Interlinking Product and Insurance Markets: Experimental Evidence from Contract Farming in Kenya*

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Abstract

By requiring the upfront payment of the premium, standard agricultural insurance products introduce a transfer of income across periods. Enforcement limitations typically prevent insurers from offering contracts that only feature transfers across states. Using an RCT implemented in a contract farming scheme in Kenya, we test a novel interlinked product in which the buyer of the crop offers insurance and deducts the premium from farmer revenues at harvest time. Take-up rates at actuarially fair levels are 71.6%, 67 percentage points higher than the equivalent standard contract. We argue that the insurance product jointly addresses multiple potential intertemporal distortions and behavioral biases. Evidence from a second experiment and survey data show that, by removing liquidity constraint concerns, the interlinked insurance achieves better targeting of poorer farmers.

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1 Introduction

One of the key roles of large organizations is to overcome constraints arising from missing markets (Williamson (1975) Williamson (1985)). As an important example in agricultural value chains in developing countries, large firms in contract farming schemes provide input loans to producers that have otherwise limited access to outside credit markets. In this paper, we explore the potential of interlinked agricultural insurance contracts to improve farmer risk management. We show that interlinking product markets and insurance markets addresses some of the fundamental issues that, according to the literature, may spur low insurance adoption rates, such as liquidity constraints, behavioral biases, trust, and enforcement concerns. In turn, the interlinked product induces very high levels of farmer take-up, even at actuarially fair premia.

The welfare gains from insurance come from the transfer of income from those states of the world with low marginal utility of consumption to those with high marginal utility. In the case of production insurance, such as agricultural insurance, this means transferring income from states in which output is high to states in which output is low. Consistent with this premise, leading models of agricultural insurance demand often include purely ex-post transfers between parties (Clarke (2011) Mobarak and Rosenzweig (2012)).[1] However, standard insurance products in the developing world most often feature an intertemporal component. In agricultural insurance, subscribing farmers are typically required to pay a premium in the early stages of the production process, while they receive payout after the harvest is completed if the "bad state" is realized. This implies that, in addition to transferring income across states, standard insurance products lead to a transfer of income across periods (at least in expected value).

Enforcement concerns are a reasonable candidate for this fundamental gap between the canonical idea of insurance and the actual insurance products we observe. In settings where access to courts is limited and the size of each insurance contract is small, it would be extremely hard for third party insurers to enforce any premium payment after a "good state" harvest is realized. This marks a stark difference from developed countries, where contract enforcement is likely to be a smaller issue. For instance, before the 2008 Farm Act,[2] farmers'

[1] A relevant exception is Sarris (2002).
[2] *Public Law 110-234*.

premium billing date for the U.S. Federal Crop Insurance was shortly after the harvest time.

The interlinked insurance contract presented in this paper reduces the enforcement concerns by allowing the insurer to deduct the premium from the amount due to the farmers at harvest time, resulting in transfers of income solely across states and not across time. Payment of the premium through deduction can affect take-up for at least two types of reason. First, when markets are incomplete, standard insurance with upfront payment forces the insured agent to hold a very illiquid form of savings and hence activates any intertemporal distortions, including liquidity constraints and time-inconsistent preferences. Second, the premium in the standard insurance contract is a payment from the farmer to the insurer, whereas the premium in the interlinked contract consist in a deduction, a smaller payment from the buyer to the farmer. While this difference would be irrelevant in neo-classical theories, several behavioral theories suggest it could be important. According to prospect theory, if the payment is counted as a loss, but the deduction as a smaller gain, then the premium would count more heavily in the standard insurance contract. In addition, models of relative thinking suggest that the premium under deduction, being framed in terms of the final payment, could appear smaller to the consumer than the standard premium.

In addition to the opportunity to write more complex types of contracts, data availability represents another potential benefit from interlinking insurance and product markets. For administrative purposes, large buyers in contract farming schemes often collect detailed plot-level data on output and farm sizes, among others. These records, which can span for decades, can address data limitations, a fundamental constraint in the design of area yield products (Elabed et al. (2013)). This may be particularly relevant as area yield products may display lower basis risk than the rainfall index ones (Elabed et al. (2013)).

Interlinkages are an important feature of many agricultural markets in developing countries Bardhan (1980); Bell (1988); IFAD (2003). Contract farming schemes are a noticeable organizational form of such interlinkages. Their penetration has been steadily increasing over the last few decades, with the growth of foreign firm presence and the so called supermarket revolution (Reardon et al. (2012)). For instance, contract farming schemes cover 75% of poultry in Brazil, 90% of cotton and milk in Vietnam, and 60% of tea and sugarcane in Kenya (UNCTAD (2009)). While provision of inputs on credit is the traditional rationale for the emergence of contract farming schemes, we argue that the potential to provide better insurance to production shocks represents another important potential advantage of these organizational forms.

We work in partnership with a Kenyan sugarcane contract farming firm, one of the largest agri-business companies in East Africa. The scheme includes around 80,000 plots, mostly below one hectare. At harvest time, farmers are paid per tons of sugarcane. During the 16-month harvest cycle, the company typically provides several inputs to these plots, including land preparation, fertilizer, transport and harvesting services. Farmers are subject to significant risks, both idiosyncratic and aggregate, from rainfall, climate, pests and cane fires. In this research, we collaborate with the company to test the introduction of an insurance product whose premium is deducted from the harvest proceedings, akin to the input charges, and compare it to the equivalent standard insurance product whose premium is paid up front.

We conduct a randomized controlled trial with 605 farmers who are already contracted with the company. The company offers to all these farmers a double trigger area yield insurance product, where payout occurs if both plot yields and area yields are below a certain threshold of their respective predictions (Elabed et al. (2013)). In the first group, farmers who sign up pay upfront the premium at "full price", which equals 85% to 100% of the actuarially fair value across the sample. In the second group, the upfront insurance premium is discounted by 30%. In the third group, farmers who sign up pay the premium through deduction at harvest time. For this group, the premium is set at the "full value" plus interest charges, at a rate roughly equal to the one the company charges on input loans. The premia for the first and third group are therefore equivalent in net present values from the company standpoint.

