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The effect of weather index insurance on social capital: Experimental evidence from Ethiopia

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The effect of weather index insurance on social capital:

Experimental evidence from Ethiopia*

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Abstract

In this study, using data from lab-in-the-field experiment, we explore whether the introduction of weather index insurance crowds in or crowds out social capital in northern Ethiopia. We use contributions in the public good game as a measure of social capital. We find that weather index insurance crowds out social capital. The free-riding problem created by the positive externality of weather index insurance and development of self-sufficiency behavior are found to be the causal mechanisms behind the crowding out phenomenon. Our results indicate that formal insurance mechanisms do not occur in a vacuum and may have unintended effects. Hence, this study suggests that novel insurance product design and marketing strategies should be used to ameliorate such unintended effects.

JEL Classification: C93, G22, H41, O17

Keywords: Weather index insurance; social capital; public good game; Ethiopia

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1. Introduction

Weather risks are ubiquitous in developing countries. These risks have been remained uninsured because the pervasive asymmetric information problems such as moral hazard, adverse selection and high transaction costs inhibit the introduction of the conventional indemnity insurance mechanisms. In the absence of formal insurance markets, farmers in developing countries mainly rely on the informal risk sharing strategies to overcome a wide variety of risks. However, even if informal risk sharing strategies cover idiosyncratic risks, they do not provide reliable protection against covariate risks such as drought occurring at a village level (Morduch, 1999; Townsend, 1994). The recent weather index insurance aims to fill this gap in developing countries. It is a promising innovation which addresses the asymmetric information problems as payouts are made based on a meteorological index which is exogenous for the insured and directly observed by the insurer (Leblois and Quirion, 2013). Weather index insurance indemnifies covariate(weather) risks which are hardly covered by the pre-existing informal risk sharing strategies.

Recently, the relationship between weather index insurance and informal risk sharing strategies attracts significant attention. There is a growing literature that attempts to uncover the effect of the pre-existing informal risk sharing strategies on the demand for weather index insurance. However, the empirical evidence on this subject is mixed. On the one hand, some studies indicate that as weather index insurance indemnifies covariate risks and informal risk sharing strategies cover idiosyncratic risks such as basis risk[1], informal risk sharing strategies would increase the demand for weather index insurance. For example, Mobarak and Rosenzweig (2012) offer weather index insurance to informal networks in India and find that informal networks increase demand for weather index insurance if they indemnify idiosyncratic risks. Dercon et al. (2014) also find similar results when they offer weather index insurance to informal funeral insurance groups (iddir) in Ethiopia. In their experiment, iddir leaders were randomly assigned to either a training sessions which focus on the individual benefits of weather index insurance or training sessions which focus on the benefits of sharing idiosyncratic risks such as basis risk within the informal funeral insurance groups. They find that trainings focused on the benefits of sharing basis risk substantially increase the demand for weather index insurance compared to trainings emphasized on the individual benefits of

[1]Basis risk is the mismatch between the actual losses incurred by the insurance purchasers and insurance payouts paid by the insurers. The main drawback of weather index insurance is that it does not cover basis risk.

weather index insurance. Likewise, using artefactual field experiments, Berg et al. (2017) find that while the informal risk sharing increases the demand for weather index insurance, it decreases the demand for an indemnity insurance.

By contrast, other studies argue that informal risk sharing strategies may decrease the demand for weather index insurance. For example, in their theoretical study De Janvry et al. (2014) argue that if an individual's utility partly depends on the aggregate wealth of informal risk sharing groups, insurance purchase by one individual may create positive externality on others and induce free-riding. This in turn decreases the demand for weather index insurance. Likewise, Munro (2015) finds that in societies where there are norms of redistribution of insurance payouts in the aftermath of common shocks, informal risk sharing decreases the demand for weather index insurance.

The aforementioned studies focused on the effect of informal risk sharing strategies on the demand for weather index insurance. There is a long-standing hypothesis which suggests, however, that the introduction of formal insurance may crowd out pre-existing informal insurance mechanisms. Yet, less is known on whether and how the recent weather index insurance affects the informal risk sharing strategies and related social capital. Therefore, this study aims to investigate whether the introduction of weather index insurance crowds in or crowds out social capital.

Theoretically, weather index insurance could affect social capital in either direction. Since weather index insurance and social capital mainly insure two different types of risks, covariate and idiosyncratic risks respectively, weather index insurance may crowd in social capital. By contrast, weather index insurance may crowd out social capital in at least three ways. First, weather index insurance purchase may encourage adoption of very risky technologies and thereby impose external costs (a moral hazard problem) on informal insurance groups. Consequently, insurance non-purchasers may reduce their investment in social capital (Boucher and Delpierre, 2014). Second, weather index insurance purchase creates positive externality on others and in turn induces free-riding behavior (De Janvry et al., 2014). Insurance purchasers are aware of this free-riding problem before they decide to purchase weather index insurance. Therefore, they may reduce their investment in social capital once they purchase weather index insurance. Third, as weather index insurance covers covariate risks such as drought in which its adverse effects span for several years, insurance purchasers may develop self-sufficiency behavior. As a result, they may invest less in their social capital. In this study, we first investigate whether the introduction of weather index insurance crowds in or crowds out social capital. Second, if we find a crowding out effect, we disentangle the mechanisms leading to the crowding out effect. As indicated earlier, weather index insurance may crowd out social capital because of the moral hazard problem in the informal risk sharing groups, the free-riding problem or the self-sufficiency behavior. We argue that if the crowding out effect is due to the non-purchasers, moral hazard in the informal risk sharing groups would be the possible mechanism to the crowding out effect. Conversely, if the crowding out effect is due to the insurance purchasers, we claim the causal mechanisms to the crowding out effect would be either the free-riding problem, or self-sufficiency behavior or both.

This study contributes to two strands of literature. First, it contributes to the growing literature on the recent weather index insurance. Existing studies on weather index insurance focus either on the drivers of demand for weather index insurance (Berg et al., 2017; Clarke, 2016; Cole et al., 2013; De Janvry et al., 2014; Dercon et al., 2014; Giné et al., 2008; Giné and Yang, 2009; Mobarak and Rosenzweig, 2012; Norton et al., 2014) or on the short-term intended impacts of weather index insurance on agricultural investment and welfare (de Nicola, 2015; Giné and Yang, 2009; Karlan et al., 2014; Mobarak and Rosenzweig, 2012). However, less is known on the long-term unintended effects of weather index insurance. Hence, unlike the previous studies, this study explore the unintended effects of weather index insurance on social capital. As farmers with low literacy level may need a while to understand the design and features of weather index insurance, the introduction of weather index insurance may also take a long time to affect the pre-existing social capital. This study thus investigates the effect of weather index insurance which has been commercialized for a relatively longer time, six to nine years, to farm households in northern Ethiopia. Second, this study contributes to the broad literature on the effect of formal institutions on informal institutions.

The rest of this paper is organized as follows. The next section presents a review of related literature. Section 3 briefly discusses the evolution of weather index insurance in Ethiopia. Section 4 discusses the data used for this study; study area and sample selection, measurement of social capital and descriptive statistics. Section 5 discusses the estimation strategy. We provide the estimation results and the robustness checks in section 6. The last section concludes.

2. Related Literature

A small but growing literature discusses the effect of formal indemnity insurance which covers idiosyncratic risks on the informal insurance mechanisms. These studies suggest that the introduction of formal indemnity insurance crowds out informal insurance mechanisms. For example, Attanasio and Rıos-Rull (2000) show that the welfare program in Mexico crowds out private transfers. Likewise, in rural areas of Ethiopia, Dercon and Krishnan (2003) find that public transfers in the form of food aid crowd out informal risk sharing mechanisms. A recent study by Strupat and Klohn (2018), in a nation-wide formal health insurance scheme in Ghana, also show that the introduction formal health insurance crowds out informal transfers among informal insurance groups.

