Indirect protection: the impact of cotton insurance on farmers' income portfolio in Burkina Faso*

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Abstract

While risk is known to harm farmers' production investments, there is still limited evidence of index-insurance impact on household ex-ante behavior. This paper studies a pilot area-yield index insurance project sold to cotton farmer groups in Burkina Faso. Insurance sales were randomized, and in the treatment area, an encouragement design was generated by providing premium subsidies (between 25% and 75%) randomly distributed to farmer groups. No impact was found on cotton production, most likely in reason of the late sale period (during the sowing period). However, substantial and significant impacts were found on several activities and assets such as field investments, sesame cultivation and livestock herding. The mechanisms behind these indirect effects are discussed. Overall, the findings suggest a promising role of index insurance for stimulating ex-ante investments, but also draws attention on implementation gaps which currently threaten this type of intervention.

Keywords: Index insurance; cotton; Burkina Faso; risk; indirect impact; productive investments; randomized evaluation; mixed-methods.

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

[NOTE: PRELIMINARY AND INCOMPLETE]

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1 Introduction

Designing efficient poverty alleviation interventions requires identifying and addressing the main constraints faced by poor households. An increasing amount of evidence suggests that the lack of instruments for intertemporal resource allocation (saving, credit and insurance) plays a major role in preventing households to accumulate assets and improve their future wellbeing. This prevents household from perfectly smoothing consumption (Kazianga and Udry, 2006; Dercon, 2002), and causes adverse shocks to have harmful lifetime consequences (Alderman et al., 2006; Hoddinott and Kinsey, 2001). Besides the impact of realized shocks, risk has also a negative impact on poor households in Sub-Saharan Africa. Farmers indeed renounce to risky but highly profitable investment opportunities by adopting low-risk, low-return portfolio strategies, such as cultivating "safe" crops (Stoeffler, 2016; Zimmerman and Carter, 2003). This situation is striking in the Sahel in general and in Burkina Faso in particular, where levels of risk are high and overall levels of investments in input and productive assets are low. Consequently, besides avoiding harmful consequences of shocks, it seems urgent to propose development interventions which can protect farmers in order to help them accumulate assets and improve their future wellbeing.

In this context, index insurance has emerged as a promising tool to help farmers overcome the pervasive ex-ante and ex-post effects of risk. As part of an emerging social protection strategy in Sub-Saharan Africa, index insurance aims to protect and promote households through insuring household productive assets or agricultural revenue (Chantarat et al., 2013). However, delivering contingent transfers in case of shocks is more challenging than providing constant transfers to the poorest (Stoeffler et al., 2015). Index insurance bases its transfers on an outside index (such as the level of rainfall), which allows the insurance to be affordable for poor farmers and prevents moral hazard issues. However, insurance payments are not perfectly correlated with farmers' losses, which means that the value of the protection provided can be in fact relatively low (Clarke, 2011). In practice, only a few pilot projects have been implemented so far in Sub-Saharan Africa (De Bock and Gelade, 2012). Research has focused mostly on index insurance demand, and on the factors explaining the low take-up observed in most projects (Karlan and Morduch, 2010; Binswanger-Mkhize, 2012; Carter et al., 2015; Cole et al., 2013; Jensen et al., 2014c). However, the core economic value of the protection is rarely assessed (Barré et al., 2016; Clarke et al., 2012; Jensen et al., 2014a). Only a few studies have shown an impact on insured households after a shock occurred (Janzen and Carter, 2013), or an ex-ante impact on household investments (Jensen et al., 2014b; Elabed and Carter, 2015; Karlan et al., 2012).

This paper contributes to the thin literature on the investment effect of index insurance, by measuring the impact of an implemented cotton index insurance project in Burkina Faso. Cotton farming in Burkina Faso, as in other West African countries, is a highly profitable but risky activity, given the crop's vulnerability to the region's variable weather patterns and the lack of insurance mechanisms for these farmers. As cotton requires more investment in agricultural input and labor than other food or cash crops (e.g. sorghum), small-scale farmers often forgo this profitable opportunity (or limit the area they plant to cotton) in order to minimize their exposure to risk. This "risk rationing" strategy (Boucher et al., 2008) has adverse effects on the entire farming system, because cultivating cotton is often the only channel for Burkinabe households to obtain input for their other crops. In this context, insuring cotton has the potential to impact not only cotton production but the whole household portfolio strategy- and consequently, farmers' long-term wellbeing.

For these reasons, a pilot cotton insurance project was initiated in Burkina Faso in 2014 by the cotton company Sofitex, Planet Guarantee, and other partners. This index insurance product takes advantage of the organization of the cotton sector by Sofitex, which provides input on credit to farmer groups. These farmer groups were allowed to purchase the insurance on credit, as the cotton production serves as collateral (similar to other input) through Sofitex distribution channels (local agents). The insurance is an area-yield product, based on actual yields of farmer groups weighted by Sofitex when the production is purchased to farmers. Given these factors, and because exposure to covariate risk (such as drought and floods) is high for Sahelian, rainfed agriculture, this insurance product was considered as promising.[1] The pilot project was implemented in the Houndé region, one of the main cotton production regions. In our research area comprises eighty farmer groups, half of them being randomly selected and offered the insurance product for purchase. We collected data among 1000 households twice: at baseline before the intervention in January 2014, and again in January 2015 to measure the short-term impact on insured households.

The key research questions explored in this paper relates to risk, household investments and out-of-poverty strategies. Does alleviating risk encourage households to invest in risky activities such as cotton production? Did the cotton index insurance project increase input use and investments, surface cultivated and yields in the cotton production in Houndé? Were there spillover effects of the insurance in other activities such as food and cash crops production, livestock herding- or on living conditions and food consumption? We answer these questions through different econometric specifications exploiting our double randomization. Indeed, the index insurance was offered to half of the farmer groups in our research area; among these, farmer groups were randomly allocated a level of insurance premium subsidy between 0% and 75% to generate an encouragement design. We can thus exploit this level of subsidy as an instrument to predict endogenous insurance demand and increase the precision of our estimation. In addition, we also explore the heterogeneity of the results among farmer groups which received a shock during the study year.

Take-up was very high compared to other index insurance pilots: approximatively 45% of the farmer groups purchased the insurance in our research area. However, other implementation gaps thwarted the project's expectations: in particular, the product was sold too late during the season for farmers to be able to adjust their input demand and surface cultivated. As a consequence, no direct impact was found on cotton cultivation for insured households. However, we found an impact on other activities or assets such as sesame cultivation, livestock owning or field infrastructure. For instance, sesame cultivation among insured households increased by 17.3 percentage points compared to non-insured households. In terms of mechanisms, our hypothesis is that the additional protection provided to farmers' portfolio did actually encourage investments, but that because cotton cultivation could not be adjusted at this point, these investments were directed towards other parts of the portfolio (i.e. other risky activities). Overall, these results suggest that the index insurance product had a productive impact, but that this impact was indirect. They emphasize both the potential and the complexity of index insurance products, whose implementation remains challenging.

The following section describes the insurance product as well as context and design of the research. The third section presents the data, while the fourth section shows the results of the analysis. The fifth section discusses potential mechanisms explaining the results, and the last section concludes.

2 A cotton index insurance

The cotton sector is well structured in Burkina Faso, but leaves large shares of risk uninsured for individual farmers. This context is particularly relevant for the development of an index insurance product. Our research takes advantage of this potential and studies a promising index insurance project.

2.1 Risk & cotton production in Burkina Faso

The pervasiveness of risk and its consequences have been well studied in Burkina Faso. Based on the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) survey, research has shown that food shortfall were common for the poorest households (Carter, 1997), and that contrary to popular belief, livestock was not widely used as a buffer against adverse shocks (Fafchamps et al., 1998). As a consequence, droughts impact negatively poverty (Reardon and Taylor, 1996), as poor households are far from perfectly smoothing consumption (Kazianga and Udry, 2006). Extreme variability in agricultural production pushes households to diversify income in-farm and off-farm, but the

[1] For a detailed analysis of the actual value of this insurance product, see Barré et al. (2016).

poorest households remain trapped in low-return activities (Reardon et al., 1992; Stoeffler, 2016). Nevertheless, in the presence of shocks, poor households tend to smooth assets to protect future income from catastrophic collapse, as shown theoretically (Zimmerman and Carter, 2003) and empirically (Carter and Lybbert, 2012). Naturally, these mechanisms are not specific to Burkina Faso (Townsend, 1994; Udry, 1994; Rosenzweig and Binswanger, 1992). This suggests that better understanding risk alleviation mechanisms and their impact is crucial for improving farmers' living conditions in Burkina Faso and in many other parts of the developing world.

