The index insurance take-up puzzle: new experimental and quasi-experimental evidence from Burkina Faso

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Abstract

Index insurance is a promising avenue for addressing risk and improving household long-term well-being in developing countries. But demand for index insurance products has often found to be disappointingly low, and for that reason most pilot projects are not scaled up. This article studies an index insurance product which generated high demand and sales in the first year, and was scaled up nationally subsequently: the area-yield insurance product sold (on credit) to cotton farmers in Burkina Faso. We exploit experimental and quasi-experimental variations to measure the effect of three important factors on insurance demand: price, information, and quality. Our results suggest that price has a critical effect on demand, while information also plays an important role. For quality, only the design elements that are obvious to farmers are found to matter. Measures associated with insurance triggers are not associated with demand, either in the pilot phrase or in the scale-up program. We discuss these econometric results in the light of qualitative data that we collected. Altogether, these findings suggest that relatively high quality index insurance products can be attractive for small-scale farmers, but that price for value (along with other "behavioral" factors) remains a major barrier to adoption.

Keywords: index insurance; demand; Burkina Faso; RCT; mixed-methods.

JEL codes: D91, G22, I38, O12, O13, O22, O33, Q12

1 Introduction

The low demand for insurance products in the developing world is a puzzle for policy makers and researchers alike. There is now a wide recognition that existing risk and realized shocks are among the main factors that generate poverty traps by causing long-lasting effects on physical and human capital on the one hand, and by preventing households to realize risky but profitable investments on the other hand (Carter & Barrett, 2006). While insurance in general is a natural response to risk, demand for index insurance products in particular has been generally very low, as revealed by the academic literature as well as practitioners (Jensen & Barrett, 2017).

Behavioral and cultural factors have been identified by earlier studies to attempt to solve these puzzling evidence, as knowledge, education and trust may be barriers to demand for complex financial products. In addition, recent studies have sought alternative explanations that are more related to the core economic properties of index insurance products. Indeed, Clarke (2016) has showed that the uncertain nature of index insurance payments, that depend on an external index rather than on actual losses, makes it unattractive for the most risk-averse households. Consequently, the quality of the index in terms of correlation with actual losses may be an important driver of index insurance value and, thus, of demand (Jensen et al., 2018). The right timing of premium and payout payments is also likely to affect farmers' well-being and the desirability of the insurance product (Jensen et al., 2019; Casaburi & Willis, 2018). Overall, it is important to consider the actual value that index insurance provides to poor farmers (or other clients), including the quality of the protection that they receive, and the price of the insurance premium that they have to pay (Barré & Stoeffler, 2018).

Focusing in particular on the value of the product, this article presents new empirical evidence related to the demand for index insurance by identifying the determinants of the purchase of an area-yield insurance for cotton farmers in Burkina Faso. The setting is well-suited to study index insurance demand for a number of reasons. Area-yield products are often described as "the best you can do" in terms of index insurance, since actual yields of an area (or a group) are taken into consideration as the index instead of a proxy (such as rainfall levels) (Elabed et al., 2013; Flatnes et al., 2018). Second, cotton production is a highly profitable commercial cash crop cultivated on credit (via contract farming) but a risky investment for poor farmers compared to traditional food crops such as sorghum (Stoeffler et al., 2019; Stoeffler, 2016). As such, the potential gains from purchasing an index insurance product are important in terms of stimulating agricultural investments and improving farmers' well-being. Finally, demand during the pilot phase of the project was high, which allows us to study "what works" to stimulate demand- rather than focusing on marginal improvements in the demand for an overall unattractive product.

Moreover, our research design allows us to exploit experimental and quasi-experimental features to identify causal factors associated with insurance demand. First, subsidies were randomly distributed to farmer groups to measure how price affects the demand for index insurance products. Second, prior to insurance sales, some farmer groups were randomly selected to play insurance games- to improve their understanding of and stimulate their interests in the product- whose effect on demand can be estimated. Third, we exploit a quasi-experimental variation in the quality of the contract offered to farmers. Indeed, insurance contracts are designed for a finite number of categories (five in the pilot) in which farmer groups are assigned based on their yields. Thus, farmer groups are exogenous assigned better or worst contracts within a category, depending on how close their average yields are from the category threshold. In sum, these three design features allow us to study exogenous variations in price, information, and contract quality. We also measure other demographic, economic and insurance design factors that are

likely to be associated with the purchase of cotton index insurance.

Our analysis relies on three sources of data. First, we conducted a household survey among approximately 500 cotton farmers in 40 farmer groups to whom an area-yield insurance was offered in 2014 during the pilot phase of the program.[1] Second, we conducted extensive qualitative fieldwork in 2016 to understand better demand and impact mechanisms in the pilot research area. Third, we extend our analysis to the administrative, 2018 sales data that we obtained from the scaled-up program, during which the price and game incentives were not provided, but the quasi-experimental variation in contract quality is still present.

Thus, our study contributes to the literature on index insurance, and more generally on technology adoption and poverty traps, in two main areas. First, it is one of the first empirical studies that measures empirically how the value of the product for farmers affect their purchase- which is an emerging avenue for explaining theoretically the index insurance low demand puzzle, besides "behavioral" explanations (Barré & Stoeffler, 2018; Clarke, 2016). Specifically, it is the first study to capture both price and quality factors for understanding index insurance demand in addition to a "behavioral" and information intervention. Second, the study combines an analysis of the pilot phase with further investigations at the scaled-up phase in order to check how the results from a small-scale project (based on the analysis of a household survey) generalize when the program is taken to scale.

Results suggest that price plays a major role in explaining index insurance demand. While the behavioral intervention also seems to play a role, this result is not as robust. On the other hand, elements of insurance quality do only appear to matter when these are obvious to farmers. In particular, the distance of historical yields of the farmer group to the insurance trigger does not seem to impact demand. The results confirm that price is a major barrier to the value and purchase of index insurance products, but suggest that lower-cost, high quality index insurance is highly attractive to small-scale farmers.

The following section starts by reviewing the various pieces of the low index insurance take-up puzzle. Section 3 describes the insurance product and project. Section 4 presents the data and the estimation strategy. Results are showed and discussed in section 5, while the last section concludes and draws policy implications.

2 The low index insurance take-up puzzle

Cotton production is highly dependent on weather conditions which makes climatic shocks like drought or flood as major threats to the well-being of cotton farmers. For coping with these types of threats, farmers might look for informal risk sharing mechanisms from their social network. However, these mechanisms usually exclude the poorest who need insurance the most because of social exclusion (Santos & Barrett, 2011). Thus, formal insurance is needed along with informal risk sharing mechanisms. Wide range of literature focus on the fear that formal insurance might crowd out informal insurance. Even though theoretical evidence supports this fear (Lin et al., 2014), empirical results show that formal insurance doesn't make insured people contribute less on social capital. [2] Also, public safety net providing transfers doesn't crowd out informal insurance (Dercon, 2002).

[1] Data was collected among 1015 households at baseline (2014) and follow-up (2015) for the impact evaluation of the pilot project. We focus on the study of the treatment group at baseline to study factors affecting take-up.

[2] Cecchi, F., Duchoslav, J., Bulte, E. (2016). Formal insurance and the dynamics of social capital: Experimental evidence from Uganda. Journal of African Economies, 25(3), 418-438.

