Evidence of Demand for Index Insurance: Experimental Games and Commercial Transactions in Ethiopia

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 This research was partially funded by NSF grants NSF-SES 0345840 and NSF-SES 0951516.

1. Abstract

We present the results of a series of experimental games with smallholder farmers in the Tigray region of Ethiopia in 2010. In the games, participants were asked to allocate money to different risk management options. One of the options was drought index insurance that was identical to commercial products sold in the region. Participants exhibited a clear preference for more aggressive insurance contracts with higher frequency payouts, as well as a preference for index insurance over other risk management options, including a simulated savings account with an interest rate higher than local market averages. The preference for higher frequency payouts is mirrored in the commercial sales of the product. This evidence challenges concerns that the very poor universally choose to purchase minimal index insurance coverage and supports claims that insurance demand may outpace the supply of responsible insurance products.[1]

Keywords: microinsurance, index insurance, climate risk, climate adaptation

JEL Codes: C93, G22, O10, O13

2. Introduction

Climate risk management is an urgent issue for development. Weather shocks such as droughts can exacerbate poverty both directly and indirectly, as farmers often develop conservative risk management strategies when faced with an uncertain climate (Carter and Barrett, 2006). Better climate risk management may improve livelihoods in unfavorable years and enable farmers to take the productive risks necessary to ensure a bountiful return in favorable years.

Weather index insurance is a promising tool for transferring risk from rural communities to global insurance pools. Index insurance refers to an insurance policy written on an "index" of weather variables, such as rainfall in the case of drought insurance, which serve as proxies for crop yields,. The insurance contract is based on objectively observed weather variables, which circumvents some of the drawbacks of traditional indemnity-based insurance products, such as the costly and potentially subjective adjustment process. In a developing country, a single contract can cover farmers in a given area when it would be prohibitively costly to adjust for conditions on individual farm plots.

There have been many questions about weather index insurance in the academic literature, especially in regard to demand for the product among rural populations in developing countries. Previous studies suggest that farmers will not only buy insurance at low numbers, but also buy the least amount of coverage possible. One of the puzzles about index insurance is that if it is as useful as people claim, then why is demand for the product so underwhelming?

[1] Abbreviations: HARITA (Horn of Africa Risk Transfer for Adaptation)

We present results that are in direct contrast to the available evidence that demand for index insurance has been universally "disappointing" (Giné 2011). At the beginning of the 2010 cropping season, we conducted a series of experimental games in four villages in the Tigray region of Ethiopia that would later be offered commercial insurance. In the games, participants were given an endowment they could allot in any quantity between four risk management options. The endowment was twice the typical participation fee of 35 birr for project activities, which is considered a day's pay for participants. The four options for allocation were: 1) take the money home that day, 2) place the money in a simulated savings account, 3) place the money in a community-based risk pool, and 4) purchase index insurance at realistic commercial pricing. These options represent a variety of choices for hedging risks at different parts of the cropping calendar. The index insurance option paid out at the conclusion of the growing season according to observed rainfall, identically to the commercial product. (For more details, see Section 4: Experimental Design)

Participants were given the choice to buy index insurance at one of two frequencies, either a 1 in 3 year payout or a 1 in 5 year payout. Participants demonstrated a strong preference for payments in 1 of 3 years (87% to 13%), even with the additional cost required to cover the same risk. The amount of money allocated to purchasing index insurance was greater than the money allocated to the simulated savings account and the community-based risk pooling. In two of four villages, participants purchased more index insurance than they took home as an immediate cash payment.

Even at the first level of analysis, the results of this game challenge prevailing thought regarding demand for index insurance among rural smallholders. First, the preference for the more frequent, aggressive insurance product undermines claims that low-income farmers universally purchase minimal levels of index insurance. (Binswanger-Mkhize, 2012) Much of the debate about index insurance involves the concept of take-up rates, or the rate at which eligible households decide to purchase insurance. (Giné and Yang, 2009, Cole et al., 2009) Our experimental games are not positioned to weigh in on the take-up rate debate, but the results demonstrate the value of index insurance when competing with other risk management options. For example, by allocating more money to index insurance than the savings option, participants demonstrated a preference for a risk-contingent payout over an interest-bearing savings account.

The results of the game are not just an artifact of the game design, as the commercial sales of the insurance product experienced nearly identical results. 83% of purchasers of the commercial product bought the high frequency product and 17% bought the low frequency product.

However, although it is clear that farmers in Tigray prefer a 1 in 3 year payout for index insurance, it is not at all clear why, or if such an aggressive product

is responsible to offer. It may be that frequent payouts fit into a rational decision model in ways that we do not yet fully understand, or it may be that the preference is evidence of a market inefficiency such as the lack of a commitment device for managing below average rainfall seasons. We interpret the results as offering a cautionary statement that farmers may opt into aggressive insurance contracts because of a lack of other financial management tools. Index insurance projects should not sell insurance just for the sake of insurance, but should focus on two-way learning as well as offering responsible, useful insurance products that effectively complement farmer decision-making.

This paper is structured as follows: Section 3 is a review of relevant literature, Section 4 is devoted to the context of the experimental games in the Horn of Africa Risk Transfer for Adaptation (HARITA) project, Section 5 details the experimental design, Section 6 presents results of that experiment, Section 7 is discussion of the results, and Section 8 contains concluding remarks.

