Rosenzweig [2012] randomly offer households the opportunity to purchase a rainfall insurance contract. They find that insured households are more likely to plan a variety of rice that has a significantly higher yield but is less drought tolerant. Cai et al. [2009] randomly distributed the opportunity to purchase an insurance contract to Chinese farmers in Southwestern China. They find that increased insurance adoption leases to an increase in sows. Cai [2012] uses a natural experiment and a household level panel data set in rural china to study the impact of government weather insurance program. She finds that insurance results in a significant increase in the production area of the insurance crop, a decrease in the production diversification. [Vargas Hill and Viceisza, 2010] designed framed field experiment in rural Ethiopia. In the games, farmers were asked to decide between whether to purchase a fertilizer and if so how many bags. Fertilizers represent the high risk high return activity in those experiments. Introducing a hypothetical insurance contract induces farmers to take more risk by purchasing more fertilizers than their non-insured counterparts.

3 Context and evaluation

3.1 Background on cotton production in Mali

Cotton is the main cash crop in Mali. It participates by up to 1% of the country's GDP and 15% of export revenues (African outlook 2013). Moreover, it plays a crucial role in rural development: between 10 and 13 million Malians depend directly on the cotton sector for their livelihood (IFDC2013). Most of the production takes place in Southern Mali in the regions of Sikasso, Bougouni, Fana, Sikasso and Kita.

Cotton is an annual crop, and grown on an average of 2 ha in rotation with other staple and cash crops such as maize. Its planting season coincides with the rainy season, which starts in late May or early June. The harvest takes place during the months of December and January. Since cotton constitutes one of the main sources of cash for Malian households, it is an important input into households' food security. In addition, the cotton crop functions as collateral to get input loans for the staple crops such as maze. Cotton producers are eligible for fertilizer loans from the national agricultural bank, with the obligation to repay at harvest time. In a setting where individual credit is nonexistent, this is a very important attribute.

The cotton sector in Mali is characterized by four main features. First, it is characterized by a high degree of vertical integration. The CMDT, the company Malienne des Textiles, is a national company that controls the cotton sector in Mali. Upstream, it acts as a monopsony by providing farmers with inputs and technical assistance. Downstream, it acts as a monopoly by purchasing all the cotton harvest from the farmers. In addition, CMDT divided the cotton growing area in several Secteurs (there is a total of 5 Secteurs in South of Mali). Each sector is divided into Zones de Production Agricole (ZPA), and each ZPA is in turn divided into cooperatives comprised of 25-30 farmers each.

The second feature of the cotton sector in Mali is that production takes place in cooperatives. An individual farmer has no access to credit to finance cotton production inputs. This is due to the usual problem of moral hazard that guarantee the failure of individual microcredit in rural areas of the developing world. To solve the problem of lack of access to credit, cotton production in Mali takes place in cooperatives. In a given village there are from 1 to 2 cooperatives with an average of 20 farmers. The main role of a cooperative is to give its members an access to input loans, mainly seeds, urea and the complexe cotton – the main fertilizer used in cotton.[2] The Banque National de Developpement Agricole (BNDA) is the primary source of input loans for the cotton sector. It passes loans to the CMDT, which on-lends the funds to individual village cooperatives. Every cooperative has a bank account at the BNDA.

The third feature is that the input loan comes with a binding joint liability clause. If at least one producer is unable to pay back his loan, all the other members of the cooperative have to pay back the difference. Therefore, productive cotton farmers bear the burden of less productive farmers, which creates tensions within the cooperatives. There is evidence that joint liability is enforced in the area. Members who were not able to pay back their loans are forced to sell their productive assets.

The final characteristic of the cotton sector in Mali is that farmers do not face a price risk since the CMDT announces the price long before the onset of the growing season. However, they face a substantial production risk. Since cotton is entirely rain fed in the study area, its production is vulnerable to weather shocks. The household survey we conducted highlights the extreme poverty and vulnerability of these farmers to adverse shocks: more than three quarters of the households reported that they suffered financially because of a drought during the year preceding the survey (i.e. in 2011). The average reported cost of this drought is equal to almost 348,000 CFCA (approximately 696 USD), which represents half of the financial costs of the shocks experienced by the households in 2011.

Households unable to pay back their input loans suffer a loss of their productive assets, and go through costly risk coping mechanisms. While insurance is a potential solution to the effects of these adverse shocks, it is widely absent in Mali. In this context, the Index Insurance Innovation Initiative launched in 2010 a pilot in the sector of Bougouni, in Southern Mali.

3.2 Design of the cotton insurance contract

The study area consists of the Secteurs of Dogo and Bougouni located within the region of Bougouni. There are a total of 270 cooperatives in these two Secteurs. Since the cotton industry in Mali is controlled by a monopsony/monopoly, and the production takes place in cooperatives, we decided to make the cotton

[2] At the beginning of the growing season, each member of the cooperative lists his needs in terms of production inputs. The secretary of the cooperative gathers the list from all the members and gets an input loan in kind from the BNDA. Then the cooperative distributes the inputs in kind among its members. After the harvest, The CMDT sends trucks to the villages and publicly weighs the cotton production, then transport it to its processing facilities. Then, the amount of the loan is deducted from the CMDT payment to pay back the loans. Then it distributes the profits to the village cooperatives, which are responsible for distributing the profit among their members.

cooperative as the insured unit. The contract we designed is an innovative area-yield index insurance contract. Unlike traditional insurance that pays individual farmers based on the losses they experience in their fields, a conventional index insurance pays based on an index that is designed to be highly correlated but not identical to farmer's losses. A conventional area yield index insurance contract pays a cooperative if the average yield in an aggregate area falls below a predetermined historical level.

The contract is a double-trigger lump sum indemnity contract. Compared to conventional single trigger contract, this contract has the advantage of reducing uninsured basis risk faced by cooperatives. The first trigger is the cooperative average yield, and it varies between 264 and 913 kg/ha. The second trigger is the ZPA yield and is equal to 900 kg/ha. We adjusted the level of the first trigger to keep the price of the insurance contract constant across cooperatives. Payoff occurs only if both the cooperative yield and the ZPA yield are below their triggers. Thus a cooperative with a yield of 740kg/ha would receive a payoff if the ZPA yield is 780kg/ha, but not if the ZPA yield is 1000kg/ha.

The triggers were set based on an estimation of the statistical distribution of the yield data at both levels. The CMDT provided cotton yield data at the ZPA level for all the ZPAs of Bougouni Region for 7 years (from 2001/2002 to 2007/2008). In addition we obtained cooperative level yields for nearly all the cooperatives in the Secteurs of Dogo and Bougouni for the last 5 or 6 years. The probability of getting a payment is set at 7%, and the insurance payment is equal to a lump sum of 95000 CFA/ha (or about 190 $US per hectare). It corresponds approximately to the amount of the loan taken by the farmers at the beginning of the growing season from the BNDA.

The upside of these contracts is that they reduce the basis risk for the cooperative while avoiding the moral hazard that would occur if payments were made only based on cooperative level yields. Under this dual trigger contract, insured cooperatives have no perverse incentives to reduce their yields, since payoffs are made only if the greater area of the ZPA has a low average yield. For more details about this contract see [Elabed et al., 2013].

Since the insured unit is the cotton cooperative, cooperative members decide to purchase the contract thanks to an internal decision making process. The decision has to be made before the beginning of the growing season, i.e. before the end of May. If the cooperative decides to buy the insurance contract, then the CMDT signs a formal insurance agreement with the insurance company, naming the covered cooperative and the appropriate number of hectares insured. The CMDT pays the insurance company directly and then deduct the premium charges from the cooperatives using the same mechanism it uses to recover loan repayment (that is, loan and insurance charges are to be deducted from the value of cotton sales which are made directly to the CMDT).

3.3 Experimental Design

The final set of cooperatives that were priced by the reinsurance company contains 87 cooperatives. We randomly allocated two thirds (59) of the cooperatives into treatment group and we maintained one third

(28) of the cooperatives as a control group. We then offered the treatment cooperatives the option of purchasing the insurance contract. The contracts are identical from an actuarial point of view. They have the same probability of payment, and differ in terms of the triggers set at the cooperative and ZPA level. The actuarially fair premium of the insurance contract is equal to 7125 CFA (15 USD). The insurance company charged a 50% mark-up, which results in a premium of 10716 FCFA/ha (22 USD).

To increase the likelihood of substantial take-up, we adopted an encouragement design: treatment cooperatives received randomly distributed discounts that reduced the price to 50%, 75%, or 100% of the actuarially fair premium. Overall there are three categories of prices, implying three levels of subsidies. The first category corresponds to a price of 7125 FCFA (15 USD), the actuarilly fair price, which implies a subsidy of 3591 FCFA/ha (7 USD). The second category corresponds to a price of 5344 FCFA/ha (11 USD), which represents 75% of the actuarially fair price. The third price is 3563 FCFA/ha (7 USD), which is 50% of the actuarially fair premium.

The implementation of the randomization consisted of three steps. We organized a workshop in Bamako to train a group of local extension agents about the insurance contract and the implementation of the randomization. During the months of April and May 2011, these agents organized group trainings with the secretaries of the cooperatives from the treatment groups to inform them about the intervention. The idea was that the secretary would then train the members of his cooperative about the insurance contract. In the final stage of the implementation process, the extension agents were supposed to visit each cooperative from the treatment group to hold a general meeting with all its members. The outcome of the meeting would be a decision of the farmers of whether they want to subscribe to the insurance contract or not.

We administered a follow-up survey in December 2011 and January 2012, after the harvest. We sampled the households to survey in one wave in 2011/2012. There was no baseline survey but we relied on recall data over a short period of time. To draw the sample, groups of enumerators were assigned a certain number of cooperatives in the study area. Then, each group coordinator asked the chief of the cooperative to list the names of the cooperative members. Using a randomization table, the survey coordinator identified 12 household heads to survey. The final sample frame consisted of 312 household members from the control group, and 669 households from the treatment group.

The questionnaire included demographic, wealth, production and food consumption modules. There was also a module about insurance purchases. In every household, we surveyed the household head, the woman in charge of preparing the meals (the food queen), and the woman who has the youngest children in the household. We also measured the heights and weights of children aged from 6 months to 5 years.

To make sure that the implementation of the intervention complies with the procedure we established, we included an audit question in the impact survey. Specifically, we asked the surveyed cooperative member whether he knew that his cooperative had access to an insurance contract or not. Surprisingly, 9 cooperatives out of the 59 initially allocated to the treatment group have a high percentage of negative answers. We further investigated this issue by talking to the extension agents who implemented the intervention. We found out at that at least 3 cooperatives were not offered the possibility of purchasing the insurance contract. The reason behind this imperfect implementation is primarily the deadline we imposed on the collection of the insurance subscriptions by the extension agents. In fact, since we are also interested in studying the ex-ante decisions of farmers, we imposed the deadline of May 31st to guarantee that farmers made their insurance purchase decisions before starting to make their planting decisions. To account for the high level of negative answers within the 9 cooperatives, we decided to reclassify them in the control group. The rest of the paper carries the analysis using the audit-based reclassification. In the appendix, we carry robustness checks with a more conservative approach in which we reclassify to the control group only the three cooperatives with a 100% negative response rate. The appendix also shows the same analysis using the original classification.