Traditional formal insurance is underdeveloped because of asymmetric information that is causing moral hazard and adverse selection. Besides these problems, formal insurance requires monitoring and verifying the losses of insurees, resulting in high costs (Takahashi et al., 2016). An external index reduces high costs that arise from monitoring and verifying (Stoeffler et al., 2019), along with moral hazard and adverse selection problems (Miranda & Farrin, 2012). Lowered cost helps to reach the people who need insurance most (Jensen & Barrett, 2017). Also, it is demonstrated that index insurance is more responsive than food aid programs for drought shocks.[3] In our study, we used area-yield index based insurance that is correlated with actual yields instead of a proxy such as rainfall. Because of this, area-yield based index based insurance is considered as one of the highest quality index insurance products (Flatnes et al., 2018).

Index insurance helps farmers by reducing income variability and utility cost. Also since risk rationing is alleviated, farmers invest more in profitable activities other than insured one (Elabed et al., 2013). Similarly, recent index insurance product proposed to cotton farmers in Burkina Faso showed that insured farmers invested more on livestock and sesame cropping (Stoeffler et al., 2019). Also in Kenya, IBLI (Index Based Livestock Insurance) increased investments in productivity and revenue, along with reducing hardships that arise from droughts during sales period (Jensen et al., 2017).

Even though index-insurance is an effective tool for poverty reduction, the take-up rate is lower than expected (Cole et al., 2013; Goodrich et al., 2020). Moreover, demand for IBLI is also decreasing (Takahashi et al., 2016). Several studies have tried to explain the reasons behind the lower take-up rate. There might be factors that are related to value of the insurance such as price, basis risk or quality; or behavioral factors that consists of timing of sales and experience with insurance.

According to Barré & Stoeffler (2018), index insurance products fail to provide adequate protection for the given price. Thus, lack of value for the price is one of the reasons that makes farmers abstain from purchasing index insurance. Carter et al. (2017) in their review study also claim that demand is lower than expected without high and continuous subsidies because of high price. In addition, Barré & Stoeffler (2018) used subsidies in a study conducted in Burkina Faso in order to test price effect on demand and found significant rise on purchase rates. Elabed & Carter (2014) used same subsidy levels for Malian farmers and found similar results with Barré & Stoeffler (2018). In the first year of the program after introducing subsidies, 16 out of the 58 treatment groups (30%) agreed to purchase the index insurance contract, suggesting that designing index insurance contracts with minimal basis risk that helps value to compensate the price is important for take-up rate. In addition, Takahashi et al. (2019) show that one time subsidies doesn't affect take-up rate for IBLI in the following year. In our study, we used similar design that we randomize subsidies to measure the effect of price in our context.

Other part of the reason of price effect on demand is the low protection level that is causing risk for not covering losses. The main risk that farmers face while purchasing index insurance is called the basis risk. Basis risk is the imperfect correlation between the index and losses experienced by the policy holder (Barnett & Mahul, 2007). It is either the possibility of no indemnity payment when policyholder experiences a loss, or the possibility of receiving indemnity payment when there is no loss. Even at fair premium rates, a risk averse individual may refrain purchasing index insurance because of basis risk (Jensen et al., 2016). Similarly, a research survey demonstrated that respondents compromise about a 30% reduction in the premium in order to compensate for only a 1% probability of not getting a payment in case of a loss (Wakker et al., 1997).

In a study observing coffee farmers by McIntosh et al. (2015), it is found that risk can reduced

[3]Chantarat, S., Barrett, C. B., Mude, A. G., Turvey, C. G. (2007). Using weather index insurance to improve drought response for famine prevention. American Journal of Agricultural Economics, 89(5), 1262-1268.

by distributing the insurance payout across farmers with respect to their losses on an indemnity basis. Because there is a trade-off between basis risk and moral hazard; reducing the scale of the index to bring it closer to the farmer reduces basis risk, but increases moral hazard (Elabed et al., 2014). Another moral hazard problem might arise from coordination of farmers of same group to reduce their yields and receive indemnity payment that they don't deserve, where index is determined through the group's yield records. In order to prevent this and reduce moral hazard, double trigger design can be used (Barré & Stoeffler, 2018) (See "Project Description" section). However, having one index for different households creates disincentive for the demand because of differences in production structures (Stoeffler et al., 2019). Thus, reducing the risk is not an easy task, nevertheless, it might be reduced by some degree with a high quality insurance.

Quality of insurance increases as it reduces the risk that farmers face (Carter et al., 2015). In other words, quality of insurance can be found by observing the correlation between insurance payments and actual losses (measured as deviations from expected yields obtained by farmers) (Barré & Stoeffler, 2018). Carter et al. (2015) state that minimizing basis risk is vital where farmers' behavior deviate from expected utility theory. In this study we used the distance between smallest payout threshold and average group yield as quality measure.

Another important risk factor of index insurance for farmers is the timing. In their field experiment in West Africa, Serfilippi et al. (2015) show that since insurance payouts are stochastic but payment of a premium is not, the demand for index insurance is reduced by preference for certainty. They also show the observation of comments from most of the farmers as: "you mean I have to pay the premium even when there is a drought". Similarly, Casaburi & Willis (2018) report that removing liquidity constraints by postponing payment of insurance premiums until harvest time increased take-up rate from 5% to 72%. In addition, according to Hamp et al. (2011), microfinance's success can be accounted for having flexible repayments. These results reveal the importance of removing liquidity constraints on demand. In our study unlike traditional implementations, we proposed credit based index insurance. Sofitex (the parastatal company) provided input on credit to farmer groups (GPCs).

For stressing liquidity constraints on demand, Burkinabe farmers were offered to play games that consist of identical contracts framed in a different way where only one allows for uncertain premium (Serfilippi et al., 2015). With these games, players had chance to see the difference between having certain and uncertain premium. Therefore had better understanding about index insurance. In our research, we aimed to investigate effect of playing these games on index insurance demand. It is shown that the potential clients of index insurance are uneducated and have little understanding of financial tools so that complicated contracts like index insurance is not appealing to them (Jensen & Barrett, 2017). In order to increase farmers' education on index insurance and overcome learning difficulties in financial education, games that simulate potential gains from insurance can be used (Lybbert et al., 2010). A randomized game experiment by Jensen et al. (2018) in Kenya show that participation in the game had strongly positive and significant impact on performance on the IBLI knowledge test, increasing scores by 23%. They also tested the game participation effect on perception on basis risk. Results show that increase of IBLI knowledge coming from participation in the randomized educational game increased sensitivity to basis risk significantly. Meaning that as farmers become more aware of the product, they respond more strongly to product quality (Jensen et al., 2018).

3 Project and product description

Cotton sector in Burkina Faso is governed by a local monopoly company, named Sofitex. Sofitex provides input for production (cotton plants, fertilizer etc.) on credit to farmer groups that are called Groupes de Producteurs de Coton (GPC). After farmers cultivate cotton, Sofitex weights the yields of individual farmers and the information of weighted cotton yield are gathered in a data for each farmer since 2001, consisting of 704 farmer groups. Index insurance was designed based on this data. The production of each farmer is bought from Sofitex each year and used as credit reimbursement for the input that Sofitex provides. Credit reimbursement has joint liability. Therefore, if one farmer fails to provide enough cotton for reimbursement, other farmers in the group should pay his/her debt. This feature is added in our analysis with the variable "Declared in default by other members in present year". Index insurance is being sold by Planet Guarantee in collaboration with the cotton producer union (UNPCB) and Sofitex since 2014.