3. Literature

There is an extensive body literature on the fundamentals of weather index insurance as a risk-smoothing tool (Turvey, 2001; Vedenov and Barnett, 2004), as well as literature that expounds on the compelling advantages of offering index insurance in developing countries (Barnett and Mahul, 2007; Morduch, 2006). However, there are comparatively few papers that offer direct evidence from index insurance pilot programs in developing countries, a trend that is changing with the proliferation and maturation of index insurance research in developing countries (Vargas-Hill and Robles, 2011; Mude et al., 2010).

Giné and Yang (2009) performed one of the first randomized field experiments on index insurance. In Malawi they offered farmers credit by itself and also coupled with index insurance. They observed that take-up for the loan with index insurance was lower than the loan offered by itself, and suggest that this reveals that farmers can more efficiently self-insure above and beyond the ability of the insurance to smooth risk.

More empirical evidence on the patterns of rainfall insurance participation is presented by Giné et al. (2008), who offer results from a household survey in India. They note that households with less land and less wealth are less likely to participate in index insurance projects, but that the two major constraints to index insurance participation are credit constraints and issues of familiarity or trust.

Cole et al. (2009) conduct a series of controlled, randomized trials in India that account for several aspects of the index insurance business process. They identify several possible explanations for depressed demand for index insurance, including high price-elasticity, liquidity constraints, and trust.

Based on these papers, the common perception among many academics is that weather index insurance suffers from low demand among smallholder farmers even though that message is not explicitly written. For example, in Giné and Yang (2009) take-up rates for both products are still quite high (18% and 33%) and the difference between them is not statistically significant. In Cole et al. (2009), the authors write:

"We do not view these barriers to index insurance as insurmountable, nor do we view the relatively low purchase rates as reflecting a lack of demand for pooling risk."

However, the message that has percolated to the wider academic community is that index insurance suffers from low demand and interest from smallholder farmers. For example, Banerjee and Duflo (2011) devote a subsection of *Poor Economics* to the question "Why Don't Poor People Want Insurance?" The discussion on weather insurance is mainly based on Cole et al. (2009), and the authors conclude:

"There seem to be deep reasons that most people don't yet feel comfortable with the kinds of insurance products that the market is willing to offer." (p. 154)

Likewise, this sentiment is well represented in an article by Hans Binswanger-Mkhize (2012). In a paper entitled "Is there too much hype about index insurance?" he states:

"Pilot index-based insurance programs for agriculture often find that demand for the offered products is low in three ways: (1) Only a small proportion of farmers buy the insurance offered; (2) the purchasers usually buy the smallest coverage offered; (3) the poor farmers who would benefit the most are not usually among the purchasers."

In the current exercise, we perform an explicit test of point (2) above, providing farmers high and low insurance coverage options within a portfolio of risk management options. We do not directly test take-up rates. Instead, our experimental structure measures the relative amount of money farmers distribute across a portfolio of options. It is worth noting that in the subsequent commercial scaling of the insurance product that take-up rates were high and that extremely low income farmers were the primary purchasers of the insurance.

There have been recent efforts to understand the complexities of demand for index insurance. Clarke (2011) theorizes that low demand is a rational response to inefficiencies in the index insurance model, such as basis risk. Several studies further investigate the determinants of index insurance adoption, such as risk aversion and trust (Vargas-Hill et al., 2011; Morsink and Guerts, 2011). Guarav et al. (2011) measure the effects of different marketing treatments on demand for index insurance, including financial education workshops. Norton et al (2012), using the data set from our current study, observe a significant increase in commercial sign-up rates in the randomized population that was selected for the games exercise. This

result follows such papers as Patt et al. (2009) who note that experimental games increase financial literacy and willingness to purchase insurance in participants. However, index insurance may also alter the use of other strategies, leaving some farmers vulnerable to other risks, including those related to financial markets (Peterson 2012).

The preference for higher frequency payouts may be problematic from both an economic and ecological point of view. Transaction costs will increase with more frequent payouts, leading to higher prices for the insurance. Recent research also suggests that frequent payouts lead to less sustainable grazing management practices for pastoralists (Müller et al., 2011).

If the preference for high frequency payouts proves durable, it may be evidence for an additional development intervention, such as a commitment device for farmers to self-insure in years that are below average but not catastrophic. Commitment devices are broadly defined as "arrangements people make to formalize and facilitate their goals" (Bryan et al., 2010). Although banks have been shown to decrease rural poverty (Burgess and Pande, 2008), smallholder farmers in rural areas often have difficulty with building up a savings buffer. This may be because of the preference for near-term expenditure or because of transfers within families (Rosenzweig, 1988). Researchers have performed randomized experiments with commitment devices as a way to increase household savings (Ashraf et al., 2006). In this experiment, the payments in both near-term and longer term may function as a *de facto* commitment device.

The game design is very similar to other contemporary experimental games efforts, such as Clarke et al. (2011), that offer index insurance alongside other risk management options. Our game is also similar to other recent initiatives such as McPeak et al. (2010) and Carter et al. (2008) in that it was designed to accomplish multiple goals, i.e., educating consumers as to the details of the index insurance as well as informing project design. For example, the community risk pool option in the game is a first step towards understanding the role of localized decision-making in managing risks. Index insurance is best targeted towards large covariate or yield risks, but there are also idiosyncratic or individualized risks that are suited for a community-based approach (Ligon, 2009; Dercon et al., 2006; Bhattamishra and Barrett, 2009; and Hill, 2010)

4. HARITA Project Context

The games were conducted in the context of an ongoing development initiative in Tigray called the Horn of Africa Risk Transfer for Adaptation (HARITA) project, sponsored by Oxfam America, Swiss Re, and a host of other partners. Launched in 2009, the project attempts to use community-based 'design teams' at the core of its product development process, with farmer groups specifying the crops, coverage periods, and also serving to verify the accuracy of historical meteorological data through recollections of their own experience with drought.