Cotton production in West Africa constitutes an opportunity for developing index insurance products, given the organization of the sector. As in other Sahelian countries (Cameroon, Mali, etc.), the cotton sector in Burkina Faso is organized by parastatal companies that have local monopolies in large regions. In the Houndé, one of the main cotton regions of the country, Sofitex is the company that purchases the entire production to farmer groups (*Groupes de Producturs de Cotton, GPC*). Each cotton farmer has to belong to a farmer group of ten to fourty members (but sometimes up to eighty members *de facto*). Sofitex provides all inputs on credit (seeds, fertilizer, pesticide, etc.) using the group's cotton production as a collateral. In fact, Sofitex is one of the only sources of formal credit for input for farmers, and consequently, the main source of input purchase. In theory, farmers are not allowed to use these inputs on other crops, and input diversion is monitored by Sofitex agents (*Agents Techniques de Coton, ATCs*). In practice, it is widely know that part of the inputs purchased is applied to other crops (in particular fertilizer, which is used to produce maize), which makes cotton production central for farmers' entire crop portfolio.[2]

One of the costs of this well structured input credit system is the rigidity of the input provision chain. Indeed, credit demand is expressed early during the year: as early as September, (y_{-1}) for sowing in June (y_0), harvesting in January and being paid as late as April (y_{+1}). Input demand has to be validated by the farmer group, by Sofitex agents, and by the bank which provides the credit (Ecobank). Uncertainty is high before the sowing season: besides the weather uncertainty, other factors affect each farmer's production capacities such as her own health, her family labor supply, or her productive assets (livestock for ploughing).[3] There is also a certain price uncertainty, reinforced by the length of the production timeline described above: Sofitex guarantees a minimum price at the beginning of the cotton season, but this "floor price" is low and the final price fluctuates. The rigidity of the system combined to its uncertain context pushes farmers to be conservative in their input requests, and limits their capacity to invest when conditions change in the short term (e.g. when insurance is provided). Also, the rigidity of the output purchase makes cotton production somewhat unattractive compared to other crops whose output can be sold immediately after harvest (e.g.: sesame). These features have been well described theoretically and empirically by Malan et al. (2015) and Theriault et al. (2013).

In addition, while this joint-liability borrowing structure allows farmer to obtain input, it also generates tensions among farmers: if an individual farmer does not produce enough on year, the group (other members) reimburses her credit and the farmer has to reimburse the group the following year(s). Given the high frequency of shocks, individual defaults are common. Gelade (2016) describes the high social cost of defaulting for farmers, and its consequences in terms of ex-ante limitation of the amount of credit obtained. These limitations are both externally imposed by the farmer group or Sofitex agents, and internalized by the farmer herself. This situation has a negative ex-ante impact on cotton production at the intensive and at the extensive margin: it pushes some cotton farmers to take smaller loan to decrease their exposure to defaults, and it prevents some farmers to enter the cotton sector at all.[4] There are also ex-post economic consequences of defaulting, since farmers tend to liquidate productive assets (e.g. livestock) in order to pay back the loan when yields are insufficient in a given

[2] Sofitex has started to react to this situation by providing smaller input loans for cereals to well performing farmer groups.

[3] Among other annecdotes, several farmers reported the lack of family labor because the (adult) children of the household head did not return from the small-scale mines to work in the fields.

[4] Some farmers are indeed excluded from a group and/or not able to join any goup. In addition, when an entire group is not able to reimburse its loan, it is usually suspended until the loan is reimbursed- preventing its members to produce cotton in the meantime.

year. In sum, while rules are somewhat flexible, the overall feature of the system is a high cost of production shocks and limited protection against covariate shocks such as droughts or floods.

2.2 Index insurance project

In this context, index insurance is a particular promising solution that can potentially benefit from and resolve issues of the cotton production organizing system. The index insurance project studied in this paper builds on a previous pilot experience in Mali (Elabed et al., 2013). Despite presenting promising results, that experience in Mali had to be interrupted in 2013 because of the military coup (Elabed and Carter, 2015). The pilot project restarted in Burkina Faso in 2014 in the Houndé region, implemented by the NGO Planet Guarantee and several partners. Sofitex participates actively to the project by providing yearly data, but is also in charge of the sale of the insurance: its local agents conduct the information session and the marketing of the insurance product.[5] While involving several partners in a development intervention can be an asset, it also generates risks of implementation gaps by increasing the number of intermediaries between and within each organization.

The index insurance was designed based on data collected by Sofitex among 704 farmer groups since the 2000-01 agricultural season. The data shows actual yields of farmers, weighted by Sofitex in each village for payment to farmer groups and reimbursement of the input loan.[6] Farmer groups were grouped in five categories, depending on their yield historical average: the yield distribution was estimated for each category, and each category was offered a different contract based on this distribution. For more details regarding the design and the quality of the index insurance product, see Elabed et al. (2013) and Barré et al. (2016).

The insurance provides three levels of payment. When yields are below 20% of the yield distribution (a 1 in 5 years event), farmers receive a "small payout" of 11,200 FCFA per hectare insured.[7] This insurance payment was designed to correspond to the value of the insurance premium (so that the premium is reimbursed to farmers in case of small shock). When yields fall below 8% of the yield distribution, the insurance provides a "medium payout" of 34,000 FCFA. Finally, in case of yields falling below 4% of the distribution (a 1 in 25 years event), the farmers receive a "big payout" of 90,000 FCFA per hectare, which corresponds approximatively to the value of the input loan. The yields used for the calculation of insurance payments are those weighted by Sofitex agents for payments to farmer groups. As such, it covers all types of covariate shocks, which is a clear advantage compared to index insurance products based on a rainfall index for instance and cover only rainfall-related shocks.

Similar to the product implemented in Mali, the Burkinabe index insurance has a double trigger mechanism (Elabed et al., 2013). This means that farmers receive payments under two conditions. First, the farmer's groups need to be below a given threshold corresponding to its category of yields (e.g.: yields below 800 kg / ha). Second, the other farmer groups in the neighborhood of the insured group need to have somewhat low yields as well: there is a "neighborhood" threshold as well, which is higher than the own farmer group threshold (e.g.: yields in the neighborhood needs to be below 1000 kg / ha). This neighborhood condition was designed to avoid potential moral hazard issues. Indeed, since farmers of a group live in the same village and are usually members of the same family, ethnic group or religious community, there were concerns of potential coordination within one group. The neighborhood condition prevents such coordination by ensuring that yields are not particularly good in other groups in the area as well. However, it introduces some basis risk at the farmer group level[8]

The insurance was sold commercially to farmer groups in May-June 2014 for the first time, by Sofitex agents. The insurance was sold on credit, as for other inputs (but sold much later). A farmer group had to collectively decide to purchase the insurance, and the entire surface cultivated had to be

[5] Other partners include Ecobank, the institution that finances farmer loans; HannoverRe, the reinsurer of the insurance product; and I4 researchers, which contributed to the design of the index insurance product.

[6] Only the data after the 2006 were used for the computation of the index insurance. Indeed, the 2005-06 season represents a potential structural break due to a crisis of the cotton sector in Burkina Faso.

[7] For reference, 656.07 FCFA = 1 euro (fixed echange rate).