Index insurance was sold to GPCs before the agricultural season. Like Elabed et al. (2013) used in their research, the insurance has double-trigger mechanism for reimbursement. The first trigger works at group level, total group yield should be less than a certain threshold. Second trigger is at neighborhood level, neighboring groups also have to be below the threshold. Neighborhood is created from maps: each group is related to at least 2 groups in the same village. If there are not enough GPCs in the village, then GPCs from neighboring villages are linked. If both of two conditions for first and second trigger are met, GPC will receive insurance payout. The reason of obligating second trigger is to eliminate possible moral hazard problems that can arise from the GPC having low yields intentionally, in order to receive payment. Although neighborhood threshold is higher than the GPC threshold, this increases the basis risk as the number of different villages increase. Because having different villages as neighbors arise geographical differences, that directly affects cotton production. We use this feature in our analysis by including number of different villages in neighboring groups variable in regressions.

GPCs are grouped in five categories, depending on their yield data average between 2001 and 2014. Each category was offered a different contract with different trigger levels. Farmer groups that have lower yields historically have lower trigger levels. There are three different triggers corresponding to three different payment levels; small, medium and big payment. When yields are below 20% of the yield distribution, insurance provides a “small payout” that is 11,200 FCFA per hectare insured, which is the same value of the insurance premium. When yields fall below 8% of the yield distribution, farmers receive a “medium payout” of 34,000 FCFA. Lastly, for the yields less than 4% of the distribution, the insurance provides a “big payout” of 90,000 FCFA per hectare, that is approximately the same value with the input loan.

2017 - 2018 agricultural season had lots of shocks. Thus, government and Sofitex were interested in scaling up the insurance in 2018. Consequently, the product was scaled-up in 2018, designed in the same way as previous one and offered to cotton farmers in 7 different regions of Burkina Faso. However, sales were lower than expected for the scaled-up insurance. We did not observe the sale process therefore we suspect implementation issues given the timing of sales and the logistics. There is a possibility that the agents selling the product have not visited all the groups, or all the departments.

For the index insurance that was offered in 2014, even though the price suggested by the design team was fair, adding mark-ups for the commercial partners makes commercial premium approximately three times higher than the fair price. Because of this, farmers complained about the price of the insurance. For investigating price effect on demand, subsidies were offered in the research area in 2014 to 40 GPCs.

Randomly selected each 10 of them received coupons of 75%, 50%, 25% and 0% for the insurance premium.

Other than subsidies, educational games were introduced to Burkinabe farmers by Serfilippi et al. (2015) for investigating demand of micro-insurance. The main idea behind the games is to compare players' behavior when being asked to choose between two risky lotteries. The experiment is implemented in 30 villages, including 557 cotton farmers who are selected randomly. There are three games in the experiment: In the first two games, participants' risk aversion and discontinuity for preferences are tested. In the last game researches try to obtain willingness to pay and demand for index insurance. In our research we aim to look at the effect of playing these games on demand. It is expected that playing games that are simulating index insurance would increase farmer's knowledge and awareness of the insurance and consequently increasing tendency to purchase.

The following section describes the data collected for this project.

4 Data & methods

In our research we investigated two different quantitative data sets, first one is from 2014 household level data with subsidies and games being played. Second one is group-level scaled-up insurance from 2018. In addition to these quantitative data, there is also qualitative data which shows comments of cotton farmers about their perception on the index insurance.

4.1 Research Area Sample

First data is from Hounde region of Burkina Faso, consisting 1015 households that create 80 farmer groups. Among each group, approximately 13 households were given to a survey. Survey questions were investigating information about agricultural activities; mainly cotton production, cereal production, credit and group dynamics. Also, household well-being was questioned by asking livestock, assets, food consumption, educational structure and participation to mining activities. Along with descriptive statistics of the households that are collected from this survey, subsidy and game information are also present in the data. The focus in this research is on the groups to which insurance was offered. Also, we mainly used baseline data, the answers of survey questions that are given before purchasing the insurance. Descriptive statistics is shown in the below table.

Table 1: Descriptive Statistics for Hounde Region (2014)

	(1) Insurance offered	(2) Bought insurance	(3) Refused insurance	(4) T-test p-value
Subsidy Level	0.77	0.89	0.67	-6.27***
Distance from Strike Point	240.9	238.8	242.7	0.51
Normalized distance from Strike Point	0.37	0.38	0.36	-1.28
Number of different villages in neighboring groups	2.79	2.72	2.85	1.18
Had a shock in previous year (2013)	0.23	0.22	0.24	0.51
Declared in default by other members in present year	0.13	0.18	0.088	-2.97***
Field contains GMO cotton	0.39	0.31	0.46	3.30***
Average GPC yield	937.9	915.6	956.9	3.28***
Category (1-5)	3.19	3.04	3.32	3.61***
Ethnicity of household head is Mossi	0.33	0.29	0.37	1.86*
Household size	10.4	10.6	10.3	-0.57
Age of household head	43.6	43.2	43.9	0.53
CM had some formal schooling	0.23	0.21	0.26	1.34
Tropical livestock unit (TLU)	5.86	5.23	6.39	1.64
Roof of dwelling is solid	0.51	0.53	0.50	-0.58
No toilets used	0.62	0.67	0.57	-2.54**
Farm activities in the last 7 days	0.95	0.95	0.95	-0.21
Progress out of Poverty Index	36.8	36.4	37.1	0.66
Observations	505	233	272	506

mean coefficients; *t* statistics in second column

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

From descriptive statistics it is shown that subsidy and games are associated with insurance take-up, which are investigated further with regression analysis. Household size is large with approximately 10 members on average. Distance from strike point threshold (quality measure) is also large with 240 kg/ha. It is shown that almost a quarter of all survey participants had a shock in previous year, which

is surprisingly high. Genetically modified cotton (GMO Cotton) provides less input and less time for cultivation, therefore adaptation of it is approximately 40%. For average GPC yield, our target amount is 1000 whereas it is seen that groups are slightly below from the target. Reason behind this might be possible shortage of enough input. By providing insurance we aim to increase average yields to the targeted amount. Formal schooling percentage is very low with only 23%. This situation can brought up two things in terms of games: games are not needed because participants would not understand them because of their low education level; or games are needed because they will help participants to understand how insurance works. In the table it can be seen that 95% of participants have had farm activities in last 7 days, showing that surveyed people are farmers.

4.2 Scaled-up Group Level Sample

Second quantitative data is under group level, we have information of 6884 farmer groups (GPCs) in 7 different regions of Burkina Faso. Cotton production properties are provided in the data, such as cotton yields and number of payouts received. These farmer groups were all offered of insurance so there is no randomization test in this sample. Because of the suspicion that the promotion of the product was not done properly in some departments and provinces, as robustness check we also consider only departments and provinces where sales occurred. For this reason, we implement regression analysis of these sub-samples. Summary of descriptive statistics are presented below in the following table.

Table 2: Descriptive Statistics for Scaled-Up Group Level Sample (2018)

	(1) All Groups (Provinces with Sales only)	(2) Bought Insurance	(3) Refused Insurance (Provinces with sales only)	(4) T-test p-value
Distance from the strike point	156.8	170.3	156.3	-2.43**
Normalized distance from the strike point	0.23	0.24	0.23	-1.59
Shock in 2016-17	0.22	0.18	0.23	1.49
Average GPC Yield	880.6	909.9	879.6	-2.43**
There are no different villages as neighbors	0.68	0.68	0.68	-0.24
There is one different village as neighbor	0.17	0.20	0.17	-0.88
There are two different villages as neighbors	0.092	0.076	0.092	-0.74
No missing values in previous years	0.43	0.60	0.42	-4.85***
One missing value in previous years	0.45	0.32	0.45	3.60***
Two missing values in previous years	0.054	0.049	0.054	0.30
Category 1	0.019	0	0.020	1.94*
Category 2	0.17	0.16	0.17	0.37
Category 3	0.24	0.24	0.24	0.07
Category 4	0.23	0.28	0.23	-1.79*
Category 5	0.34	0.31	0.34	0.81
Observations	5630	184	5446	5630

mean coefficients; *t* statistics in second column

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

It is shown that shocks are still largely occurred with 22% in 2018. Also, average GPC yield is still lower than expectation (1000 kg/ha) in the year 2018. Having no different villages as neighbors is majority with 68%. For 88% of all GPCs, at most 1 year is missing in the data. In terms of category, being in Category 1, that is for lowest historical yield average, has positive significant effect on purchases. Whereas Category 4 has almost same, but opposite effect on demand.