Using these community-based methods, HARITA seeks to reduce household level climate risk exposure by using weather index insurance to motivate further adaptive actions at the local levels. The primary innovation of this project is in its introduction of an 'insurance-for-work' scheme which allows cash-strapped households an opportunity to pay for weather index insurance by contributing an equivalent amount of labor to drought risk reduction activities in their community. In 2010, participants chose to use this option by a 5-to-1 margin over paying premiums in cash.

The HARITA project has since been re-launched with additional support from the World Food Programme and the Rockefeller Foundation as the R4 Rural Resiliency Initiative, to reflect the project's four broader methods of addressing climate risk: risk reduction (like composting and terracing), risk pooling (via a community savings fund), prudent risk taking (microfinance), and risk transfer (weather index insurance).

The project not only provides a context for our experiment, but commercial signup statistics allow us to gauge the usefulness of our game experiment in predicting large-scale farmer behavior outside of experimental settings. Sign-up statistics for 2010 are listed in Table 1, and the scaling of the project is detailed in Table 2. Most relevant to our experiment, in the 2010 HARITA commercial product farmers were offered a choice between high frequency and low frequency insurance options, similar to what was tested in our game.

[Table 1 about here]

[Table 2 about here]

(For more information on the HARITA project, please refer to Chen et al. (2010), Hellmuth et al. (2009), or Peterson (2012).)

5. Experimental design

Our game is designed to test demand for index insurance in the presence of several other competing risk management options. Participants were given an endowment of 70 birr (about 5 USD) and were asked to divide the endowment into several different categories. Allocations were allowed in multiples of 5 birr, for a total of 14 "units" to distribute among the various options. The options (explained in detail below) were: 1) the option to receive the money immediately, 2) to place the money into a simulated savings account, 3) to place the money into a group risk pool, and 4) to buy index insurance. The index insurance option consisted of two options that differed based on the expected frequency of payouts, and participants were permitted to allocate money only to one or the other.

The experimental games were conducted with approximately 100 participants at each of four villages in Tigray Region, namely Adi Ha, Awet Bikalsi, Geneti, Hade Alga. The first two of these villages, Adi Ha and Awet Bikalsi, are adjacent to each other in the *woreda* of Kola Tembien in central Tigray. The last two Geneti and Hade Alga, are approximately 10 kilometers apart in the *woreda* of Raya Azebo. The two *woredas* are over a hundred kilometers apart within the Tigray region. Participants were selected at random from a list of household heads in each village. Invitations were weighted to include a representative sample of female-headed households (30% of total) and divided equally among four sub-villages in each village. Summary statistics of the participants are listed in Table 3.

[Table 3 about here.]

There are a few distinctions between villages. First, the insurance sales were offered in Adi Ha in the previous year, but not any of the other three villages. (Early outreach efforts also included the farmers from Awet Bikalsi but they were ultimately not offered commercial insurance in 2009.) In addition, the agronomy of the two areas is different, in that the major crops in the Kola Tembien (Adi Ha and Awet Bikalsi) region area are maize and teff (an indigenous Ethiopian cereal grain similar to wheat). The Raya Azebo region (Geneti and Hade Alga) is mainly a sorghum-producing area. Further, because of differing rainfall patterns, the rainy season was already well underway in Raya Azebo but had not yet begun in Kola Tembien. Table 4 contains a short description of the differences between the two areas.

[Table 4 about here.]

Because three of the options provide payment after the cropping season was finished, the research team made two visits; one to allow participants to make their initial allocations, and one to resolve any payments that resulted from those allocations. The first visit to Tigray was in April/May 2010, before the growing season, and the follow-up visit was conducted after harvest in November 2010.

The four options for how to distribute that endowment were:

1) Keep the money

The option to *keep the money* consisted of the portion of the endowment that the participant chose to receive that day. This was offered in lieu of a participation fee, and was the only option in which people could receive any payment on the initial visit. This option encompasses the notion of self-insurance, or the ability of farmers to self-insure more effectively than index insurance can offer.

2) A "savings" account

The *"savings" option* was intended to simulate an interest-bearing account. The money committed to that option was disbursed in November with an additional

10% bonus (equal to a 20% annual interest rate). 10% was chosen for ease of computation and payment of currency, and is more generous than the approximately 5% annual rate that banks in Ethiopia typically offer for savings accounts. The savings option is intended to allow for self-insurance savings options to compete with formal index insurance purchases in the game.

3) A community risk pool (or group savings account)

The *community risk pool* option in the game builds on farmers' associations that are already present in the communities. The money committed to the community risk pool was similar to the savings option in that it was disbursed in November with a bonus of 10%. However, the money was given directly to community leaders to disburse according to their discretion or the community's need.

The community risk pool was intended to address one of the major drawbacks in index insurance, namely basis risk (Barnett and Mahul, 2007). Basis risk takes many forms but is generally thought of as the inability to cover the exact risk exposure at any given time or place. The HARITA project strategically chose to offer drought insurance in part because large, slow-onset covariate risks such as droughts are easy to quantify spatially and temporally. However, there are many crop perils that are not tied to a deficit in rainfall, such as pest infestations, hail, or excessive moisture. These risks can also cause crop loss but fall outside the parameters of a drought insurance contract. In each game session, game facilitators described scenarios that would be best addressed through community action. Potential uncovered risks include variance of rainfall within villages if there were local microclimates as well as risks that happen on an individual basis like damage from animals. In each case, the participants were referred to the community risk pool as a mechanism for addressing the risks that the index insurance did not cover.