Some experimental studies also supported the crowding out hypothesis. In a laboratory experiment, Lin et al. (2014) find that the introduction of formal insurance crowds out informal risk sharing strategies and the presence of moderate degree of altruism exacerbated the crowding out effect. Landmann et al. (2012) using an experimental data from rural Philippines show that formal market-based products such as formal insurance lowers informal voluntary transfers among informal risk sharing groups. They further asserted that the effect of formal insurance persists even after the insurance mechanism is removed. Cecchi et al. (2016) also documented that formal health insurance crowds out social capital which is proxied by the contribution to a common pot in a public good game. Interestingly, the crowding out effect is due to the lower contribution of uninsured households in the public good game. They point out 'signal sending as a causal mechanism', that is, uninsured households may feel 'left behind' as the rich ones leave the informal risk sharing groups. As a result, they signal their discontent by lowering their cooperation with insured households.

Our study is similar with the above mentioned studies but differs from two perspectives. First, we focus on the effect of weather index insurance, which indemnifies covariate risks such as drought, on social capital. As highlighted above, the previous studies focus on the effect indemnity insurance such as food aid, welfare programs and health insurance which only covers individual risks. Second, unlike the previous studies,[2] we focus on the effect of formal insurance on social capital than on the informal risk sharing. This is because informal risk sharing is only one specific component of social capital.

[2]The study by Cecchi et al. (2016) is a notable exception.

3. The Weather Index Insurance Scheme

As in many agrarian economies, welfare of the Ethiopian farmers has been constantly threatened by weather-related shocks. Absence of formal insurance markets exacerbated the adverse effects posed by these shocks. Until recent years, there was no formal insurance product specifically designed to address these weather related shocks in the rural areas of the country. It is only in recent years that a wide experimentation of formal insurance is taking place. There were a series of pilots in many parts of the country since 2006. For instance, in 2006, the World Bank implemented a pilot project with 28 farmers on weather index insurance in Alaba woreda, southern Ethiopia. The results from the pilot project revealed the key issues that require considerable attention to scale up and sustain the project in the country. Likewise, in collaboration with several partners, International Livestock Research Institute (IRLI) has also been piloting index-based livestock insurance (IBLI) in Borena, southern Ethiopia to protect livestock herders from drought related livestock losses. For more detail information on the evolution of microinsurance sector in Ethiopia, see Amha et al. (2013).

In this study, we focus on the weather index insurance scheme initially known as Horn of Africa Risk Transfer for Adaptation (HARITA) which was initiated by Relief Society of Tigray (REST) in collaboration with Oxfam America, International Research Institute (IRI), Nyala Insurance Share Company (NISCO), Dedebit Credit and Saving Institution (DECSI) and Swiss Re in Adiha tabia[3], Tigray region in 2009. The weather index insurance offers a payout when the weather index is below or above a particular threshold level. Given the encouraging results from the pilot tabia, the HARITA project was expanded to four additional tabias (Geneti, Hade Alga, Awet Bikalsi and Hadush Adi) in 2010.

In 2011, World Food Programme (WFP) and Oxfam America (OA) sustain and scale up the weather index insurance scheme building on the initial success of the HARITA project. In 2016, the weather index insurance scheme expanded to more than 86 tabias insuring a total of 29,127 farmers, of which about 27,027 farmers in the region of Tigray and 2,103 farmers in the region of Amhara (Oxfam, 2016)[4]. The insurance product insures different types of

[3]Tabia is the lowest administrative unit in Ethiopia. The administrative structure of the country in ascending order goes as follows: Tabia, Woreda (District), Zone, Region and Federal.

[4]Currently, the program scaled up to four countries in Africa; Ethiopia, Senegal, Malawi and Zambia. In 2016, a total of 41,867 farmers participated in this project, of which about 70% (29,127) are from Ethiopia. The project has a vision of reaching 500,000 participants in 2020 (Oxfam, 2016).

crops (Wheat, Maize and Sorghum) grown in the region. Farmers have an option to pay their premiums either by cash or by working additional number of days in the productive safety net program. The minimum premium paid in 2016 was about 160 Ethiopian Birr and the corresponding mimimum liability was about 800 Ethiopian Birr.

4. Data

4.1. Study area, sampling and data collection

The study takes place in Tigray region, northern Ethiopia. About 80 percent of the regional population is living in the rural areas and their livelihood is mainly dependent on rain-fed agriculture. The production environment in the region is characterized by low soil quality, sparse and erratic rainfall and is vulnerable to frequent droughts (Hagos et al., 1999). More than half of the regional highlands are highly degraded and the average yield of cereal crops is less than one ton per hectare. The average landholding per household in the region is about one hectare. The regional mean annual rainfall has been estimated at about 650mm (Pender and Gebremedhin, 2007) and the region has experienced more than 25 severe drought periods in the last millennium (Di Falco et al., 2007).

The weather index insurance scheme was introduced in 2009 to strengthen farmer's food and income security in the region. Though the region in general could be eligible to receive the weather index insurance, some districts (woredas) were treated earlier than others. In 2010, three districts (woredas), namely Kolla Temben, Raya Azebo and Saesie Tsaedaemba, were selected from different parts of the region based on their vulnerability to drought. Five tabias were selected from these three districts to get access to weather index insurance. In 2016, the weather index insurance scaled up to 9 districts and more than 80 tabias insuring about 27,027 farm households.

The data for this study was collected from two randomly selected districts (Raya Azebo and Alamata) which are vulnerable to frequent drought related shocks. Eight tabias, five with access and three without access to weather index insurance were randomly selected from these two districts. We selected 384 households using a two stage stratified random sampling procedure. First, we randomly sampled 240 and 144 households with and without access to weather index insurance respectively. Second, households were stratified by their insurance status, that is, households that purchased weather index insurance and those that did not purchase weather index insurance. Of the 240 households with access to weather index insurance, 120 of them were purchasers and the remaining 120 were non-purchasers. As the sample consisted of insurance purchasers and non-purchasers, we obtained the list for the two groups from two different data sources. An insurance foreman in each tabia has a list of household names that purchased index insurance. We randomly selected the 120 insurance purchasers from this list. On the other hand, insurance non-purchasers were randomly selected from tabia household name lists and cross-checked with household name lists available from the insurance foreman to avoid contamination.

The data was collected from March to May, 2017. Households first participated in a public good experiment to measure their social capital. After the experiment session, households participated in a short socio-economic survey. The survey included questions on household assets and wealth, details on insurance access, insurance purchase, household demographics and membership in local associations, inter alia. The data collection was handled by experienced enumerators who had rich experience in data collection activities. In addition, as we have used tablets and CSPro software for our data collection, enumerators were also required to have an experience of using tablets and CSPro software package.

4.2. Measuring social capital

The key challenge in the social capital literature is that it has been defined and measured in several ways. Social capital has been measured using either survey or experimental approaches or both. In this study, we use the behavior in a public good game in the lab-in-the-field experiment as a measure of social capital. The advantage of lab-in-the-field-experiment is that it enables respondents to credibly reveal their actual behavior. Moreover, it also helps to address the problems related with social desirable biases in self-reported surveys. The use of public good game as a measure of social capital has been employed in several studies (Attanasio et al., 2015; Carpenter et al., 2004; Cecchi et al., 2016; Gilligan et al., 2015; Karlan, 2005). However, to probe the robustness of our results we also used some survey measures of social capital such as households participation in community projects and informal private transfers.