Take-up rates under the full price, standard insurance are 4.6%, low but not inconsistent with the rates of many other smallholder insurance studies when the value of premium is close to actuarially fair. The 30% discount makes little difference: the take-up rate in the second group is 5.9%, not statistically different from the previous one at conventional levels. Take-up in the interlinked group, however, is 71.6%, making payment through deduction among the most effective ways observed of increasing insurance take up at actuarially fair levels.

These results suggest that the intertemporal transfer required by the upfront premium may be an important driver of low insurance take-up. Within the class of intertemporal reasons several mechanisms are candidates. The most obvious one is liquidity constraints, which are widely documented in populations similar to the one targeted by the experiment. Consistent with this hypothesis, in a second experiment, we find that take-up rates in the upfront premium group increase from 13% to 33% when giving farmers cash transfers worth the amount of the insurance before offering the product (similar to Cole et al. (2013a)).[3] However, this 20 percentage point increase is still much smaller than the 63 percentage point increase observed in this second sample when offering the insurance through the interlinked contract and reciprocity concerns suggest that this is an upper bound. This is consistent with the hypothesis that some farmers may be credit constrained on many dimensions, thus using the cash transfer for usages other than the insurance purchase. In addition, even when not liquidity constrained, some farmers may value the insurance below its premium when this has to be paid upfront. Consistent with the results from this second experiment, heterogeneity analysis from the main experiment also shows that poorer households are differentially more likely to take-up the deduction premium insurance than the standard upfront one.

Interlinkages between product and insurance markets provide a feasible mechanism to enforce payments of the premium at harvest time. Evidence that farmers increase their investments and production when subscribing for agricultural insurance (Karlan et al. (2014)) provides another rationale for interlinked contracts. If product buyers are partial residual claimant on the farmer production - for instance because of imperfectly competitive downstream markets - they make a profit on the additional quantities produced by the farmer. This implies that, unlike a third party insuring agent, they do not need to necessarily break even on the insurance sales. In the paper we also argue that, by making the introduction of multi-year subscription feasible, interlinked product-insurance contracts may also increase re-insurance rates; something that other studies find to be low particularly following a year with no payout (Karlan et al. (2014); Cole et al. (2014)).

In the paper we also discuss potential drawbacks, such as limited understanding of the product and side-selling risk (i.e. the option for farmers to sell to other buyers, thus defaulting on the insurance premium loan). We argue that neither of these are first order concerns in many other settings and, more generally, in scaling up these products to other contract

[3]This experiment is at a substantially smaller scale than the main one and its details were not included in the trial registration description.

farming environments. We conclude by discussing feasibility of similar products beyond contract farming settings.

This paper is mainly related to two strands of literature. First, numerous papers have investigated the demand for upfront agricultural insurance and the factors which constrain it. Demand for such insurance at actuarially fair prices is typically found to be low: Karlan et al. (2014) find the highest take-up rates among these studies, at around 40%, and many find lower rates Cole et al. (2013a). Theories for these low take-up rates have tended to focus on risk preference reasons, such as basis risk and risk aversion Clarke (2011); Elabed et al. (2013), rather than intertemporal reasons. Interventions to increase insurance take up have had mixed results, often with sizeable impacts in percentage terms but small impacts in percentage pointsCole et al. (2013a). Other studies have attempted to interlink insurance and credit markets (Gine and Yang (2009); Karlan et al. (2014); Banerjee et al. (2014); Liu et al. (2013)). Most of these studies find low additional take-up for these products when compared to traditional loans. Indeed two of them Gine and Yang (2009) Banerjee et al. (2014) find that demand for credit actually decreases when bundled with insurance, the former arguing that farmers often already have an implicit insurance through the limited liability constraint. This points exactly at the enforcement concerns the interlinkage between product and credit markets aims to address. Liu et al. (2013) find that, in the context of a government-run and highly subsidized indemnity insurance in China, allowing the farmer to pay at the end of the insurance contract period raises take-up rates from 5% to 15.7%.[4]

Second, a significant literature exists on the importance of interlinked transactions in agriculture. Bardhan (1980), Bardhan (1989), and Bell (1988) summarize a large body of theory looking at transactions that relate land, labour, product, and credit markets. In particular, our work is related to the body of research that documents the presence of informal insurance agreements in output and credit market contracts (Udry (1994),Minten et al. (2011)). The paper also relates to a more recent line of empirical research on the emergence and impact of interlinked transactions (Casaburi and Macchiavello (2014), Casaburi and Reed (2014), Casaburi et al. (2014), Ghani and Reed (2014), and Macchiavello and Morjaria (2013) Macchiavello and Morjaria (2014)). In particular,Casaburi and Macchiavello (2014) discuss how

[4]A number of papers investigate the impact on sales of offering on credit health products, such as insecticide-treated mosquito nets and water filters (Tarozzi et al. (2014); Guiteras et al. (2013)).

reputation allows large firms to credibly provide interlinked services to their suppliers. While they focus on the interlinked provision of saving services, some of the arguments apply to insurance products, too.

To the best of our knowledge, this is the first paper to conduct a field experiment that explores the potential of interlinking product and insurance markets and highlights the impact of deduction premium payment on take-up. In contemporary work to ours, Carter (2014) show in a field lab experiment with contract farming in Burkina Faso that the framing of the premium has an impact on take-up, consistent with Andreoni and Sprenger (2012)).

The remainder of the paper is organized as follows. Section 2 describes the setting in which the experiment took place, the design, marketing and costing of the insurance product offered, and the experimental design. Section 3 discusses our main results and benchmarks them against existing studies. It also discusses potential channels for the results and reports treatment heterogeneities and results from an additional, smaller experiment. Section 4 concludes the paper with a discussion of the applicability of similar interventions in other settings. It discusses both the potential of insurance products that do not require an upfront payment and the possibility of interlinking product and insurance markets to solve the associated enforcement problem.

2 Experimental setting and design

2.1 Setting

We work in partnership with a Kenyan sugarcane contract farming firm which contracts with around 80,000 farmers and is one of the largest agri-business companies in East Africa. Farmers enter in to a contract with the firm and are subsequently provided inputs such as seedcane, fertilizer and land preparation on credit, to be deducted from their harvest revenues. The harvest is typically sixteen months after planting and the farmers are bound by the contract to sell their harvest to the company. Harvests are weighed and farmers are paid per ton, at a price set by the Kenyan Sugar Board, minus the cost of the inputs provided (plus interest). All input costs and revenues are recorded by the firm in an administrative database. The fact that yields are already recorded is a huge benefit from interlinking insurance and product markets since the administrative cost involved in measuring yields typically makes doing so prohibitively expensive for use in insurance. The firm recruits farmers using outreach workers. Because of fixed costs in input provision the outreach workers must group neighboring plots into administrative units called fields which can be provided inputs concurrently. In our study sample, fields contain on average 8.7 plots. Contracted farmers are typically subsistence farmers growing mainly Maize. However, some plots are owned by “telephone farmers” who live far from the plots and manage them remotely. The average plot size in our sample is 0.81 acres (0.32 hectares).