Informal community insurance activities are common in Ethiopia, primarily for burial costs through associations called *iddirs* (Dercon et al., 2006). Two of the villages in this sample also had existing informal community insurance schemes for providing credit and addressing drought and crop loss. However, while local risk sharing associations may have the benefit of effectively addressing small or idiosyncratic losses, they may be overwhelmed by large, covariate loss events.

Although the concept of the community fund was discussed with the group, the determination of how the community risk pool would be allocated was not formally specified. Each contribution to the community fund was made on an individual or decentralized basis. Upon the receipt of the community risk pool funds during the visit in November, the community leaders indicated that they intended to use the payment as seed capital for local farmers. The leaders also indicated their intention to ask for contributions either in cash or in kind from those that had not contributed to the community risk fund during the game activities.

4) Index insurance

The *index insurance option* consisted of two types of index insurance. Participants were able to choose the frequency with which the insurance provided payment, but were restricted to only buying one type of contract. The "high frequency" contract offered a pay out in one of three years, and the "low frequency" contract was designed to pay out in one of five years.

Any money placed into the insurance option would provide a payment in November in the case of a rainfall deficit over the cropping season. The insurance contracts were created using the same methods as the commercial insurance contracts, and explicitly included costs similar to what an insurance company would charge.

The historical schedule of payouts for each village was printed on a poster and presented alongside the technical parameters for each village's contract. We demonstrated a simplified version of the contracts to the assembled participants. Partial payouts were possible in the insurance contract if the rainfall total was low enough to trigger a payment, but not low enough to signify a severe drought. In the demonstration, we presented versions of the contracts that only had maximum payouts.

A graphical representation of an example insurance contract appears in Figure 1. In this case, the High and Low Frequency contracts have some characteristics in common, such as the fact that the maximum payout is reached at 80 mm of rainfall. However, the High Frequency contract has a trigger of 130mm while the Low Frequency insurance is triggered by rainfall totals below 100mm. The High Frequency insurance will offer payment for rainfall totals between 100 and 130mm, but the Low Frequency insurance will pay out a greater amount for rainfall totals below 100mm.

[Figure 1 about here.]

The trigger for the frequent insurance in each village was set to a rainfall amount that had five payouts in the fifteen year historical record. The less frequent insurance had a rainfall trigger that would have made three payouts in that same time. For both contracts, payments from one-third (five) of the years would go to the loading costs of holding risk[2]. For the high frequency insurance, the remaining ten years of contributions would be returned as 2x the annual premium in the five worst years. For low frequency insurance, the remaining ten years of premiums would be paid as 3.33 times the premium in the three worst years. Therefore, for each 5 birr allocation to the high frequency insurance, 10 birr was "paid" in the five "worst" years (i.e. if a yellow or red ball was drawn). For the low frequency insurance, the payment was rounded to a whole number for the sake of the

[2] Loading is the additional charge added to the actuarially fair premium that encompasses the notions of uncertainty, transaction costs, and the cost of holding risk.

demonstration, so that each 5 birr allocation would "pay" 15 birr in each of the three "worst" years (i.e. if a red ball was drawn).

From a slightly different perspective, for each 5 birr allocation, participants could expect one-third of that amount (1.67 birr) to go towards the costs of insuring risk. Thus, for each 5 birr allocation, 3.33 birr was considered the actuarially fair cost of the insurance premium, with the remaining 1.67 birr as the additional "loading" percentage of insuring risk. A loading percentage of 50% of the premium was chosen for computational ease, but is comparable to rates offered by private insurance companies working with the HARITA project for the commercial transaction.

The expectation of payouts between the two insurance options is identical. Two-thirds of the money put into insurance could be expected back in the form of insurance payouts. The products differ in the number of years payment could be expected, with the high frequency insurance spreading those payments over more years. Thus, the high frequency insurance may be considered more aggressive, as it required greater contributions for the same payout in any given year.

Several practice rounds were conducted to convey the concepts of the game and demonstrate the consequences of investing money in each option in different types of years. In each practice round, participants allocated their money between the four options. After each participant made his or her allocation of the money, one member of the group chose a ping-pong ball from a box. This ping-pong ball represented the rainfall for that season and was one of three colors: green, yellow, and red. The green ball represented a good year, the yellow ball a dry year, and the red ball a very dry year. The number of balls of each type is listed in Table 5. Either a yellow or red ball triggered the "High Frequency" insurance (5 balls in 15), while the "Low Frequency" insurance was only triggered by a red ball (3 balls in 15).

[Table 5 about here]

After the ball was chosen, participants were told how much money they would receive on the return visit. The payment was based on how much money they allocated to savings and insurance and the outcome of the rainfall in that year. For the demonstration, the rainfall for the year was represented by the ping-pong ball. After several practice rounds, the participants made the final allocation of their endowments. Payments for the final allocation were based on satellite estimates of rainfall and would pay out after the conclusion of the growing season in the case of a rainfall deficit.

6. Results

We see evidence that participants exerted some choice when allocating their endowment among the different options. A null hypothesis for a naïve allocation of resources may be taken from Benartzi and Thaler (2001). In their study of

retirement accounts in the U.S., the authors note that if there are *n* options for allocation, participants will often allocate *1/n* percent of their resources to each one. In this game, participants were allowed to allocate a total of 14 discrete currency units (5-birr units) into four different options. Therefore, there is no perfectly even *1/n* allocation, but even so, only 6 of 402 participants put at least 3 currency units (15 birr) into each option.