4 Sample and balance tests

We targeted 12 household from each of the 88 cooperatives in the study area, for a total sample size of 1056 households. We completed the survey of 981 households for an overall response rate of 93%. Column (1) of Table 1 provides the descriptive statistics for the households belonging to the control group. The average household head is approximately 56 years old, and has limited formal education (one year of schooling). Moreover, 60% of the surveyed farmers are Bambara, while only 30% are Peuhl. Most of the farmers are non-immigrants (80%) and more than half of them are related to the village chief. The respondents have a relatively long experience farming (19 years on average) and being a cooperative member (9 years on average). In terms of living standard we observe some variability, especially in terms of the values of agricultural assets and the values of livestock.

Column (1) of table 2 provides the baseline production statistics for the households belonging to the control group. The total area in cotton per household is around 2 ha, with a yield of 1070 kg/ha. The total area allocated to the other crops (corn, millet, mill, sorghum and rice) is around 4 ha per household. Overall, the study sample is made by really poor small scale cotton farmers.

We did not implement a baseline survey, but included recall data in the survey following the intervention. Hence to check the balance between treatment and control groups, we look at recall variables related to the 2010-2011 growing season, which preceded the insurance intervention. Although the period of recall was relatively short, 60% of the surveyed household members were not able to remember the area of land they allocated to cotton and the value of their cotton productions in 2010. Therefore, the differences in these two variables that we observe at the baseline between the treatment group and the control group are only true for the subsample of farmers who remembered their production decisions in 2010.

Tables 1 and 2 present the baseline characteristics of households by treatment status using both the original classification and the audit-based reclassification. It shows that the randomization achieved balance across a range of baseline observables for both classifications. However, cotton yields are not balanced between treatment and control groups. The control cooperatives seem to be more productive than the treatment ones at the baseline. This difference will not impact our analysis since yields are also subject to ex-post factors such as droughts and we are only interested in ex-ante outcomes.

		Original specification		Preferred specification	
		(1)	(2)	(1)	(2)
	Obs	Control	Treatment	Control	Treatment
Household head characteristics:					
Age	962	55.54	54.84	54.95	55.14
		[13.99]	[14.32]	[14.23]	[14.19]
Education	981	1.00	0.92	1.06	0.87
		[2.19]	[1.83]	[2.24]	[1.70]
1 if Bambara	981	0.60	0.65	0.61	0.65
		[0.49]	[0.48]	[0.49]	[0.48]
1 if Peuhl	981	0.33	0.26	0.30	0.27
		[0.47]	[0.44]	[0.46]	[0.44]
Agricultural experience (# years)	970	18.88	19.69	19.33	19.50
		[14.61]	[14.12]	[14.64]	[13.99]
Coop. membership (# years)	970	8.53	8.41	8.09	8.70
		[5.02]	[5.92]	[4.71]	[6.23]
1 if has a function at the coop.	981	0.24	0.22	0.25	0.22
		[0.43]	[0.42]	[0.43]	[0.41]
1 if non-immigrant	972	0.78	0.81	0.79	0.80
		[0.42]	[0.40]	[0.41]	[0.40]
1 if related to village chief	981	0.53	0.58	0.51	0.60*
Living standards		[0.50]	[0.49]	[0.50]	[0.49]
1 if stone walls	970	0.17	0.14	0.17	0.14
		[0.37]	[0.35]	[0.38]	[0.34]
1 if mud walls	970	0.78	0.77	0.77	0.78
		[0.42]	[0.42]	[0.42]	[0.42]
1 if sheet metal roof	970	0.56	0.52	0.56	0.52
		[0.50]	[0.50]	[0.50]	[0.50]
1 if straw roof	970	0.38	0.38	0.38	0.37
		[0.49]	[0.49]	[0.49]	[0.48]
1 if private well	970	0.26	0.35	0.29	0.35
		[0.44]	[0.48]	[0.45]	[0.48]
1 if public well	970	0.17	0.24	0.17	0.25*
		[0.38]	[0.43]	[0.38]	[0.43]
1 if borehole pumps	970	0.52	0.40	0.50	0.39
		[0.50]	[0.49]	[0.50]	[0.49]
1 if flashlight battery	970	0.47	0.47	0.47	0.47
		[0.50]	[0.50]	[0.50]	[0.50]
Livestock 2010 (CFA)	981	1,975,600	1,756,528	1,866,165	1,796,297
		[5,885,622]	[2,883,937]	[5,268,821]	[2,948,892]
Ag. asset value 2011 (CFA)	970	182,445	183,990	222,200	155,047
		[283,715]	[837,798]	[1,077,520]	[150,336]
House value (CFA)	951	290,100	303,533	285,275	308,949
		[369,146]	[418,258]	[380,043]	[418,866]
Household size (#)	970	18.37	19.50	17.68	20.17
		[12.05]	[14.46]	[11.54]	[15.06]
Household asset value (CFA)	984	204,416	194,804	199,178	196,722
		[181,666]	[159,382]	[179,673]	[157,011]

Columns (1) and (2), (3) and (4) show means with standard deviations in brackets. The stars in column (2) and (4) correspond to the level of significance of the coefficient on treatment from regressions of each characteristic on treatment clustering standard errors at the cooperative level.
***Difference is significant at the 1 percent level. **Difference is significant at the 5 percent level. *Difference is significant at the 10 percent level.

Table 1: Baseline household characteristics

	Obs	Original specification (1) Control	(2) Treatment	Preferred specification (1) Control	(2) Treatment
Cotton					
Cotton area 2010 (ha)	586	2.20	2.41	2.19	2.44
		[1.39]	[1.70]	[1.33]	[1.77]
Cotton harvest 2010 (kg)	584	2,339	2,288	2,316	2,291
		[1,822]	[1,879]	[1,741]	[1,939]
Cotton yield 2010 (kg/ha)	584	1,070	926**	1,053	914***
		[440]	[345]	[422]	[342]
Maize area 2010 (kg)	969	2.12	1.77	2.00	1.79
		[5.33]	[1.94]	[4.72]	[1.96]
Rice area 2010 (ha)	969	0.20	0.21	0.26	0.16
		[0.55]	[0.68]	[0.78]	[0.51]
Sorghum area 2010 (ha)	969	1.20	1.37	1.20	1.40
		[1.63]	[1.84]	[1.64]	[1.86]
Fonio area 2010 (ha)	969	0.04	0.04	0.04	0.03
		[0.29]	[0.23]	[0.33]	[0.17]
Mil area 2010 (ha)	969	0.54	0.43	0.49	0.45
		[1.28]	[1.12]	[1.22]	[1.14]
Millet area 2010 (ha)	969	0.03	0.05	0.03	0.06
		[0.26]	[0.33]	[0.25]	[0.35]
Area other crops	969	4.13	3.87	4.02	3.90
		[5.64]	[2.88]	[5.10]	[2.89]

Columns (1) and (2), (3) and (4) show means with standard deviations in brackets. The stars in column (2) and (4) correspond to the level of significance of the coefficient on treatment from regressions of each characteristic on treatment clustering standard errors at the cooperative level.
*** Difference is significant at the 1 percent level. **Difference is significant at the 5 percent level. *Difference is significant at the 10 percent level.

Table 2: Baseline production statistics

5 Insurance uptake

5.1 Descriptive results

A total of 16 cooperatives out of the 59 treatment cooperatives (30%) purchased the insurance contract. This corresponds to 184 households out of the 669 households in the treatment group, or an uptake rate of 27%. The total area of cotton in 2010 in the treatment group was 970 ha. The insured area is equal to 229 ha, or 23% of the total area eligible for the insurance product.

The encouragement design allows us to examine the demand of this product. Recall that the intervention targets cooperatives since they are the insured units. Therefore, we observe 87 discrete decisions of whether a given cooperative participates in the program or not. Figure 1 shows the number of cooperatives purchasing insurance as a function of the price of insurance. Demand slightly dropped when the price went from 100% of the fair premium to 75% of the fair premium. Then it slightly increased when the price went down to 50% of the fair premium. As Figure 1 shows, correcting the misclassification does not change the pattern of the demand.

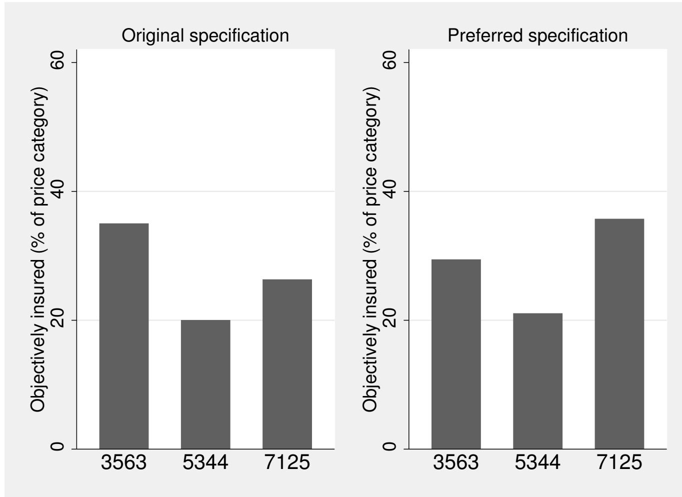

Figure 1: Insurance Take up by Price per ha (CFA)

5.2 Empirical estimation and results

We estimate the up-take of insurance using the following specification:

$$I_c = \alpha_1 + \beta_1 T_c + \varepsilon_{1c} \tag{1}$$

where I_c is an indicator of whether cooperative c decided to purchase the insurance contract, T_c is cooperative c treatment status (original or audit-based), and is equal to 1 if cooperative c belongs to the treatment group. Since the treatment $T_c = 1$ was randomly assigned, we should expect $E(\varepsilon_{1c}|T) = 0$ and the ordinary least square estimate of β_1 is unbiased.

Since the price at which the cooperatives were offered the possibility of purchasing the insurance contract randomly varied, we can also estimate another variant of specification 1:

$$I_c = \alpha_2 + \beta_2 T_c + \gamma_1 T_c P_{50} + \delta_1 T_c P_{75} + \varepsilon_c \tag{2}$$

where P_{50} and P_{75} are the prices that corresponds to a 50% and 75 % discount in the actuarially fair price of the contract, respectively. The coefficients β_2, γ_1 and δ_1 are also unbiased since the price discounts were randomly assigned to the cooperatives in the treatment group.

Table 3 presents the regression results using the original specification . Column (1) shows that 27 % of the cooperatives in the original treatment group purchased the insurance contract. Column (2) shows the regression results of Equation 2. It is the regression analog to Figure 1. It shows that the pattern of the demand is not as predicted by the theory of demand. While the demand at 50% of the actuarially fair premium is 1 % lower than the demand at 100% of the premium, the demand at 75% of the fair premium is surprisingly 9 % lower than the demand at 100% of the actuarially fair premium. However, the coefficients on the prices are not jointly different from zero, as shown by the value of the F-test.