Cane seed lasts upwards of three cycles (one Plant and two Ratoon), each lasting sixteen months, so a typical contract lasts at least four years. The first cycle, called the Plant cycle, involves higher input costs and hence lower profits then the subsequent cycles, the Ratoon cycles. Yields decline over cycles and are subject to risks from rainfall, climate, pests and cane fire. Crop failure is rare but crop yields are subject to significant variation.

2.2 Experimental Design

The aim of the experiment described in this paper was to test the potential of interlinked insurance contracts to increase take-up rates relative to standard insurance contracts. The environment described above presents an ideal setting for the evaluation and potential scale-up because of the large number of outgrowers, a long panel data of production and farmer characteristics, and important production risks. Additionally the long, sixteen month growing cycle for sugarcane in the region means that the difference between upfront insurance and deductible insurance is particularly stark.

The insurance product offered was a double trigger area yield insurance. Since risk factors other than rainfall affect yields, this was preferred to a standard rainfall insurance product.[5] The payout is disbursed if two conditions are triggered. First, plot yield has to be below 90% of its predicted level. Second average yield in the field must be below 90% of its predicted level.[6] The design borrows from other studies that have used similar double trigger products in different settings (Elabed et al. (2013)). The product provides partial insurance. In the

[5]The company does collect rainfall information through stations scattered across the scheme. However, data quality issue is a concern and the predictive power of this rainfall data is low.

[6]In future work, we plan to explore the relative benefits of varying the size of the area upon which the second trigger is based. An expansion in this size can induce a trade off between basis risk and collective moral hazard.

states where the conditions are triggered, it covers half of the plot losses below the 90% trigger, up to a cap of 20% of the predicted production revenues.

Computation of predicted yields at the plot and area level was based on a rich plot level administrative panel data. This included information on production levels, plot size, plot location, and production cycle, among others. The data were available for a subsample of plots for the period 1985-2006 and for the entire scheme from 2008 onwards. This made it possible to run several simulations of alternative prediction models to compare predictive power and costing of the insurance products.

In particular, we use the simulations to verify the performance of the double trigger. The product performs quite well in terms of basis risk. The proportion of farmers who receive a payout when the second area-level trigger is added is about 74% of those who would receive it with a single-trigger insurance. Preliminary calculations suggest that this does much better than an alternative product based on rainfall indexes.

Costing of the insurance varied slightly across the pilot, taking values between 85% and 100% of the actuarially fair value. For those farmers who were offered the opportunity to pay insurance product through deduction, the company charged an interest rate similar to the one charged on other loans (around 1% per month).[7]

The insurance marketing targeted 938 plots in the early stages of the ratoon cycles (first, second, and third). This choice was driven by the fact that the yield prediction model performs better for ratoon than for plant cycles, since previous yields within the same contract, which are available only for ratoon cycles, are a much better predictor of current yields than yields of harvests in a previous contract. The study targeted most of the company catchment area, with the exception of some locations where other companies compete for the same farmers and therefore the risk of side-selling is higher. Further restrictions applied based on plot size (large plots were removed from the sample), plot yields (outliers excluded), the number of plots in the field (the study targeted only fields with at least five plots), the number of plots per farmer (within each field, the few farmers with multiple plots were eligible to receive insurance in only one of those) and the number of farmers per plot (plots owned by groups of farmers were excluded from the sample). In addition, the study focused on non-telephone

[7]For this group, the expected interest was added to the initial premium when marketing the insurance product.

farmers.

The company offered the double trigger area yield insurance described above to each of the farmers. The product was marketed through village visits during which a short baseline survey was conducted. Importantly, the specific purpose of the visits was not announced in advance. 639 of the 938 target farmers (68.1%) attended the meetings. The primary reason (75%) for non attendance was that these farmers were busy somewhere far away from the meeting location. In the initial stage of the meeting, marketing officers confirmed the target farmers mastered very basic concepts required to understand the insurance (e.g. the concept of tonnage and of acre). A small number of farmers (5.3%), typically elder people, was deemed non eligible at this stage. The final sample for the randomization was 605 farmers. Comparing to the 333 who did not enter the sample, these farmers had slightly larger plots (0.81 vs. 0.75 acres; p-value=0.015) and similar yields (138.7 vs. 136.2 tons per acre; p-value=0.41)

Marketing officers described in detail the product in subsequent one-to-one meetings with each farmer. They provided plot-specific visual aids concerning insurance triggers and payout scenarios. In addition, before offering the product, they verified the target farmer could answer correctly basic questions on the product and re-explained it if not. Farmers then had three to five business days to subscribe. Given the small plot sizes, farmers could only subscribe for the entire plot, not just for parts of it.

Randomization for the first and main experiment occurred at the farmer level and was stratified by field. In the first group (A1), farmers were offered the opportunity to subscribe for the product by paying upfront the premium. The premium was charged at "full" value, which across the study spanned between 85% and 100% of the actuarially fair one. In the second group (A2), subscription was again by upfront payment but farmers received a 30% discount relative to the full value. Finally, in the third group (B) farmers could subscribe for the insurance with the premium (full value) and the interest charges deducted at harvest time, similar to charges for the other inputs the company supplies.

Table 1 provides descriptive statistics for the three treatment groups for both administrative data and survey data. Since stratification occurred at the field level, we report p-values capturing the differences across the groups that are obtained from regressions that include field fixed effects.[8] Consistent with the specification we use for some of our analysis, we also report p-values when bundling treatments A1 and A2 and comparing them to B.