4.3 Qualitative Data

In addition to quantitative data collection in 2014 and 2018, we also conducted fieldwork research in the same study area of 2014 insurance offerings, in June 2016. The fieldwork consists of discussions between fourteen focus groups: two focus groups with farmers who were never insured, two focus groups with small producers, two focus groups with women, four focus groups with producers who received an insurance payment and two focus groups with farmers who renewed their insurance. These discussions were acquired us the perception of farmers for index insurance and how these perceptions have altered after 2014-15 sales period. Discussion topics were under three main branches: cotton insurance, production and investment behaviors, and artisanal gold mining. In addition to focus group discussions, interviews with individual farmers, farmer group leaders and Sofitex employees were also conducted. Results are presented in the section 5.3.

4.4 Econometric Specifications and Balance

In this research, our aim was to test the factors behind purchase decision for index insurance. The most important three aspects are educational games, subsidy level that is offered and quality of the insurance, which is mainly the distance of average yield of groups from the smallest strike point. We exploit an empirical strategy on these three exogenous variables. First, for robustness check of randomization, balance tests for subsidy and games are conducted and results are presented below.

Table 3: Balance Table for Subsidy and Games

	(1) No games played	(2) Games played	(3) Games T-statistic p-value	(4) Subsidy F-statistic p-value
Subsidy Level	0.70	0.84	0.00019***	-
Distance from Strike Point	241.1	240.8	0.97	0.325
Number of different villages in neighboring groups	2.81	2.76	0.69	0.093
Had a shock in previous year (2013)	0.15	0.31	0.000013***	0.746
Declared in default by other members in present year	0.13	0.13	0.96	0.520
Field contains GMO cotton	0.40	0.38	0.80	0.345
Average GPC yield	950.9	925.1	0.041*	0.864
Category (1 - 5)	3.28	3.10	0.015*	0.385
Ethnicity of household head is Mossi	0.23	0.44	0.00000037***	0.136
Household size	9.74	11.1	0.013*	0.004*
Age of household head	43.5	43.6	0.97	0.113
CM had some formal schooling	0.23	0.24	0.77	0.854
Tropical livestock unit (TLU)	5.84	5.87	0.96	0.121
Roof of dwelling is solid	0.52	0.51	0.68	0.532
No toilets used	0.66	0.58	0.066	0.520
Farm activities in the last 7 days	0.94	0.96	0.28	0.117
Progress out of Poverty Index	35.2	38.3	0.0045**	0.614
Observations	250	255	505	505

Variable averages and p-value of the difference of means between treatment and control groups.
a The F-test is the joint test of significance of the coefficients for a regression of each variable on the two randomized variables: (1) the treatment status; (2) the subsidy variable.
* (p<0.05), ** (p<0.01), *** (p<0.001)

Subsidy is offered to randomly assigned farmers with a level that is also randomized for acquiring unbiased results. Because of there are different levels in subsidy (25%, 50%, 75% and 100%), F test was used. Results show that only household size seems to be significant with a low degree.

As like subsidy, games were assigned and played randomly by farmers. The data includes whether people were present in the game or not along with their preferences and choices in the game. T test was used in balance test for games by controlling whether individual farmer played the game or not. Results show that being Muslim, having a shock in previous year and subsidy levels are statistically significant. Household size being significant can be explained by having mostly Muslim people in the game, because they tend to have larger household size as a consequence of oligopolistic family structure. Though, significance level of subsidy level can not be explained because subsidy levels itself is also randomized.

In addition, having a shock in previous year can not be explained either since it doesn't occur depending on a specific situation. Even though games are not perfectly balanced, it is exogenous.

For having a quality measure in our research, we created quasi-experimental "distance from strike point" variable. This variable stands for the difference between average actual yields of GPCs from 2000 to 2014 and small payout trigger level. Difference is calculated by simply subtracting. Normalizing differences also gave same results, which is shown in Appendix part. Distance provides the quality of the insurance from the buyer's perspective because it is the major determinant for insurance payouts. More distance means worse insurance deal for the GPC.

We also created "number of different villages" variable. Because of double-trigger system for insurance payouts (explained in part 3) having different villages as neighbors is one of the major drawbacks of index insurance. Therefore this variable was needed in the research.

Having a shock in previous year can be an important predictor for insurance demand because it may be more likely that one can demand insurance if being encountered with an agricultural shock before. Since purchase of index insurance is based on group decision, group dynamics such as declaring default by other members is also an important determinant.

Decision of insurance take-up for group i is as follows:

$$Y_i = \begin{cases} 1 & \text{if group } i \text{ purchase insurance} \\ 0 & \text{otherwise} \end{cases}$$

Since our dependent variable is binary, we use probit regression in our model. In a paper that investigates microcredit which is a group product just like index insurance, Godquin (2004) used probit model for both individual and group research too. In addition to Probit, we also used OLS model. Similarly, Karlan (2007) used both OLS and probit for both individual and group characteristics.

$$P(Y = 1|x_1, .., x_k) = \phi(\beta_0 + \beta_1 x_1 + ... + \beta_n x_n) \tag{1}$$

Above equation shows the probit model Where ϕ denotes standard normal distribution function. The aim of this research is to explain demand for index insurance by exploiting three main exogenous variables: playing initiation games, the level of premium subsidies received, and the quality of the insurance contract sold to particular farmer groups given their historical yield averages.

$$P(Y = 1|x_1, .., x_k) = \phi(\beta_0 + \beta_1 Games_i + \beta_2 Quality_i + \beta_3 Subsidy_i) \tag{2}$$

Subsidy denotes subsidy level received by the farmer, being 0.25, 0.50, 0.75 and 1. Quality is the difference between average group yield and small payout trigger level, unit is in kg/ha. Games is a binary variable, being 1 if present in the game, 0 otherwise. For further investigation, we added other exogenous variables "Neighboring groups in the same village", "Idiosyncratic risk", which is calculated by the standard deviation of the yields belonging individual farmers in a same group for the year 2014, "having shock in the previous year", "Declaring default by other members", being 1 if at least one farmer has defaulted in the group, 0 otherwise, "Progress out of poverty index", "Being muslim" and category dummies. Also, errors are clustered in provinces.

5 Results

The section focuses first on our experimental and quasi-experimental results based on our analysis of the data from the Houndé project in 2014. The second and third subsection aim at unpacking these results quantitatively and qualitatively. The last part of this section extends the analysis to the data from the 2018 national scale-up of the index insurance program.

5.1 Main results: insurance demand in Houndé in 2014

Table 4 shows the OLS and Probit models that explain the decision to purchase insurance by introducing one by one the three experimental and quasi-experimental variables of interest: the level of premium subsidy (in share of the commercial premium) in columns (1) and (2); a dummy variable for households that played the initiation games in columns (3) and (4); and our measure of insurance quality that consist in the distance between a farmer group's yield historical average and the index insurance strike point (specified in realized cotton yields in the contract of a given farmer group) in columns (5) and (6). Columns (7) and (8) pool together the three variables.