Old treated	0.2712***	0.3043***
	(0.0586)	(0.0982)
Low price		-0.0102
		(0.1498)
Medium price		-0.0938
		(0.1372)
Constant	0.0000***	0.0000***
	(0.0000)	(0.0000)
N	87.0000	87.0000
r2_a	0.0964	0.0829

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 3: Cooperative level insurance uptake

6 Impact of insurance on the production decisions

6.1 Theory of change

Figure 2 summarizes the theory of change, which is the causal pathway linking the intervention to its anticipated outcomes and impacts. As described in Section 3, the randomization unit is the cotton cooperative. Let's assume that a cooperative was offered an insurance contract. A cooperative member is (objectively) insured if his cooperative members decide to purchase the insurance contract after an internal process of decision making.

As figure 2 shows, this objective risk reduction does not translate into a behavioral change at the individual level. Since the insurance uptake decision might occur without the participation of all the cooperative members, some members might not know whether they are insured or not.

Knowing that the cooperative is insured is a necessary condition for a perceived risk reduction. However, this condition is not sufficient: knowing that the cooperative is insured does not guarantee a perceived risk reduction. For example, an individual who does not trust the insurance company will not trust that he will get a payment in case the index is triggered. Therefore, this individual will not perceive a risk reduction.

Perceiving a risk reduction does not guarantee a behavioral change. For example, if an individual is extremely risk averse, he might not think that the risk reduction provided by the contract is enough to encourage him to invest in risky but profitable activities.

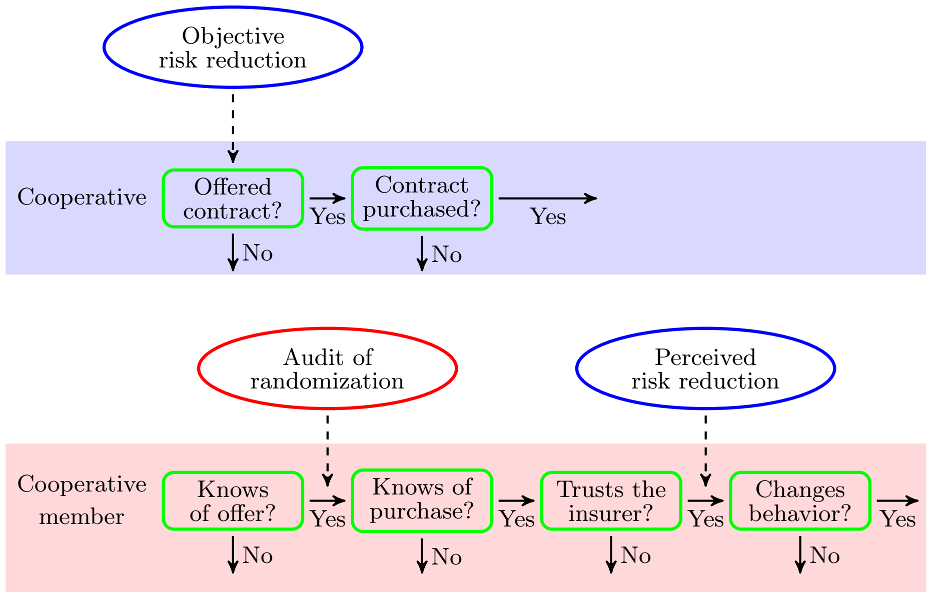

Figure 2: Theory of change

6.2 Descriptive results

Figures 3-6 summarize the impact of having access to insurance on the farmer's ex-ante decisions. We carry the analysis using the audit-based reclassification. Section A.1 of the Appendix carries the same analysis using the original treatment variable.

Figure 3 plots the cumulative probability distribution functions of the total area in cotton, separately by audit-based treatment status. It shows that the CDF of the area in cotton for households in the treatment group is slightly shifted to the right of that of control group suggesting a slight increase in the area in cotton. To improve the readability of Figure 3 , the left panel of Figure 3 plots the CDF below the 75th percentile, while the right panel of Figure 3 plots the CDGs above the 75th percentile. It seems that the impact is concentrated in the left tail of the cotton area distribution. Figure 3 seems to suggest that there might be a heterogeneous impact of the insurance product on households based on their wealth levels as proxied by the area in cotton that they own.

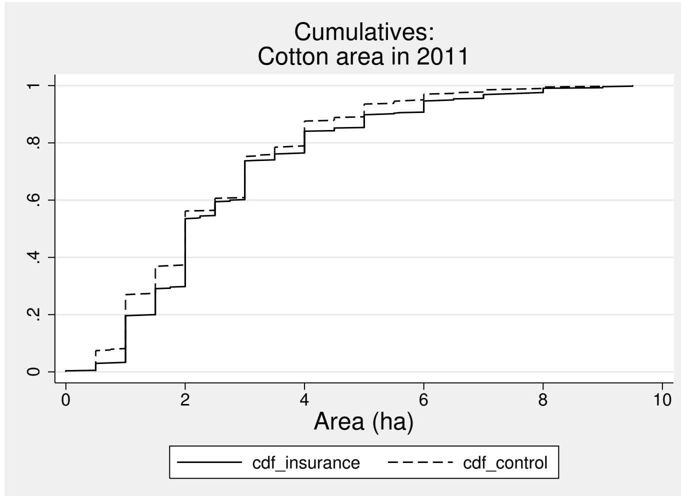

Figure 3: Effect of Insurance on cotton area in ha

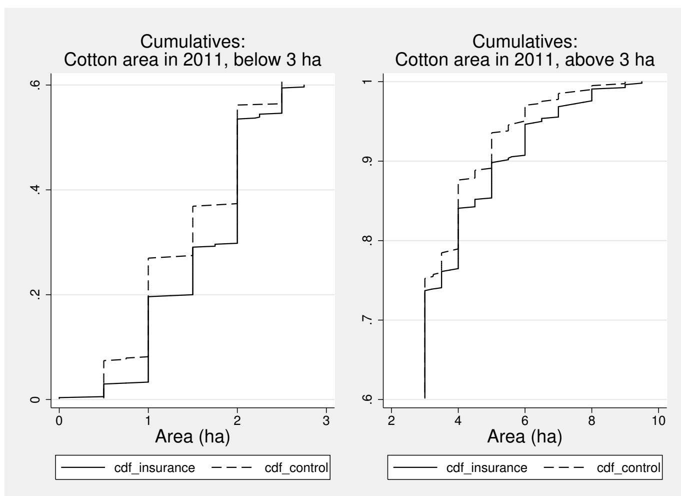

Figure 4: Effect of Insurance on cotton area in ha

Figure 5 plots the CDFs of the fertilizers used by the cotton farmers in CFA per ha, by treatment status. There does not seem to be an impact on this variable. A formal Kolmogorov Smirnov test of the equality of the different distributions does not reject the hypothesis that the two distributions are the same.

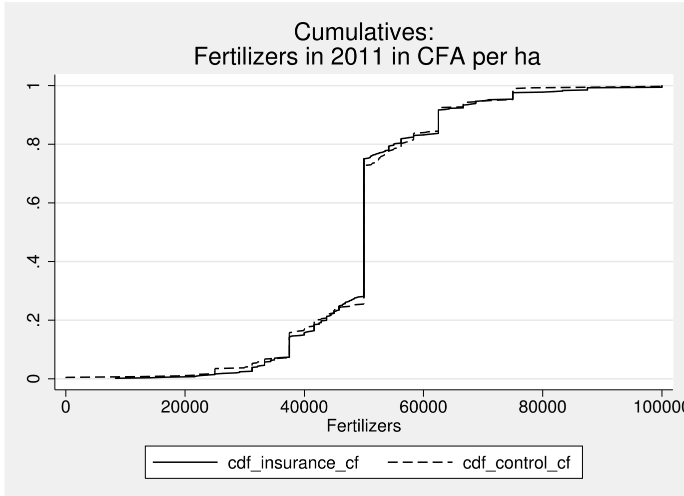

Figure 5: Effect of insurance on the use of fertilizers in CFA per ha

Figure 6 plots the CDFs of the cotton seeds planted in CFA per ha by the cotton farmers, by treatment status. The intervention seems to have an impact. A formal Kolmogorov Smirnov test of the equality of the different distributions rejects the hypothesis that the two distributions are the same at the 5% level. Providing access to insurance encouraged farmers to spend more on seeds per ha compared to their counterparts who did not have access to insurance.

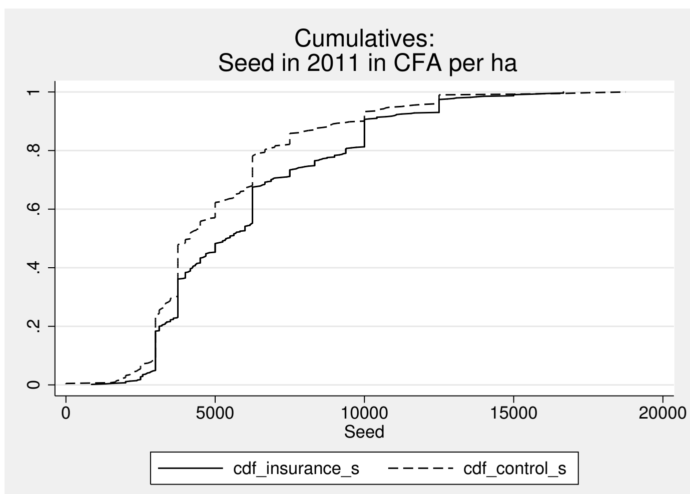

Figure 6: Effect of insurance on seeds in CFA per ha

These descriptive result seems to suggest that the insurance led to an extensification of the cotton production: the area in cotton increased, by the input use per ha did not increase. Table 4 further investigates this observation e by describing the post-intervention production outcomes by treatment status using both classifications. The results suggest that the intervention had an impact on the area in cotton, the expenditure on seeds and fertilizers as well as the total area of land owned. Section 6.3 studies whether these findings are statistically significant.

	Obs	Original specification (1) Control	(2) Treatment	Preferred specification (1) Control	(2) Treatment
Cotton area (ha)	954	2.61	2.82	2.53	2.92*
		[1.73]	[2.08]	[1.68]	[2.15]
Cotton harvest (kg)	941	2630	2704	2567	2761
		[2051]	[2202]	[2015]	[2247]
Cotton loans (CFA)	966	321,571	325,248	301,740	339,998
		[253,858]	[273,125]	[237,712]	[285,427]
Cotton seed (CFA)	951	13,375	16,327*	12,688	17,338**
		[11,701]	[15,013]	[11,001]	[15,705]
Cotton fertilizer (CFA)	950	127,273	145,301	126,974	148,538*
		[87,618]	[115,883]	[95,115]	[115,576]
Cotton seed per ha (CFA/ha)	951	5,304	6,034*	5,256	6,199**
		[2,937]	[3,291]	[2,904]	[3,342]
Cotton fertilizer per ha (CFA/ha)	952	53,412	53,079	53,996	52,583
		[47,253]	[27,630]	[45,048]	[25,514]
Livestock 2011(CFA)	981	1,921,562	1,668,482	1,807,337	1,705,517
		[5,891,599]	[2,812,553]	[5,272,773]	[2,869,146]
Land holding 11 (ha)	969	11.85	14.06	11.97	14.36*
		[10.94]	[13.35]	[11.12]	[13.59]
Were you offered an insurance contract? % yes		25.00%	75.00%	25.00%	84.00%
Are you insured? % yes		0.00%	27.00%	5.00%	29.00%

Columns (1) and (2), (3) and (4) show means with standard deviations in brackets. The stars in column (2) and (4) correspond to the level of significance of the coefficient on treatment from regressions of each characteristic on treatment clustering standard errors at the cooperative level.
***Difference is significant at the 1 percent level. **Difference is significant at the 5 percent level. *Difference is significant at the 10 percent level.