[8] An analysis of the historical data used to design the insurance shows that the second trigger prevents about 20% of insurance payments (of any level) which farmer groups would have received if this second condition did not exist.

insured in that case. The commercial premium was about 11,200 FCFA, which is above the actuarially fair premium by at least 75% (Barré et al., 2016). Farmers complained about the high price of the insurance during qualitative fieldwork. However, premium subsidies were provided in our research area to most of the farmer groups (see below). The other common complaint among farmers is basis risk, either at the group level- it could rain for the groups in the next village but not in their own village- or at the individual level- a farmer could have low yields for idiosyncratic reasons whereas the rest of the group had high yields. These are common features of index insurance products, whose impacts we aim to evaluate in spite of their limitations. Additionally, a major implementation gap is that sales occurred very late during the agricultural season (i.e. during the cotton sowing season and the first rains). Besides concerns regarding insurance take-up (groups could choose not to purchase when they saw that the climate was favorable this year), this implementation gap threatens the ex-ante impact of the insurance an investments. Indeed, given the rigidity of the cotton sector, it was not possible at that point for farmers to acquire additional inputs from Sofitex and thus very difficult to increase surface cultivated and input use. However, our data collection and research design allow us to measure impact beyond cotton production only.

3 Research design & data

The research presented in this paper is the result of a randomized impact evaluation that was designed prior to project implementation in the Houndé region.

3.1 Research design & data collection

Our research area is constituted of 80 farmer groups of the Houndé cotton region. Among these groups, the intervention was randomized in two manners. First, half of the farmer groups were randomly selected and were offered the insurance for purchase. Thus, the treatment area comprises 40 farmer groups, whereas the 40 farmer groups in the control area could not purchase the insurance (it was not offered in their villages). Second, an encouragement design is generated among the treatment group by randomly distributing subsidy coupons. These subsidies covered 0%, 25%, 50% and 75% of the premium cost for 10 farmer groups each. The objective of these subsidies was to increase take-up in the whole treatment area, and to be used as an instrument to predict take-up and increase the precision of the estimation. Indeed, the instrumentation allows us to measure impact on households which actually purchased the insurance (as predicted by the subsidy level) without generating a selection bias issues due to the endogeneity of the insurance purchase decision (which is *a fortiori* an issue given the late timing of the sales).

Data was collected among 1015 households in the 80 farmer groups: 507 and 508 households were randomly sampled among cotton farmers in the treatment and control groups respectively. About 13 households of each farmer group were selected approximatively. The first survey occurred in January 2014, before the first insurance sales of May-June 2014. A second survey was conducted in January 2015 to measure the short-term impact of the intervention. Thanks to the efforts of the data collection team and to the use of tablet-based survey methods, attrition was kept very low (only 5 households out of 1015, or below 0.5%). Questionnaire modules included detailed information regarding the household fields, cotton and cereal production, credit, cotton group dynamics, livestock, assets, food consumption, and other modules such as the household structure and the participation to small-scale mining activities. The agricultural module is decomposed at the plot level, with additional detailed production information collected for cotton and cereals. A farmer group module was also conducted to gather information at the group level. By measuring the short-term impact of the treatment, we expect to see a greater impact, if any, on agricultural activities and investment decisions rather than on measures of wellbeing (consumption and living conditions). In January 2015, indeed, farmers did not have time to benefit from agricultural investments realized after purchasing the insurance, nor did they receive any insurance payments yet. Thus, the study measures the ex-ante impact of the insurance in isolation.

3.2 Empirical specifications

Our two main empirical specifications rely on this double randomization design of the study for their identification strategy. The first specification measures the Intention to treat (ITT) effect by taking the difference-in-difference (DID) between our treatment and control groups, before and after the intervention. As such, it provides a conservative estimate of the impact, with low precision, as long as take-up is not 100% in our treatment group (recall that farmers had to pay for the insurance at commercial or subsidized price). Formally, the estimation takes the form:

$$y_{it} = \beta_0 + \beta_1 * T_{it} + \beta_2 * D_{it} + \beta_3 * T_{it} D_{it} + \epsilon_{it} \quad (1)$$

where y_{it} is one of the outcomes of interest, $T_{it} = 1$ in if farmer i belongs to the treatment farmer groups, $D_{it} = 1$ when $t = 2015$, and β_3 measures the effect of being offered the insurance in 2015. Standard errors are clustered at the farmer group's level.

The second specification aims at measuring the Average treatment effect (ATE) on the treated. It relies on the randomization of the subsidy level, which is used as an instrument in the first stage to predict insurance take-up. The predicted insurance purchase decision is then used in a second stage, in a first-difference (FD) specification to measure the change introduced by the purchase of the insurance compared to baseline outcomes (identical in essence to the DID specification in Equation 1). In this specification, we also add covariates to estimate the impact with additional precision. Formally, the first stage is written:

$$Ins_i = \gamma_0 + \gamma_1 * T_i + \gamma_2 * S_i + \Gamma * X + v_i \quad (2)$$

and the second stage is:

$$\Delta y_i = \beta_0 + \beta_1 * \hat{Ins}_i + B * X + \epsilon_i \quad (3)$$

where $Ins_i = 1$ when the farmer purchases the insurance, $S_i = \{0, 0.25, 0.5, 0.75\}$ is the level of subsidy, X is a vector of covariates, and $\hat{Ins}_i$ describes the predicted insurance purchase. Δy_i indicates the first difference taken between follow-up and baseline outcomes. The covariates include baseline differences between the treatment and the control groups such as GMO cultivation. Because this second specification measures the ATE effect and the instrumentation increases precision, this IV specification is preferred when analyzing results.[9]

3.3 Descriptive statistics

Table 1 and table 2 present descriptive statistics for household characteristics and agricultural activities respectively. Households are large (more than 10 members on average) and household heads have a low education level on average (1.2 years). The average surface cultivated is about 10 ha, with approximatively 4.5 ha devoted to staple food crops (maize, sorghum, millet and rice), 4 ha of cotton and 1.5 ha of diversification food or cash crops (sesame, groundnut, bean, etc.). Average cotton yields are relatively low (829 kg / ha) and fertilizer usage is 2.3 NPK 50kg bags / ha, below the level of 3 bags recommended by Sofitex agents. Most households raise animals, with an average livestock size of 6.4 Tropical Livestock Units (TLU).[10] The t-test results indicate that the sample is well balanced between the treatment and the control groups. However, the share of households cultivating GMO cotton is

[9] This specification would be vulnerable to spillover effects if the take-up of a farmer group in a village has an impact in the behavior of farmers belonging to another farmer group which is not purchasing the insurance. We cannot think of a credible pathway to generate such an indirect impact. If such a spillover effect occured, it would make our estimates conservative compared to the true effect.

[10] The TLU formula used in this study is: TLU = 0.7 * cattle + 0.35 * calves + 0.1 * (goats + sheeps) + 0.01 * (chicken + other poultry) + 0.2 * pigs + 0.5 * horses + 0.3 * donkeys.

much higher in the control group, which suggests a need to control for baseline GMO cultivation in the estimations.

Table 3 shows the occurrence of shocks affecting cotton and cereal plots in our sample for the 2013-14 and 2014-15 agricultural seasons. The share of households affected by shocks is very high in both years, but is much higher in 2014-15.[11] In 2013-14, 29% of the farmers received shocks on their cotton, and 33% on their cereals. These numbers rise to 55% for cotton and 63% for cereals in 2014-15. The fact that farmers receive more shocks on their cereal fields is consistent with the fact that herbicides and pesticides are used in cotton fields (these input are part of the Sofitex package). As a consequence, farmers report higher weed shocks for cereal fields. The main shock recorded by farmers is drought (lack of rain) for both cotton and cereals, with about 15% of the fields affected in 2013-14, and about 30% of the fields affected in 2014-15. For cereals, the second main shock is weed, followed by floods (excess of rain) and livestock damage (animals eating crops). For cotton, weeds also matter but to a lesser extent, and floods, livestock damage and pest are also among the main shocks. Overall, there is a wide variety of shocks affecting cotton and cereal production, which speaks in favor of an area-yield insurance as opposed to a single-peril insurance product. However, some of these shocks may not be covariate at the level of the "neighborhood" grouping of farmer groups (see section 2.2) and rather idiosyncratic at the farmer group or even individual level. During focus groups, farmers indicated that even climatic shocks (such as the lack of rain) which are usually thought as covariate are actually fairly localized in our research area. In fact, taking into account all observed shocks (in terms of yield losses), Barré et al. (2016) estimate that about half of the observed shocks are covariate, the remaining half being idiosyncratic.