Table 1 suggests that the randomization mostly achieved balance across the observed covariates. However, there are variables that differ across some of the three groups, such as respondent age and plot size. While it is important to be aware of these differences, it is unlikely they have a first order impact on our conclusions. First, most of these differences are of small magnitude. For instance, average farmer age in group A2 is 6.3% higher than in group B. These magnitudes can hardly drive the large variation in take-up across treatment groups we document in the next section. Second, only age is significantly different when comparing the bundled A group (A1+A2) to B. On the other hand, the take-up results are found even in these comparisons. Third, we verify that the point estimates of the analysis are virtually unchanged when including controls for the baseline variables.

In order to provide supportive evidence for the role of liquidity constraints, we ran another smaller-scale experiment. In this design, we cross-cut the upfront vs. deduction premium treatment (at full value) with a cash drop that was worth roughly the amount of the insurance. The latter treatment mimics closely Cole et al. (2013a), who find that a cash gift of roughly the cost of one unit of their insurance increased take up by 40 percentage points. The purpose of this further experiment is both to study the impact of the cash drop and to compare it with that of the deduction premium payment option. Randomization for this second experiment achieved substantial balance across observable baseline covariates, as documented in Table A.1.

3 Results

3.1 Main Results

Achieving high take-up rates at premia close to the actuarially fair value has consistently proven hard across a wide range of geographical settings and product characteristics (Cole et al. (2013a); Elabed et al. (2013); Mobarak and Rosenzweig (2012)). However, gains from insurance, both direct and indirect, could be large in many settings: farmers are subject

[8] This also implies that characteristics that do not vary across field, such as location, specific ratoon cycle and average field yield are perfectly balanced across treatment groups.

to substantial income risk from which they are unable to shield consumption. In addition, previous studies suggest that when farmers access agricultural insurance they increase their investment levels (Karlan et al. (2014); Mobarak and Rosenzweig (2012); Cole et al. (2013b)).[9] Gains from insurance could be being forgone because of an important difference between standard actual insurance products and canonical insurance; farmers may want risk protection but not illiquid savings. With this in mind, the main outcome of interest of the analysis is a farmer take-up binary indicator.

Figure 1 summarizes the take-up rates across the three treatment groups. For groups A2 and B, it also includes 95% confidence intervals of the difference from A1, obtained from a simple regression of take-up on treatment dummies. The first striking result is the low take-up rate in the baseline group. Average take-up for farmers offered insurance through an upfront premium at full value is 4.6%. Remarkably, this suggests that, at least in our setting, reducing basis risk through the area yield double trigger design is not enough to raise adoption rates. From this perspective, availability of rich plot-level data, one of the main advantages a large firm may bring to insurance design, is not sufficient to generate high demand for insurance. It must be noted that, while these rates are very low, they are also consistent with many of the other studies mentioned above.

The second stark result of the study is that the interlinked insurance contract increases take up rates to 71.6%. This amounts to an increase of 67 percentage points from the baseline (A1) level. As discussed above, the main feature of this design is to allow premium payment to occur through deduction from the harvest proceeds. Importantly, the payment options are equivalent in net present value terms, because of the interest rate adjustment.

The third result, which allows us to benchmark the first, is that offering a 30% discount, while retaining the requirement to pay the premium upfront, has no statistically significant impact on take-up rates. Even when considering the upper bound of the confidence interval, rates only increase by 7.7 percentage points.

Table 2 presents regression analysis of the treatment effects. Column (1) reports the coefficient from the simple regression used to generate the histogram in Figure 1. Column

[9]Due to the limited sample size of the pilot described here, we have limited power to study the impact on farmer investment and yields. Consistent with this premise, we only included take-up as outcome in the registration plan submitted to the AEA RCT Registry. In future work we plan to test the impact of insurance on these outcomes, although not upfront vs. deductible insurance. The impact on productive investment may be smaller in the case of contract farming, since many inputs are already provided on credit.

(2) adds fixed effects at the field level, the stratification unit. The results are virtually unchanged. Column (3) pools A1 and A2, consistent with the specification we use later in the heterogeneity analysis. Column (4) and (5) further add controls for plot and farmer characteristics, respectively. Finally, Column (6) includes both types of controls. Throughout the table the coefficients display remarkable stability. This is likely to ease concerns arising from some of the baseline unbalance documented in Table 1.

One concern with the high take-up is that the current design may lead farmers to excessive excessive subscription and potential regrets. In order to alleviate this concern, several months after the recruitment, we called back 40 farmers who had signed up for the insurance. We confirmed that all of them had understood the nature of the product and the meaning of the double trigger. We then ask if they would sign again for the product. 80% said they would while 7.5% said they would not. The remaining 12.5% stated that their choice would depend on the outcome of the current cycle. This results suggest that, several months after the recruitment, most farmers do not regret signing up. We also note that the insurance product does not bring any immediate monetary benefit. There is a fundamental difference between the sale of goods on credit and the provision of insurance through deduction premium. In the former, there costs are borne after the benefits. On the contrary, the latter eliminates the time gap that standard insurance products feature.

Two types of channels could be driving the results are intertemporal distortions and behavioral biases associated with payments as deductions being counted differently to outright payments. The results show that a combination of the two together form a large barrier to insurance take up and that providing canonical insurance by creating interlinkages between product and insurance markets goes a long way in achieving high take-up levels. Recent research has focused on other, risk preference reasons affecting insurance take-up such as the role of social networks (Mobarak and Rosenzweig (2012); Cai et al. (2013)), basis risk (Elabed et al. (2013); Clarke (2011)), and financial literacy (Cole et al. (2013a)). However, interventions focusing on these elements were typically either conducted in the context of highly subsidized products or the interventions themselves were very expensive. On the other hand, so far, it has been hard to achieve take-up rates at the levels presented in this section when selling the insurance at actuarially fair premia in a commercially viable manner. We argue that the contract introduced in our experiment induced such high rates by assessing several of the key drivers of take-up - liquidity constraints, impatience, loss aversion, and trust - at once.

3.2 Channels

Liquidity constraints are a likely candidate to explain the strong impact of the option to pay the premium through harvest time deduction. Several studies have documented the relevance of these constraints among similar populations in the region of the study (Duflo et al. (2011); Cohen and Dupas (2010)). These constraints may reduce demand for standard insurance products if they bind or if, in a buffer-stock argument, farmers expect that they may be binding in some state of nature over the cycle.