Several other patterns in the results are readily obvious. First, the high frequency insurance was strongly preferred to the low frequency insurance, which runs counter to claims that farmers universally prefer to buy the minimum level of coverage. Second, participants payed more money for insurance than they placed into savings or the community risk pool, showing the value of a risk-contingent payout. In two of the four villages, participants put more money into index insurance than they chose to take home that day.

We did not design our game to study the independent decision to purchase insurance in a commercial transaction. Rather, we wanted to study the allocation between the different options, especially between the two insurance options. Surprisingly, over 99% of participants bought some amount of index insurance, a figure that is unlikely in a market setting.

Detailed results:

[Table 6 about here]

- *High frequency payouts were strongly preferred to low frequency payouts.*

87% participants chose the high frequency payouts compared with 13% who chose the low frequency payouts (excluding the 1% of participants who chose to buy no insurance). Performing a Binomial Means test, the difference is significant well beyond the 1% level for the whole population. The results of the binomial test are listed in Table 7. For the entire sample population, as well as in each village, the difference was significant well above the 1% level.

[Table 7 about here]

The preference for high frequency insurance is not an artifact of the game design. Farmers who purchased insurance in subsequent commercial insurance sales exhibited the same preference for high frequency insurance (as seen in Table 8).

[Table 8 about here]

- *The index insurance option was strongly preferred to the savings option*

Participants contributed more money on average to the index insurance option than the savings option. A two-sample paired t-test of the difference is presented in Table 9. We view this as evidence for the preference of a risk-contingent payout over an interest-bearing payment.

[Table 9 about here]

Participation in the savings option was still popular, and near universal in three of the four villages. However, it is unclear if the benefit from the savings option is from the additional money that participants could earn in interest, or as a commitment device. The monies were returned regardless of rainfall totals, which could be used for unanticipated costs and obligations after the conclusion of the cropping season.

It is possible that the rate of return on the savings was not sufficient to allow it to compete effectively with other options. This may make sense in the context of studies like Holden et al., (1998), who estimate a rate of time preference (RTP) in excess of 50% for farmers in Ethiopia, which is far greater than the 20% annual interest rate offered by the savings option. The savings option in this game was offered as a control for the index insurance, but future research could vary the interest rate between a very high rate of interest and no interest at all to better understand the tradeoffs between interest-bearing accounts, commitment devices, and index insurance.

- *In some cases, the insurance option was more popular than taking home that day.*

In the Raya Azebo sites, Geneti and Hade Alga, people contributed more total money to the index insurance options than they chose to take home with them that day. Participants seem to have been heavily influenced by production decisions, as planting was already underway in Raya Azebo and it was not as useful to invest money in their fields. Upon the return visit in November, in an attempt to explain the differences between villages, the research staff asked several questions about production decisions as detailed in Table 10. The answers to those questions indicate that participants in Raya Azebo invested the money they chose to keep from the games in seeds and/or fertilizer at a much lower rate than in Kola Tembien. Apparently, at the point in time that the games were conducted, participants in those villages saw more usefulness in reducing the variance of their future income with index insurance than self-insuring with the Keep the Money option. Also, one difference between the two regions that is more difficult to quantify from our data is that participants from the Raya Azebo region reported up to three below average years in a row before the 2010 cropping season, and were potentially more worried about the prospect of drought.

[Table 10 about here]

Another interesting facet of the experimental game results is the high percentage (88-90%) of people that contributed some money to the community risk pool in the Raya Azebo *woreda*. The frequency of contributions was greater in Geneti and Hade Alga than in Awet Bikalsi and Adi Ha, although the total value of those contributions was not appreciably greater. Most participants contributed near the minimum discrete amount to the community risk pool option (5 birr). Since this decision was made independently and was not reached as a group, this likely represents to some degree the amount of trust that people had in local community groups. Anecdotal evidence indicated that the Raya Azebo villages that had greater participation were the ones with more active, well-organized community farming associations. In fact, for the 2010 commercial insurance transactions, farmers in Geneti placed a portion of their insurance premium in a community savings account instead of index insurance.

The contributions to the community risk pools were smaller than any other option. Only 3% of participants committed 20 birr or above to this option, which is the smallest percentage of any of the five options. It is possible that participants are hesitant to allocate money to a complicated group decision-making process where repayment of the funds is very uncertain. Alternatively, it may be that the limited resources in the community fund was not particularly attractive when compared to the formal index, which could provide a multiplicative effect for any money paid into the insurance option.

The 2010 cropping season was a favorable one, so that there were no insurance payouts. The community risk pool funds had not been disbursed by community leaders, as indicated by an interview with community leaders upon the return visit in December 2011. Community leaders placed the community risk pool funds from the games in an interest-bearing account, and were waiting for a good opportunity to invest the funds for the benefit of the community. One example that was given was the possibility of increasing market access for agricultural commodities through the purchase or rental of a vehicle. The main obstacle to finding an investment opportunity was that the total amount of money saved was seen as too small to invest productively.

7. Discussion

During the games activities, each participant answered a short series of survey questions, including questions about their personal characteristics, household characteristics, and farming decisions. Using the responses to these questions, we can begin to analyze the characteristics of the participants that chose the differing types of insurance. We present two-sample t-tests instead of a multiple regression because many of the variables are likely endogenous and we make no claim to causality. Our goal in this section is to present information on issues that may be worth investigating more carefully in future work.