Take-up was relatively high in the research area: 18 out of the 40 groups purchased the insurance product. This corresponds to 233 out of the 506 households to whom the insurance was offered in our sample (46.05%), which is much higher than usually observed in small index insurance pilots (Binswanger-Mkhize, 2012; Hazell, 2010). By looking at the number of group purchasing the insurance at each level of subsidy on table 4, it seems that the coupon had a strong impact on index insurance demand. While only 2 groups out of 10 purchased the insurance at commercial price, this number rises to 8 groups out of 10 at 75% subsidized price. This suggests that the level of subsidy is likely to be a relevant instrument in predicting insurance purchase.

However, the purchase decision is not an individual one, since the insurance is sold to farmer groups. In theory, the insurance is purchased during an assembly of the farmer group which is attended by all members; in practice, all farmers are not necessarily present during the assembly, or do not necessarily understand the product purchased. Appendix A presents information on farmers' decision process (table 19) and perception and knowledge (table 20) towards the cotton insurance. While informative, the answers to these questions have to interpreted with caution, as they have only been asked to the household head (who is not always in charge of cotton decisions) unfortunately. Only 52% of the farmers in groups which were offered the insurance state that their group was indeed offered the insurance. Besides, only 53% of the insured farmers know that they are insured.[12] The answers to the survey questionnaire show a relatively high level of satisfaction and a feeling of protection among those who purchased the insurance (somewhat more optimistic than qualitative interview responses). On the other hand, the level of knowledge and understanding of the insurance mechanism is not very high, with only 42% of farmers who are aware of (and understand) the double trigger mechanism (among those who know that they are insured). Only 32% of those are satisfied with the price paid, but 43% of the farmers do not know the actual price paid after subsidies. Finally, while no actual contamination of the control group occurred, a small number of farmers in control farmer groups state that they were offered and/or purchased the insurance product (results available upon request). Of all these, the most

[11] While this observation is consistent with farmers' account in our research area, these 2014-15 numbers may also be inflated by the fact that we asked questions about shocks during the 2015 survey only. Thus, the 2013-14 shocks are reported retrospectively. The higher level of shocks in 2014-15 is also inconsistent with the higher yields observed that year in our survey data, although the intensity of shocks may have been higher in 2013-14 (see section 4).

[12] Most of the others did not know that their group had a meeting to decide on insurance purchase. Among those participating at the decision meeting, most of them agreed with the insurance purchase. Formal vote was rare, but the decision was usually described as consensual during qualitative interviews.

	No insurance offered	Insurance offered	Significance level
Age of household head	44.0	43.6	
	(12.4)	(13.5)	
Household size	10.4	10.4	
	(6.38)	(6.09)	
Household size, members above 15	5.76	5.66	
	(3.72)	(3.54)	
Maximum education level in the household (years)	5.17	4.94	
	(3.40)	(3.41)	
Education level of the household head (years)	1.15	1.22	
	(2.45)	(2.52)	
Progress out of Poverty Index	36.3	36.8	
	(12.8)	(12.0)	
Roof of dwelling is solid	0.47	0.51	
	(0.50)	(0.50)	
Floor of dwelling is solid	0.28	0.32	
	(0.45)	(0.47)	
Household Diet Diversity Score (HDDS) (0-12)	7.83	7.84	
	(1.57)	(1.55)	
Number of food coping strategies (0-4)	0.47	0.40	
	(0.96)	(0.87)	
Number of different crops / products cultivated	4.02	3.97	
	(1.36)	(1.39)	
Surface of sesame (ha)	0.21	0.17	
	(0.57)	(0.51)	
Surface of groundnut (ha)	0.22	0.24	
	(0.41)	(0.47)	
Surface of bean (ha)	0.22	0.22	
	(0.43)	(0.44)	
Rent fields	0.34	0.27	*
	(0.48)	(0.45)	
Chicken	24.8	20.7	*
	(30.3)	(22.2)	
Goats	6.48	6.77	
	(8.42)	(8.45)	
Sheeps	4.38	3.82	
	(8.65)	(7.14)	
Cows	7.60	6.13	
	(14.4)	(10.8)	
Tropical livestock unit (TLU)	6.90	5.85	
	(10.6)	(7.79)	
Observations	508	507	1015

Mean coefficients, standard deviation in parenthesis. T-test of equality of mean between treatment and control groups.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 1: Test of balance: household characteristics & assets

	No insurance offered	Insurance offered	Significance level
Total surface cultivated, cotton (ha)	4.03	3.77	
	(3.77)	(3.06)	
Total surface cultivated, all cereals (ha)	4.59	4.43	
	(3.63)	(2.84)	
Total field surface cultivated	10.1	9.81	
	(8.18)	(6.53)	
Total production, cotton (kg)	3646.6	3316.3	
	(4399.2)	(3307.8)	
Yields, cotton (kg)	829.4	829.3	
	(350.8)	(338.5)	
=1 if cultivated OGM in 2013	0.63	0.42	***
	(0.48)	(0.49)	
Yields, Maize (kg)	1555.8	1563.8	
	(818.1)	(776.0)	
Yields, Millet (kg)	469.5	609.7	
	(321.1)	(1108.3)	
Yields, Rice (kg)	1605.4	1196.7	
	(1008.5)	(951.7)	
Yields, Sorghum (kg)	642.2	627.9	
	(439.7)	(465.5)	
NPK for cotton, bag per ha	2.29	2.38	
	(1.05)	(1.05)	
Uree for cotton, bags per ha	0.93	0.98	
	(0.49)	(0.46)	
Total cotton credit by ha	95437.0	96556.0	
	(38687.2)	(41150.6)	
Hired labor (men-day) per ha, cotton	17.8	22.8	
	(41.1)	(59.2)	
Observations	508	507	1015

Mean coefficients, standard deviation in parenthesis. T-test of equality of mean between treatment and control groups.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 2: Test of balance: agricultural activities

	Cotton 2013-14	Cereal 2013-14	Cotton 2014-15	Cereal 2014-15
Shock: drought	0.150	0.153	0.277	0.322
Shock: flood	0.038	0.048	0.103	0.104
Shock: weeds	0.040	0.119	0.052	0.262
Shock: crop disease	0.006	0.019	0.025	0.050
Shock: pest	0.029	0.023	0.103	0.062
Shock: farmer ill	0.000	0.002	0.013	0.008
Shock: lost labor	0.000	0.002	0.000	0.010
Shock: lost input / assets	0.000	0.006	0.000	0.010
Shock: damaged by livestock	0.043	0.044	0.087	0.076
Shock: elephants	0.004	0.005	0.002	0.005
Shock: fire	0.009	0.000	0.005	0.003
Shock: other	0.009	0.008	0.034	0.032
Shock: any	0.288	0.333	0.545	0.631
Observations	932	1006	932	1006

Share of households who received a shock on one of their plot by crop type and year. Recall data from January 2015.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 3: Shocks

	Premium subsidy level				
GPC bought the insurance	**0%**	**25%**	**50%**	**75%**	All
No	8	5	7	2	22
Yes	2	5	3	8	18
Total	10	10	10	10	40

Table 4: Take-up at each level of premium subsidy

worrisome is the lack of awareness of being insured, because household who do not know that they have an insurance are particularly unlikely to make ex-ante changes in their production decisions.

4 Results

The impacts of the index insurance project is measured through the specifications from Equation 1 and Equation 3 in order to capture the ITT and the ATE effects.