The results suggest that price subsidy and having played the initiation game are important determinants of the demand for the index insurance project in our sample from Houndé. Farmers seem particularly sensitive to price, with a 1% decrease in price generating a 0.6% increase in the likelihood to purchase the insurance product. Playing the initiation game, on the other hand, increases the likelihood to buy the insurance approximately 28%. This suggests that playing the initiation game is roughly equivalent to receiving a 50% premium subsidy in terms of stimulating demand for the product. However, the exogenous quality of the insurance contract (as measured here) does not seem to have an impact on the likelihood to purchase the product, as the coefficients are insignificant and very small in magnitude. Pooling together the three variables has little effect on the coefficients and their significance level.

Table 4: Likelihood to purchase insurance: reduced models, Houndé project

	(1) OLS	(2) Probit	(3) OLS	(4) Probit	(5) OLS	(6) Probit	(7) OLS	(8) Probit
Subsidy level	0.00618**	0.00596***					0.00567**	0.00565***
	(2.49)	(2.72)					(2.41)	(2.65)
Played game			0.286**	0.273***			0.246*	0.239**
			(2.46)	(2.71)			(2.01)	(2.31)
Distance from Strike Point					-0.000130	-0.000129	0.000163	0.000212
					(-0.14)	(-0.14)	(0.21)	(0.26)
Constant	0.223*		0.316***		0.492**		0.0795	
	(1.84)		(3.49)		(2.08)		(0.38)	
Observations	505	505	506	506	506	506	505	505

t statistics in parentheses

Probit models display Marginal Effects. Standard Errors are clustered at the village level. The construction of the independent variables is described in text.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 5 includes additional explanatory variables that are potentially endogenous to the index insurance demand. First in columns (1) and (2), we include a dummy indicating that the neighboring groups whose yields are used to condition indemnity payment are in the same village as the insured group itself.[4] Having neighboring groups in different villages may lead to a lower-quality contract (a higher level of basis risk) if group yields are better correlated within a village than between groups of different villages. This is a reasonable assumption and a perception that was shared by farmers (see sub-section 5.3 below).

In columns (3) and (4), we add a dummy for groups that were affected by a shock in the previous year (2013-14 season). Shock-affected groups are defined as groups that would have received insurance payments had they been insured at that time (before the introduction of the index insurance project). It is commonly perceived that experience with recent shocks stimulates current demand, due to behavioral factors. We also include a dummy for individuals that defaulted on their Sofitex cotton input loan (see section 3). While default may indicate economic stress that may make index insurance attractive, it may also indicate coordination failures within the group, which may limit the purchase of index insurance. In this specification, we also include two socio-demographic variables: the Progress out of Poverty Index, which is an indicator that correlates well with per capita consumption; and a dummy for an individual whose household head is of the Mossi ethnicity.

Columns (5) and (6) introduce, in addition, the index insurance category of the farmer group. The category is based on historical cotton yields and determines the threshold at which index insurance payments are triggered. As such, they matter for the absolute level of yields at which a group can receive indemnity payment. However, the category is also likely to be correlated with other omitted variables, since a high category indicates a group that is generating high levels of cotton yields.

The results show that being offered a contract with "neighboring" groups that are in its village has a strong impact on the likelihood of purchasing the insurance contract. This suggests that farmers may pay attention to the quality of the insurance product (in terms of basis risk here) based on what they can easily observe. The quality of the contract may be difficult to assess from the distance to the yield trigger (although it conditions their likelihood of receiving insurance payments) which explains the insignificant coefficient. However, farmers can easily predict that conditioning their payments with the yields of farmer groups that are further away from their own village will reduce the likelihood of payments in case of shock. We explored this question further qualitatively (see subsection 5.3) and discuss in section 6 its important policy and methodological implications for the design and assessment of index insurance product.

Experience with a shock in the previous year does not seem to be stimulating demand. This means that groups may make insurance decisions by taking into account the distribution of yields regardless of the last realization of yields. The negative sign on the shock coefficient (significant in column (4) only) may also indicate that groups affected by recent shocks are more conservative regarding the adoption of "new technologies" such as index insurance. On the other hand, having members of the group experiencing a default seems to have fostered demand. Groups may have seen index insurance as a way to solve issues related to the joint-liability that forces farmers to reimburse the cotton loan of other farmers that had a low production (see section 3).

Other socio-economic characteristics do not seem to have a strong effect on demand. The Progress out of poverty index coefficient is not significant, and being Mossi is at best marginally significant, decreasing the likelihood of purchase. Finally, being in a lower or higher category of yield (i.e. being

[4]The neighboring group yields need to be below a "neighborhood threshold" for an insured group to receive indemnity payment: see section 3 for the description of this "double-trigger" mechanism.

in a worse or better farmer group) does not have an impact on demand, after controlling for the other variables that are included.

Results after controlling for these three sets of variables also confirm the findings from Table 4 regarding price subsidies and initiation games. The coefficient of the level of subsidy is even higher and strongly significant after adding controls. The magnitude of the coefficient of the dummy for playing a game is not strongly affected by the addition of controls, but it is not significant in all specifications. The quality of the contract measure (distance to the yield trigger) remains small and not statistically significant.

Overall, these results from the pilot project suggest that the main elements that farmers take into consideration when purchasing the index insurance product are its price, simple elements of its design, and their participation to the information activity. The next section aims to understand better the purchase decision process, and in particular how knowledge and perceptions play a role in the decision to buy or not the product.

Table 5: Likelihood to purchase insurance: full models, Houndé project

	(1) OLS	(2) Probit	(3) OLS	(4) Probit	(5) OLS	(6) Probit
Subsidy level	0.00852***	0.00969***	0.00929***	0.00999***	0.0118***	0.0126***
	(3.15)	(3.15)	(3.87)	(3.66)	(4.88)	(5.19)
Played game	0.169	0.188**	0.248**	0.246***	0.166	0.178**
	(1.43)	(2.13)	(2.39)	(3.12)	(1.64)	(2.25)
Distance from Strike Point	0.000221	0.000371	0.000669	0.000826	0.000751	0.000869
	(0.26)	(0.45)	(0.93)	(1.18)	(0.72)	(1.12)
Neighboring groups in the same village	0.309*	0.326**	0.347**	0.372**	0.415***	0.475***
	(1.89)	(2.09)	(2.54)	(2.57)	(2.87)	(2.90)
Idiosyncratic risk	0.00156	0.00227*	0.00151	0.00201*	0.00178	0.00248**
	(1.34)	(1.76)	(1.41)	(1.66)	(1.64)	(2.09)
had a shock in previous year (2013)			-0.263	-0.267*	-0.214	-0.242*
			(-1.56)	(-1.92)	(-1.29)	(-1.81)
Declared in default by other members in present year			0.167**	0.170**	0.119*	0.132**
			(2.42)	(2.45)	(1.69)	(2.07)
Progress out of Poverty Index			-0.00132	-0.000543	-0.00148	-0.00122
			(-0.75)	(-0.39)	(-0.83)	(-0.97)
Ethnicity of household head is Mossi			-0.208*	-0.154	-0.226*	-0.124
			(-1.74)	(-1.39)	(-2.00)	(-1.34)
Category 2					0.283	0.187
					(1.55)	(1.00)
Category 3					0.228	0.171
					(1.57)	(1.20)
Constant	-0.592		-0.607*		-0.973**	
	(-1.64)		(-1.79)		(-2.61)	
Observations	505	505	505	505	468	468

t statistics in parentheses

Probit models display Marginal Effects.