We have included only the participants from the Raya Azebo region in our summaries, as the overwhelming preference for the High Frequency insurance in the Kola Tembien region makes analysis on the entire sample challenging. (Only 7 participants in the Kola Tembien region chose the Low Frequency insurance option.) Given the large differences between regions (as illustrated in Table 3), most of the differences we see in the entire sample are driven by the differences in region. As mentioned earlier, one important difference between the regions was that the growing season had already begun when games were played in the Raya Azebo region, and had not yet begun in the Kola Tembien area. Our focus on just two villages in one region of Ethiopia means that we cannot know if the results presented here represent local phenomena or patterns that will hold among a larger sample of the population in other areas.

[Table 11 about here.]

There are several characteristics that have statistically significant differences between the participants who chose the Low and High frequency insurance. Lacking an identification strategy, the interpretation of the results must be treated with caution. Nevertheless we do provide initial interpretations that might help guide future research.

One might expect that wealthier farmers would be more likely to choose the Low Frequency insurance option, as they would be better able to self-insure in years with below average rainfall. There are two variables which potentially support this possibility (irrigated land owned/cultivated, adults in household), and one that runs counter to this assumption (gender), which we will discuss below.

Participants who chose the Low Frequency insurance option, on average, owned or cultivated more hectares of irrigated land. Irrigated land may indicate several things. Farmers that are able to purchase irrigated land may be the wealthier farmers either through an initial endowment or through their activities. However, the ownership of irrigated land may indicate some self-selection by early adopting or innovative individuals. Lastly, it is very possible that farmers with irrigated land are more resilient and better able to withstand the below-average years that the High Frequency insurance is designed to protect against.

Participants who chose the High Frequency insurance also reported more adults in their households. The number of adults in the household likely indicates additional people to support rather than additional wage earners because it includes adult children, and elderly relatives. In addition, the response to this category is related to the gender of the household head. According to Ethiopian culture, if there is an adult male in the household then they are considered to be the household head. Thus male-headed households will often include spouses as additional adults while female-headed households will not. The Raya Azebo region reported a much higher number of adults per household (see Table 3). The difference in adults per household between the two regions is statistically

significant at the $p<0.01$ level. We cannot explain this difference. One potential explanation offered to us by Ethiopian colleagues was that with a higher Muslim population in the Raya region, the additional adults could be multiple wives. However, a simple test of Muslim vs. non-Muslim households shows no difference in the number of adults. Another potential explanation for a difference in the number of adults in each household is increased migration in the Kola Tembien area, however, we have no specific information to investigate this claim.

Providing counter-evidence against wealthier farmers prefering the Low Frequency option, female-headed households bought the Low Frequency at higher rates than male-headed households. The preference for Low Frequency insurance among female-headed households may be due to different risk management strategies that we do not yet fully understand. Previous data efforts in the same population found that female-headed households are poorer than male-headed households (Peterson and Mullaly, 2009). Finally, some variables that we would expect to show up strongly in a decision made by wealth do not, such as oxen. Previous studies have found the number of oxen owned to be an important indicator of wealth and an important influence on risk decisions (Yesuf and Bluffstone, 2010).

8. Conclusions

This paper describes a series of games that were played in the Tigray region of Ethiopia in 2010 concerning demand for weather index insurance. This game involved an insurance contract that was resolved by actual rainfall observations and was virtually identical to the commercial products later sold in the region. In these games as well as the commercial sales of the product, demand for index insurance was observed to be high, challenging assertions that farmers have low demand for index insurance and universally select minimal coverage options.

Through their choices in the games and commercial sales, participants have indicated a preference for higher frequency payouts from index insurance programs. The preference for more aggressive insurance products raises fundamental questions about the management of an index insurance project, and pushes the bounds of the losses that insurance often covers, as the high frequency insurance includes payouts in years that could be considered below average, but not catastrophic, typically below the deductible of traditional insurance.

Because of the large percentage of the premium that is required for insurance company costs at high payout rates, and the limitations of index insurance in accurately targeting small losses, it would be expected that it is more cost-effective to insure frequent events risk at the individual or local level and reserve index insurance for the risks that overcome the community's ability to cope. The overwhelming choice of the high-frequency insurance by participants (and commercial buyers) could possibly be evidence of the absence of sufficient mechanisms for self-insuring below-average years. Based on the needs of their customers, index insurance programs could consider including a savings program or

commitment device that can address some of the shortfalls in farmers' risk management strategies.

Our findings support growing concerns that the most salient policy challenges surrounding index insurance may not be that about insufficient demand, but that the demand and scaling of insurance outstrips the rate of improvement of products (Brown et al., 2011). If efforts are focused on increasing demand instead of focusing on client education and developing more effective insurance products and intervention bundles, large numbers of farmers may purchase inappropriate or incomplete products. Future research needs to continue to unravel the linkages between credit, savings, and insurance in order to better serve the populations that could benefit so greatly from the advantages in risk management that index insurance offers.

Acknowledgements

The authors would like to thank conference attendees at the SCC-76 and AAEA conferences, and seminar participants at Columbia/CRED and the Wharton School at the University of Pennsylvania. Also, this work would not have been possible without the comments and suggestions of Samson Abrha, Rahel Diro, Eric Holthaus, Geoff McCarney, Betsy Ness-Edelstein, Jessica Sharoff, Jeffrey Tobacman, and Ruth Vargas-Hill.

