First Three Then Me:
Group Heterogeneity and the Demand for Index Insurance

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Abstract

We test the preference for group versus individual index insurance contracts. Assuming that individuals are more likely to share risk with those who are more similar to them, we exogenously assign farmers into groups that are heterogenous versus homophilous in perceived wealth. On the extensive margin, we find that individuals weakly prefer group over individual insurance contracts, and that individuals in homophilous groups are more likely to purchase in a group contract. On the intensive margin, individuals in homophilous group contracts purchase less insurance on average as compared to heterogenous groups and individuals in isolation. Combining these effects over the extensive and intensive margins, we see that offering index insurance to groups reduces overall demand for formal insurance. We argue that if groups can informally manage idiosyncratic risk then a reduction in demand for formal insurance in group contracts can be welfare improving as compared to a world where only individual contracts are offered.

Keywords: index insurance, agriculture, groups, risk, homophily
JEL: D91, O12, D71, Q140

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1 Introduction

Farmers in the developing world face severe weather shocks which are difficult to insure without formal insurance markets. This is particularly true when farmers face common or covariate shocks, such as drought. Informal risk sharing, where farmers make indirect transfers, can help insure idiosyncratic shocks, but are rarely equipped to insure farmers against aggregate (covariate) shocks.[1] Traditional crop insurance that indemnifies farmers for individual farm losses is costly to verify due to moral hazard. More recently, index based insurance, which pays out when rainfall falls below a particular threshold reduces transaction costs as each farmer's loss does not need to be verified. In this way, index insurance is typically more accurate and cost effective at indemnification of common covariate shocks, but leaves any residual idiosyncratic risk, to the farmer. This residual risk can be due to a farmer's own idiosyncratic risk (for example a pest of disease on his or her farm) or if the satellite measurement is inaccurate around the threshold, also known as basis risk.

A proposed solution is to offer insurance to groups where informal risk sharing may be present. Dercon et al. (2014) theoretically show that if informal transfers cover idiosyncratic risk, including basis risk, then this will crowd in the demand for index insurance at the individual level. Index insurance covers covariate risk, and any additional basis risk as well as residual idiosyncratic risk will be handled by informal risk sharing. A key assumption in Dercon et al. (2014) is that informal risk sharing among group members exists. But if informal risk sharing mechanisms are not available or even just limited, then individuals are back in a world where they must purchase formal insurance to cover their overall risk, and no means to insure any additional basis risk. Another option is to offer insurance as a group contract. Group contracts can effectively introduce the possibility for informal risk sharing of idiosyncratic risk and basis risk leaving only covariate risk to be covered by formal insurance. This then would actually reduce the demand for formal insurance, while overall risk coverage (covariate, basis and own idiosyncratic) would improve.

We explore these issues using a lab-in-the-field experiment offering real index insurance to dairy farmers from farmer group associations in the Northwest of the Dominican Republic. Farmer group associations are a natural setting for offering group index insurance. Members are familiar with one another and are also interested in insuring against the same agricultural shocks, but they may not be friends or family. In our data only 10 to 20 percent of reported connections were reported as friends or family in each association, and only 25 percent listed friends and family as someone they would even turn to if their farming failed, while 62 were more likely to turn to their farmer association or a bank. First, we randomize whether farm-

[1] There are several reasons. First, informal risk-sharing networks may not be complete (Caria and Fafchamps, 2014; Chandrasekhar et al., 2017; Sadoulet, 2005) meaning that some individuals in a village will not belong to an informal risk-sharing network. Second, informal risk-sharing networks may not be sufficiently large to accommodate all risk profiles (Ambrus et al., 2014). Even if incomes are heterogeneous, individuals' preferences for risk may not be. Third, even if networks are sufficiently large and well connected, individuals may have an incentive to free ride on the disposable income of others. Finally, coordination failures can occur if individuals fail to internalize the value of their personal ties to the network at large, resulting in an underinvestment in their connections with others (Bramoullé and Kranton, 2007).