Lack of cash was, unsurprisingly, the main reason farmers mentioned when asked about their choice not to take-up the products in group A1 and A2. In order to provide evidence on this specific channel, we designed a second experiment, which targeted a different sample of 120 plots. We cross cut the treatments A1 and B of the main experiment with a cash drop treatment. In the latter, during the baseline survey, farmers were given an amount of cash, which was roughly worth the value of the insurance premium. The treatment mimics closely one of the arms in Cole et al. (2013a). This cross-cut design with the main treatment allows us to test whether the impact of the cash drop varies across the upfront vs. deduction premium payment groups, as well as assessing the relative impact of the cash drop compared to the premium deferral. Figure 2 presents the results. First, it is reassuring to note that, in this different sample, the comparison between the upfront and the deduction premium groups resembles that of the main experiment. Take-up rate for the upfront group is slightly larger (13%), but, again, introducing the deduction payment option massively raises take-up (up to 76%).

Second, we note that the cash drop raises substantively the take-up rate in the upfront group (up to 33%). However, the impact of the cash drop is much smaller than that of the deduction premium. This is consistent with the hypothesis that farmers may decide to use the additional money for other purposes (e.g. consumption, labor payments, school fees) and that credit constraints also affect consumption smoothing and investment in these activities.

Third, we note that the cash drop also has an impact on take-up rates in the deduction group (from 76% to 88%). This is consistent with a wealth effect of the money transfer. It is also consistent with a potential reciprocity channel, whereby some farmers may feel obliged to purchase the insurance after receiving the transfer. Fourth we note that the impact of the cash drop among the farmers offered the deduction premium option is about half of the impact for farmers who have to pay the premium upfront.

Table 3 confirms the patterns described above. Column (1) presents the basic level impact of the cash drop and deduction premium treatments. We add field fixed effects in column (2) and additional controls in column (3). Across these specifications, we can always reject the null on the equality of the two treatments at the 1% level. In columns (4) to (6), we then look at the interaction between the two treatments. The coefficient on the interaction is always negative. While the point estimate is large relative to the cash drop coefficient in the upfront group, our sample size is too small to obtain a precise estimate.

We then complement this analysis by looking at treatment heterogeneity by farmer wealth in the main experiment. The impact of wealth on take-up of insurance products with ex-ante premium payment is ambiguous. If liquidity constraints are indeed a major barrier to demand, wealthier people may be more likely to purchase the insurance. However, higher wealth also means better access to other sources of consumption smoothing, including one's own savings. Access to better alternatives may decrease the demand for formal insurance. The net impact of these two channels is unclear. However, for the case of insurance with deduction premium payment, the liquidity constraint channel is likely to be muted. This implies that we may expect differentially lower take-up of the deduction premium insurance, relative to the ex-ante one, for wealthier households.

In the baseline data, we collected several measures related to the farmer wealth and cash availability. These include number of acres cultivated, number of cows owned, access to savings and yield levels in the previous harvest. Table 4 presents heterogeneous treatment effects by these variables. In order to gain power, we bundle together treatment groups A1 and A2.[10] While not all of the interaction coefficient estimates are precise, the results in the table suggest that indeed wealthier households are differentially less likely to take-up the insurance when the premium is to be paid through harvest deduction. From a policy perspective, this result implies that the product with deduction premium payment may be particularly beneficial for poorer farmers, who are typically in stronger need for novel risk

[10] We mentioned this option when registering the trial.

management options.

The insurance design with deduction premium payment may also help to solve the trust issues concerning the introduction of the insurance among a population with no experience in similar products. Trust has been shown to be an important issue in shaping take-up (Cole et al. (2013a), Liu et al. (2013)). Farmers may be concerned that there is some probability that the insurance does not pay out even if it should do so according to the contractual terms (for instance if the insurance company defaults). This may decrease their willingness to put money down in a standard insurance contract. The deferral option improves this worst-case scenario. If the insurance company defaults, at least the farmer will not have to pay the premium. Consistent with this hypothesis, in a survey to a random sample of farmers who did not take-up the product in the upfront groups, trust concerns and payout payments are the second most common answer (after lack of cash). In addition, we collected several variables related to trust and relationship with the company. However, the heterogeneity analysis does not deliver any clear conclusion. In addition to limited power, it is possible that the variables do not capture properly the expectations and trust concerning the specific product. We report the results in A.2. While the failure to detect heterogeneity in treatment effect along these variables poses an obvious caveat, qualitative evidence from the survey provides suggestive evidence that the interlinked insurance contract may help to address trust issues and we hope it will motivate further work on the topic.

Further, it seems plausible that features of intertemporal preferences, including behavioral considerations, may play a role in shaping the high difference in demand for upfront vs. deduction. Demand for the interlinked product may be higher for several reasons. First, impatience rates of farmers may be higher than the interest rate charged by the company. Second, some farmers may have present biased preferences (Loewenstein et al. (2003); Duflo et al. (2011)), which would further magnify the impact of postponing the payment.

Finally, at least two behavioral theories unrelated to the intertemporal transfer could be driving the result. Both suggest that payments as deductions could counted differently to outright payments. From a prospect theory standpoint (Kahneman and Tversky (1979); Kőszegi and Rabin (2007)), payments may fall in the *loss* domain, while deductions may be perceived as *lower gains*. The fact that farmers may be sensitive to losses than gains may partially explain the large response to the structure of premium payment. Similarly, according to relative thinking (Tversky and Kahneman (1981);Azar (2007))the premium could be perceived as large when farmers consider it as an isolated expense, but as a small amount once farmers consider it as a share of their product revenues.[11]

Preliminary analysis on heterogeneous treatment effects by intertemporal preferences proxies as measured in the baseline survey does not lead to conclusive results for separating the intertemporal and non-intertemporal channels, possibly because of measurement issues and limited statistical power. We plan to further explore this topic in future work, including with additional experimental designs.

4 The Potential of Interlinked Insurance Contracts

We have documented that introducing the option of paying premia through harvest deduction goes a long way in reaching high levels of smallholder insurance take-up at actuarially fair premia, a challenge documented by a growing body of work. In doing so, the results point to the benefits of interlinking different agricultural markets. Numerous such interlinkages exist, but rigorous empirical evidence on why these types of contracts emerge and on their impact on the welfare of agents in the agricultural value chain is still limited. We argue that the design we developed with the partner company addresses at once all the intertemporal distortions which could be causing low insurance take-up: liquidity constraints, time preference concerns, loss aversion, and trust; while also framing the premium payment in a way which insights from behavioral economics suggest could significantly increase demand.