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Tables and Figures

Figure 1: Illustration of example High and Low Frequency contracts for 5 birr games premium allocation (exact numbers vary by village)

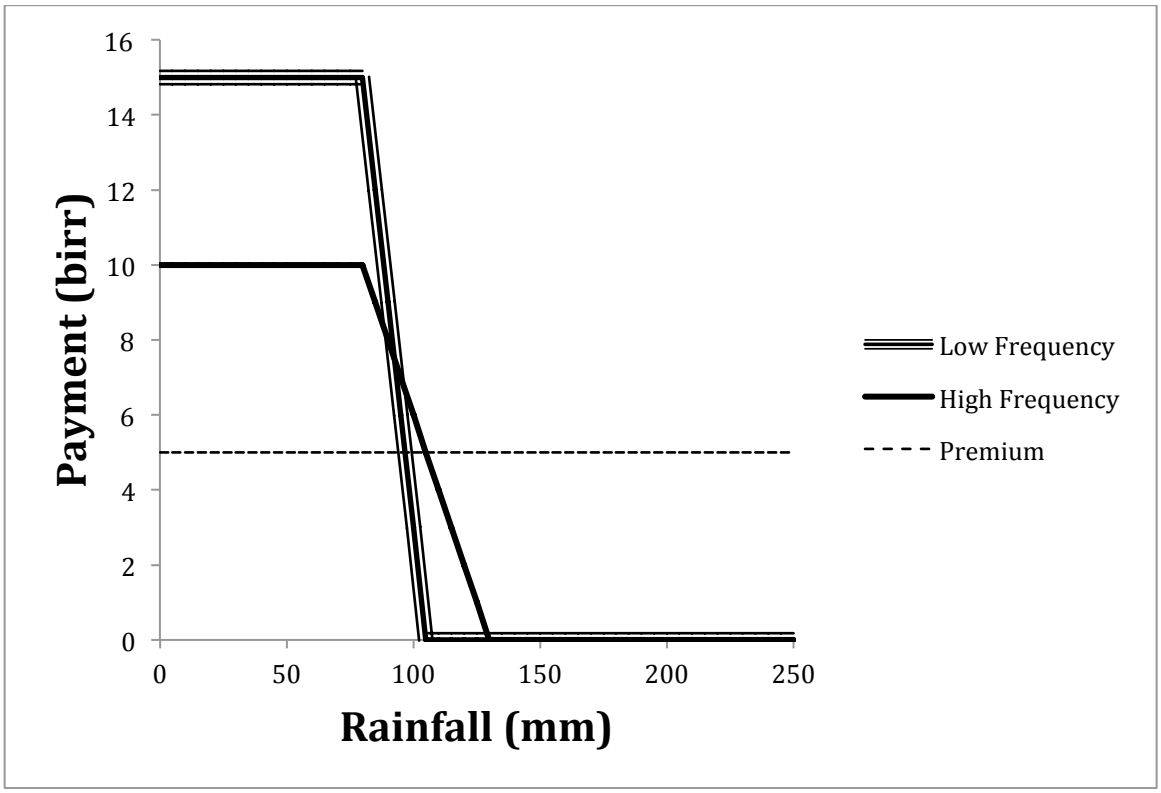

Table 1: 2010 Commercial Sales Data

		Payment Type			**Total sum Insured**	**Premium**
S/N	***Village***	***Cash***	***Labor***	***Total***	**(Birr)**	**Value (Birr)**
1	Adiha	58	276	334	248,400	133,787.16
2	Awet Bikalsi	60	209	269	176,600	93,854.04
3	Genete	49	85	134	107,600	44,038.82
4	HadeAlga	37	161	198	174,200	73,254.30
5	Hadush Adi	20	351	371	302,600	150,240.78
	Total	**224**	**1082**	**1306**	**1,009,400**	**495,175.10**

Table 2: Growth of HARITA Project

Year	**2009**	**2010**	**2011**
Covered Villages	1	5	43
Insured HHs	200	1,308	13,044
Male	125	802	8,740
Female	75	505	4,304
Total Insured	$6,765	$57,318	$934,337

Premium (@ 17 birr/$)	$1,624	$21,001	$213,743

Table 3: Summary Statistics for Participants

Region Name	**(Total Sample)**		**Kola Tembien**		**Raya Azebo**	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**
Initial Visit						
n	***402***		***205***		***197***	
Female	0.33	0.47	0.31	0.46	0.34	0.47
Age	41.31	13.09	41.46	13.16	41.15	13.04
Years of School	1.67	2.75	1.76	2.71	1.58	2.80
Rainfed Land Owned (ha)	3.43	2.47	2.67	1.60	4.22	2.93
Rainfed Land Worked (ha)	3.26	2.66	2.28	1.50	4.29	3.18
Irrigated Land Owned (ha)	0.29	0.50	0.33	0.36	0.25	0.62
Irrigated Land Worked (ha)	0.29	0.51	0.33	0.38	0.25	0.62
# Oxen Owned	0.94	0.94	1.03	0.89	0.83	0.98
Adults in HH	1.39	1.52	1.19	1.13	1.60	1.81
Children in HH	2.77	1.91	2.52	1.79	3.04	1.99
PSNP	0.49	0.50	0.47	0.50	0.51	0.50
Follow-up Visit						
n	***337***		***177***		***160***	
Muslim	0.15	0.36	0.01	0.08	0.31	0.47
Finished Planting	0.37	0.48	0.19	0.40	0.58	0.50
Used Money for Fert/Seeds	0.67	0.47	0.93	0.26	0.39	0.49