Table 4: Post-intervention outcomes

6.3 Local Average Treatment Effects

This section estimates the effect of insurance on different *ex-ante* outcomes such as area devoted to cotton, input use and fertilizer use. For each outcome, there are two effects of interest: the intent-to-treat effect (ITT), the average effect of being assigned to the treatment group, and the average effect of those that purchased the insurance contract (the Treatment on the Treated or ToT effect). The ITT estimation results are presented in Section A.2 of the appendix.

6.3.1 Using the treatment status as instrument[3]

Our impact evaluation is primarily concerned with households' ex-ante cotton production decisions. Our survey provided us with information about whether a given cooperative is insured or not. However, since we are interested in individual farmers 'decisions, it is their feeling of whether they are insured or not that matters for the analysis.

[3]Section A5 of the appendix carries the same analysis using the prices as instruments

Our main hypothesis is that if a farmer feels insured, then he will free the resources allocated as a coping mechanism against negative income shocks. At the intensive margin, he may choose to invest in cotton production. At the extensive margin, he may allocate a larger share of his land to cotton production. Insuring the farmer would then increase the overall farm revenue, protecting him from costly consumption and asset smoothing strategies.

Since we cannot measure the feeling of being insured, we proxied it by the farmer's knowledge of being insured. To do so, we asked every surveyed member whether he thinks he is insured or not. Thus, we have two variables that represent the household's insurance status. The first variable, "Being insured, "is equal to one if the household's cooperative purchased the insurance contract. The second variable, "Knowing insured," is equal to one if the household member thinks his cooperative bought the insurance contract.

Our analysis studies the impact of knowing insured and being insured on the various outcomes. To do so we use an instrumental variable approach. Denote C_{ic} the variable of interest, which is farmer i in cooperative c is "being insured" or "knowing insured." Our initial strategy consists in instrumenting C_{ic} with being assigned to the treatment group using the following regression:[4]

$$C_{ic} = \alpha + \delta T_{ic} + \gamma X_{ic} + \varepsilon_{ic} \tag{4}$$

where T_{ic} is the treatment status of cooperative c, X_{ic} is a vector of household i of cooperative c characteristics and ε_{ic} is an error term.

We then estimate the impact of insurance on Y_{ic} with the following second stage regression:

$$Y_{ic} = \alpha + \beta \hat{C}_i + \gamma X_{ic} + \epsilon_{ic} \tag{5}$$

where $\hat{C}_i$ is the predicted value of the "insured" variable using the first stage regression 4.

The first-stage relationship between the cooperative treatment status and "being insured" is strongly positive: the treatment status is significantly related to "being" insured at over 95 percent confidence" (panel A2 in table 5) and this relationship is robust to the inclusion of control variables. Being part of a treated cooperative typically leads to 25% chance of "being insured."

Panel A1 of Table 5 displays the IV local average treatment effects estimates of the impacts of "being insured" without controlling for baseline characteristics. The estimation results are consistent with the

[4]We have also estimated the average effect of feeling insured on the area in cotton by estimating the following equation:

$$Y_{ict} = \theta_{ic} + \beta C_{ic} + \varepsilon_{ict} \tag{3}$$

where t is the year and θ_{ic} is the individual time invariant fixed effect. We used a fixed effect model and instrumented the variable "feeling insured" C_i by the treatment status. Using the original treatment assignment as instrument, the results imply a 0.41 ha increase in the area of land devoted to cotton compared to the baseline level. This number increases to 0.68 ha when we consider the audit-based treatment status. However, the point estimates are not precisely estimated because the sample size is reduced: only 40% of the respondents were able to remember their 2010 cotton production decisions.

hypothesis that the intervention led to a change in the farmer's behavior at the extensive margin. In fact, farmers who know that they are insured increased their area devoted to cotton by 63%. Consistent with the hypothesis of an extensification of the cotton production, the total expenditures on seeds and fertilizers significantly increased by 157% and 70%, respectively. Although not significant, the total amount of loans has increased by 50%.

The total area of land owned by the household increased by 85%. In addition, the total area allocated to the other major crops (corn and grains) did not significantly increase. This suggests that the increase in the area of cotton occurred by buying more land and not by allocating less land to other competing crops .[5]

The total expenditure on seeds per ha increased by 135%. However, cotton production did not significantly increase. Since the area in cotton increased, the results suggest that insurance did not have a significant impact on yields. There are two possible reasons for this finding. First, as shown in Table 2, there is a slight yield imbalance between the treatment and control villages that might have persisted after the intervention. In addition, yield is an ex-post outcome that might have been affected by shocks that occurred after farmers made their production decisions.

Panel B displays the result of the same specification as in Panel A, but controlling for covariates. Adding covariates slightly changes the magnitude of the impacts, but improves the precision of the estimates.

[5] Land is acquired in the area of study by requesting it from the village chief. Usually the land is first cleared to become usable.

	Area (ha)	Harvest (kg)	Loans (kCFA)	Seed (kCFA)	Fertilizer (kCFA)	Seed per ha (kCFA/ha)	Fertilizer per ha (kCFA/ha)	Other crops (ha)	Land owned (ha)
Panel A1. IV-2SLS, without control variables									
Insured	1.56*	754.59	155.518	18.561**	85.655*	3.786**	-5.696	-0.52	9.86*
	(0.93)	(848.62)	(112.410)	(8.660)	(48.466)	(1.906)	(9.690)	(1.33)	(5.86)
Constant	2.45***	2,534.16***	294.453***	11.783***	122.904***	5.066***	54.288***	4.05***	11.48***
	(0.16)	(171.35)	(19.866)	(1.436)	(8.740)	(0.333)	(2.602)	(0.33)	(0.946)
Observations	954	941	966	951	950	951	952	969	969
R2 (adj)	-0.116	-0.027	-0.079	-0.306	-0.108	-0.232	-0.005	-0.004	-0.109
Panel A2. First stage, without control variables									
Audit-based T	0.2486769**								
	(0.07)								
Constant	0.049505								
	(0.035)								
Observations	954								
R2 (adj)	0.09								
F-stat treat var	10.89								
Panel B1. IV-2SLS, with control variables									
Insured	1.352	442.34	138.198	16.944**	74.682*	3.793**	-6.554	-0.39	7.98*
	(0.841)	(740.272)	(97.525)	(7.723)	(44.395)	(1.863)	(9.924)	(1.15)	(4.84)
Constant	0.271	179.99	93.453	3.611	25.576	6.837***	59.124***	3.92**	-6.33**
	(0.434)	(655.26)	(64.747)	(3.808)	(23.039)	(0.935)	(5.992)	(1.94)	(2.84)
Observations	938	925	949	935	934	935	936	952	952
R2 (adj)	0.101	0.187	0.093	-0.149	0.076	-0.191	-0.005	0.089	0.089
Panel B2. First stage, with control variables									
Treated	0 .25**								
	(0.07)								
Observations	938								
R2 (adj)	0.147								
F-stat treat var	11.39								

Table 5: LATE, "Being insured"

Panel A1 of Table 6 displays the local average treatment effect estimates of the impact on the farmers of "knowing insured" using the original treatment status. Panel A2 displays the result of the same specification as in Panel A1, but controlling for covariates. We find the same qualitative results as when we run the regression on"being insured." However, the magnitudes of the impacts are higher when a farmer knows that he is insured. The area in cotton significantly increased by 75% and the expenditure on seeds per ha increased by 116%. In addition, the amount of land owned more than doubled.

	Area	Harvest	Loans	Seed	Fertilizer	Seed per ha	Fertilizer per ha	Other crops	Land owned
	(ha)	(kg)	(kCFA)	(kCFA)	(kCFA)	(kCFA/ha)	(kCFA/ha)	(ha)	(ha)
Panel A1. IV-2SLS, without control variables									
Believe insured	1.77*	923.83	179.805	20.503**	98.176*	4.115*	-6.504	-0.61	11.16*
	(1.01)	(938.84)	(121.391)	(9.584)	(53.405)	(2.187)	(10.779)	(1.52)	(6.19)
Constant	2.34***	2,462.14***	283.664***	10.498***	116.275***	4.807***	54.739***	4.10***	10.78***
	(0.21)	(222.705)	(24.992)	(2.055)	(11.636)	(0.497)	(3.253)	(0.43)	(1.32)
N	945	933	956	942	941	942	943	959	959
R2 (adj)	-0.248	-0.056	-0.131	-0.708	-0.265	-0.602	-0.007	-0.012	-0.179
Panel A2. First stage, without control variables									
Treated		0.22***							
		(0.070)							
Constant		0.1***							
		(0.039)							
Observations		945							
R2 (adj)		0.03							
F-stat treat var		10.11							
Panel B1. IV-2SLS, with control variables									
Sub. insured	1.445*	544.77	148.777	17.727**	81.059*	3.929**	-6.991	-0.42	8.52*
	(0.876)	(783.96)	(99.403)	(7.824)	(46.707)	(1.903)	(10.472)	(1.21)	(4.86)
N	929	917	939	926	925	926	927	942	942
R2 (adj)	0.014	0.178	0.059	-0.435	-0.033	-0.505	-0.005	0.085	0.067
Panel B2. First stage ,with control variables									
Audit-based T		0.24***							
		(0.067)							
Observations		929							
R2 (adj)		0.068							
F-stat T var		12.63							

Notes: Controls include age, education, ethnic group and agricultural experience of the household head, household assets, agricultural assets, house quality, source of water and source of electricity. Cluster robust standard errors are in parentheses, clustered at the cooperative level

****Significant at the 1 percent level. **Significant at the 5 percent level. *Significant at the 10 percent level.*

Table 6: LATE, "knowing insured"

6.3.2 Using the treatment status and the re-insurance penalty mark-up as instruments

In this section we present local average treatment effects estimates using an alternative set of instruments. The first stage regression is now:

$$C_{ic} = \alpha + \delta_1 T_{ic} + \delta_2 Z_{iC} + \gamma X_{ic} + \varepsilon_{ic} \quad (6)$$

where T_{Ic} is the treatment status of cooperative c, X_{ic} is a vector of household i of cooperative c characteristics and ε_{ic} is an error term. The new instrument, Z_{iC}, is a measure of penalty mark-up imposed by the reinsurance company for random data problems.

We then estimate the impact of insurance on Y_{ic} with the following second stage regression:

$$Y_{ic} = \alpha + \beta \hat{C}_i + \gamma X_{ic} + \epsilon_{ic} \quad (7)$$

where $\hat{C}_i$ is the predicted value of the "insured" variable using the first stage regression 6.