Our experimental setting is a one-shot linear public good game. The public good game captures the degree of cooperation among community members. At the beginning of the experiment the participants are given an initial endowment and asked how much of their endowment they want to contribute to the community project and how much to keep for themselves. The sum of the contributions in the community project is doubled by the experimenter and shared equally by all members of the group regardless of their contribution to the community project. However, only the individuals benefit from the endowment they keep for themselves.

The payoff function for individual i from the public good experiment is given as follows;

$$\pi_(i) = (E_i - C_i) + \alpha(\sum_{n=1}^{4} C_h) \tag{1}$$

where $\pi_(i)$ denotes the payoff of individual i, $C_(i)$ is the contribution of individual i to the public good, α is the marginal propensity to cooperate or marginal per capita return (MPCR) from the public good and E_i is the endowment. In this experiment, MPCR is equals to 0.5, meaning that each participant would receive 0.5 Birr for each token contributed to the public good. At the beginning of the experiment, each participant receives an endowment, E_i, of 20 tokens (which is equivalent to 20 Ethiopian Birr) with one 10, one 5 and five one Birr notes. Each experimental group in a session of 12 participants consists of four randomly and anonymously matched individuals.

The public good experiment was conducted at local public schools between March and May, 2017. Up-on arrival, participants were randomly given an identification number and asked to be seated alone on each desk in a class room. Before the experiment began, informed consent for participation in the public good experiment as well as in a short socio-economic survey was obtained from all participants. Our research study protocol was also approved by the Ethical Review Committee Inner City (ERCIC) of Maastricht University (reference no. ERCIC_028_28_02_2017). At the beginning of the experiment, experimental instructions were presented orally by the experimenters as the majority of the participants had low levels of literacy. Next, we gave several examples which enabled them to understand how the game would be played and payoffs would be calculated. In order to check their level of understanding, respondents were also given several exercises. Once all participants completed the exercises and understood the experimental procedures, the experiment began. Participants had the opportunity to ask questions privately but were not allowed to talk with other participants during the entire experiment. In total, 384 households participated in the experiment. Sessions took up to one hour. Including a show-up fee, on average, participants earned eighty Ethiopian Birr.[5] On average, participants contributed about 45% of their endowment to the public good, which is consistent with earlier evidence on the contribution in the public good game.[6]

After completing the public good experiment, respondents participated in a short socio-economic and demographic survey. Payments were made privately and in cash immediately after the survey was over.

4.3. Descriptive statistics

Table 5 in the appendix shows the summary statistics of sample households. The total sample size is about 384 household heads. Of the total sample, 76% are male headed households. The average age of a household head is about 41 years and the mean household size in the sample is 5.24, which is slightly higher than the regional average. Nearly, 5% of the household heads have secondary level of education, 22% have primary level of education, 13% of the respondents have no formal education but can read and write, while the remainder 60% are illiterate. Regarding their participation in local associations, about 95% and 42% of the sample households participate in a local funeral insurance (iddir) and local rotating saving and credit association (eqqub) respectively. The mean landholding of households in the sample is 4.75 tsimad (approximately 1.19 hectare)[7], which is slightly higher than the regional average of only 1 hectare per household (Pender and Gebremedhin, 2007). The mean livestock holding is 4.3 Tropical Livestock Unit (TLU)[8]. Nearly, 45% of the households in the sample own corrugated iron sheet roof houses and the remaining 55% own houses with a thatched roof. About 75% of the respondents own a mobile phone and only 20% of the sample households own a radio.

Table 6 and 7 in the appendix present the balance test of sample households disaggregated by

[5] 80 Birr was equivalent to €3.3 at the time of data collection

[6] In the literature subjects on average contribute 40% - 60% of their endowment to the public good (Attanasio et al., 2015)

[7] tsimad is a local measurement of farm land. 1 hectare ≈ 4 tsimad (Hagos et al., 2009)

[8] 1 TLU is equivalent to 0.8 camel, 1 cow, 8 goats or sheep (Storck et al., 1991)

their access to, and purchase, of weather index insurance respectively. The results in Table 6 show that sample households with and without access to weather index insurance are similar in most of the socio-economic characteristics. However, while sample households are balanced across several characteristics, we find few significant differences across the two groups. Of the variables tested, two variables are significantly different at 10% or less. Households with access to weather index insurance have more livestocks and higher participation in the local rotating saving and credit associations (eqqub). Likewise, weather index insurance purchasers and non-purchasers are also similar in most of the variables tested. However, as shown in Table 7, non-purchasers have a larger household size, more livestock and farming land and are more likely to own houses with corrugated iron sheet roof. We, however, control for these differences in our regression analysis below.

5. Estimation Strategy

The objective of this study is to investigate whether and how the introduction of weather index insurance affects social capital. We analyze the effect of weather index insurance by estimating the following regression model:

$$Sc_i = \alpha + \beta I_i + X_i \gamma + \epsilon_i \tag{2}$$

where Sc_i, the number of tokens shared in the public good game by household i, is our measure of social capital, I_i is a dummy variable that takes value of 1 if household i has purchased weather index insurance and 0 otherwise, X_i is a vector of controls, ϵ_i is the random error term, and β measures the effect of weather index insurance on social capital. We hypothesize that weather index insurance crowds out social capital and we expect β to be negative.

In equation 2 the dependent variable, Sc_i, takes a continuous value. In order to check the robustness of our results we generate a dummy variable and categorize respondents as cooperative or not based on their contribution in the public good game. To do so, we consider 10 as a threshold contribution amount. This is for the following reasons. First, respondents were given an endowment of 20 tokens. Hence, 10 is half of the total endowment. We consider respondents who contributed more than half of their endowment as high contributors and those who contributed less than half of their endowment as low contributors. Second, the median value of the number of tokens shared in the public good game is also 10. Third, the average number of tokens shared in the public good game is about 9 tokens which is close to the threshold amount. Hence, we took 10 as a threshold contribution amount and categorize respondents accordingly into low and high contributors and estimate the following Probit model:

$$Pr(ScH_i = 1|I_i) = \alpha + \beta I_i + X_i\gamma + \epsilon_i \tag{3}$$

where ScH_i is a dummy variable that takes value of 1 if household i has contributed more than 10 tokens, 0 otherwise, and other variables are as explained in equation 2.

Weather index insurance purchase in our social capital equations 2 and 3, however, may be endogenous for the following reasons. First, as the decision to purchase weather index insurance is on a voluntary basis, there is a possibility of self-selection to purchase or not to purchase weather index insurance. Second, the causal relationship may go the opposite direction, that is, from social capital to weather index insurance purchase. Third, there may be omitted variables that drive the decision to purchase weather index insurance and social capital simultaneously. Hence, estimates of equations 2 and 3 may provide biased results. To attenuate the endogeneity problem we employ an instrumental variables (IV) approach.

The use of an instrumental variable approach requires availability of a valid instrument, **z**, which satisfies the following two conditions. First, the instrumental variable should be correlated with the endogenous regressor (in our case, purchase of weather index insurance (I)). Second, the instrumental variable should be uncorrelated with the dependent variable (social capital, (Sc)) (Angrist and Pischke, 2008). To investigate the effect of an endogenous weather index insurance purchase on social capital we estimate the following equations:

$$Sc_i = \kappa_0 + \kappa_1 I_i + X_i\lambda + \epsilon_i \tag{4}$$

$$I_i^* = \pi_0 + \pi_1 z_i + Y_i\psi + \upsilon_i \tag{5}$$

$$I_i = \begin{cases} 1, & \text{if } I_i^* > 0 \\ 0, & \text{if } I_i^* \leq 0 \end{cases}$$

In equations 4 and 5, ϵ_i and υ_i are correlated, i.e. Cov (ϵ_i, υ_i) $\neq 0$. Hence, OLS does not provide consistent estimates. In order to obtain consistent estimates of κ_1 while the Cov (ϵ_i, υ_i) $\neq 0$, we need to have an instrumental variable, z_i, which is as much as possible correlated with I and uncorrelated with ϵ. To address the endogeneity concern, we use living in the same village (*Kushet*) as the insurance foreman as an instrument for weather index insurance purchase. As has already been indicated, *tabia* is the lowest administrative unit in Ethiopia. However, within each *tabia*, there are about four *Kushets*. The insurance foreman most likely lives in only one of these four *Kushets* and this may create some variation in the access to information and knowledge about weather index insurance.