Standard Errors are clustered at the village level. Base category is Category 4. Categories 1 and 5 are excluded because of the small number of groups in these categories (1 and 2 respectively).

Including Category 1 and 5 does not affect the results (available upon request).

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

5.2 Mechanisms: knowledge and perception

Results survey show low experience prior the insurance; most of the farmers haven't purchased insurance other than fire, and several did not know insurance was offered in the last season. We also see that

purchase process was not fully democratic but consensual, meaning that even though when some wanted to buy the insurance, group does not always purchase and individuals agree more with the decision when insurance was purchased, which indicates decision process was quite consensual. In addition, there might be a correlation between knowledge and awareness of the insurance with attending to meeting when insurance is bought.

Table 6: Survey Responses

	(1) All (Insurance offered)	(2) Bought insurance	(3) Didnt buy insurance	(4) T-test p-value
Were you present in the meeting?	0.84	0.86	0.79	-1.16
Was there a vote to decide whether to buy insurance in your GPC?	0.36	0.42	0.23	-2.21**
Has your GPC decided to take up cotton insurance?	0.62	0.95	0.028	-29.86***
In your personal opinion, do you think that the GPC should subscribe to the insurance?	0.54	0.64	0.15	-4.19***
Did some want to buy insurance?	0.63	0.88	0.60	-1.54
Heard insurance from agents	0.32	0.37	0.28	-2.29**
Heard insurance from Games	2.66	3.08	2.30	-1.71*
Heard insurance from Research Survey	0.48	0.42	0.54	0.77
How do you qualify the attitude of your GPC? Wait and see	0.23	0.12	0.42	5.11***
How do you qualify the attitude of your GPC? Would not commit	0.18	0.077	0.38	5.69***
How do you qualify the attitude of your GPC? Go ahead	0.44	0.62	0.13	-7.52***
Do you think this price is good? Not much, too high	0.44	0.37	0.56	2.69***
Are there benefits to being insured?	0.88	0.91	0.81	-2.05**
Do you find that cotton insurance is something that gets you going?	0.79	0.83	0.71	-1.92*
Did you personally agree with the GPC decision at that time?	0.76	0.88	0.53	-6.10***

If tomorrow we offer you insurance for the next campaign, would you purchase?	0.62	0.77	0.32	-6.84***
Have you heard that cotton insurance was offered last season?	0.79	0.84	0.74	-3.01***
Have you purchased an insurance policy in the past - except fire?	0.030	0.031	0.028	-0.12
Observations	505	233	272	506

mean coefficients; *t* statistics in second column

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Questions asked to only people who bought the insurance are shown in Tables 7 and 8. We see that double trigger system is not well understood by the farmers. Though, when conditioned on playing games, we see a significant rise of the knowledge of double trigger system. Error to the first trigger variable in Table 8 shows how far respondants guess the trigger level from its actual value. It is seen that playing games also has a significant effect on learning the actual trigger level.

Table 7: Questions to groups that bought the insurance

	(1) Number of Observations	(2) Mean	(3) Standard Deviation
Are you happy to be insured?	134	0.88	0.32
Has insurance created tensions in the GPC?	134	0.26	0.56
Has insurance eased tensions in the GPC?	106	0.40	0.74
Were some people reluctant at the time of decision-making?	132	0.43	0.50
Do you think the GPC will buy insurance next season?	104	0.41	0.49
Does the triggering of the insurance depend on the level of performance of your group?	125	0.87	0.34
Does the triggering of insurance depend on the level of performance of others?	119	0.59	0.49

Table 8: Knowledge conditional on playing initiation games

	(1) Played game	(2) Didnt play game	(3) T-test p-value
Does the triggering of the insurance depend on the level of performance of your GPC?	0.88	0.83	-0.71
Does the triggering of insurance depend on the level of performance of others?	0.65	0.46	-1.93*
Does the triggering of the insurance depend on your level of performance?	0.22	0.12	-1.27
Error to the first trigger	158.6	390.5	2.39**
What was the non-subsidized price per hectare?	17950.9	11287.3	-0.72
Below what yield of neighboring GPCs can you collect insurance?	675	745.6	1.00
Observations	125	73	198

mean coefficients; *t* statistics in second column

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

5.3 Unpacking the results: qualitative evidence

Focus group surveys in 2016 shows that one of the most effective factors behind low take-up rate is the late timing of insurance sales. Farmers state that they were in the fields when Sofitex employees came to promote insurance:

> *Yes [it was a problem] because those who were at the meeting were not numerous. We were in the fields. (6, FG13)*

> *They came late in the month of June. When people were in the fields, it was hard. (3, FG13)*

Comments regarding late sales were also focusing on the hardship that particular timing creates for farmers:

> *This is the time of field work and people are very busy. If it is in the dry season, everyone is in the village and we will have time to exchange. If not during the rainy season, people will be physically there, but their whole mind is focused in the field. Therefore they will understand nothing what you say (3, FG9)*

> *It's a real problem. It's better that they come during the dry season there everyone will be there in body and mind (6, FG9)*

Since sales occurred in June, which is mainly rainy season, farmers were occupied with their fields therefore ignored insurance offerings. In addition, this timing made planning impossible for farmers since they have had production plannings while ago. Thus, late timing for sales is an important factor for low demand. Maybe, late timing of sales was the reason for the low take-up rate rather than the quality of the insurance.

Even though late timing is one of the biggest factors behind low take-up rate, comments reveal that different factors also play important role. For instance, we saw the form of comments from farmers that limited people were promoted:

> *They came to pick a few members and play with them [referring to Elena's team]. Those who were at these games, it is them who engaged the insurance in GPC (3, FG13)*

In addition, comments show us that with the help of educational games and promotion, farmers have some knowledge about the insurance:

> *It is all the GPC that should be insured and it becomes as if we had taken a credit from ecobank that we cut along with the input credit to the Sofitex (12, FG1)*

On the other hand, trigger system is not well understood:

> *We forgot how they should pay us (2, FG12)*

Even though educational games were conducted, some comments reveal complaints from farmers that they don't understand how insurance works:

> *I did not understand how the insurance works. Nobody came to see me to talk about insurance (1, FG2).*

For the farmers that understood how second trigger works, it is almost impossible to learn how their neighboring GPCs performed in yields:

> *I can not go ask the performance of the gpc neighbor because it will be frowned upon (4, FG4)*

We also questioned farmers' perceptions of the insurance after the purchase. Some reveal negative comments regarding trustworthiness of the insurance price:

> *For example I insured 4 hectares, but the insurance found 6 hectares yet nobody came to measure my field. And they cut the 6 hectare money. (...) In the beginning, we felt protected and we had confidence but the insurance did not do its job properly regarding the measurement of the area of our fields insured. (6, FG2)*

In addition, some farmers had disappointment after purchasing the insurance because of over-confidence about the insurance product:

> *There are programs that go on the radio on insurance saying that when you are insured, the insurance helps you in case of problems (...). But after the shock we had last year and received nothing, it really discouraged us. (1, FG4)*

According to farmers, not only the sales timing was late, but also reimbursement was late too, and this made farmers to sell their commodities to gain money:

> *it would be very good if the compensation does not take long. This will be very useful to us. (...) The money is too late. We had to sell property (8, FG8)*

5.4 Extension: results from the 2018 national scale-up

To extend and assess the external validity of our results, we conduct further analyses based on the sales data from the national scale-up of the product. Indeed in 2018, after a 2017-18 cotton campaign plagued by severe shocks, Sofitex decided to scale-up the insurance product at once to all cotton regions where it operates, in collaboration with Planet Guarantee.[5] Unlike the pilot, the scale-up project did not offer premium subsidies to farmer groups, and information activities such as games were not conducted. Besides, the unobserved intensity of the marketing and sales activities is likely to be lower than in the pilot project areas, and may vary by province of department. The administrative data provided by Planet Guarantee and Sofitex includes information on the purchase of the insurance product in 2018 by 6884 farmer groups, as well as their yield in the last 5 to 13 years (depending on their cotton region). These historical yields were used to allocate farmer groups to 4 insurance categories (5 categories in Houndé and Dédougou), which determine the insurance contract that were offered to them, as described in section 3. Thus, this dataset provides limited information on group characteristics, but allow us to identify the distance to the yield threshold and the occurrence of past shocks similar to subsection 5.1 for the pilot project in Houndé.