The penalty mark-up is a penalty imposed by the reinsurance company on cotton cooperatives that suffered from random data problems. For instance, a cooperative for which we have cotton yields data for the past 5 years ended up having a less favorable contract than its counterpart for which we have more data, despite being located in a very similar agro climatic zone. In most of the cases the cooperative secretary keeps track of the yield data. However, if he suffers an idiosyncratic shock such as a disease or death, he tends to not handover the information to his successor. Data problems could therefore be assumed random.

To measure the reinsurance penalty markup, we have first estimated an ideal probability distribution of the cotton yields. To do so, we pooled the historical yield data generated by cooperatives located at the same agroclimatic zones and within a distance of 20 to 30 km from each other. Pooling the yields data allows us to improve the precision of the estimation of the cotton yield distributions. Then, based on our estimated probability distribution function, we calculated an ideal cooperative level trigger that determines the insurance payment. The reinsurance penalty markup is the difference between our calculated trigger, and the trigger calculated by the insurance company:

$$Z_{ic} = (Calculatedtrigger - actualtrigger) * 1000$$

We argue that the reinsurance penalty markup is a valid instrument for the endogenous variables "being insured" and "knowing insured". First, it is expected to be highly correlated with the endogenous variables "being insured" and "knowing insured". A cooperative that suffered a penalty markup because of random data problems would be less likely to uptake insurance compared to its counterpart that was not penalized. Second, this instrument is not correlated with the error term of the second stage regression and could not be included as an explanatory variable in the second stage regression. This exclusion restriction is justified by the fact that the penalty markup would affect the outcomes of interest only indirectly by increasing the likelihood of "knowing insured" and "being insured".

Figure 7 below plots the histogram of the reinsurance penalty mark-up in in the studied sample in tons per hectare. More than 96% of the cooperatives in the study area were assigned a trigger below our calculations. The median difference is 255 kg/ha, and the standard deviation is 218 kg/ha.

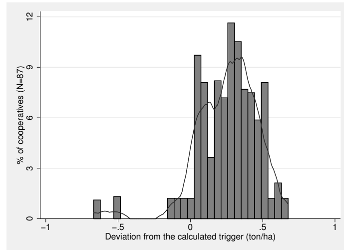

Figure 7: Distribution of the reinsurance penalty markup

The first-stage relationships between the cooperative treatment status, the reinsurance penalty and "being insured" are strongly positive: the cooperative treatment status and the reinsurance penalty are significantly related to "being" insured at over 95 percent confidence (panel A2 in table 5) and this relationship is robust to the inclusion of control variables. The same finding applies to the variable "knowing insured."

The instruments are strong for "being insured" (F-test less than 10). However, the instruments are somewhat weak for "knowing insured" (F-stat is only 6.8), suggesting that the instrumental variable estimates maybe biased towards the ordinary least square ones. Therefore, we will only discuss the local average treatment effects of insurance on "being insured."

Panel A1 of Table 7 displays the IV local average treatment effects estimates of the impacts of "being insured" without controlling for baseline characteristics. The estimation results are qualitatively similar to those obtained using only the treatment status as an instrument for "being insured," but the impacts are higher. Being insured increases the area allocated to cotton by 70% (compared to 63% using only the treatment status as an instrument). The total expenditures on seeds and fertilizers have also significantly increased by 125% and 75%, respectively. The amount of loans significantly increased by 50%, which is consistent with the increase in input expenditures. The IV estimates of the impacts on "knowing insured" are qualitatively similar to those on "being insured." However, we don't discuss them since the instruments are weak.

	Area (ha)	Harvest (kg)	Loans (kCFA)	Seed (kCFA)	Fertilizer (kCFA)	Seed per ha (kCFA/ha)	Fertilizer per ha (kCFA/ha)	Other crops (ha)	Land owned (ha)
Panel A1. IV-2SLS, without control variables									
Insured	1.71**	1,333.54*	145.943*	15.748**	91.467**	2.335	-2.047	-0.45	4.99
	(0.73)	(693.22)	(82.197)	(6.729)	(37.877)	(1.504)	(6.867)	(0.98)	(4.05)
Constant	2.42***	2,421.57***	296.277***	12.327***	121.778***	5.347***	53.582***	4.04***	12.41***
	(0.12)	(131.81)	(13.563)	(1.129)	(6.725)	(297.110)	(1.957)	(0.28)	(0.75)
Observations	954	941	966	951	950	951	952	969	969
R2 (adj)	-0.137	-0.074	-0.071	-0.225	-0.123	-0.092	-0.002	-0.004	-0.032
Panel A2. First stage, without control variables									
Treated	0.233**								
	(0.073)								
Penalty	-0.443								
	(0.197)								
constant	0.169								
	(0.071)								
Observations	954								
R2 (adj)	0.154								
F-stat instruments	9.69								
Panel B1. IV-2SLS, with control variables									
Insured	1.38**	951.93	114.462*	13.367**	74.997**	2.288	-3.568	-0.51	3.20
	(0.61)	(590.69)	(65.920)	(5.687)	(33.055)	(1.468)	(7.257)	(0.89)	(3.41)
Constant	0.27	171.28	94.203	3.742	25.564	6.892***	59.015***	3.92**	-6.17**
	(0.43)	(632.40)	(64.468)	(3.660)	(23.041)	(865.947)	(5.803)	(1.93)	(2.70)
Observations	938	925	949	935	934	935	936	952	952
R2 (adj)	0.097	0.156	0.112	-0.057	0.075	-0.053	-0.001	0.087	0.155
Panel B2. First stage, with control variables									
Treated	0.242**								
	(0.072)								
Penalty	- 0.423								
	(0.201)								
constant	0.092								
	(0.145)								
Observations	938								
R2 (adj)	0.198								
F-stat instruments	10.11								

Table 7: LATE "Being insured"

	Area (ha)	Harvest (kg)	Loans (kCFA)	Seed (kCFA)	Fertilizer (kCFA)	Seed per ha (kCFA/ha)	Fertilizer per ha (kCFA/ha)	Other crops (ha)	Land owned (ha)
Panel A1. IV-2SLS, without control variables									
Sub.Insurance	2.04**	1,266.49	197.597*	21.652.**	111.241**	3.977*	-5.862	-0.62	10.13*
	(1.04)	(947.60)	(116.772)	(10.045)	(55.253)	(2.259)	(10.109)	(1.50)	(6.10)
Constant	2.27***	2,379.87***	279.495***	10.225***	113.165***	4.840***	54.586***	4.10***	11.02***
	(0.21)	(221.32)	(23.249)	(2.180)	(12.066)	(0.521)	(3.074.)	(0.43)	(1.30)
N	945	933	956	942	941	942	943	959	959
r2_a	-0.333	-0.107	-0.160	-0.789	-0.342	-0.564	-0.005	-0.012	-0.142
Panel A2. First stage, without control variables									
Audit-based T	0.220**								
	(0.069)								
difftrig	-0.104								
	(0.183)								
constant	0.136								
	(0.049)								
Observations	945								
R2 (adj)	0.0381								
F-stat instruments	5.09								
Panel B1. IV-2SLS, with control variables									
Sub.Insurance	1.57*	705.32	153.549	18.117**	87.161*	3.822.**	-6.814	-0.49	7.76
	(0.87)	(787.44)	(95.345)	(7.924)	(47.338)	(1.939)	(10.172)	(1.21)	(4.82)
Constant	0.50	308.80	110.912*	6.047	38.003	7.288***	57.911***	3.90**	-5.10**
	(0.44)	(662.18)	(64.513)	(3.813)	(23.307)	(0.857)	(5.515)	(1.86)	(2.44)
N	929	917	939	926	925	926	927	942	942
r2_a	-0.020	0.162	0.052	-0.459	-0.063	-0.477	-0.005	0.084	0.089
Panel B2. First stage, with control variables									
Audit-based T	0.238**								
	(0.106)								
Penalty	-0.074								
	(0.182)								
constant	-0.139								
	(0.0951)								
Observations	929								
R2 (adj)	0.068								
F-stat instruments	6.38								

Table 8: LATE “knowing insured”

Overall, the results of this section suggest that perceiving a risk reduction (knowing insured) yields stronger impacts than simply experiencing an objective risk reduction. IMPLICATIONS

7 Conclusion

In the absence of formal insurance markets, poor rural households in developing countries may rely on costly risk-management mechanisms, including income smoothing strategies that entail avoiding riskier technologies with higher expected returns. In this paper we report results from a randomized field experiment that evaluates the effectiveness of microinsurance on agricultural production decisions among cotton farmers in

Mali.

In the first year of the program, 16 out of the 59 treatment cooperatives (30%) agreed to purchase the index insurance contract. This uptake rate is well above up-take rates in some other pilot projects. The impact results imply that the intervention had impacts primarily on the extensive margin by increasing the area devoted to cotton, increasing the total input expenditures, and increasing the amount of loans. In addition we find that percieved insurance status and objective insurance status do not yield the same magnitude of the impacts.

The results have important policy implications. Policy makers showed interest in scaling up micorinsurance pilots to target a larger sample of vulnerable households in the developing countries. However, the evidence on the effectiveness of microinsurance interventions is scarce. The results of this paper show that an innovative microinsurance contract can overcome the negative ex-ante impacts of uninsured risk by boosting investment in risky but profitable activities.

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A Appendix

A.1 Descriptive results using the original classification

Figures 8-12 summarize the impact of insurance on the farmer's ex-ante decisions. Figure 8 plots the cumulative probability distribution functions of the total area in cotton, separately by audit treatment status. It shows that the CDF of the area in cotton if households in the treatment group is slightly shifted to the right of that of control group.

To improve the readability of Figure 8, the left panel of Figure 9 plots the CDF below the 80th (check) percentile, while the right panel of Figure 9 plots the CDGs above the 80th (check) percentile. It seems that the impact is concentrated in the right tail of the cotton area distribution. While the median area in cotton is actually 2 ha for both treatment and control groups, the 99th percentile increases by about is 2.5 ha, from a base of 8 ha. We observe a slighter impact on the 25th percentile: it increases by 0.5 ha from a base of 1.