Weather index insurance is not an easy concept that farmers with low literacy level understand instantly. Hence, for farmers to make an informed decision, they need to have an adequate knowledge of the product through substantial training sessions. The insurance companies and other partners are in charge of providing the training and marketing sessions. However, a few hours training might not be sufficient for farmers to understand this complex insurance policy and to buy it. In addition, the insurance companies and their partners are not easily reachable to farmers in case they have questions about the insurance policy.

The insurance foreman, an important person between the farmers and insurance companies, plays a vital role in the marketing and sales of the insurance product. He is a member of the village who is in charge of registering farmers who are interested to purchase the insurance product. The foreman has a relatively better knowledge of the insurance policy and is the only person easily reachable to answer farmers' questions about the insurance policy. Hence, farmers living in the same village (*Kushet*) as the insurance foreman have the advantage of getting adequate information about the insurance policy and are more easliy inclined to purchase the insurance product. Moreover, it is also easy for the foreman to induce farmers who are geographically close to him to purchase the insurance product. We argue that being in the same *Kushet* as the insurance foreman is purely exogenous. Households can-not self-select to be in the same *Kushet* as the insurance foreman. But, being a member of a *Kushet* where the insurance foreman is living is more likely to affect the insurance purchase decision. As we have observed during our data collection, most of the insurance foremen are neither village leaders nor agricultural extension workers. Therefore, we argue that being geographically closer to the insurance foreman is a plausible instrument that directly affects the decision to purchase weather index insurance and social capital only indirectly through purchase of weather index insurance.

6. Estimation Results

6.1. Weather index insurance and sharing in the public good game

Table 1 presents the effect of weather index insurance purchase on social capital. Column (3) of Table 1 reports the result of OLS regression model. It shows the presence of negative and statistically significant correlation between weather index insurance purchase and social capital i.e., the amount of contribution in the public good experiment. On average, households who have not purchased weather index insurance contribute about 2.5 tokens more than households who have purchased weather index insurance. This implies there is a tendency that weather index insurance purchase crowds out social capital. In the public good experiment, we ask respondents to make any contribution to the public good from their initial endowment of 20 tokens. However, their contribution to the public good might be bounded by their initial endowment. Hence, the dependent variable, number of tokens contributed to the public good may be censored from above. To address the censoring issue, in addition to OLS we employ the Tobit regression model with right censoring (the contribution to the public good is censored at 20 tokens). Columns (2) of Table 1 reports the result of Tobit regression model and shows that weather index insurance purchase affects social capital negatively and significantly. To be precise, those who purchased weather index insurance, on average, contribute about 2.4 fewer tokens than those who have not purchased weather index insurance.

As discussed in section 5, to check the robustness of our results in columns (3), we generate a dummy dependent variable based on the existing continuous dependent variable. Hence, column (1) presents the estimation result of the Probit estimator and shows a negative and significant correlation between weather index insurance purchase and making higher contribution to the public good. This implies that households who have not purchased weather index insurance are more likely to be high contributors (contributing more than 10 tokens to the public good) than households who purchased weather index insurance. The results are robust for including or excluding other household covariates.

Our regression results in Table 1 show that contribution to the public good is correlated with only few household covariates. Consistent with the literature, female headed households are more cooperative (have stronger social capital) than male headed households. On average,

Table 1: Weather index insurance and sharing in the public good game

	Probit	Tobit	OLS	IV-LPM	2SLS
Weather Index Insurance	-0.172***	-2.402***	-2.434***	-0.204*	-3.278**
	(0.0593)	(0.798)	(0.750)	(0.113)	(1.666)
Belief about others' contribution	0.0445***	0.467***	0.430***	0.0394***	0.437***
	(0.00629)	(0.0774)	(0.0707)	(0.00511)	(0.0696)
Age	0.0356**	0.0868	0.0724	0.0283***	0.0984
	(0.0140)	(0.223)	(0.218)	(0.0102)	(0.215)
Age square	-0.0004**	-0.0003	-0.0002	-0.0003***	-0.0005
	(0.0002)	(0.0025)	(0.0024)	(0.0001)	(0.0024)
Male	-0.1170	-2.960**	-2.425*	-0.0858	-2.474**
	(0.124)	(1.343)	(1.182)	(0.0859)	(1.116)
Household size	-0.0076	0.0628	0.0827	-0.0102	0.0605
	(0.0143)	(0.219)	(0.195)	(0.0109)	(0.190)
Education	-0.0128	0.2660	0.3320	0.0065	0.4160
	(0.0598)	(0.7520)	(0.702)	(0.0455)	(0.696)
Livestock	-0.0048	-0.0748	-0.0797	-0.0039	-0.0870
	(0.0076)	(0.112)	(0.105)	(0.0051)	(0.0954)
Land size	-0.0186*	-0.165	-0.148	-0.0087	-0.169
	(0.0102)	(0.122)	(0.115)	(0.0074)	(0.120)
Corrugated iron sheet roof	0.0272	-0.321	-0.306	0.00977	-0.431
	(0.0602)	(0.607)	(0.561)	(0.0488)	(0.619)
Iddir participation	-0.0640	0.0634	-0.409	-0.0300	-0.222
	(0.126)	(1.493)	(1.668)	(0.107)	(1.672)
Eqqub participation	0.0940	1.729	1.510	0.0733	1.557*
	(0.0876)	(1.063)	(0.998)	(0.0664)	(0.886)
Constant		5.571	6.311	-0.401	6.099
		(4.846)	(4.872)	(0.269)	(4.718)
Tabia fixed effects	Yes	Yes	Yes	Yes	Yes
Observations	240	240	240	240	240
R^2			0.3381	0.3910	0.3343
PseudoR^2	0.3762	0.0643			
First stage instrument					
Insurance foreman				0.374***	0.374***
				(0.0301)	(0.0301)
First stage *F-test*				154.402	154.402

Robust standard errors in parentheses, clustered by session
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: The dependent variable in columns (2), (3), and (5) is the number of tokens shared in the public good game. Whereas, the dependent variable in columns (1) and (4) is a dummy variable that takes value of 1 if household i has contributed more than 10 tokens to the public good, 0 otherwise. Probit marginal effects in column (1).

males contribute about 2.5 fewer tokens than females. Moreover, though not robust across regression models, age of the household head positively affects contribution to the public good. Moreover, though not robust across regression models, age of the household head positively affects contribution to the public good. However, the relationship between age and contribution to the public good is non-linear. The age square variable enters negatively in all regression models. This implies that contribution to the public good initially increases with age then decreases after a certain threshold age level. In other worlds, households decrease their contribution to the public good when they are getting too old. In the public good experiment, after respondents made their decision on how much to contribute to the public good and how much to keep for themselves, we ask them to guess about the average contribution of other players in their group. This specific question captures the belief of respondents about others' contribution to the public good. Consistent with Kocher et al. (2015), beliefs of respondents about others' contribution positively and significantly affects their own contribution to the public good. To be precise, on average, a one token increase in the expectation of others' contribution to the public good increases own contribution by about 0.4 tokens.