Contract farming schemes represent a natural setting to develop, test and scale-up this type of insurance product. Importantly, it must be noted that contract farming is an organizational form of intrinsic interest. The relevance of these schemes in developing countries is growing steadily, especially in cash crops, which may represent the driver of modernization of the agricultural sector (UNCTAD (2009)). In contracts with exclusive buyers, the deduction payment can be enforced, and thus the canonical insurance product with just ex-post transfers can be made incentive compatible. In an interesting application of the theory of the second best, a market failure in one market, the product market, helps to alleviate a market failure in another market, the insurance market. Second, these companies often collect very

[11] We thank Nathan Nunn for pointing at this explanation.

detailed production data, as well as a range of information about the contracting farmers. These can be used to compute yield prediction at the plot and area level, and in turn design area yield insurance products. This is particularly valuable as lack of reliable production data is often considered one of the main hindrances to the development of such products It also means that administrative costs of the insurance can be very low. The buyer is already contracting with the farmer and payment mechanisms are in place. Another potential benefit from interlinked insurance markets arises from the fact that, under imperfect competition, buyers are often partial residual claimant on additional farmer production. In studies from other settings, those farmers that, in response to exogenous experimental variation, take-up insurance products increase their level of investment, as well as changing its composition (Karlan et al. (2014); Mobarak and Rosenzweig (2012); Cole et al. (2013b)).[12] In turn, this implies that providing insurance to farmers may induce additional profits to the product buyers by raising farmer output. Therefore, insurance sellers in the interlinked contract may not need to make profits, or even break even, specifically on the insurance markets, since their main benefit in offering the insurance product may come from the product market. On the other hand, insurance-specific profits are a requirement of standard insurers in non-interlinked transactions. Similarly, on the extensive margin, availability of similar insurance products may induce more farmers to enter contract farming schemes as these often imply a shift toward crops with higher mean profits but also higher variance.

The buyer will be best placed to provide insurance to farmers when farmers face idiosyncratic risks, which can be diversified across farmers. One concern of interlinking product and insurance markets, in the case of large aggregate risk, is that the insurance does magnify the risk already faced by the buyer. First, a large firm does not necessarily need to diversify risk within a year. Rather, better access to credit markets implies that the risk diversification at the company level can occur across years. However, it must also be noted that the purchasing agents do not need to be the ultimate risk bearer. Reinsurance of the buyer should be much easier than insurance of the farmers themselves, since the buyers are often large companies that can easily be taken to court, alleviating enforcement concerns.

Finally, given that many contract farming schemes typically include tens of thousands of

[12] As a caveat, the impact on investment in contract farming may be smaller than in other settings, as numerous inputs are already supplied on credit.

farmers, these settings also represent a unique opportunity to diffuse these products to a large number of smallholders in a cost-effective way. The gains are particularly salient in the case of agricultural insurance, since interlinking allows us to remove the intertemporal transfer which is superfluous to the gains from insurance. However it is obviously not specific to agricultural insurance; interlinking can ease credit constraints or behavioral biases for other inputs or products too. For instance, Sedlmayr et al. (2013) used a list of farmers contracting with a cotton contract farming company in Zambia to distribute mosquito nets to around 40,000 farmers.

Side-selling opportunities - whereby the farmer sells to another buyer defaulting on her existing debt - represent a potential concern for the product described in this paper.[13]The concern is that in years of good harvest, the farmer sells to another buyer in order to avoid paying the insurance premium. An obvious point is that these contracts are more feasible in settings where the contract farming functions well, for instance because of crop perishability, transport costs and limited competition Bijman (2008). However, in many settings we argue that the inclusion of an additional loan to cover the insurance premium is unlikely to generate large marginal side-selling incentives for several reasons. First, the value of the insurance premium is likely to be much smaller than pre-existing input loans, such as seeds and fertilizer. Second, for a range of outcomes, the farmer will have limited ability to observe the exact output before the harvest weighing, and therefore to assess whether she will quality for a payout or not. Third, the choice of strategic default depends on the comparison between the static benefits of the default and the continuation value of the relationship. The interlinked contract implies that the latter terms includes not only the benefit from accessing the relationship in future periods, but also all the other gains arising from the interaction with the buying company, including product purchase reliability and input provision. In other words, default on the insurance loan become much more costly in this contract that in a standard non-interlinked one. Further, if the farmers value access to insurance in future years, offering it would increase the continuation value of the relationship, and hence insurance provision could actually reduce the occurrence of side-selling.

Interlinked contracts may also have the potential to assess another key issue concerning

[13]For instance, Macchiavello and Morjaria (2014) show that, in the context of coffee in Rwanda, higher competition reduces input loans.

take-up: the low levels of farmer re-insurance in years following a year with no payout. For instance, Karlan et al. (2014) document a 17 percentage point lower take up rate among farmers who were insured in the previous season and did not receive a payout compared to a base take up rate of 44% among farmers who were uninsured in the previous season. Similar results are found in Cole et al. (2014) who further document that the impact of recent payouts on re-insurance falls over time. If farmers need to experience at least one year of payout to fully realize the value of insurance, then a potential approach would be to have farmers subscribing in the first instance for a number of years that is long enough to have a high chance of at least one payout along the duration of the insurance. In interlinked contracts, farmers could subscribe for multiple years and the premium for a specific year would then be deducted at the end of each harvest. While making the commitment for multiple years feasible, the design would not require the payment of a premium for many years at once, but rather rely on a mechanism that make yearly payments enforceable. One weaker commitment design, based on a form of nudging (Sunstein and Thaler (2008); Duflo et al. (2011)), would leave farmers an opt-out option in each year. Evidence from other settings suggest that such opt-out rates are typically very low (Choi et al. (2003); Beshears et al. (2009)). A multi-year experiment was not feasible in our specific case. We believe this is a promising avenue for future research.