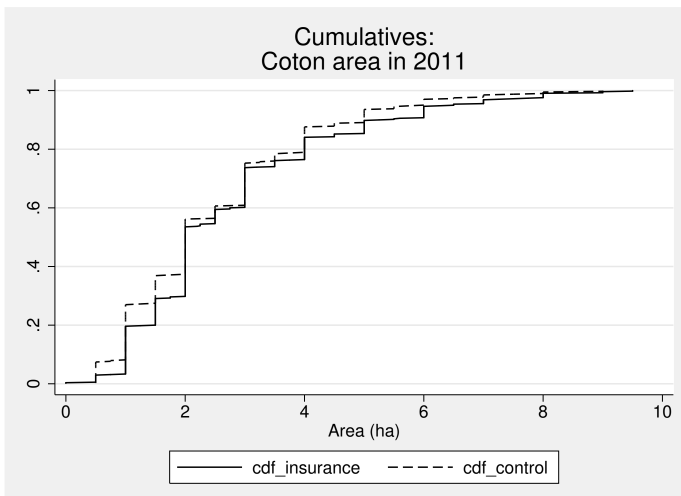

Figure 8: Effect of Insurance on cotton area

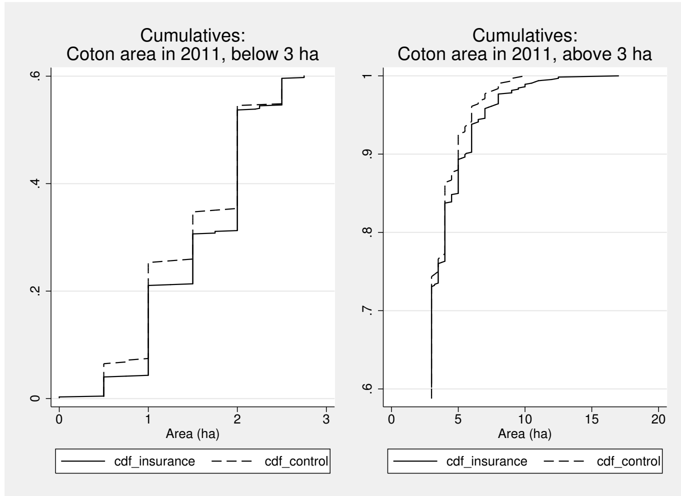

Figure 9: Disaggregated Effect of Insurance on Cotton Area

Figure 10 plots the CDFs of the different different fertilizers used for the cotton production, including urea, manure, and "complexe cotton", by treatment status. The intervention does not seem to a have an impact on these different variables. A formal Kolmogorov Smirnov test of the equality of the different distributions does not reject the hypothesis that the two distributions are the same.

Figure **??** plots the CDFs of the insecticides and pesticides used by the cotton farmers, by treatment status. Again, there does not seem to be an impact on these two variables. A formal Kolmogorov Smirnov test of the equality of the different distributions does not reject the hypothesis that the two distributions are the same.

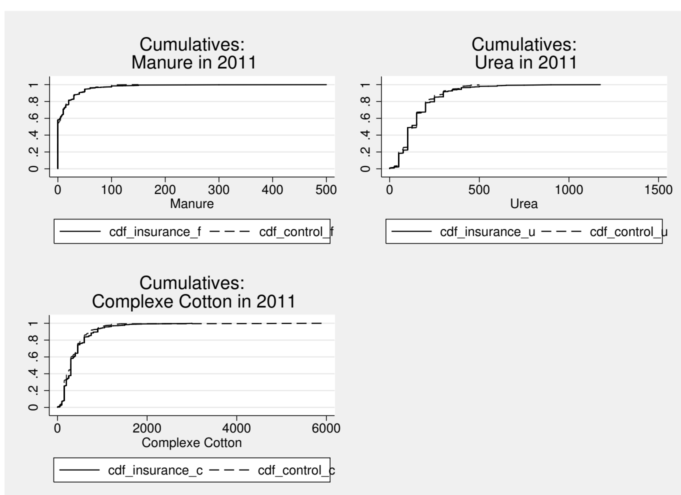

Figure 10: Effect of insurance on the use of manure

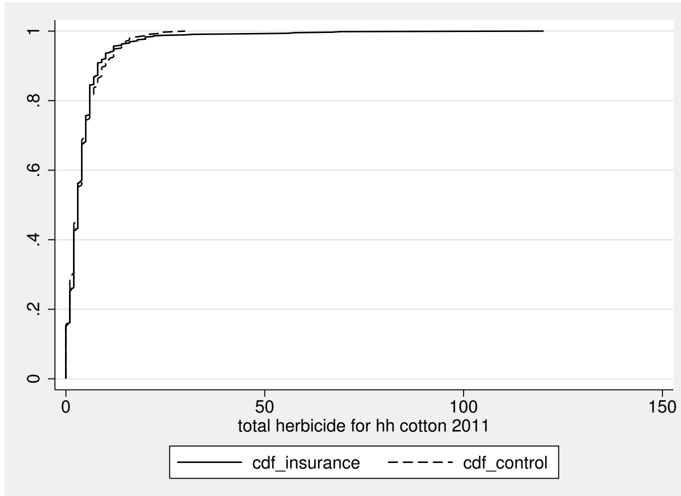

Figure 11:

Figure 12 plots the CDFs of the cotton seeds planted the cotton farmers, by treatment status. The intervention seems to have an impact. A formal Kolmogorov Smirnov test of the equality of the different distributions reject the hypothesis that the two distributions are the same at the 5% level. Figure 12 suggests that the impact is concentrated in the right tail of the seed distribution. The 75th percentile increases by about is 20 kg, from a base of 61 kg. The 95th percentile increases by about 25 kg, from a base of 150 kg.

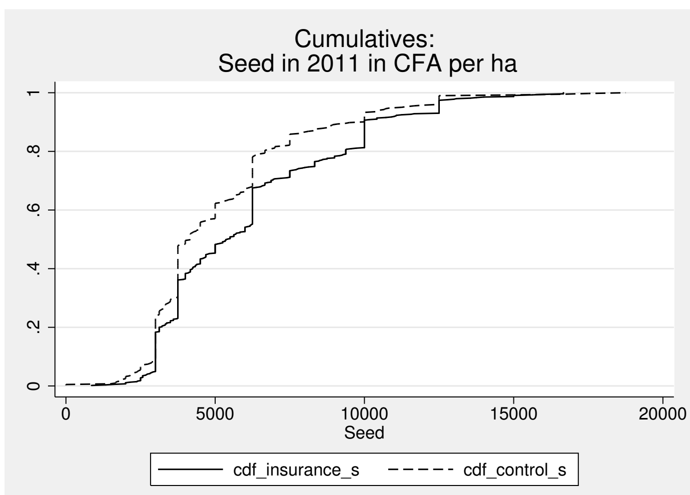

Figure 12: Effect of insurance on seeds

A.2 Reduced form estimation and results using the audit based reclassification and the original classification (ITT)

We first estimate the overall average effect of being assigned to the treatment on a given outcome by ordinary least squares with clustering at the cooperative level. We use the following specification [6]:

$$Y_{ic} = \alpha + \beta^{ITT} T_c + \varepsilon_{ic} \quad (9)$$

Denote Y_{ij} the outcome of interest measured for individual i in cooperative c. T_c is cooperative c's treatment status, and is equal to 1 if cooperative c belongs to the treatment group. The average effect of being assigned to a treatment cooperative versus a control cooperative is captured by the parameter β. Since the treatment $T = 1$ was randomly assigned, we should expect $E(\varepsilon_{ic}|T) = 0$ and the ordinary least square estimate of β is unbiased. Standard errors are clustered at the cooperative level.

	(1) Area (ha) (ha)	(2) Harvest (kg)	(3) Loans (kCFA)	(4) Seed (kCFA)	(5) Fertilizer (kCFA)	(6) Seed per ha (kCFA/ha)	(7) Fertilizer per ha (kCFA/ha)	(8) Area of other crops (ha)	(9) Land owned (ha)
Panel A. No control variables									
Audit based treatment	0.39**	191	37.883*	4.633***	21.372**	0.945***	-1.422	-0.12	2.39**
	(0.18)	(202.956)	(22.603)	(1.423)	(9.492)	(0.354)	(2.394)	(0.32)	(1.16)
Constant	2.53***	2,570***	302.114***	12.704***	127.165***	5.254***	54.006***	4.027***	11.96***
	(0.11)	(138.353)	(13.451)	(0.871)	(6.020)	(0.226)	(2.181)	(0.279)	(0.73)
N	954	941	966	951	950	951	952	969	969
R2 (adj) Panel A	0.009	0.001	0.004	0.025	0.009	0.020	-0.001	-0.001	0.008
Panel B. Control variables									
Audit based treatment	0.34**	114	34.384*	4.304***	18.969**	0.963***	-1.665	-0.09	1.98**
	(0.17)	(186)	(19.280)	(1.238)	(8.944)	(0.345)	(2.525)	(0.28)	(0.972)
Constant	0.24	164	90.593	3.391	24.646	6.787***	59.210***	3.93*	-6.47**
	(0.42)	(688)	(67.193)	(3.505)	(22.773)	(0.844)	(6.088)	(1.98)	(2.71)
N	938	925.	949	935	934	935	936	952	952
R2 (adj) Panel B	0.20	0.201	0.170	0.137	0.172	0.053	0.000	0.091	0.181

Notes: Controls include age, education, ethnic group and agricultural experience of the household head, household assets, agricultural assets, house quality, source of water and source of electricity.

****Significant at the 1 percent level. **Significant at the 5 percent level. *Significant at the 10 percent level.*

Table 9: ITT results with audit-based reclassification

[6] We have also estimated the average effect of being assigned to the treatment on the area in cotton by estimating the following equation, using a fixed effect model:

$$Y_{ict} = \theta_{ic} + \beta T_c + \varepsilon_{ict} \quad (8)$$

where t is the year and θ_{ic} is the individual time invariant fixed effect. Using the original treatment assignment, the reduced form results imply an 0.08 ha increase in the area of land devoted to cotton compared to the baseline level. This number increases to 0.18 ha when we consider the audit-based treatment status. However, the point estimates are not precisely estimated because the sample size is reduced: only 40% of the respondents were able to remember their 2010 cotton production decisions.

	(1) Area (ha) (ha)	(2) Harvest (kg)	(3) Loans (kCFA)	(4) Seed (kCFA)	(5) Fertilizer (kCFA)	(6) Seed per ha (kCFA/ha)	(7) Fertilizer per ha (kCFA/ha)	(8) Area of other crops (ha)	(9) Land owned (ha)
Panel A. No control variables									
Treated	0.21	74.84	3.677	2.952*	18.027*	0.729*	-0.332	-0.25	2.20*
	(0.18)	(212.96)	(22.221)	(1.490)	(9.358)	(0.369)	(2.852)	(0.37)	(1.15)
Constant	2.61***	2,630.09***	321.571***	13.375***	127.273***	5.304***	53.412***	4.12***	11.85***
	(0.13)	(167.51)	(15.117)	(1.088)	(6.585)	(0.277)	(2.681)	(0.34)	(0.83)
N	954	941	966	951	950	951	952	969	969
r2_a	0.002	-0.001	-0.001	0.009	0.005	0.010	-0.001	-0.000	0.006
Panel B. Control variables									
Treated	0.25	69.84	14.229	3.093**	20.017**	729.248**	-0.557	-0.22	2.18**
	(0.17)	(195.62)	(19.743)	(1.265)	(8.598)	(359.765)	(2.873)	(0.37)	(0.98)
Constant	0.20	158.12	91.448	2.893	19.669	6.660***	59.126***	4.00*	-7.03**
	(0.43)	(699.78)	(69.554)	(3.605)	(22.852)	(0.858)	(6.596)	(2.05)	(2.82)
N	938	925	949	935	934	935	936	952	952
r2_a	0.200	0.201	0.167	0.125	0.172	0.042	0.000	0.091	0.182

Notes: Controls include age, education, ethnic group and agricultural experience of the household head, household assets, agricultural assets, house quality, source of water and source of electricity.