ers participate in sessions where they are offered only individual insurance contracts versus sessions in which they are offered group insurance contracts (with the option of opting out of the group to purchase an individual contract alone).This allows us to study the effect on demand when group insurance is an option versus when it is not an option. Next, in the groups sessions, we randomize individuals into groups of either perceived similar wealth profiles (homophilous groups) or perceived dissimilar wealth profiles (heterogenous groups) to identify if group similarity will increase risk - a key factor for improving overall risk coverage. Since farmers are not obligated to purchase with their randomly assigned group we can observe whether farmers who are more similar are more likely to enter group contracts, and then how much insurance they collectively purchase.

There are several strands of literature that suggest that individuals with similar wealth profiles would be more likely to risk share (i.e. enter into group contracts on the extensive margin), particularly in a setting where individuals are otherwise fairly homogenous, such as our own. From a networks perspective, Attanasio and Rios-Rull (2000) show that informal risk sharing occurs among friends and family, and friend networks tend to be homophilous networks in terms of socio-economic characteristics (McPherson et al., 2001). De Weerdt (2005) shows that wealth, as measured by livestock and land holdings, is a strong predictor for risk sharing in rural Tanzania along with kinship, geographical proximity, the number of common friends, clan membership, and religious affiliation. They find that rich households choose each other as network partners, but poor households avoid each other as network partners. Fafchamps and Lund (2003) show that individuals who share risk in the Philippines exhibit similar income rankings regardless of what role each has played - lender or borrower. From a behavioral perspective individuals may also prefer to share risk with more similar individuals if they are averse to unequal redistributions (Alesina and Angeletos, 2005). From a game theoretic perspective Johnson and Smirnov (2018) show that individuals are more likely to cooperate in groups the more homophilous their group wealth. This is because individuals derive information regarding past play in a prisoner's dilemma framework.

We find that farmers have a weak preference to purchase insurance in a group (64%, t-statistic = 4.2, if different from 50%). Next we find that farmers are more likely to enter into group contracts the more homophilous or more similar they perceive other farmers' wealth to be. A 5% (1 cow) increase in the similarity of group wealth results in a 6% increase in the probability of purchasing group insurance. However, conditional on entering into a group contract, more heterogenous groups purchase more insurance. Overall, the amount of insurance purchased in group sessions is lower on average than individuals sessions; farmers purchase 39 pesos less of insurance in the group sessions. This decline is largely driven by the homophilous groups. A 5% increase (1 cow) in the similarity of group wealth for the average farmer results in a decline in insurance purchased by 2 pesos. For heterogenous groups, where the average distance is around 17 cows, this 2 pesos decline explains the difference in the amount of insurance purchased in heterogeneous versus homophilous groups. Combining the effects over the extensive and intensive margins, offering index insurance to groups reduces overall demand for index insurance. Homophilous groups are more likely to remain in a group together, but their average premium purchased is lower than what they would have purchased alone. Heterogenous groups purchase more than homophilous groups, but no differently from what individuals purchased in isolation. Thus, the total demand for index insurance goes down when offering group contracts. This finding agrees with other concurrent studies investigating different aspects of group heterogeneity; however, we argue that lower demand in index insurance among groups could be welfare improving if groups can insure overall risk better than isolated individuals (McIntosh et al., 2015).[2]

The remainder of the paper proceeds as follows. Section 2 provides details on the background of dairy farmers in the Dominican Republic. Section 3 describes the satellite-based index used in the index insurance design. Section 4 reviews the game protocols and the implementation strategy. Section 5.2 describes how information about farmers was calculated during a session. Section 6 presents the results of the study. Section 7 provides robustness checks and Section 8 concludes.