Finally, a key question concerns the feasibility of the interlinked insurance product described in this paper in settings beyond contract farming. First, cooperatives and farmer groups represent another important organizational form where this interlinked contract may be feasible. These organizations often group harvests from their member farmers and then sell to one (or few) buyers. A specific buyer could provide insurance to the individual members and then rely on the cooperative, and on the social capital embedded in them, to enforce the product sales. Second, even in settings where coordinating institutions such as cooperative are lacking, enforcement could still be achieved if buyers could partner with the banks where farmers hold savings account. In a case in which the farmer sells to somebody else, the bank could agree to transfer at harvest time the premium amount from the farmer saving account to the buyer who offered insurance. The obvious caveat is that farmers may change the financial institution where they hold their money. However, rural producers have typically access to few banks. In addition, switching costs (i.e. account opening and closing costs) are typically high. We are aware these ideas are speculative at best at this stage. However, given the high promises that interlinked contracts have shown in our experiment, we believe they fully deserve further exploration.

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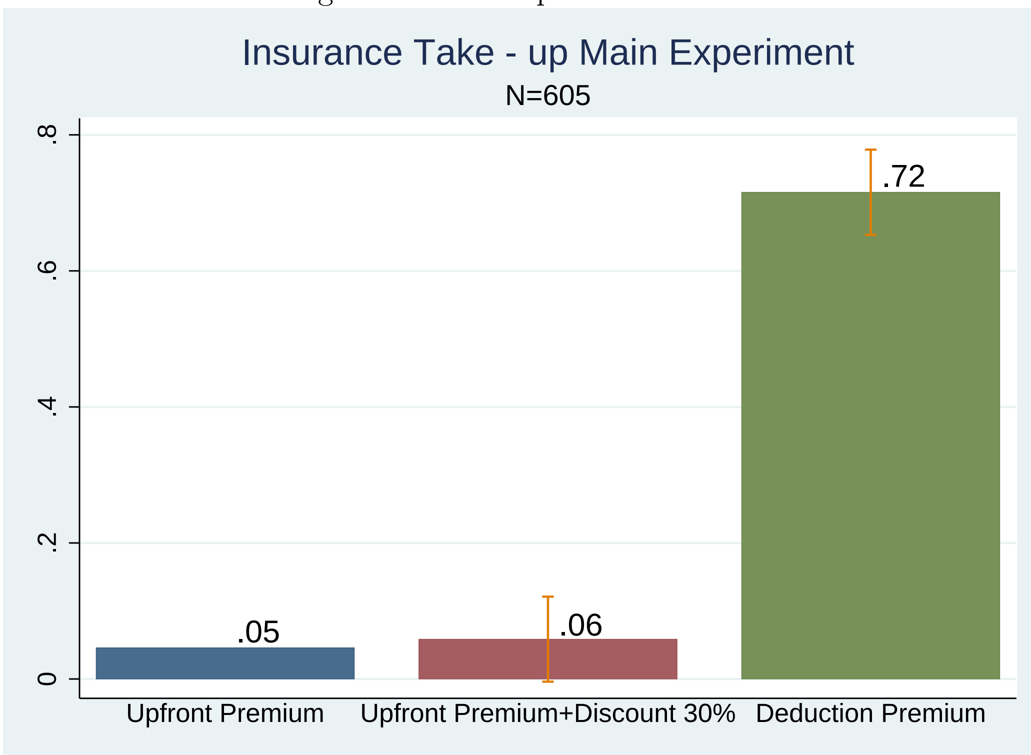
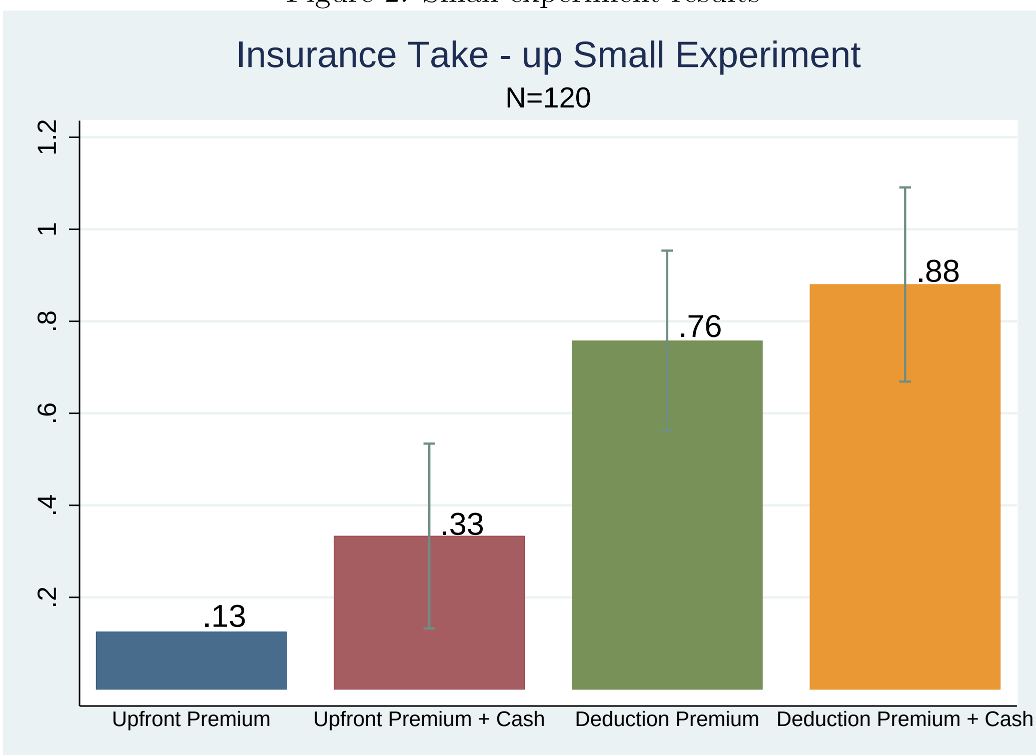
Figures

Figure 1: Main experiment results



Notes: The figure shows insurance take up rates across the three treatment groups in the main experiment. The bars capture 95% confidence intervals

Figure 2: Small experiment results



Notes: The figure shows insurance take up rates across the four treatment groups in the small experiment. The bars capture 95% confidence intervals

Tables

Table 1: Balance table for main experiment (with field FE)