4.1 Main impacts

Because the insurance covered cotton yields, the first outcomes studied relate naturally to cotton production. However, cotton inputs are often diverted to cereal fields (see section 2.1), and most of the covariate shocks affecting cotton production are likely to affect cereal production as well (especially the main shock: droughts). For these reasons, the survey questionnaire included detailed information on cereal plots as well (maize, sorghum, millet and rice). For both cotton and cereals, information was collected on surface cultivated, input use (NPK, urea, herbicide, pesticide, organic fertilizer, etc.), paid labor, total production and yields. Table 5 and table 6 present the DID and IV estimations for cotton respectively, while table 7 and table 8 present these estimations for cereals. The overall finding is the absence of significant impacts on cotton and cereal production. There was no change of surface cultivated or input used for cotton and cereals among treated households and insured households. As a consequence, there is no significant change in yields or total production. While not significant in most cases, the decrease in cotton and cereal production among treated households is relatively large. This is apparently due to shocks affecting a small number of insured farmer groups (see subsection 4.2). The decrease in yields is smaller and not significant. The DID estimate for labor indicates a significant decrease in the number of paid labor employed in cotton fields. However, this variable is likely to be affected by shocks as well (less labor is required when there is less cotton to harvest). It seems that shocks apart, the index insurance product failed to induce the ex-ante effect expected. This failure is most likely due to the implementation gap described in section 2.2: the insurance was sold too late during the agricultural season. By the time farmers become insured, they had already made input commands from the cotton company, without straightforward options to purchase additional input and increase surface cultivated.

We also measure the changes that the index insurance causes in other activities and assets among insured households. Indeed, activities and investments are closely interlinked, since households face common time, cash and asset constraints for different activities, and covariate risk between cotton production and other activities is correlated (see section 4.3). We start by measuring investments in field small infrastructure investments such as fences and small dams and irrigation in tables 9 and 10. Results show that the insurance generated a significant increase in household investments in fence and irrigation- and also in field total investments. The magnitude of the impact is modest (ATE of about 7,800 FCFA of investment) because only a minority of households conduct any field infrastructure investment in a given year.[13] However, the ATE estimate of the impact on the log of field investments indicates an average increase by 170% of the total amount invested by insured households.

Table 11 and 12 show the impact on crops other than cotton and cereals. After cotton and cereals (maize, sorghum and millet), the crops cultivated by the largest number of households are peanut, bean and sesame. While peanut and bean can be either consumed or sold, sesame is essentially a cash crop. Sesame cultivation has developed rapidly in the last ten years in Burkina Faso, and is considered as the main competitor of cotton cultivation due to its low input costs and the rapidity of sales after harvest (Stoeffler, 2016). Results show that the number of households cultivating sesame increased significantly among insured farmers: the ITT is 8 percentage points and the ATE is 17.3 percentage points. According to the IV specification, insured households also increased the surface of

[13] About 10.2% of our sample households invested in any field infrastructure in 2014, 11% in 2015, and only 2.6% invested in both years. The ATE raises to about 52,800 FCFA when restricting the sample to those who invest.

	Surface	NPK/ha	Herbecide/ha	Input FCFA/ha	Labor (Man-Day)	Production	Yields
Treated	-0.337	0.0359	0.249	5597.1	21.71	-428.8	-15.48
	(-0.64)	(0.31)	(1.06)	(1.49)	(1.38)	(-0.82)	(-0.42)
2015	0.310*	0.131*	-0.138	-146.6	6.411	990.6***	157.1***
	(2.01)	(1.74)	(-1.02)	(-0.07)	(0.68)	(5.32)	(5.48)
Treated 2015	-0.0179	-0.0124	-0.265	-2912.1	-30.92**	-399.5	-40.03
(DID estimates)	(-0.10)	(-0.13)	(-1.47)	(-1.08)	(-2.18)	(-1.68)	(-0.92)
Constant	4.237***	2.312***	1.935***	67984.6***	71.86***	3877.3***	849.5***
	(9.76)	(27.18)	(11.98)	(27.05)	(7.05)	(9.24)	(27.05)
Observations	1856	1856	1856	1856	1855	1856	1856

t statistics in parentheses

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

Table 5: Impacts on cotton, DID model (ITT)

	Surface	NPK/ha	Herbecide/ha	Input FCFA/ha	Labor (Man-Day)	Production	Yields
insured	-0.0541	0.0259	-0.620	-1893.4	-36.07	-536.2	-27.05
	(-0.16)	(0.14)	(-1.61)	(-0.47)	(-1.44)	(-1.18)	(-0.39)
=1 if cultivated	-0.151	0.157	0.213	9014.5***	-3.043	110.6	30.21
OGM in 2013	(-1.01)	(1.61)	(1.47)	(3.75)	(-0.18)	(0.70)	(0.90)
Constant	0.396**	0.0339	-0.246	-6071.9***	0.567	851.2***	126.7***
	(2.25)	(0.39)	(-1.46)	(-2.91)	(0.04)	(4.19)	(3.77)
Observations	928	928	928	928	927	928	928

t statistics in parentheses

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

Table 6: Impacts on cotton, IV model (ATE)

	Surface	NPK/ha	Input FCFA/ha	Labor (Man-Day)	Production	Yield
Treated	-0.167	0.0549	2583.4	-5.874	-241.8	14.86
	(-0.42)	(0.31)	(0.56)	(-1.52)	(-0.33)	(0.14)
2015	-0.220	-0.0648	581.5	-5.094	429.3**	99.19**
	(-1.50)	(-0.75)	(0.21)	(-1.03)	(2.51)	(2.45)
Treated 2015	-0.00548	-0.0168	-1035.0	1.348	-409.3*	-32.86
(DID estimates)	(-0.03)	(-0.17)	(-0.33)	(0.25)	(-1.84)	(-0.53)
Constant	4.717***	1.274***	38525.9***	24.66***	5738.8***	1222.4***
	(13.17)	(9.52)	(9.99)	(7.53)	(11.33)	(18.72)
Observations	1850	1852	1850	1855	1850	1850

t statistics in parentheses

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

Table 7: Impacts on cereals, DID model (ITT)

	Surface	NPK/ha	Input FCFA/ha	Labor (Man-Day)	Production	Yield
insured	0.0171	-0.0479	-833.5	1.732	-463.7	-34.80
	(0.04)	(-0.19)	(-0.10)	(0.16)	(-1.30)	(-0.29)
=1 if cultivated	-0.0463	0.0841	2231.2	-0.580	22.52	29.33
OGM in 2013	(-0.24)	(0.50)	(0.41)	(-0.09)	(0.11)	(0.58)
Constant	-0.207	-0.108	-1014.9	-4.479	302.1	72.24
	(-1.05)	(-0.63)	(-0.18)	(-0.55)	(1.58)	(1.46)
Observations	923	925	923	927	923	923

t statistics in parentheses

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

Table 8: Impacts on cereals, IV model (ATE)

	Investment fence	Investment dam	Investment irrigation	Investment field (total)	Log invest field
Treated	-432.0	-1162.3	-1069.1*	-2663.4**	-0.205
	(-0.95)	(-1.54)	(-2.01)	(-2.18)	(-1.03)
2015	-373.4	1452.1	-894.3**	184.3	0.128
	(-0.82)	(0.87)	(-2.03)	(0.09)	(0.79)
Treated 2015	668.7	743.6	1299.5**	2711.7	0.553**
(DID estimates)	(1.20)	(0.37)	(2.63)	(1.20)	(2.26)
Constant	862.7**	1960.8***	1090.4**	3913.9***	0.702***
	(2.15)	(2.82)	(2.06)	(3.36)	(4.72)
Observations	1856	1856	1856	1856	1856

t statistics in parentheses

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

Table 9: Impacts on field infrastructure investments, DID model (ITT)

	Investment fence	Investment dam	Investment irrigation	Investment field (total)	Log invest field
insured	2470.9**	3318.6	2034.9*	7824.4*	1.703***
	(2.08)	(0.87)	(1.90)	(1.69)	(2.92)
=1 if cultivated	1228.4**	3038.6	656.3	4923.3**	0.640***
OGM in 2013	(2.13)	(1.63)	(0.85)	(2.37)	(2.97)
Constant	-1265.8**	-577.3	-1058.2	-2901.2	-0.328*
	(-2.02)	(-0.47)	(-1.33)	(-1.64)	(-1.73)
Observations	928	928	928	928	928

t statistics in parentheses

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

Table 10: Impacts on field infrastructure investments, IV model (ATE)