Table 4: Description of Study Sites

	Area 1	**Area 2**
Villages Visited	Adi Ha, Awet Bikalsi	Geneti, Hade Alga
Location in Tigray	Central	Southern
Main Crop	Maize	Sorghum
Critical Period Begins [a]	May 1st	April 11th
Critical Period Ends [a]	June 30th	June 11th
Critical Period Begins [a]	August 21st	July 1st
Critical Period Ends [a]	September 20th	September 10th

[a]: According to farmer interviews

Table 5: Number of balls and simulated payouts for each option

Color	# of balls	Represents	Simulated Payout - High Frequency	Simulated Payout - Low Frequency
Green	10	Good Season	None	None
Yellow	2	Dry	2x	None
Red	3	Very Dry	2x	3x

Table 6: Detailed games results

Totals (birr)

	Keep	Savings	Community	High Frequency	Low Frequency
Adi Ha	4195	880	280	1405	90
Awet Bikalsi	3290	1505	455	2195	50
Geneti	1800	1240	750	2495	585
Hade Alga	1910	1310	825	2145	745

Percentage of Total Spent

	Keep	Savings	Community	High Frequency	Low Frequency
Adi Ha	61.24%	12.85%	4.09%	20.51%	1.31%
Awet Bikalsi	43.90%	20.08%	6.07%	29.29%	0.67%
Geneti	26.20%	18.05%	10.92%	36.32%	8.52%
Hade Alga	27.54%	18.89%	11.90%	30.93%	10.74%

Percentage of Participants Putting Some Money Into That Option

	Keep	Savings	Community	High Frequency	Low Frequency
Adi Ha	100.00%	77.55%	34.69%	91.84%	4.08%
Awet Bikalsi	100.00%	99.07%	56.07%	97.20%	2.80%
Geneti	95.92%	97.96%	88.78%	78.57%	21.43%
Hade Alga	100.00%	97.98%	89.90%	75.76%	24.24%

Percentage of People Buying Index Insurance

Adi Ha	95.92%
Awet Bikalsi	100.00%
Geneti	100.00%
Hade Alga	100.00%

Table 7: High Frequency versus Low Frequency insurance decisions

	N	Expected	Assumed p	Observed	Observed p	p-value
Adi Ha	94	47	0.50	90	0.96	0.00

Awet Bikalsi	107	53.5	0.50	104	0.97	0.00
Geneti	98	49	0.50	77	0.79	0.00
Hade Alga	98	49	0.50	75	0.76	0.00
Total	398	199	0.50	346	0.87	0.00

Table 8: Commercial sign-up data for High Frequency and Low Frequency options in comparison to games results

	# Policies Bought	High Frequency	Low Frequency
Adi Ha	334	280	54
Awet Bikalsi	269	207	62
Geneti	135	86	49
Hade Alga	198	160	38
Hadush Adi	372	352	20
Total	1308	1085	223
Percentage		**83%**	**17%**
Games Data	398	346	52
Percentage		**87%**	**13%**

Table 9: Results of t-test of difference in means between insurance (both types) and savings

	Observations	Mean	Standard Error	Standard Deviation
Insurance	402	24.15	0.54	10.86
Savings	402	12.28	0.34	6.87
Difference	402	11.88	0.66	13.31
t:		17.89		
Degrees of Freedom:		401		

Table 10: Selected responses to survey questions

When the games were conducted, were you finished planting your crops for this year?			
	Yes	**No**	**% Yes**
Adi Ha	15	66	18.5%
Awet Bikalsi	19	77	19.8%
Geneti	36	37	49.3%
Hade Alga	57	31	64.8%
Did you use any of the money that you received from the			

games for fertilizer or seeds?			
	Yes	**No**	**% Yes**
Adi Ha	76	5	93.8%
Awet Bikalsi	88	8	91.7%
Geneti	29	44	39.7%
Hade Alga	35	53	39.8%

Table 11: Differences in Sample Means between participants who chose High Frequency and Low Frequency insurance (Raya Azebo region only)

	High Frequency Mean	Low Frequency Mean	Difference
Initial Visit			
n	**45**	**152**	
Female	0.22 (0.42)	0.38 (0.49)	0.15*
Age	42.71 (13.16)	40.69 (13.01)	-2.02
Years of Education	1.40 (2.57)	1.63 (2.87)	0.23
Rainfed Land Owned (ha)	1.08 (0.65)	1.05 (0.76)	-0.02
Rainfed Land Worked (ha)	1.15 (0.81)	1.05 (0.79)	-0.11
Irr. Land Owned (ha)	0.02 (0.05)	0.08 (0.17)	0.06**
Irr. Land Worked (ha)	0.01 (0.05)	0.08 (0.17)	0.06**
# Oxen Owned	0.87 (0.94)	0.82 (0.99)	-0.04
Adults in Household	2.33 (2.08)	1.39 (1.68)	-0.95***
Children in Household	3.02 (1.84)	3.05 (2.04)	0.02
PSNP	0.58 (0.50)	0.49 (0.50)	-0.09
Follow-up Visit			
n	**38**	**122**	
Muslim	0.23 (0.43)	0.34 (0.48)	0.11
Finished Planting	0.68 (0.47)	0.54 (0.50)	-0.14
Used Money for Fertilizer/Seeds	0.50 (0.51)	0.36 (0.48)	-0.14

Note: Standard Deviations in parentheses. Asterisks denote p-values of *=0.10, **=0.05, ***0.01.