	A1 [A1]	A2 [A2]	B [B]	P-value [A1-A2]	P-value [A1-B]	P-value [A2-B]	P-value [A-B]	N
Plot Size	.3092	.3401	.3193	.012**	.187	.219	.875	605
	(.1288)	(.1471)	(.1337)					
Yield (t-1)	53.93	56.80	55.72	.23	.112	.67	.581	605
	(17.29)	(18.00)	(17.71)					
Woman	.3296	.2680	.3282	.114	.732	.387	.779	571
	(.4713)	(.4440)	(.4707)					
Age	48.38	48.30	45.41	.983	.06*	.019**	.023**	568
	(13.59)	(14.21)	(11.71)					
Land Cultivated (Acres)	3.212	3.153	2.819	.734	.978	.259	.674	561
	(6.485)	(4.026)	(2.980)					
Any Cow	.7611	.8082	.8031	.22	.209	.952	.452	566
	(.4275)	(.3946)	(.3986)					
Savings for Sh1,000	.2849	.2797	.3333	.936	.273	.362	.207	564
	(.4526)	(.4500)	(.4726)					
Good Relationship with Company	.3626	.3419	.3005	.821	.357	.933	.553	568
	(.4820)	(.4756)	(.4596)					
Trust Company Field Assistants	3.027	2.834	2.803	.163	.11	.877	.347	567
	(1.013)	(1.017)	(1.090)					
Trust Company Managers	2.469	2.340	2.445	.319	.999	.513	.678	565
	(1.113)	(1.058)	(1.126)					

Notes: P-values are based on specifications which include field fixed effects. *p<0.1, **p<0.05, ***p<0.01.

Table 2: Main experiment results

	(1)	(2)	(3)	(4)	(5)	(6)
A2: Reduction 30%	0.013	0.004		0.013	0.005	0.016
	[0.032]	[0.033]		[0.033]	[0.032]	[0.033]
B: Deferred Premium	0.670***	0.675***	0.673***	0.680***	0.682***	0.690***
	[0.032]	[0.033]	[0.028]	[0.033]	[0.032]	[0.032]
Field FE	N	Y	Y	Y	Y	Y
Plot Controls	N	N	N	Y	N	Y
Farmer Controls	N	N	N	N	Y	Y
Mean Y Control	0.046	0.046	0.052	0.046	0.046	0.046
Observations	605	605	605	605	605	605

Notes: The dependent variable is take up of insurance. Specification 3 groups treatments A1 and A2. Stratification occurred at the field level. *p<0.1, **p<0.05, ***p<0.01.

Table 3: Small Experiment Results

	(1)	(2)	(3)	(4)	(5)	(6)
B: Deferred Premium	0.593***	0.603***	0.597***	0.633***	0.635***	0.649***
	[0.074]	[0.077]	[0.075]	[0.100]	[0.105]	[0.103]
Cash	0.167**	0.132*	0.140*	0.208**	0.167	0.195*
	[0.074]	[0.079]	[0.077]	[0.102]	[0.110]	[0.107]
B * Cash				-0.086	-0.071	-0.114
				[0.148]	[0.156]	[0.153]
Field FE	N	Y	Y	N	Y	Y
Plot Controls	N	N	Y	N	N	Y
Mean Y Control	0.125	0.125	0.125	0.125	0.125	0.125
P-value: B = Cash	0.000	0.000	0.000	0.000	0.000	0.000
Observations	120	120	120	120	120	120

Notes: The dependent variable is take up of insurance. Randomization was at the field level so *p<0.1, **p<0.05, ***p<0.01.

Table 4: Main Experiment: Heterogeneity by Wealth

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Land Cultivated (Acres)	0.000	-0.000						
	[0.003]	[0.003]						
... *B	-0.017**	-0.018**						
	[0.008]	[0.009]						
Any Cow			0.008	0.070				
			[0.040]	[0.045]				
... *B			-0.082	-0.141*				
			[0.069]	[0.079]				
Savings for Sh1,000					-0.039	0.008		
					[0.036]	[0.043]		
... *B					-0.110*	-0.175**		
					[0.060]	[0.069]		
Yield (t-1)							0.001	0.001
							[0.001]	[0.001]
... *B							-0.005***	-0.004**
							[0.002]	[0.002]
B: Deferred Premium	0.748***	0.759***	0.766***	0.823***	0.737***	0.764***	0.915***	0.922***
	[0.036]	[0.038]	[0.062]	[0.069]	[0.033]	[0.035]	[0.090]	[0.101]
p-value $\gamma + \delta$	0.029	0.024	0.194	0.270	0.002	0.003	0.002	0.014
Field FE	N	Y	N	Y	N	Y	N	Y
Observations	561	561	566	566	564	564	605	605

Notes: The table shows heterogeneity of insurance take up by different wealth proxies, as well as their interactions with deducatable premium. The dependent variable is take up of insurance. *p<0.1, **p<0.05, ***p<0.01.

A Appendix

Table A.1: Balance table for small experiment

	A [A]	A + Cash [A + Cash]	B [B]	B + Cash [B + Cash]	P-value [B - A]	P-value [Cash - No cash]	N
Plot Size (t-1)	.3015	.2903	.2833	.282	.18	.967	120
	(.1075)	(.0923)	(.1210)	(.0886)			
Harvest Tons (t-1)	15.88	16.42	17.11	14.98	.398	.876	120
	(7.456)	(6.761)	(8.483)	(5.267)			

Notes: P-values are based on specifications which include field fixed effects (the unit of stratification for the randomization). *p<0.1, **p<0.05, ***p<0.01.

Table A.2: Main Experiment: Heterogeneity by Trust

	(1)	(2)	(3)	(4)	(5)	(6)
Good Relationship with Company	0.054	0.088**				
	[0.034]	[0.041]				
... *B	-0.043	-0.063				
	[0.060]	[0.070]				
Trust Company Field Assistants			0.019	0.035*		
			[0.016]	[0.019]		
... *B			0.032	0.021		
			[0.026]	[0.029]		
Trust Company Managers					0.020	0.028
					[0.015]	[0.017]
... *B					0.017	0.027
					[0.025]	[0.028]
B: Deferred Premium	0.711***	0.726***	0.613***	0.656***	0.657***	0.642***
	[0.034]	[0.035]	[0.079]	[0.087]	[0.067]	[0.073]
p-value $\gamma + \delta$	0.832	0.661	0.013	0.017	0.068	0.014
Field FE	N	Y	N	Y	N	Y
Observations	568	568	567	567	565	565

Notes: The table shows heterogeneity of insurance take up by different measures of relationship with the company, as well as their interactions with deducatable premium. The dependent variable is take up of insurance. *p<0.1, **p<0.05, ***p<0.01.