Unlike what was found in the pilot project, demand was low during the first year of the scale-up. Only 184 farmer groups purchased the insurance out of 6884 farmer groups for which a contract was designed, which corresponds to 2.7%. In the departments where at least one purchase was realized (indicating that the marketing campaign was conducted) about 5% of the 3736 farmer groups purchased the insurance product. These numbers are similar to what was found in other index insurance pilots. Consistent with our results from 5.1, this suggests that the interventions conducted in the pilot area (price subsidies and information games) were critical to generate successful take-up rates.[6]

Table 9 shows the estimation of the factors associated with the purchase of the insurance product in 2018 using OLS (column (1)) and Probit (column (2)) models. In column (4) and (5), only observations from provinces and department (respectively) with at least one sale are used. This excludes areas were no sales were realized, which may indicate a low intensity of the marketing and sales operations. In column (6), we exclude Houndé and Dédougou that have longer experience with the insurance product but do not have yield data for 2016-17 in the dataset. In column (7) we exclude observations with only a few yield observations given that the computation of the yield category of these groups is likely to lack precision, and that these groups may have other specific characteristics (they may be recent or have encountered difficulties for several years). Results are very similar across all specifications.

Results from table 9 confirm the findings from the Houndé pilot project. The distance to the yield threshold is not significant in any of the specifications. Unlike the results observed in Houndé, the purchase decision was not affected by the location of the farmer groups that constitute the "neighborhood" (in or outside of the village) and to the basis risk this may generate. A shock in the previous year (or in the year before that) does not seem to affect demand in any direction.[7] Finally, groups in higher yield categories (i.e. with higher historical yields and with higher insurance yield thresholds) tend to have a higher likelihood to purchase the product. Consistent with the results from the pilot, this correlation may

[5] Sofitex has a local monopoly in the main cotton areas of Burkina Faso and manages most of the country's cotton production (see section **??**).

[6] From an operational point of view, the number of sales indicates that the project was successfully scaled-up in only one year from a small pilot to a national program. However, take-up rates remain disappointingly low.

[7] In the light of the pilot results in Houndé were shocks have a negative coefficient, shocks in 2017-18 may have both stimulated farmers' interest in the insurance and limited their capacity to purchase the product.

be due to the various factors that make groups in higher categories function better: these groups may have a better relationship with Sofitex, use more input, have more educated members, be more interested in innovation, etc. Regardless, this may suggest that an index insurance product seems more attractive to groups that are more successful, or that the low yield thresholds offered to groups with low historical yields seem unattractive.

Taken altogether, these results from the scale-up program confirm that farmers were not able to use the available information to assess the quality of the contract offered to them. In a context where the information and marketing strategies employed during the pilot phase were not available, farmers appear less sensitive the important design elements such as the basis risk introduced by the second insurance trigger. This suggests that the emphasis on insurance quality- rather than merely on demand- is critical when offering complex products to farmers, as discussed in the next section.

6 Discussion & conclusion

Index insurance products are complex and imperfect, but all index insurance products are not created equal. This article shows that well-designed, high-quality index insurance products can be purchased by small-scale farmers. In this context of relatively high demand, two types of factors appear to play an important role in the insurance purchase decision. On the one hand, the Burkinabe farmers in our samples seem to react to "behavioral" factors (information, trust, etc.) that were put forward in the earlier index insurance literature (Binswanger-Mkhize, 2012; Karlan & Morduch, 2010). Specifically, insurance games played with a subset of farmer groups appear to foster both the understanding of the product and the demand for it. Besides, demand was much higher in the pilot project that was implemented with more effort among a small number of groups than the national scale-up that expended at once to thousands of groups in several regions. On the other hand, the most important determinants of the insurance purchase remain the economic characteristics of the product offered to farmers, specifically price and risk coverage, factors that are discussed by the more recent index insurance literature (Clarke, 2016; Barré & Stoeffler, 2018). Farmers pay particular attention to aspects of the insurance value that they can easily grasp: price and (in the pilot) geographic determinants of basis risk (geographic scale of the insurance neighborhood). However, while farmers were found to understand well these features and the limitations of the product, they do not seem to be able to assess the important variation introduced by design in the value of the product offered for purchase: the relative level of the insurance thresholds compared to their historical yields. These findings have important implications both for our understanding of index insurance and for using index insurance as a public policy instrument for improving resilience, fostering agricultural productivity and alleviating poverty.

First, the low demand for index insurance observed in several contexts may very well be related to the low quality of the products sold to farmers (as in (Clarke et al., 2012)). Thus, we should be careful in our aim to boost insurance demand with commercial or managerial objectives. While knowledge about the product should be extensively provided, pushing farmers to buy low quality products through behavioral "nudges" is potentially harmful. This is especially true when farmers are not able to understand the most technical details of the product, as we found in our samples from Burkina Faso. These technical details however are likely to have an impact on farmers' well-being after purchasing an insurance, as shown by Barré & Stoeffler (2018) and Jensen et al. (2019). Besides, our qualitative results also suggest that farmers value the core economic characteristics of an insurance product (individual and group-level basis

Table 9: Likelihood to purchase insurance: national scale-up

	(1) OLS Full Sample	(2) Probit Full Sample	(3) Raw Distance	(4) Province with Sales Only	(5) Department with Sales Only	(6) Excluding Hounde and Dedougou	(7) Excluding groups with less than 3 observations
Normalized distance from Strike Point	0.0152	0.0186		0.0173	0.0294	0.0182	0.0279
	(0.75)	(0.84)		(0.72)	(0.80)	(0.77)	(1.16)
Distance from Strike Point			0.0000300				
			(0.84)				
Shock in 2016-17	-0.00803	-0.0104	-0.0104	-0.00838	-0.00766	-0.0115	-0.00944
	(-1.32)	(-1.52)	(-1.51)	(-1.16)	(-0.67)	(-1.16)	(-1.31)
Shock in 2017-18						0.00539	
						(0.40)	
There are no different villages as neighbors	-0.000764	-0.00110	-0.00102	-0.00140	-0.0126	-0.00196	-0.000530
	(-0.15)	(-0.18)	(-0.17)	(-0.19)	(-0.87)	(-0.17)	(-0.08)
Category 3	0.00535	0.00715	0.00592	0.00949	0.0133	0.00753	0.00739
	(1.30)	(1.38)	(1.14)	(1.56)	(1.57)	(1.12)	(1.25)
Category 4	0.0114	0.0133*	0.0114	0.0150*	0.0214*	0.0134	0.0139*
	(1.45)	(1.71)	(1.41)	(1.65)	(1.81)	(1.12)	(1.73)
Category 5	0.0127*	0.0147*	0.0120*	0.0105	0.0113	0.00844	0.0163**
	(1.79)	(1.85)	(1.67)	(1.28)	(0.95)	(0.78)	(2.03)
Number of missing values in previous years	-0.00206	-0.00327	-0.00315	-0.00249	-0.00536	-0.00534	
	(-0.44)	(-0.54)	(-0.52)	(-0.37)	(-0.55)	(-0.61)	
Banfora	-0.0229	-0.0160	-0.0167			-0.0205	-0.0149
	(-0.91)	(-0.96)	(-0.98)			(-0.95)	(-0.82)
Bobo	-0.0341	-0.0261*	-0.0269*			-0.0359*	-0.0279*
	(-1.62)	(-1.74)	(-1.75)			(-1.91)	(-1.85)
Diebougou	-0.00759	-0.00412	-0.00495			-0.00479	-0.00451
	(-0.36)	(-0.31)	(-0.36)			(-0.29)	(-0.31)
Dedougou	-0.0383*	-0.0326*	-0.0334**			0	-0.0352**
	(-1.76)	(-1.94)	(-1.97)			(.)	(-2.08)
Hounde	-0.0525**	-0.0529***	-0.0519**			0	-0.0547**
	(-2.27)	(-2.59)	(-2.53)			(.)	(-2.54)
Ndorola	-0.0567**	0	0			0	0
	(-2.77)	(.)	(.)			(.)	(.)
Province dummies	NO	NO	NO	YES	NO	NO	NO
Department dummies	NO	NO	NO	NO	YES	NO	NO
Constant	0.0495**						
	(2.42)						
Observations	6884	6185	6185	5585	3585	3736	5818