However, as has already been mentioned in section 5, weather index insurance purchase is non-random and may be endogenous. To attenuate the potential endogeneity problem, we use an instrumental variable (IV) approach. We use living in the same *Kushet* together with the insurance foreman as an instrument for weather index insurance purchase. Before running the IV regression model, we check the validity of our instrument in several ways. First, to probe whether the instrumental variable is robustly correlated with the endogenous explanatory variable, weather index insurance purchase, we run a series of regression analysis starting from the most simple specification of column (1) of Table 8 with the instrumental variable as the only explanatory variable to the most elaborative regression specification of column (3) where other household covariates and *tabia* fixed effects are included in the model. Our regression results show a positive and statistically significant correlation between being geographically closer to the insurance foreman and weather index insurance purchase. Interestingly, the coefficient for the insurance foreman variable is stable across all regression specifications. Next, we check whether the instrumental variable directly affects the outcome variable or only indirectly through weather index insurance purchase. Column (4) of Table 8 shows that the instrumental variable enters insignificantly once we control for the weather index insurance purchase.

Now, we turn into running our instrumental regression model. As indicated in section 5 for a certain instrument to be valid it should satisfy the following two conditions. First, the instrumental variable should be correlated with the endogenous regressor. We report the first stage of the IV regression in columns (3) and (4) of Table 1 and more formally in column (3) of Table 8 in the appendix. Our regression results show that the instrumental variable is positively and significantly correlated with the adoption of weather index insurance. The Kleibergen-Paap rk Wald F statistic is reported and used to test the relevance of the instrument. The relevance test for the instrumental variable in columns (3) and (4) of Table 1 indicates that being in the same *Kushet* with the insurance foreman is a relevant instrument for index insurance purchase. Referring to the Stock-Yogo critical values for the relevance test, the F statistic exceeds the critical values, and we reject the null hypothesis of weak instrument. The second criterion is that the instrumental variable should be uncorrelated with the outcome variable. In column (4) of Table 9, we showed that the instrumental variable affects the outcome variable indirectly through the endogenous explanatory variable, purchase of weather index insurance. This implies that our instrument is relevant in capturing an exogenous change in index insurance purchase.

As has already been shown, our instrument is valid and plausible. We now proceed to estimating the effect of weather index insurance purchase on social capital using IV-LPM instead of the Probit equation in column (1) and 2SLS instead of the OLS equation in column (3). Column (5) of Table 1 shows that weather index insurance purchase affects social capital measured by the number of tokens contributed to the public good negatively and significantly. Column (4) of Table 1 shows qualitatively similar results. The coefficient for the purchase of weather index insurance for the 2SLS is -3.278, meaning that weather index insurance purchasers contributed 3.278 fewer tokens than non-purchasers. The coefficient for the purchase of weather index insurance for the IV-LPM is -0.204, meaning that being a purchaser of index insurance decreases the probability of contributing more than 10 tokens to the public good by 20.4 percent. Hence, our regression results support the long-standing hypothesis that the introduction of formal insurance mechanisms crowd out pre-existing informal insurances and related social capital. As indicated earlier, farmers have an option to pay their premiums either by cash or by labor. Hence, we check whether purchasing weather index insurance fully in cash or in labor affects social capital differently. As shown in Table 12, we find no significant effect of the payment vehicle on social capital. Next we ask, to what extent are we confident that our results are robust, true effects and consistent with the real world behavior? To do so, we conduct a series of robustness checks.

6.2. Robustness Checks

6.2.1. Sharing in the public good game: adopters vs non-adopters WOA and non-adopters WA vs non-adopters WOA

We have collected data using the same experimental design and survey instrument from farm households without access to weather index insurance (WOA). We used this data to mimic the intention to treat effect of having access to weather index insurance on social capital. Hence, to check the robustness of our regression results in 6.1, we first compare the contribution to the public good between households who have purchased weather index insurance and those without access to weather index insurance. Second, we compare the contribution to the public good between households with access to weather index insurance (WA) but who have not purchased weather index insurance with households without access. If our results in 6.1 are driven by the introduction of weather index insurance, we expect that those who have purchased weather index insurance to contribute fewer number of tokens to the public good than those without access. In other words, we expect that there should not be any significant difference in the contribution to the public good between households with access but who have not purchased index insurance and households without access.

To probe the robustness of our results, we run a series of specifications starting from the parsimonious specification with the dependent variable and belief about others' contribution to the public good as only regressors to the full specification where household covariates are included in the model. The regression results in columns (1) and (2) of Table 2 show that index insurance adopters are less likely to make a higher contribution (more than 10 tokens) to the public good than households without access. In other words, being purchaser of index insurance decreases the probability of contributing more than 10 tokens to the public good by 31.6 percent as compared to households without access. Likewise, the regression results in column (6) of Table 2 shows that, on average, index insurance purchasers contribute about 1 token less than households without access. On the other hand, columns (3) and (4) of Table 2 show that there is no significant difference between households with access but who have not purchased index insurance and households without access in making higher contributions to the public good. Similarly, we find no significant difference in the number of tokens contributed to the public good between non-adopters with access and households without access as shown in columns (7) and (8) of Table 2. These results reinforce our previous findings that the introduction of weather index insurance crowds out social capital.

Table 2: Sharing in the Public Good Game: Adopters vs Non-adopters WOA and Non-adopters WA vs Non-adopters WOA

Dependent variable	Cooperation				Tokens shared			
	Probit(1)	Probit(2)	Probit(3)	Probit(4)	OLS(1)	OLS(2)	OLS(3)	OLS(4)
Adopters	−0.226***	−0.316***			−2.385***	−1.128***		
	(0.0105)	(0.0559)			(0.0412)	(0.280)		
Non adopters WA			−0.0387	−0.0752			−0.0392	0.321
			(0.0277)	(0.0510)			(0.0944)	(0.372)
Belief about others' contribution	0.0386***	0.0412***	0.0437***	0.0476***	0.466***	0.497***	0.486***	0.523***
	(0.0058)	(0.0061)	(0.0054)	(0.0072)	(0.0683)	(0.0776)	(0.0581)	(0.0757)
Age		0.0137		0.0373		0.0599		0.330
		(0.0211)		(0.0265)		(0.291)		(0.284)
Age square		−0.00008		−0.0004		0.0004		−0.0030
		(0.0003)		(0.0003)		(0.003)		(0.003)
Male		0.0234		0.0687		−0.456		0.0283
		(0.0913)		(0.0776)		(0.964)		(0.831)
Household size		−0.0282		−0.0522***		−0.0983		−0.495
		(0.0175)		(0.0181)		(0.333)		(0.291)
Education		0.0718		0.0138		1.395		0.759
		(0.0842)		(0.0965)		(1.169)		(1.001)
Livestock		0.004		0.0006		−0.114		0.0156
		(0.0092)		(0.0083)		(0.100)		(0.0601)
Land size		−0.0125**		−0.0164***		−0.0383		−0.112***
		(0.0061)		(0.0046)		(0.133)		(0.0282)
Corrugated iron sheet roof		0.0731*		0.108**		1.448		1.224
		(0.0387)		(0.0438)		(0.942)		(0.856)
Iddir participation		0.148**		0.173**		0.794		2.192*
		(0.0752)		(0.0761)		(0.886)		(0.974)
Eqqub participation		0.0298		0.0546		0.845		0.856
		(0.0835)		(0.0620)		(1.108)		(0.595)
Constant					6.298***	0.166	5.572***	−3.864
					(0.627)	(7.096)	(0.714)	(6.804)
Tabia fixed effects	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Observations	264	263	264	263	264	263	264	263

Robust standard errors, clustered by Tabia: marginal effects after Probit in columns (1)-(4)
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: The dependent variable in columns (1 - 4) is a dummy variable that takes value of 1 if household i has contributed more than 10 tokens to the public good, 0 otherwise. Whereas, the dependent variable in columns (5 - 8) is the number of tokens shared in the public good game.