	Rent field(s)	Number crops	Surface cultivate (ha)	Cultivate sesame	Sesame Peanut Bean (ha)
Treated	-0.0713	-0.0522	-0.258	-0.0492	-0.0146
	(-1.35)	(-0.32)	(-0.24)	(-1.03)	(-0.15)
2015	0.0131	0.190***	0.128	0.157***	0.170***
	(0.36)	(3.10)	(0.73)	(5.52)	(3.34)
Treated 2015	0.0722	0.139	0.142	0.0798*	0.167**
(DID estimates)	(1.67)	(1.49)	(0.65)	(1.78)	(2.03)
Constant	0.342***	4.048***	10.85***	0.207***	0.660***
	(7.63)	(35.45)	(12.33)	(5.20)	(10.39)
Observations	1856	1856	1856	1856	1856

t statistics in parentheses

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

Table 11: Impacts on other crops, DID model (ITT)

	Rent field(s)	Number crops	Surface cultivate (ha)	Cultivate sesame	Sesame Peanut Bean (ha)
insured	0.213***	0.108	0.312	0.173*	0.271
	(2.75)	(0.52)	(0.77)	(1.84)	(1.49)
=1 if cultivated	-0.00713	-0.184**	0.0562	0.0283	-0.0108
OGM in 2013	(-0.18)	(-2.09)	(0.25)	(0.62)	(-0.12)
Constant	0.00475	0.335***	0.0985	0.142***	0.198***
	(0.15)	(3.49)	(0.48)	(3.24)	(2.89)
Observations	928	928	928	928	928

t statistics in parentheses

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

Table 12: Impacts on other crops, IV model (ATE)

land rented from other households. These results are consistent with our interpretation of the absence of impact on cotton production: sesame does not require inputs other than seeds, which can be easily purchased, and land, which can be rented out. However, such impacts would imply an indirect effect of the insurance on other crops and activities (see section 4.3 for a discussion of such a mechanism).

Finally, we measure the impact of the index insurance on livestock owning in tables 13 and 14. Tables 13 and 14 show that insured households increased their level of livestock substantially. The increase is not significant for total livestock due to large standard errors (see subsection 4.2). However, insured farmers increased significatively their total cattle stock, as well as their number of cows (non-plowing ox). The number of chicken also increased significatively in the IV specification. The ATE effect is 1.6 cattle animals and 6.8 chicken on average, which are large increases.

We also measured the impact on durable goods and food security, for which we do not expect short term impacts, and on off-farm activities. Most of the coefficients are not significant for these variables. Detailed results are presented in Appendix B.

4.2 Impacts heterogeneity

The main results indicate that the index insurance purchase did not have any significant impact on cotton and cereal production. However, the relatively large negative coefficient is puzzling and calls

	Cattle #	Cows #	Goats/sheeps #	Chicken #	TLU	Log TLU
Treated	-1.495	-0.727	-0.122	-4.460	-1.060	-0.0665
	(-1.48)	(-1.41)	(-0.08)	(-1.58)	(-1.40)	(-0.47)
2015	0.133	-0.0501	1.813***	-0.969	0.326*	0.118***
	(0.55)	(-0.36)	(2.90)	(-0.60)	(1.75)	(2.93)
Treated 2015	0.750*	0.485**	0.405	3.411	0.464	0.0980
(DID estimates)	(1.91)	(2.16)	(0.51)	(1.68)	(1.52)	(1.51)
Constant	7.736***	2.893***	10.91***	25.37***	7.025***	1.194***
	(9.92)	(6.91)	(9.70)	(10.71)	(11.56)	(11.75)
Observations	1856	1856	1856	1856	1856	1856

t statistics in parentheses

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

Table 13: Impacts on other crops, DID model (ITT)

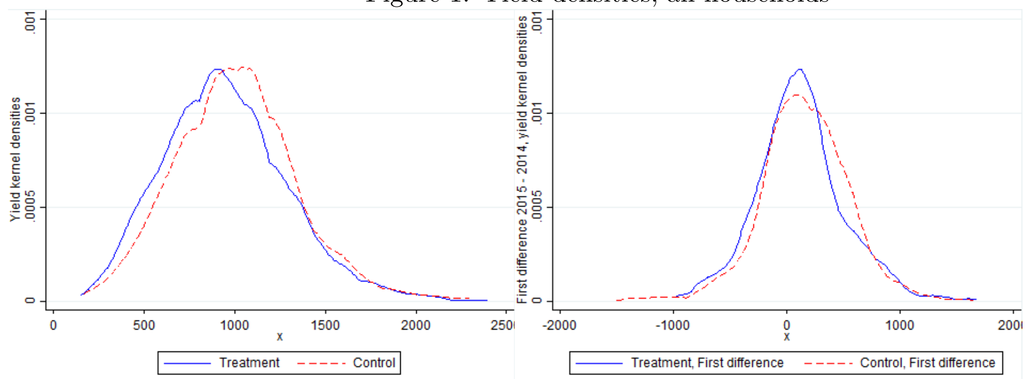
	Cattle #	Cows #	Goats/sheeps #	Chicken #	TLU	Log TLU
insured	1.635*	0.987*	0.889	6.830*	1.053	0.191
	(1.70)	(1.87)	(0.58)	(1.65)	(1.45)	(1.42)
=1 if cultivated	0.235	0.0751	0.864	3.348*	0.186	0.0477
OGM in 2013	(0.62)	(0.33)	(1.29)	(1.93)	(0.65)	(0.69)
Constant	0.0110	-0.0712	1.346**	-2.621*	0.219	0.0976*
	(0.04)	(-0.42)	(2.26)	(-1.67)	(1.05)	(1.77)
Observations	928	928	928	928	928	928

t statistics in parentheses

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

Table 14: Impacts on other crops, IV model (ATE)

Figure 1: Yield densities, all households



for further inquiry. A first step consist in comparing not only the average yields among treatment and control groups, but the distribution of yields among these groups. Figure 1 presents the distribution of yields in 2015 among the two groups (left) and the distribution of the yield first difference between 2014 and 2015 (right). In both cases, the yield densities of the treatment group are located on the left of the densities of the control group, indicating lower yields for the treatment group.

After the 2014-15 agricultural season, the insurance was actually triggered in four farmer groups of the research area.[14] Three of these groups are located in one of the four *départements* of our research area, Founzan. Reports from the field also indicated that this *départements* had been affected by a lack of rain which explained lower cotton yields. In our data, the lowest yields are obtained in three farmer groups located in Founzan, and insured. We explores the heterogeneity of the results in Founzan and non-Founzan *départements* to unpack the main results. Tables 15 and 17 show the effect of being insured for cotton and cereals respectively in the 20 farmer groups located in the *département* affected by shocks (Founzan), while tables 16 and 18 show the impact in the other areas (60 farmer groups located in 3 *départements*) not affected by a covariate shock according to field reports. Results show that the decrease in both cotton and cereals is much stronger in Founzan than in non-Founzan areas for total production and yields. The coefficients are actually significant in Founzan for cotton. These coefficients seem to be driven by the three insured farmer groups which had the lowest yields. Thus, they are likely to be caused by a shock affecting randomly these farmer groups rather than by the fact of being insured. Yield kernel densities in figure 2 confirm that the distribution of yields is simular for insured and non-insured households in non-Founzan areas, but that yields are lower for insured households in Founzan.

Whereas adverse selection is likely to have occured (farmer groups observing low rains at the beginning of the season could purchase the insurance), it does not drive our results, since we are instrumenting the insurance purchase decision with the level of subsidies randomly provided (see section 3.2). However, moral hazard may reinforce the impact of shock on cotton production and yields: insured farmers may have provided lower effort in the face of shocks if they relied on insurance payments to compensate losses. While this hypothesis is possible, it seems relatively unlikely, *a fortiori* for a product sold for the first year and in which trust from farmers may be limited.[15] Besides, the double trigger mechanism reduces the risk of moral hazard: farmers have to be sure that the neighborhood condition will trigger before being able to take action within their farmer group. Finally, in the rest of our research area, the yield and production coefficients are not significant, which indicates that the insurance had no impact- but did not have a negative impact.

For the other variables studied, the impact tends to be larger and significant for non-Founzan areas compared to Founzan, but the smaller sample size in each group makes it harder to obtain significant

[14]These payments occured about six months after the harvest and data collection.