t statistics in parentheses

t Observations are groups

With probit Ndorola predicts perfectly absence of sales therefore it is dropped from regressions. Koudougou is the base region. (1) OLS is used for full sample, (2) Probit is used for all sample

(3) Difference between threshold and average GPC yield (Raw Distance) is used as quality measure. (4) Provinces that doesn't have any sales excluded from sample, (5) Departments that doesn't have any sales excluded from sample.

(6) For taking last year as 2017, Hounde and Dedougou are excluded since their 2017 data is not avaliable. (7) For the last four years, GPC's that doesn't have observations for more than two years are not included in the sample.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

risk, benefits over costs, etc.). For that reason, selling index insurance products at a price that is closer to the actuarially fair price than most commercial products seems a promising avenue. Indeed, price is both a important element of the value of an index insurance product (Barré & Stoeffler, 2018) and one of the main determinants of purchased in our and other recent studies. Nevertheless, subsidizing low-quality index insurance products are not likely to be efficient in terms of meeting public policy objectives or making clients satisfied.

All these elements suggest that the priority for development actors interested in index insurance is to create, support or select high quality index insurance products. This is consistent with the theoretical results and simulations from Clarke (2016) and Barré & Stoeffler (2018). While the product studied in this paper was relatively high-quality, important aspects of its core economic value remain invisible to farmers at the time of purchase (whether they face a favorable insurance yield threshold or not). Some have suggested certification or regulatory mechanisms to identify and support only high-quality products. Regardless of the tool employed, awareness and understanding of the importance of the quality of index insurance products among practitioners is a first, major step.

Finally, and consistent with the literature from the last decade (as reviewed by Carter et al. (2017)), it appears that index insurance is unlikely to become a mainstream, attractive product for small-scale farmers at commercial price. For that reason, it should not be advertised as a self-sufficient, market-based response to the pervasiveness of risk faced by farmers and to various market failures in poor, rural areas. Instead, the positive development impacts found for some index insurance projects (Janzen & Carter, 2018; Stoeffler et al., 2019; Elabed & Carter, 2014; Karlan et al., 2014) is a sufficient justification for considering public funding for such products (as in the Kenya Livestock Insurance Program). A fairer assessment for index insurance programs would be to compare them to social protection alternatives such as cash transfers (Jensen et al., 2017; Ikegami et al., 2017). This is important if index insurance products, to be sold and have an impact on farmers, require an intensive support in terms of information (such as games), trust building, marketing- and most importantly, basis risk reduction and price subsidy.[8] Would have cotton farmers preferred to receive public funding as a subsidized, high-quality and well marketed area-yield insurance, or would they have preferred to receive a small cash transfer? Which of these two alternatives would have generated the greatest well-being and the highest response in terms of asset accumulation and agricultural productivity? These are open questions for the social protection literature.

[8]Costly but potentially quality improving mechanisms to reduce basis risk include audit mechanisms such as those described by ceballos2019feasibility,flatnesimproving.

7 Appendix

Table 10: Normalized Distance

	(1) 1a OLS	(2) 1b logit	(3) 2a OLS	(4) 2b logit	(5) 3a OLS	(6) 3b logit
Subsidy level	0.00804***	0.0275**	0.00883***	0.0591***	0.0102***	0.0665***
	(3.22)	(2.54)	(3.98)	(2.65)	(3.99)	(2.61)
Played game	0.157	0.532	0.237**	1.561**	0.172	1.199*
	(1.38)	(1.62)	(2.37)	(2.53)	(1.60)	(1.72)
Normalized distance from Strike Point	0.597	2.298	0.730*	5.672*	0.652	4.642
	(1.36)	(1.39)	(1.84)	(1.76)	(1.01)	(1.03)
There are no different villages as neighbors	0.358**	1.171*	0.382***	2.801**	0.424***	2.999*
	(2.13)	(1.75)	(2.86)	(1.98)	(3.03)	(1.91)
had a shock in previous year (2013)			-0.245	-1.776*	-0.212	-1.824*
			(-1.63)	(-1.82)	(-1.30)	(-1.73)
Declared in default by other members in present year			0.153**	1.059**	0.139*	0.993**
			(2.07)	(2.47)	(1.84)	(2.27)
= Progress out of Poverty Index			-0.00156	-0.0101	-0.00191	-0.0116
			(-0.82)	(-0.94)	(-0.95)	(-0.96)
Ethnicity of household head is Mossi			-0.227*	-1.145	-0.220*	-1.228
			(-1.85)	(-1.54)	(-1.80)	(-1.49)
Category 2					0.0960	0.657
					(0.41)	(0.39)
Category 3					0.176	1.248
					(1.21)	(1.16)
Constant	-0.247	-2.660**	-0.204	-5.162**	-0.335	-5.775*
	(-1.27)	(-2.54)	(-0.95)	(-2.07)	(-1.10)	(-1.91)
Observations	505	505	505	505	468	468

t statistics in parentheses

Standard Errors are clustered at the village level.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 11: Departments with no sales excluded

	(1) Insurance offered	(2) bought insurance	(3) refused insurance	(4) T-test p-value
Raw Distance	156.6	170.3	155.9	-2.49**
Normalized Distance	0.23	0.24	0.23	-1.80*
Is there any shock last year 1617	0.21	0.18	0.22	1.16
There is no different village as neighbor	0.77	0.68	0.78	2.92***
No missing years in last four years	0.47	0.60	0.46	-3.85***
One missing year in last four years	0.42	0.32	0.42	2.79***
Two missing years in last four years	0.045	0.049	0.045	-0.27
Three missing year in last four years	0.043	0.016	0.045	1.85*
Four missing year in last four years	0.027	0.011	0.027	1.36
Category 1	0.023	0	0.024	2.14**
Category 2	0.19	0.16	0.19	1.07
Category 3	0.26	0.24	0.26	0.73
Category 4	0.24	0.28	0.24	-1.47
Category 5	0.28	0.31	0.28	-0.81
Observations	3606	184	3422	3606

mean coefficients; *t* statistics in second column

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

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