6.2.2. Weather index insurance and real world behavior

We now proceed to the second robustness check using some real world social capital variables which are also relevant to mimic the behavior in the public good experiment. To check the robustness of our results, we use an alternative measure of social capital such as making private transfers to fellow villagers and financial contributions to community projects in the past twelve months. Analogous to 6.1, we examine if there is any systematic difference in investments on social capital between weather index insurance purchasers and non-purchasers. Table 9 in the appendix shows that index insurance purchasers are less likely to make private transfers and finance community projects than non-purchasers. The proportion of households who made private transfers to fellow villagers and finance community projects among those who have purchased weather index insurance is 34% and 74% (standard errors, 0.044 and 0.040) while that of those who have not purchased weather index insurance is 45% and 90% (standard errors, 0.046 and 0.030) respectively.

More formally, our Probit regression results in column (1) of Table 3 shows that weather index insurance purchasers are less likely to make private transfers to fellow villagers than non-purchasers. In a similar vein, column (3) of Table 3 also shows that households who purchase weather index insurance are less likely to finance community projects than non-purchasers. However, as has already been indicated, adoption of weather index insurance may be endogenous. To attenuate the potential endogeneity concern, we employ an instrumental variable (IV) approach. Again, we use living in the same *Kushet* with the insurance foreman as an instrument for weather index insurance purchase. As shown in column (2) of Table 3, though making private transfers to fellow villagers has the expected negative sign it does not enter significantly in the IV-LPM model. On the other hand, column (4) of Table 3 shows that weather index insurance purchasers make significantly fewer financial contributions to community projects. That is, households who did not purchase weather index insurance are more likely to finance community projects than purchasers. To be precise, on average, weather index insurance non-purchasers are 22.3% more likely to make financial contributions to community projects than purchasers. This result partially supports our regression results presented in 6.1 and 6.2.1 that the introduction of weather index insurance crowds out social capital.

Table 3: Weather index insurance and real world measures of social capital

Dependent variable	Private transfer		Made financial contribution	
	Probit	IV-LPM	Probit	IV-LPM
Weather index insurance	−0.133**	−0.185	−0.163***	−0.223*
	(0.0664)	(0.163)	(0.0460)	(0.129)
Age	0.0149	0.0154	−0.0197	−0.0138
	(0.0197)	(0.0185)	(0.0161)	(0.0150)
Age square	−0.0001	−0.0001	0.0003	0.0002
	(0.0002)	(0.0002)	(0.0002)	(0.0002)
Male	−0.0512	−0.0499	0.0838	0.0790
	(0.0891)	(0.0818)	(0.0744)	(0.0718)
Household size	−0.0089	−0.0103	0.0331**	0.0282*
	(0.0199)	(0.0189)	(0.0136)	(0.0144)
Education	0.0687	0.0677	0.0374	0.0585
	(0.0726)	(0.0693)	(0.0473)	(0.0529)
Livestock	−0.0132	−0.0133	0.0122*	0.0096
	(0.0100)	(0.0090)	(0.0069)	(0.0059)
Land size	0.0145	0.0127	−0.0241**	−0.0256**
	(0.0136)	(0.0137)	(0.0095)	(0.0106)
Corrugated iron sheet roof	0.104	0.0885	−0.142**	−0.137**
	(0.0765)	(0.0787)	(0.0577)	(0.0573)
Iddir participation	0.0547	0.0760	0.0271	0.0254
	(0.176)	(0.184)	(0.146)	(0.118)
Eqqub participation	−0.0704	−0.0624	−0.0683	−0.0489
	(0.0851)	(0.0788)	(0.0575)	(0.0552)
Constant		0.0410		1.113***
		(0.431)		(0.304)
First stage *instrument*				
Insurance foreman		0.379***		0.379***
		(0.0591)		(0.0591)
First stage *F-test*		41.108		41.108
Tabia fixed effects	*Yes*	*Yes*	*Yes*	*Yes*
Observations	240	240	240	240

Robust standard errors in parentheses: :Probit marginal effects in columns (1)and (3)
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: The dependent variable in columns (1) and (2) is a dummy variable that takes value of 1 if a household has made transfers to fellow villagers,0 otherwise, and the dependent variable in columns (3) and (4) is a dummy variable that takes value of 1 if a household has made financial contributions to community projects,0 otherwise

6.3. Weather index insurance, free-riding and self-sufficiency behavior

Our regression results show that the introduction of weather index insurance crowds out social capital. Moreover, we also find that insurance purchasers are responsible for the crowding out effect. The next task will be to identify the channel(s) through which index insurance purchase crowds out social capital. In section 1 we identified three possible channels through which weather index insurance purchase may crowd out social capital. The first potential channel is the moral hazard problem in the informal risk sharing groups (Boucher and Delpierre, 2014). The second mechanism could be the free-riding problem (De Janvry et al., 2014). The third channel through which index insurance may crowd out social capital is the self-sufficiency behavior.

As shown in Table 1, the crowding out effect is due to the low contribution of insurance purchasers. Hence, we do not expect that the moral hazard problem in the informal risk sharing groups would be a causal mechanism. This is because as mentioned in section 1 if the informal risk sharing groups suffer from the moral hazard problem, insured households may adopt risky technologies and impose external costs on the informal risk sharing groups. In this case, it is the non-purchasers who should have invested less on social capital than the purchasers. Moreover, as shown in Table 11 in the appendix, we also find no significant difference in technology adoption between purchasers and non-purchasers. This implies that either the free-riding or the self-sufficiency behavior or both will be the potential channel(s) through which this crowding out effect takes place. It is hard to disentangle between these two mechanisms. Fortunately, in our survey we included questions about households' self-sufficiency behavior and their perception about free-riding in their villages. Specifically, to measure households' self-sufficiency behavior, following Di Tella et al. (2007) we ask households the question "Do you believe that it is possible to be successful on your own, or a large group that supports each other is necessary?". Likewise, to measure the free-riding problem in each village, we ask households the question "Do you think most people in this village would try to take advantage of you if they got a chance, or would they try to be fair?".

The result in Table 10 in the appendix shows that weather index insurance purchasers are more likely to respond that "it is possible to be successful on your own" and "village people would take advantage of you if they got a chance" than non-purchasers. The proportion of households answering the options "it is possible to be successful on your own" and "village people would take advantage of you if they got a chance" among those who have purchased weather index insurance is 0.483 and 0.342 (standard errors, 0.0458 and 0.044) respectively while that of those who have not purchased weather index insurance is 0.325 and 0.25 (standard errors, 0.0429 and 0.040) respectively.

Similarly, our regression results in columns (1) and (3) of Table 4 show a statistically significant correlation between weather index insurance purchase and perception about villagers free-riding and self-sufficiency behavior. However, as discussed earlier, index insurance purchase may be endogenous and the Probit estimator may provide inconsistent estimates. To address the potential endogeneity concern, we employ linear probability model with an instrumental variable. We use living in the same *Kushet* with the insurance foreman as an instrument. Column (2) shows that weather index insurance purchasers are more likely to perceive that fellow villagers would free-ride on them if they got a chance. In a similar vein, column (4) shows that insurance purchasers are more likely to believe that they can be successful without the support of a large group. This implies that weather index insurance crowds out social capital via both the development of self-sufficiency behavior and the free-riding problem created by the positive externality of index insurance purchase (consistent with De Janvry et al. (2014)).