[15]While the impacts found on investments suggest that farmers trusted the insurance, moral hazard behaviors require a higher level of trusts, as they imply to *reduce* production deliberately.

	Surface	NPK/ha	Herbecide/ha	Input FCFA/ha	Labor (Man-Day)	Production	Yields
insured	0.589	-0.0129	-0.157	-4466.5	-57.30**	-850.1***	-235.9**
	(1.28)	(-0.10)	(-0.31)	(-1.17)	(-2.22)	(-3.29)	(-2.13)
=1 if cultivated	-0.432*	0.332***	-0.0745	6885.0**	13.64	89.80	83.22
OGM in 2013	(-1.81)	(2.99)	(-0.41)	(2.24)	(0.49)	(0.29)	(0.91)
Constant	0.0699	-0.147	-0.438***	-8575.5***	2.314	603.2***	149.4**
	(0.35)	(-1.42)	(-2.74)	(-3.01)	(0.13)	(3.56)	(2.20)
Observations	225	225	225	225	224	225	225

t statistics in parentheses

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

Table 15: Impacts on cotton (ATE), Founzan

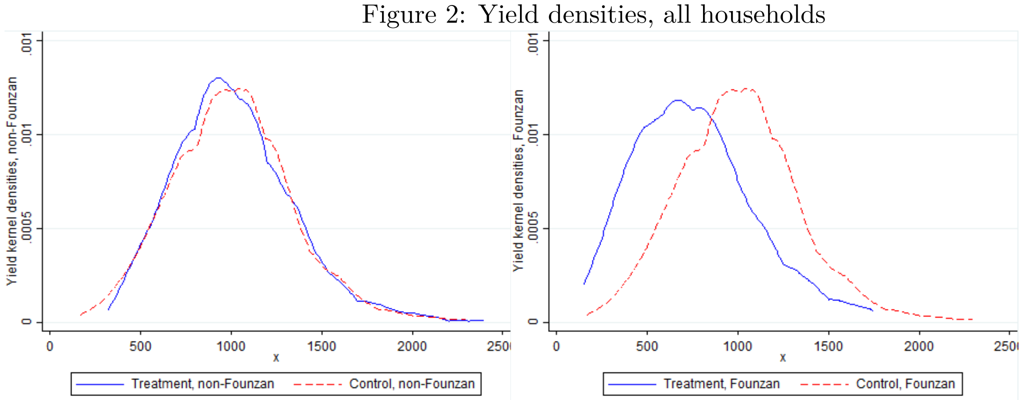
	Surface	NPK/ha	Herbecide/ha	Input FCFA/ha	Labor (Man-Day)	Production	Yields
insured	-0.436	0.0166	-0.939*	-2139.2	-17.58	-444.5	76.15
	(-1.14)	(0.06)	(-1.81)	(-0.40)	(-0.54)	(-0.74)	(1.36)
=1 if cultivated	-0.128	0.0476	0.256*	7818.8***	-7.956	-41.21	-5.133
OGM in 2013	(-0.78)	(0.43)	(1.67)	(2.79)	(-0.42)	(-0.25)	(-0.18)
Constant	0.512***	0.147	-0.175	-3975.8	0.284	1044.7***	140.4***
	(2.73)	(1.42)	(-0.88)	(-1.49)	(0.01)	(4.52)	(5.86)
Observations	703	703	703	703	703	703	703

t statistics in parentheses

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

Table 16: Impacts on cotton (ATE), non-Founzan

Figure 2: Yield densities, all households



	Surface	NPK/ha	Input FCFA/ha	Labor (Man-Day)	Production	Yield
insured	-0.440	-0.0625	-1614.1	2.334	-620.8	-42.20
	(-1.34)	(-0.79)	(-0.60)	(0.44)	(-1.54)	(-0.49)
=1 if cultivated	-0.312	-0.147**	-3508.1*	7.220*	452.4	160.5**
OGM in 2013	(-0.70)	(-2.16)	(-1.89)	(1.88)	(1.21)	(2.04)
Constant	0.288	-0.0166	568.5	-12.49***	493.7	4.000
	(0.95)	(-0.23)	(0.28)	(-2.98)	(1.45)	(0.06)
Observations	224	224	224	225	224	224

t statistics in parentheses

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

Table 17: Impacts on cereals (ATE), Founzan

	Surface	NPK/ha	Input FCFA/ha	Labor (Man-Day)	Production	Yield
insured	0.288	-0.0752	-1213.5	0.448	-176.6	-22.60
	(0.57)	(-0.21)	(-0.10)	(0.03)	(-0.41)	(-0.14)
=1 if cultivated	0.118	0.153	3612.5	-5.002	18.19	-19.94
OGM in 2013	(0.59)	(0.69)	(0.49)	(-0.59)	(0.07)	(-0.36)
Constant	-0.437**	-0.149	-1609.5	0.149	163.3	109.2*
	(-2.12)	(-0.64)	(-0.20)	(0.01)	(0.86)	(1.92)
Observations	699	701	699	702	699	699

t statistics in parentheses

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

Table 18: Impacts on cereals (ATE), non-Founzan

differences between insured and non-insured households. Detailed results are available upon request.

We also decomposed the impact among the households who know about that they are insured and those who do not know. Results indicate no clear difference between informed and non-informed households (available upon request).

4.3 Indirect impacts: mechanisms

Overall, the results indicate a relatively strong impact on assets and activities which were not directly insured by the cotton area-yield product offered to farmers. Given the link between cotton and maize farming through cotton input "diversion", an impact on cereals could have been expected.[16] However, an indirect impact on field investments, sesame cultivation and livestock may appear more surprising.

Indirect impacts of development interventions within and across households are not uncommon. Designed primarily to support consumption, nutrition and/or human capital accumulation, cash transfers have been shown to generate an indirect productive investments on beneficiary households as well in Malawi, Mexico and Niger (Gertler et al., 2012; Covarrubias et al., 2012; Stoeffler et al., 2016).[17] Progresa's impacts in Mexico actually go beyond beneficiary households as they generate spillover for non-beneficiaries (Barrientos and Sabatés-Wheeler, 2010; Angelucci and De Giorgi, 2009). In Bangladesh, beneficiary from a "Targeting the Ultra-poor" (TUP) intervention from BRAC realized large investments in land (renting and owning) even though this was not an objective of the program, which focused on livestock and entrepreneurship (Bandiera et al., 2015). Thus, indirect impacts from interventions related to social protection and poor household promotion are not uncommon.

In the case of crop insurance and cotton farming in Burkina Faso, indirect productive impacts are even more likely given the relationship between different crops and activities. The main shock affecting cotton, drought, is clearly a shock for other crops and livestock, indicating a strong correlation between the cotton index (cotton area-yield) and sesame or livestock outcomes (Berg et al., 2009; Fafchamps et al., 1998). In theory, index insurance has the potential to stimulate the insured, risky, high-return activity compared to low-return, self-insurance investments (Karlan et al., 2014). This has been shown empirically for agricultural activities in Ghana (Karlan et al., 2014), cotton in Mali (Elabed and Carter, 2015), or livestock in Kenya (Jensen et al., 2014b). If farmers want to invest in a given high-return crop which is insured (cotton), but cannot because of an external constraint (timing of the sale and organization of the cotton input chain), it is rational for them to invest in other risky, high-return crops or activities of their portfolio such as sesame or livestock. Indeed, shocks affecting sesame and livestock are likely to be highly correlated with the insurance payments as well. Besides, in the study area, investing in livestock or sesame is the main diversification strategy (along with gold mining) of households trying to invest to improve future well-being Stoeffler (2016). Consequently, the indirect impacts found in this article support the idea that risk is an important constraint to poor farmer productive investments, and that risk-reducing products are promising tools for promoting small-scale farmers.

5 Conclusion

This article studies the short-term impact of an index insurance project offered to cotton farmers in the Houndé region in Burkina Faso. The objective of the insurance project was to protect farmer and foster their investments in a risky but profitable cash crop. A randomized evaluation combining pure treatment and control assignment with an encouragement design (through insurance premium subsidies) is employed to identify the impacts of the insurance product. The relatively high take-up in the treatment group (approximatively 45%) allows us to conduct analyses and measure impacts on insured households.