2 Dairy Farmers in the Dominican Republic

For many farmers in the Dominican Republic, climate change means more extreme and frequent "bad" years. According to the Intergovernmental Panel on Climate Change (IPCC) the Caribbean will experience higher average temperatures and a decrease in precipitation under some climate scenarios, potentially leaving producers increasingly vulnerable (Collins et al., 2013). The Northwest region of the Dominican Republic (DR) has uniquely dry conditions, as opposed to other regions of the country, with two distinct yearly dry seasons.[3] The experimental site is comprised of upland, as well as coastal municipios (municipalities) in the Northwest Region including Monte Cristi, Valverde, Dajabon, and Santiago Rodriguez. Studying this region is important not only because it is vulnerable to drought, but also because a significant percentage of the milk production for local consumption in the Dominican Republic happens in these four municipios. There are about 9,000 dairy producers in the region, out of the 59,000 countrywide.

The average cattle farm in the region has a size of 34 acres (not irrigated) with about 20 cows producing 10 liters per day during the rainy season and about 6 liters during the dry season. On average, dairy producers received 18 Dominican Pesos (DOP), or 0.42 USD, per liter of milk after accounting for handling fees (in 2014). However, production costs per cow each month range between 2,175 and 3,045 DOP (50 and 70 USD), during the dry season and rainy season, respectively. These costs typically include: supplementary feed, labor, veterinary costs, and pasture packs. Each cow's monthly production has a high variance across seasons, with an average profit of 243 DOP (5.60 USD) in the dry season and 3,290 DOP (76 USD) in the rainy season. With rising temperatures and strain to groundwater availability

[2]Note that this concurrent and closely related study also investigates the impact of heterogeneity in groups; however, they vary the heterogeneity in expected losses not heterogeneity in ex ante wealth within a group, which is what permits them to estimate preferences over wealth.

[3]The first dry season, typically with a widespread impact across the region, runs from December to March. The second dry season begins in July and lasts until September, usually affecting the coastal zones more dramatically.

(Caffrey et al., 2013), producers are increasingly faced with risks to milk production. During severe drought, such as in 2011, milk production can decrease by up to 60-70% from normal levels, reaching as low as 3-4 liters per day per cow as opposed to 10 liters during the most productive times of the year. As a result, producers face increasingly complex climate risk management decisions. These include increasing their investments for cattle feed, selling off productive cows to manage financial burdens due to drought impacts, managing the loss of productive cows, increasing their contract labor force, and spending more time collecting water from farther distances.

A substantial percentage of the producers in this region are organized into farmer associations. Associations serve as milk procurement centers, as well as platforms for discussion where farmers are able to examine the best risk management strategies available to them as a community during challenging circumstances. The participating associations are structured under one federation, FEDEGANO, the Federation of Dairy Farmers of the Northwest. FEDEGANO plays an administrative role, arranging contract opportunities for the associations with dairy processing companies, such as Parmalat Dominicana, Nestle, and the local entity, Pasteurizadora Rica, and promoting the implementation of climate risk management strategies with its members. FEDEGANO facilitated this study's setup, by using already established connections within the federation to reach out to associations of dairy farmers who were willing to participate in the study.

3 Dry-Run Satellite Vegetation Index Product

The trigger for an insurance payout is determined based on a vegetation index, or a measurement of the landscape's response to the arrival of (or lack of) rainfall necessary for vegetation to grow. The USAID Dominican Republic's Climate Resiliency and Index Insurance Program (referred to as USAID DR CRII hereafter) uses the normalized difference vegetation index (NDVI), a Moderate Resolution Imaging Spectroradiometer (MODIS) VI product. The raw NDVI image files from eMODIS were sourced via FEWSNET,[4] a USAID-supported drought and famine early warning program implemented by several US Federal agencies. The NDVI index provides an indication of vegetative health (greenness) at any given time in a given area, and as a result, can serve as an intermediary in assessing greenness, biomass and primary production. NDVI is a spectral transformation of the visible (red) and near-infrared (NIR) bands. NDVI is a reliable spatial and temporal measurement of terrestrial photosynthetic activity allowing us to monitor seasonal and long-term variations in biophysical parameters of the pastures in the study region (Huete et al., 2002). NDVI is one of the most widely used satellite-based vegetative index in index insurance, with examples in Canada, the United States, Spain, Kenya, Ethiopia, and India (Leblois and Quirion 2012).