Our regression results in Table 4 show that self-sufficiency behavior and perception about fellow villagers' free-riding behavior are correlated to a range of household covariates. Obviously, literate households are more likely to believe that they can be successful on their own than the illiterate ones. Similarly, wealthy households such as those with large land size and own houses with corrugated iron sheet roof are less likely to believe that a large group is necessary to be successful. Moreover, households with large land size and own houses with corrugated iron sheet roof are also more likely to perceive that fellow villagers' would try to take advantage of them if they got a chance. By contrast, wealthy households with large number of livestock are more likely to believe that they need a large group to be successful. This may be because of the fact that rearing livestock requires a collective action of a community specially in developing countries where livestock roam freely in open grazing lands. Hence, for households in which their livelihood is mainly dependent on grazing livestock, to be successful they need a huge support from fellow villagers in protecting their communal grazing lands to effectively feed their livestock. Households with large number of livestock are also more likely to perceive that their fellow villagers do not free-ride on them.

Table 4: Weather index insurance, free-riding and self-sufficiency behavior

	Fairness		Self-sufficiency	
	Probit	IV-LPM	Probit	IV-LPM
Weather index insurance	−0.119**	−0.351**	0.196***	0.316**
	(0.0607)	(0.154)	(0.0664)	(0.157)
Age	−0.0204	−0.0108	0.0190	0.0142
	(0.0194)	(0.0200)	(0.0226)	(0.0206)
Age square	0.0002	0.0002	−0.0003	−0.0002
	(0.0002)	(0.0002)	(0.0003)	(0.0002)
Male	−0.0013	−0.0168	0.0397	0.0442
	(0.0795)	(0.0831)	(0.0929)	(0.0837)
Household size	0.0281	0.0154	0.0071	0.0128
	(0.0188)	(0.0184)	(0.0217)	(0.0187)
Education	−0.0967	−0.0571	0.169**	0.137*
	(0.0688)	(0.0699)	(0.0753)	(0.0713)
Livestock	0.0224**	0.0171**	−0.0367***	−0.0289***
	(0.0091)	(0.0078)	(0.0109)	(0.0081)
Land size	−0.0367***	−0.0378***	0.0254*	0.0252*
	(0.0126)	(0.0121)	(0.0139)	(0.0131)
Corrugated iron sheet roof	−0.196***	−0.206***	0.194***	0.189***
	(0.0699)	(0.0673)	(0.0739)	(0.0691)
Iddir participation	0.0702	0.111	−0.0975	−0.133
	(0.171)	(0.192)	(0.221)	(0.197)
Eqqub participation	0.0185	0.0359	0.0031	−0.0129
	(0.0780)	(0.0715)	(0.0878)	(0.0763)
Constant		1.202***		0.0584
		(0.438)		(0.467)
Tabia fixed effects	*Yes*	*Yes*	*Yes*	*Yes*
Observations	240	240	240	240
R^2		0.0436		0.1620
PseudoR^2	0.1022		0.1501	
First stage instrument				
Insurance foreman		0.379***		0.379***
		(0.0591)		(0.0591)
First stage F-test		41.108		41.108

Robust standard errors in parentheses:Probit marginal effects in columns (1) and (3).
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: The dependent variable in columns (1) and (2) is a dummy variable that takes value of 1 if the respondent believes that most people in his/her village would try to be fair, 0 otherwise, and the dependent variable in columns (3) and (4) is a dummy variable that takes value of 1 if the respondent believes that he/she can be successful on his/her own, 0 otherwise

7. Conclusion and Policy Implications

In developing countries, welfare of poor farmers has been constantly threatened by weather risks. Weather risks remained uninsured because most households lack access to the traditional crop insurance as it is fraught with adverse selection, moral hazard as well as high transaction costs. In the absence of formal insurance markets, households use alternative informal risk management strategies to overcome a wide variety of risks. However, informal mechanisms are best suited to overcome idiosyncratic risks but not covariate risks such as drought occurring at a village level. The recent weather index insurance aims to fill this gap in developing countries.

There is a long-standing hypothesis which suggests, however, that the introduction of formal insurance may crowd out pre-existing informal insurance mechanisms. However, less is known on the effect of the recent weather index insurance, which indemnifies covariate risks, on social capital. This paper, thus, aims to provide empirical evidence on whether the introduction of index insurance crowds in or crowds out social capital. To do so, we use a unique data set from lab-in-the-field experiment from northern Ethiopia where weather index insurance has been commercially traded for several years to smallholder farmers. In this study, we use contributions in the public good game as a measure of social capital.

Our empirical results support the crowding out hypothesis. We find that weather index insurance purchase is negatively and significantly related with the number of tokens contributed to the public good. The development of self-sufficiency behavior and the free-riding problem are found to be the causal mechanisms behind the crowding out phenomenon. As index insurance and social capital indemnify different types of risks, covariate and idiosyncratic risks respectively, the crowding out effect may deteriorate welfare. Our results, thus, suggest that formal index insurances do not occur in a vacuum and may crowd out social capital. Thus, policy makers should be aware of such unintended effects and use novel insurance product design and marketing strategies to avoid such effects. For example, as suggested by Boucher and Delpierre (2014) and De Janvry et al. (2014) offering index insurance to groups instead of individuals could be one possible solution which may increase demand for weather index insurance and may also crowd in social capital.

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Appendix

Table 5: Summary statistics

Variable	Mean	Std. Dev.	Min.	Max.	N
Outcome indicators					
Tokens shared	8.904	6.575	0	20	384
Cooperation	0.328	0.47	0	1	384
Belief					
Belief about others' contribution	10.719	5.375	1	20	384
Demographic Characteristics					
Age	40.755	11.254	19	75	383
Age square	1787.261	1003.748	361	5625	383
Male	0.76	0.428	0	1	383
Household size	5.24	2.052	1	13	383
Marital status	0.820	0.385	0	1	383
Illiterate	0.598	0.491	0	1	383
Can read and write	0.133	0.34	0	1	383
Primary school	0.219	0.414	0	1	383
Secondary school	0.05	0.217	0	1	383
Wealth					
Livestock (TLU)	4.268	4.104	0	20	383
Land size (Tsimad)	4.745	3.471	0	18.5	383
Corrugated iron sheet roof	0.452	0.498	0	1	383
Own radio	0.198	0.399	0	1	383
Own phone	0.752	0.432	0	1	383
Membership in associations					
Iddir participation	0.950	0.217	0	1	383
Eqqub participation	0.418	0.494	0	1	383

Table 6: Descriptive statistics by access to weather index insurance

	No-access	Access	Diff	P-value
Outcome indicators				
Tokens shared	9.2361	8.7042	0.5319	0.4435
Cooperation	0.3194	0.3333	-0.0139	0.7797
Belief				
Belief about others' contribution	10.8056	10.6667	0.1389	0.8067
Demographic Characteristics				
Age	41.091	40.554	0.5367	0.6522
Age square	1840.03	1755.82	84.2071	0.4278
Male	0.7203	0.7833	-0.0631	0.1632
Household size	5.0559	5.3500	-0.2941	0.1752
Marital status	0.7762	0.8458	-0.0696	0.0869
Illiterate	0.5804	0.6083	-0.0279	0.5911
Can read and write	0.1678	0.1125	0.0553	0.1238
Primary school	0.2028	0.2292	-0.0264	0.5476
Secondary school	0.0490	0.0500	-0.0010	0.9636
Wealth				
Livestock	3.0254	5.0078	-1.9824	0.0000
Land size	4.5545	4.8592	-0.3046	0.4068
Corrugated iron sheet roof	0.5035	0.4208	0.0827	0.1165
Own radio	0.2098	0.1917	0.0181	0.6681
Own phone	0.7483	0.7542	-0.0059	0.8972
Membership in associations				
Iddir participation	0.9301	0.9625	-0.0324	0.1582
Eqqub participation	0.3566	0.4542	-0.0975	0.0615
Observations	383			