[16] The detailed cereals module (equivalent to the cotton module) is a proof of this expectation.

[17] Beneficiaries have even been found to investment in livestock when they were strongly discouraged to do so by project managers who wished that they focused on child nutrition (Olivier de Sardan, 2013).

While the area-yield product sold to farmers is promising in terms of design and quality, the poor implementation of the project (especially the bad timing of the sale) most likely prevented any direct positive impact on cotton farming. However, it appears that insured farmers realized different types of investments in field infrastructure, livestock and seasame croping. Such and indirect impacts of the insurance are consistent with the fact that farmers make portfolio decisions in a farming system where outcomes are highly stochastic and correlated with each other. These impacts suggest that index insurance can have a productive impact on poor farmers and support them in their income growth and asset accumulation strategies.

Although relatively promising, these results open several questions which require further investigation. What would be the impact of the insurance product on cotton farmer under a better implementation scheme: would farmers focus their investments in the insured crop by increasing surface cultivated and/or input use? Also, will the impact on indirect investments be sustained and initiate some positive dynamics among poor farmers, or is the impact found in the first year of the project only a short-term effect? How do these investments compare to alternative interventions- such as saving programs or cash transfers- in terms of cost-effectiveness? Given the implementation challenges specific to index insurance, these questions call for further empirical research with respect to index insurance impacts on productive investments.

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Appendix A

	(1) All offered	(2) Refused insurance	(3) Bought insurance
Heard about cotton insurance past year?	394 502	199 271	195 231
Was the insurance offered to your farmer group?	201 385	71 197	130 188
There was an information meeting	186 201	65 71	121 130
There was a purchase decision meeting	138 200	42 71	96 129
Were you present at this meeting?	116 138	33 42	83 96
There was a vote to decide on purchase?	48 132	9 40	39 92
Your group bought the insurance	124 200	2 71	122 129
Were some members reticent?	53 122	1 2	52 120
Were some farmers willing to buy it?	47 75	40 67	7 8
Did you agree with the decision?	152 200	37 70	115 130
Personnally, would have purcahse insurance	140 201	28 71	112 130
Insurance experience (excl. fire insurance)	6 199	2 71	4 128
Insured against fire in the past	54 200	17 71	37 129
Heard about insurance from research team	166 394	89 199	77 195
Heard about insurance from Sofitex/UNPCB	164 394	76 199	88 195
Heard about insurance from another farmer	56 394	29 199	27 195
Observations	502	271	231

sum coefficients; count in second row

$^{+}$ $p < 0.10$, * $p < 0.05$

Table 19: Insurance decision

	(1)	(2)	(3)
	All	Refused insurance	Bought insurance
Are you satisfied to be insured?	118 134	2 2	106 122
Discussed insurance purchase with someone	129 229	36 71	75 130
Feels very well protected for cotton	60 134	1 2	54 122
Feels somewhat protected for cotton	55 134	1 2	49 122
Feels not well protected for cotton	19 134	0 2	19 122
Insurance created tensions	28 134	1 2	27 122
Insurance decreased tensions	26 106	1 1	24 95
Understand insurance has double trigger	52 134	0 2	51 122
Knows the GPC had a subsidy	97 1010	19 273	78 233
Knows correct level of subsidy	54 94	12 18	42 70
Knows the price actually paid after subsidy	70 134	1 2	69 122
Knows the price actually paid before subsidy	95 134	2 2	89 122
Find the price way too high or little bit too high	162 229	54 71	92 130
Finds the price good	45 229	8 71	30 130
There are advantages being insured	198 229	57 71	116 130
There are drawbacks being insured	82 229	26 71	46 130
Group would buy insurance next year, same price	98 134	2 2	90 122
Group should buy insurance next year, same price	134 229	21 71	98 130
Would personnally buy insurance next year, same price	137 229	22 71	99 130
Farmer group would buy insurance next year, no subsidies	43 108	3 20	39 80
Farmer group should buy insurance next year, no subsidies	54 108	3 20	49 80
Would personnally buy insurance next year, no subsidies	55 108	5 20	47 80
Observations	1010	273	233

sum coefficients; count in second row

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

Table 20: Insurance perception and information

Appendix B

	PPI index	Has cart	Has plow	Has motor-cycle	Food items consumed	HDDS (Diet Diversity)	Food coping
Treated	0.760	-0.0111	0.0278	0.0655	-0.00230	0.0514	-0.0674
	(0.49)	(-0.17)	(0.18)	(0.74)	(-0.01)	(0.35)	(-0.93)
2015	-1.050**	-0.0240	-0.216	0.0283	-0.266*	-0.109	-0.190***
	(-2.45)	(-0.83)	(-1.68)	(0.73)	(-1.77)	(-1.42)	(-3.99)
Treated 2015	-0.869	0.0666	-0.113	-0.0305	0.0867	-0.0595	0.0190
(DID estimates)	(-1.06)	(1.62)	(-0.67)	(-0.54)	(0.34)	(-0.45)	(0.28)
Constant	36.36***	0.719***	1.898***	0.730***	10.71***	7.791***	0.460***
	(32.49)	(15.63)	(20.26)	(13.96)	(76.35)	(83.77)	(9.82)
Observations	1856	1856	1856	1856	1856	1856	1856

t statistics in parentheses

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

Table 21: Impacts on other crops, DID model (ITT)

	PPI index	Has cart	Has plow	Has motor-cycle	Food items consumed	HDDS (Diet Diversity)	Food coping
insured	-1.735	0.157	-0.0599	-0.0896	0.895*	0.286	0.0681
	(-1.28)	(1.51)	(-0.20)	(-0.64)	(1.75)	(1.13)	(0.46)
=1 if cultivated	-0.514	0.0445	0.147	0.0174	0.414	0.161	0.0355
OGM in 2013	(-0.93)	(0.97)	(0.96)	(0.26)	(1.37)	(1.16)	(0.61)
Constant	-0.814	-0.0503	-0.338**	0.0240	-0.651**	-0.291**	-0.215***
	(-1.39)	(-1.06)	(-2.41)	(0.43)	(-2.45)	(-2.32)	(-3.39)
Observations	928	928	928	928	928	928	928

t statistics in parentheses

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

Table 22: Impacts on other crops, IV model (ATE)

	Off-farm 7d	Off-farm 12m	Off-farm all	Off-farm members	Off-farm share	Off-farm: gold
Treated	0.00799	-0.0736*	-0.0380	-0.427**	-0.0406**	0.0723
	(0.17)	(-1.78)	(-0.91)	(-2.20)	(-2.29)	(1.08)
2015	0.0748**	0.210***	0.0876***	0.958***	0.0537***	-0.162***
	(2.40)	(6.01)	(4.14)	(6.38)	(5.05)	(-5.28)
Treated 2015	-0.00659	0.0518	0.0617	0.0504	0.00583	-0.00855
(DID estimates)	(-0.13)	(0.93)	(1.56)	(0.26)	(0.37)	(-0.19)
Constant	0.659***	0.413***	0.803***	2.199***	0.223***	0.371***
	(19.43)	(17.58)	(29.29)	(14.80)	(17.10)	(7.12)
Observations	1855	1855	1855	1855	1855	1855

t statistics in parentheses

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

Table 23: Impacts on other crops, DID model (ITT)

	Off-farm 7d	Off-farm 12m	Off-farm all	Off-farm members	Off-farm share	Off-farm: gold
insured	-0.0369	0.0325	0.0566	0.458	0.0314	-0.0279
	(-0.36)	(0.30)	(0.70)	(1.30)	(1.03)	(-0.31)
=1 if cultivated	-0.00745	-0.0603	-0.0431	0.288**	-0.00368	-0.0464
OGM in 2013	(-0.16)	(-1.23)	(-1.19)	(2.02)	(-0.28)	(-1.21)
Constant	0.0847*	0.263***	0.130***	0.726***	0.0517***	-0.135***
	(1.93)	(4.67)	(3.89)	(4.38)	(3.69)	(-3.74)
Observations	927	927	927	927	927	927

t statistics in parentheses

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

Table 24: Impacts on other crops, IV model (ATE)