****Significant at the 1 percent level. **Significant at the 5 percent level. *Significant at the 10 percent level.*

Table 10: ITT results with original classification

Panel A of Table 2 provides evidence on the average treatment impact of insurance on cotton production decisions using equation 9. The adjusted R-squared is provided at the bottom of the table. The regressions do not include co-variates. The estimation results are consistent with the hypothesis that the intervention had impacts on both the extensive margin and the intensive margin. Column (1) shows that compared to households from the control group, households from treated cooperatives significantly increased the area of cotton by 15%. In addition, the total expenditure on seeds per household significantly increased to 4,572 CFA from a base of 12,766 CFA, which represents a 35% increase. The amount of fertilizers used and agricultural loans did also increase but the point estimates are not significantly different from zero.

At the intensive margin, households from the treated cooperatives used seeds more intensively than their counterparts in the control group. In fact, the intervention resulted in 14% increase in the expenditure on seeds per hectare per household. The amount of fertilizer per ha decreased but the point estimates are not significantly different from zero.

Panel B of Table 2 shows that the point estimates do not change much when we consider the original treatment variable.

A.3 Reduced form impacts using other reclassification methods

In this section we investigate the reduced form impacts of being assigned to the original treatment group on different ex-ante indicators using three types of audit-based reclassification of the cooperatives. The first strategy consists in reclassifying only the three cooperatives for which we are certain that they were not offered the insurance contract. The second drops all these 3 cooperatives. The last strategy drops the 9 cooperatives with a high negative response rate to the audit question.

We begin by estimating the Intent to treat equation using the following specification:

$$Y_{ic} = \alpha + \beta T_c + \varepsilon_{ic} \quad (10)$$

Table 11 displays the estimation results.

	reclassify three	drop all three	drop all nine
Area			
treatment= 1 if offered insurance	0.184	0.210	0.310
	(0.183)	(0.191)	(0.198)
Constant	2.637***	2.611***	2.611***
	(0.123)	(0.134)	(0.134)
N	954.000	922.000	858.000
R2 (adj)	0.001	0.001	0.004
Seed per ha			
treatment= 1 if offered insurance	717.594*	597.031	668.595
	(404.941)	(423.197)	(437.442)
Constant	5410.448***	5531.011***	5531.011***
	(318.720)	(341.573)	(341.746)
N	952.000	920.000	856.000
R2 (adj)	0.007	0.004	0.005

Table 11: Reduced form impacts on cotton production decisions

A.4 Local average treatment impacts using other reclassification methods

Table 12 shows the average treatment impact of the insurance intervention using the three reclassification strategies described in section H.2 3.

	reclassify three	drop all three	drop all nine
Area			
Sub.Insurance	0.979	1.179	1.510
	(0.972)	(1.097)	(1.083)
Constant	2.529***	2.467***	2.428***
	(0.211)	(0.249)	(0.251)
N	945.000	913.000	850.000
r2_a	-0.071	-0.107	-0.190
Seed per ha			
Sub.Insurance	3341.907	2893.008	2937.440
	(2451.054)	(2636.509)	(2450.193)
Constant	5065.829***	5204.862***	5199.601***
	(608.233)	(680.169)	(655.616)
N	943.000	911.000	848.000
r2_a	-0.277	-0.221	-0.232

Table 12: IV impacts on cotton area and seeds

A.5 Local average treatment effects using the audit based classification

A.5.1 Using the prices as instruments

The second identification strategy consists in instrumenting $C_{ic}$with the set of interactions between the treatment status and the price offered to the cooperative, using the following first stage regression:

$$C_{ic} = \alpha + \beta_1 T_c P_{50} + \beta_2 T_c P_{75} + \gamma X_{ic} + \varepsilon_{ic} \quad (11)$$

We then estimate the impact of insurance on Y_{ic} with the following second stage regression:

$$Y_{ic} = \alpha + \beta \hat{C}_i + \gamma X_{ic} + \epsilon_{ic} \quad (12)$$

where $\hat{C}_i$ is the predicted value of the “insured” value using either the first stage regression 11.

	Area (ha)	Harvest (kg)	Loans (kCFA)	Seed (kCFA)	Fertilizer (kCFA)	Seed per ha (kCFA/ha)	Fertilizer per ha (kCFA/ha)	Other crops (ha)	Land owned (ha)
Panel A1. IV-2SLS, without control variables									
Sub.Insurance	1.50*	978.71	198.009.*	13.382**	79.848*	2.396	-6.000	0.28	11.55**
	(0.79)	(819.38)	(112.502)	(6.346)	(40.826)	(1.800)	(8.720)	(1.35)	(5.36)
Constant	2.40***	2,448.96***	279.399***	12.191***	120.638***	5.216***	54.619***	3.89***	10.69***
	(0.18)	(207.31)	(24.522)	(1.583)	(10.051)	(0.419)	(2.814)	(0.387)	(1.23)
N	945	933	956	942	941	942	943	959	959
r2_a	-0.175	-0.063	-0.161	-0.302	-0.173	-0.215	-0.005	-0.001	-0.195
Panel A2. First stage, without control variables									
Audit-based T	0.327**								
	(0.115)								
prem252	-0.172								
	(0.140)								
prem502	-0.116								
	(0.148)								
constant	-0.107**								
	(0.039)								
Observations	945								
R2 (adj)	0.04								
F-stat instruments	3.85								
Panel B1. IV-2SLS, with control variables									
Sub.Insurance	1.150*	505.89	143.064*	11.554**	62.546*	2.534	-6.387	0.18	8.95**
	(0.634)	(635.39)	(80.608)	(5.331)	(33.441)	(1.666)	(8.374)	(1.08)	(4.10)
Constant	0.454	285.20	109.693*	5.317	35.322	7.145***	57.958***	3.98**	-4.96**
	(0.437)	(663.58)	(64.751)	(3.674)	(22.908)	(0.815)	(5.490)	(1.88)	(2.44)
N	929	917	939	926	925	926	927	942	942
r2_a	0.081	0.181	0.067	-0.122	0.047	-0.200	-0.004	0.091	0.053
Panel B2. First stage, with control variables									
Audit-based T	0.34**								
	(0.10)								
prem252	-0.16								
	(0.13)								
prem502	-0.13								
	(0.14)								
constant	-0.15**								
	(0.07)								
Observations	929								
R2 (adj)	0.07								
F-stat instruments	4.86								

Table 13: LATE, audit-based reclassification, adhesion, prices

	Area	Harvest	Loans	Seed	Fertilizer	Seed per ha	Fertilizer per ha	Other crops	Land owned
	(ha)	(kg)	(kCFA)	(kCFA)	(kCFA)	(kCFA/ha)	(kCFA/ha)	(ha)	(ha)
Panel A1. IV-2SLS, without control variables									
Insured	1.34	753.15	171.260	15.192**	73.077*	3.204*	-6.510	-0.23	10.67*
	(0.83)	(816.70)	(111.433)	(7.340.53)	(43.167)	(1.755)	(8.330)	(1.26)	(6.06)
Constant	2.49***	2,534.44***	291.455***	12.435***	125.340***	5.179***	54.445***	3.99***	11.33***
	(0.15)	(167.38)	(20.380)	(1.338)	(8.271)	(0.326)	(2.434)	(0.31)	(1.00)
N	954	941	966	951	950	951	952	969	969
r2_a	-0.088	-0.027	-0.092	-0.211	-0.080	-0.168	-0.006	-0.002	-0.126
Panel A2. First stage, without control variables									
Audit_based T	0.327**								
	(0.137)								
prem252	-0.068								
	(0.175)								
prem502	-0.147								
	(0.166)								
constant	0.049								
	(0.035)								
Observations	954								
R2 (adj)	0.11								
F-stat instruments	3.78								
Panel B1. IV-2SLS, with control variables									
Insured	1.02	338.11	131.273	13.162**	57.485	3.227*	-6.719	-0.14	8.28*
	(0.66)	(633.71)	(83.290)	(6.149)	(35.099)	(1.704)	(8.011)	(1.02)	(4.76)
Constant	0.28	181.77	93.672	3.750	26.230	6.857***	59.130***	3.91**	-6.34**
	(0.42)	(660.26)	(64.585)	(3.614)	(22.372)	(0.907)	(5.953)	(1.94)	(2.84)
Observations	938	925	949	935	934	935	936	952	952
R2 (adj)	0.138	0.192	0.099	-0.052	0.109	-0.132	-0.005	0.090	0.083
Panel B2. First stage, with control variables									
Audit_based T	0.342**								
	(0.134)								
prem252	-0.079								
	(0.166)								
prem502	-0.166								
	(0.163)								
constant	-0.004								
	(0.122)								
Observations	938								
R2 (adj)	0.163								
F-stat instruments	4.07								

Table 14: LATE, audit-based reclassification, achat, prices

A.6 Local average treatment effects using the original classification

A.6.1 Using the treatment status as instrument

	Area (ha)	Harvest (kg)	Loans (kCFA)	Seed (kCFA)	Fertilizer (kCFA)	Seed per ha (kCFA/ha)	Fertilizer per ha (kCFA/ha)	Other crops (ha)	Land owned (ha)
Panel A1. IV-2SLS, without control variables									
Sub. insured	1.30	578.58	26.545	16.838.	109.782	3.933	-2.006	-1.50	12.78
	(1.18)	(1,210.204)	(130.334)	(11.389)	(69.113)	(2.860)	(16.265)	(2.30)	(8.05)
Constant	2.45***	2,545.03***	319.575***	11.369***	113.513***	4.850***	53.670***	4.31***	10.40***
	(0.26)	(293.11)	(27.816)	(2.612)	(15.014)	(0.681)	(4.541)	(0.60)	(1.76)
N	945	933	956	942	941	942	943	959	959
R2 (adj)	-0.130	-0.021	-0.001	-0.478	-0.332	-0.552	-0.000	-0.055	-0.248
Panel A2. First stage, without control variables									
Teatment		0.17**							
		(0.07)							
Observations		945							
R2 (adj)		0.02							
F-stat treat var		5.97							
Panel B1. IV-2SLS, with control variables									
Sub. insured	1.39	498.89	79.189	16.085*	109.351*	3.607	-2.892	-1.18	11.50*
	(1.068)	(1,011.12)	(108.927)	(9.288)	(61.738)	(2.415)	(14.727)	(2.01)	(6.74)
N	929	917	939	926	925	926	927	942	942
R2 (adj)	0.026	0.182	0.136	-0.339	-0.193	-0.423	0.001	0.056	-0.044
Panel B2. First stage, with control variables									
Treatment		0.19**							
		(0.06)							
Observations		929							
R2 (adj)		0.05							
F-stat treat var		7.64							

Table 15: LATE with original classification

Notes: Controls include age, education, ethnic group and agricultural experience of the household head, household assets, agricultural assets, house quality, source of water and source of electricity. Cluster robust standard errors are in parentheses, clustered at the cooperative level