Table 7: Descriptive statistics by insurance status

	Non-purchasers	Purchasers	Diff	P-value
Outcome indicators				
Tokens shared	9.4333	7.9750	1.4583	0.0805
Cooperation	0.3667	0.3000	0.0667	0.2752
Belief				
Belief about others' contribution	10.1500	11.1833	-1.0333	0.1527
Demographic Characteristics				
Age	39.575	41.533	-1.9583	0.1515
Age square	1673.808	1837.833	-164.0250	0.1761
Male	0.8250	0.7417	0.0833	0.1181
Household size	5.5750	5.1250	0.4500	0.0824
Marital status	0.8667	0.8250	0.0417	0.3735
Illiterate	0.6250	0.5917	0.0333	0.5986
Can read and write	0.1167	0.1083	0.0083	0.8390
Primary school	0.2167	0.2417	-0.0250	0.6466
Secondary school	0.0417	0.0583	-0.0167	0.5555
Wealth				
Livestock	5.7519	4.2638	1.4881	0.0081
Land size	5.3092	4.4092	0.9000	0.0343
Corrugated iron sheet roof	0.5000	0.3417	0.1583	0.0129
Own radio	0.1917	0.1917	0.0000	1.0000
Own phone	0.7750	0.7333	0.0417	0.4556
Membership in associations				
Iddir participation	0.9500	0.9750	-0.0250	0.3101
Eqqub participation	0.4667	0.4417	0.0250	0.6988
Observations	240			

Table 8: Insurance foreman, weather index insurance purchase and first stage - IV

	OLS (1)	OLS (2)	First stage - IV	OLS (3)
Weather Index Insurance				-2.285***
				(0.751)
Insurance foreman	0.378***	0.379***	0.374***	-0.372
	(0.0329)	(0.0322)	(0.0301)	(0.657)
Belief about others' contribution			0.00508	0.432***
			(0.00802)	(0.0708)
Age			0.0278*	0.0707
			(0.0152)	(0.218)
Age square			-0.000220	-0.000230
			(0.000166)	(0.00242)
Male			-0.116*	-2.358*
			(0.0598)	(1.178)
Household size			-0.0314**	0.0917
			(0.0142)	(0.193)
Education			0.0834	0.333
			(0.0597)	(0.696)
Livestock			-0.00553	-0.0816
			(0.00834)	(0.105)
Land size			-0.0196*	-0.149
			(0.0109)	(0.117)
Corrugated iron sheet roof			-0.131**	-0.301
			(0.0626)	(0.570)
Iddir participation			0.316**	-0.536
			(0.146)	(1.629)
Eqqub participation			0.0573	1.500
			(0.0447)	(1.000)
Constant	0.294***	0.295	-0.405	6.500
	(0.0974)	(0.235)	(0.365)	(4.971)
Tabia fixed effects	No	Yes	Yes	Yes
Observations	240	240	240	240
R^2	0.1418	0.1420	0.2438	0.3388

Robust standard errors, clustered by session
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: The dependent variable in columns (1), (2), and (3) is weather index insurance purchase and the dependent variable in column (4) is the number of tokens shared in the public good game.

Table 9: Weather index insurance and real world measures of social capital

	Made private transfer		Made financial contribution	
	Purchasers	Non-purchasers	Purchasers	Non-purchasers
Made private transfers to someone in the village (1=Yes)	34.2%	45%		
	(0.044)	(0.046)		
Made financial contribution to community projects (1=Yes)			74.2%	90%
			(0.040)	(0.030)

Standard errors in parentheses

Table 10: Weather index insurance, free-riding and self-sufficiency behavior

	Free-riding problem		Success - alone	
	Purchasers	Non-purchasers	Purchasers	Non-purchasers
Village people would try to take advantage of you(1=Yes)	34.2%	25%		
	(0.044)	(0.040)		
It is possible to be successful on your own(1=Yes)			48.3%	32.5%
			(0.0458)	(0.0429)

Standard errors in parentheses

Table 11: Effect of weather index insurance on technology adoption

	(IV-LPM) Improved seed	(IV-LPM) Pesticide	(IV-LPM) Fertilizer	(IV-LPM) Manure
Weather Index Insurance	0.148	0.0216	0.0223	-0.352***
	(0.137)	(0.149)	(0.142)	(0.131)
Distance to farmer training center	-0.00210*	-0.000645	0.000437	0.00103
	(0.00113)	(0.00107)	(0.00117)	(0.00111)
irrigation	0.317***	0.131	0.340***	0.127
	(0.109)	(0.0970)	(0.0888)	(0.0876)
Belong to 5 to 1 farmers network	0.0586	0.0693	0.0801	0.0235
	(0.0688)	(0.0821)	(0.0839)	(0.0772)
Age	0.0118	0.00609	0.0223	0.0227*
	(0.0142)	(0.0203)	(0.0148)	(0.0127)
Age square	-0.000125	-0.0000360	-0.000246	-0.000242*
	(0.000148)	(0.000225)	(0.000156)	(0.000134)
Male	0.0274	0.112	0.0109	-0.0535
	(0.0633)	(0.0692)	(0.0710)	(0.0646)
Household size	-0.0171	0.0107	0.0110	-0.00662
	(0.0167)	(0.0172)	(0.0177)	(0.0143)
Education	0.00739	0.157***	0.0798	0.00331
	(0.0595)	(0.0602)	(0.0573)	(0.0501)
Livestock	0.00608	-0.0123	-0.00818	-0.00526
	(0.00773)	(0.00827)	(0.00812)	(0.00730)
Land size	0.0119	0.0330***	0.00818	0.0102
	(0.0109)	(0.0125)	(0.0103)	(0.0115)
Corrugated iron sheet roof	0.0390	0.0135	0.104*	0.0631
	(0.0649)	(0.0658)	(0.0611)	(0.0612)
Iddir participation	0.0576	0.0483	0.0990	0.130
	(0.106)	(0.124)	(0.122)	(0.125)
Eqqub participation	0.0818	0.0491	0.0943	0.0360
	(0.0621)	(0.0642)	(0.0664)	(0.0608)
Constant	-0.133	-0.366	-0.612*	-0.401
	(0.317)	(0.418)	(0.334)	(0.306)
Observations	240	240	240	240
R^2	0.1198	0.2836	0.2731	0.1028

Robust standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 12: Effect of purchasing WII in labor and in cash on sharing in the Public Good Game

	Probit	Tobit	OLS
Buy WII in labor	0.0435	-2.043	-1.407
	(0.351)	(1.758)	(1.561)
Belief about others' contribution	0.133***	0.494***	0.432***
	(0.0316)	(0.151)	(0.140)
Age	0.0232	-0.298	-0.291
	(0.0822)	(0.383)	(0.340)
Age square	-0.000113	0.00415	0.00401
	(0.000883)	(0.00413)	(0.00366)
Male	-0.454	-3.331*	-2.922*
	(0.424)	(1.899)	(1.716)
Household size	0.0172	0.592	0.529
	(0.0832)	(0.406)	(0.360)
Education	0.133	0.338	0.255
	(0.343)	(1.364)	(1.267)
Livestock	0.0185	-0.205	-0.177
	(0.0467)	(0.209)	(0.195)
Land size	-0.0878	-0.132	-0.114
	(0.0749)	(0.274)	(0.260)
Corrugated iron sheet roof	0.0465	0.0318	0.113
	(0.354)	(1.579)	(1.466)
Iddir participation	-0.289	-1.593	-2.025
	(0.526)	(2.183)	(2.521)
Eqqub participation	0.206	2.102	1.901
	(0.421)	(1.622)	(1.566)
Constant	-2.477	11.73	11.96
	(1.872)	(8.639)	(7.880)
Observations	120	120	120
PseudoR^2	0.3350	0.0439	

Robust standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

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