****Significant at the 1 percent level. **Significant at the 5 percent level. *Significant at the 10 percent level.*

	Area (ha)	Harvest (kg)	Loans (kCFA)	Seed (kCFA)	Fertilizer (kCFA)	Seed per ha (kCFA/ha)	Fertilizer per ha (kCFA/ha)	Other crops (ha)	Land owned (ha)
Panel A1. IV-2SLS, without control variables									
Insured	0.75	261.32	13.150	10.333*	63.097*	2.554*	-1.163	-0.90	7.91*
	(0.68)	(744.61)	(79.344)	(5.841)	(36.270)	(1.426)	(9.925)	(1.34)	(4.62)
Constant	2.61***	2,630.09***	321.571***	13.375***	127.273***	5.304***	53.412***	4.12***	11.85***
	(0.13)	(166.45)	(15.022)	(1.081)	(6.544)	(0.275)	(2.664)	(0.34)	(0.83)
N	954	941	966	951	950	951	952	969	969
r2_a	-0.032	-0.006	-0.004	-0.104	-0.061	-0.109	-0.001	-0.010	-0.073
Panel A2. First stage, without control variables									
Treatment	0.24***								
	(0.06)								
constant	(omitted)								
Observations	954								
R2 (adj)	0.11								
F-stat treat var	22.17								
Panel B1. IV-2SLS, with control variables									
Insured	0.92	250.62	51.809	11.108**	71.902**	2.618*	-2.003	-0.80	7.97*
	(0.67)	(697.37)	(73.655)	(5.343)	(35.397)	(1.441)	(10.180.492)	(1.38)	(4.17)
Constant	0.28	183.26	96.182	3.825	25.681	6.880***	58958***	3.93**	-6.33**
	(0.42)	(665.50)	(65.785)	(3.569)	(22.825)	(0.875)	(5.964)	(1.94)	(2.84)
N	938	925	949	935	934	935	936	952	952
R2 (adj)	0.147	0.195	0.149	-0.008	0.082	-0.078	-0.000	0.083	0.089
Panel B2. First stage, with control variables									
Treatment	0.27***								
	(0.05)								
constant	-0.08								
	(0.12)								
Observations	938								
R2 (adj)	0.15								
F-stat treat var	21.73								

Table 16: LATE with original classification, achat assurance

A.6.2 Using the prices as instruments

	Area (ha)	Harvest (kg)	Loans (kCFA)	Seed (kCFA)	Fertilizer (kCFA)	Seed per ha (kCFA/ha)	Fertilizer per ha (kCFA/ha)	Other crops (ha)	Land owned (ha)
Panel A1. IV-2SLS, without control variables									
Sub.Insured	1.22	647.56	65.371	11.758	97.463	2.551	-2.823	-0.90	11.42
	(1.07)	(1,143.50)	(131.997)	(9.012)	(59.884)	(2.451)	(14.821)	(2.13)	(7.17)
Constant	2.47***	2,528.47***	310.477***	12.577***	116.445***	5.179***	53.864***	4.17***	10.72***
	(0.24)	(282.27)	(28.258)	(2.199)	(13.737)	(0.585)	(4.208)	(0.56)	(1.62)
N	945	933	956	942	941	942	943	959	959
R2 (adj)	-0.115	-0.026	-0.014	-0.234	-0.261	-0.242	-0.001	-0.022	-0.190
Panel A2. First stage, without control variables									
Treat	0.210**								
	(0.103)								
prem25	-0.075								
	(0.120)								
prem50	-0.027								
	(0.133)								
constant	-0.118**								
	(0.049)								
Observations	945								
R2 (adj)	0.02								
F-stat instruments	2.07								
Panel B1. IV-2SLS, with control variables									
Sub.Insurance	1.38	562.82	90.032	13.393	104.034*	2.833	-3.644	-0.86	11.32*
	(1.00)	(975.74)	(106.471)	(8.181)	(57.010)	(2.249)	(14.266)	(1.98)	(6.40)
Constant	0.48	291.94	103.525	5.521	39.841	7.178***	58.263***	3.86**	-4.69*
	(0.44)	(660.97)	(63.667)	(3.705)	(24.751)	(0.834)	(5.181)	(1.79)	(2.45)
N	929	917	939	926	925	926	927	942	942
R2 (adj)	0.029	0.176	0.127	-0.202	-0.159	-0.255	0.000	0.071	-0.03
Panel B2. First stage, with control variables									
Treat	0.215**								
	(0.102)								
prem25	-0.049								
	(0.116)								
prem50	-0.019								
	(0.130)								
constant	-0.199**								
	(0.083)								
Observations	929								
R2 (adj)	0.051								
F-stat instruments	2.56								

Table 17: LATE, original classification, adhesion, prices

	Area (ha)	Harvest (kg)	Loans (kCFA)	Seed (kCFA)	Fertilizer (kCFA)	Seed per ha (kCFA/ha)	Fertilizer per ha (kCFA/ha)	Other crops (ha)	Land owned (ha)
Panel A1. IV-2SLS, without control variables									
Insured	0.54	147.90	1.681	9.619	54.223	2.635*	-1.002	-1.063	7.8*
	(0.67)	(722.01)	(75.375)	(6.055)	(37.796)	(1.369)	(8.878)	(1.254)	(4.61)
Constant	2.65***	2,652.15***	323.755***	13.513***	128.992***	5.289***	53.380.***	4.155***	11.86***
	(0.13)	(162.31)	(15.105.)	(1.123)	(6.784)	(0.281)	(2.513.896)	(0.318)	(0.85)
N	954	941	966	951	950	951	952	969	969
R2 (adj)	-0.019	-0.003	-0.001	-0.092	-0.046	-0.116	-0.001	-0.013	-0.072
Panel A2. First stage, without control variables									
Treat	0.280**								
	(0.106)								
prem25	-0.072								
	(0.152)								
prem50	-0.063								
	(0.143)								
constant	0.000								
	(1.000)								
Observations	954								
R2 (adj)	0.127								
F-stat instruments	7.51								
Panel B1. IV-2SLS, with control variables									
Insured	0.676	98.69	36.175	10.462*	61.484*	2.798**	-1.446	-1.00	7.53*
	(0.656)	(664.68)	(69.271)	(5.436)	(36.506)	(1.364)	(8.897)	(1.23)	(4.04)
Constant	0.294	185.86	96.676	3.849	26.078	6.873***	58.937***	3.94**	-6.32**
	(0.416)	(674.12)	(66.224)	(3.544)	(22.496)	(0.877)	(5.932)	(1.93)	(2.81)
N	938	925	949	935	934	935	936	952	952
R2 (adj)	0.167	0.199	0.155	0.004	0.102	-0.093	-0.000	0.080	0.097
Panel B2. First stage, with control variables									
Treat	0.277**								
	(0.105)								
prem25	0.063								
	(0.145)								
prem50	-0.062								
	(0.140)								
constant	-0.080								
	(0.119)								
Observations	938								
R2 (adj)	0.166								
F-stat instruments	7.42								

Table 18: LATE, original classification, achat, prices

A.6.3 Using the reinsurance penalty as instrument

	Area	Harvest	Loans	Seed	Fertilizer	Seed per ha	Fertilizer per ha	Other crops	Land owned
	(ha)	(kg)	(kCFA)	(kCFA)	(kCFA)	(kCFA/ha)	(kCFA/ha)	(ha)	(ha)
Panel A1. IV-2SLS, without control variables									
Sub.Insurance	1.76	1,135.34	71.132	18.905	129.235*	3.733	-1.364	-1.42	11.05
	(1.28)	(1,223.19)	(126.129.)	(12.438)	(75.481)	(2.957)	(14.402)	(2.18)	(7.68)
Constant	2.34***	2,411.36***	309.127***	10.878***	108.882***	4.898***	53.518***	4.29***	10.81***
	(0.284)	(292.38)	(26.495)	(2.871)	(16.664	(0.709)	(4.091)	(0.58)	(1.67)
N	945	933	956	942	941	942	943	959	959
R2 (adj)	-0.245	-0.086	-0.017	-0.602	-0.464	-0.499	-0.000	-0.049	-0.175
Panel A2. First stage, without control variables									
Treat55	0.169**								
	(0.069)								
difftrig	-0.089								
	(0.180								
constant	0.145								
	(0.056)								
Observations	945								
R2 (adj)	0.021								
F-stat instruments	2.97								
Panel B1. IV-2SLS, with control variables									
Sub.Insurance	1.55	682.43	87.676	16.603*	115.971*	3.488	-2.796	-1.24	10.45
	(1.09)	(1,016.77)	(107.067)	(9.650)	(63.632)	(2.465)	(13.974)	(1.98)	(6.58)
Constant	0.50	306.09	103.251	5.878	41.141*	7.250***	58.358***	3.82**	-4.79*
	(0.45)	(661.75)	(63.691)	(3.777)	(24.963)	(0.858)	(5.277)	(1.79)	(2.46)
N	929	917	939	926	925	926	927	942	942
R2 (adj)	-0.014	0.165	0.129	-0.369	-0.237	-0.395	0.001	0.053	-0.001
Panel B2. First stage, with control variables									
Treat	0.189**								
	(0.068)								
difftrig	-0.051								
	(0.178)								
constant	-0.181								
	(0.102)								
Observations	929								
R2 (adj)	0.05								
F-stat instruments	3.87								

Table 19: LATE, original classification, adhesion, dtrigg

	Area (ha)	Harvest (kg)	Loans (kCFA)	Seed (kCFA)	Fertilizer (kCFA)	Seed per ha (kCFA/ha)	Fertilizer per ha (kCFA/ha)	Other crops (ha)	Land owned (ha)
Panel A1. IV-2SLS, without control variables									
Insured	1.16*	956.85	58.425	10.804*	76.287**	1.723	0.415	-0.70	4.35
	(0.69)	(657.87)	(71.153)	(5.892)	(37.456)	(1.330)	(6.590)	(1.01)	(3.63)
Constant	2.53***	2,494.83***	312.947***	13.284***	124.718***	5.465***	53.106***	4.08***	12.53***
	(0.13)	(142.02)	(13.822)	(1.114)	(6.858)	(0.284)	(1.977)	(0.28)	(0.74)
N	954	941	966	951	950	951	952	969	969
R2 (adj)	-0.068	-0.041	-0.018	-0.113	-0.087	-0.052	-0.001	-0.007	-0.025
Panel A2. First stage, without control variables									
Treat	0.258**								
	(0.061)								
difftrig	-0.405**								
	(0.175)								
constant	0.119								
	(0.055)								
Observations	954								
R2 (adj)	0.161								
F-stat instruments	13.33								
Panel B1. IV-2SLS, with control variables									
Insured	1.10*	799.07	60.387	9.788.89*	73.145**	1.628	-0.793	-0.76	3.57
	(0.63)	(589.09)	(63.616)	(5.418)	(33.786)	(1.356)	(6.875)	(1.05)	(3.19)
Constant	0.27	173.89	95.911	3.874	25.634	6.916***	58.913***	3.93**	-6.19**
	(0.42)	(637.94)	(65.274)	(3.564)	(22.910)	(0.852.308)	(5.818)	(1.93)	(2.70)
Observations	938	925	949	935	934	935	936	952	952
R2 (adj)	0.129	0.167	0.145	0.016	0.079	-0.013	-0.000	0.084	0.152
Panel B2. First stage, with control variables									
Treat	0.254**								
	(0.061)								
difftrig	-0.384**								
	(0.183)								
constant	0.019								
	(0.143)								
Observations	938								
R2 (adj)	0.195								
F-stat instruments	12.66								

Table 20: LATE, original classification, achat, dtrigg