The raw NDVI data in this study are a measure of the greenness of pastureland in each municipality and district averaged across a five-day period. The satellite-based vegetation index pays out only when the estimates of the greenness are below a pre-established level.

[4] http://www.fews.net/

We did not design an index for our research test. Instead we utilized the specific insurance product developed by the CRII insurance implementation, designed to provide a payout during the three worst droughts in the past twelve years, one full and two partial, or one full payout every six years. This satellite-measured index used a 13-year data set to calculate the payouts (since 2000). Additional features of the index were also tested in parallel to our experiment, to support CRII project design questions, including assessing demand for alternate seasonal timing and packaging of products. These additional activities did not interact with the hypotheses we test.

4 Experimental Design

The game was played with 354 participants in the Northwest region of the Dominican Republic, with 13 dairy associations, approximately 25 participants per session, across eleven sessions between January 28th and January 31st, 2014. Each session consisted of registration, training in index insurance, concept discussion and then the game. The game alone took two hours, but the training was essential as index insurance was an unfamiliar and complex product, and past research has shown that training is important for take-up as as well as for understanding the product (Carpena et al., 2012; Gaurav et al., 2011).

The 13 associations were randomly selected from a list of associations for the monitoring and evaluation segment of a wider USAID DR CRII project, and represent coastal as well as upland dairy farmer communities. The 25 participants from each association were randomly selected from a complete list of farmer names from within each farmer group. Selected farmers were invited and notified of the day and time of participation by our partners at the Rural Economic Development Dominicana (REDDOM) and farmer association heads. Two co-authors fluent in Spanish from the Financial Instruments Sector Team (FIST) at the International Research Institute for Climate and Society at Columbia University facilitated the games by reading instructions and answering questions. A team of 8 facilitators from USAID DR CRII and Rural Economic Development Dominicana (REDDOM) provided support during the game (by collecting recorded allocations and surveys). Swiss Reinsurance Company Ltd (SwissRe), a global reinsurance company, provided resources to support the experiment. REDDOM, the project's local implementing institution, facilitated the recruiting process in the region. The same set of moderators assisted participants across all sessions.

Individuals participated in a game protocol in which they were given 17 tokens each worth 25 DOP (60 cents USD) for a total of 425 DOP (or about 10 USD at the time). Following Norton et al. (2014), producers could allocate their tokens between different financial instruments options for climate risk management: (1) taking the money home, (2) personal savings earning a 25% return, (3) community savings earning 10% return,[5] and (4) commercial index insurance (Figure 3), which would provide a 3x payout once every 6 six years in the even

[5] Community funds were used to implement community level risk management measures, which were not announced until game payments were made, to benefit only those who did contribute.

of a drought.[6] This initial setup is similar to other interactive index insurance simulation exercises (Carter et al., 2008; Gaurav et al., 2011; Norton et al., 2014).

The game endowment, 425 DOP (10 USD), equated to approximately two and a half days worth of dairy production during the rainy season.[7] Note that the community savings option was binary. We restricted farmers to allocating a maximum of 1 token (25 DOP) to the community savings option to ensure a uniform investment across participants in each association, as disbursement would be made as one payment to the association. We included community savings because it was an existing and standard option within the farmer association, and partners preferred that we include it to mimic real options. However, we chose a return of 25% for the personal savings to essentially "quiet" the community savings option and better observe participants' preferences between savings and insurance, where a 25% return presented a legitimate counter option to insurance. The insurance that participants purchased in the game was realized based on vegetation greenness (NDVI), which was measured throughout the remainder of the year until September 2014. In the case that vegetation greenness levels fell below a predetermined level, participants would receive three times their investment in the index insurance option.[8]

Each session progressed as follows. Upon registration each dairy producer was assigned a unique number and given a bag with an initial endowment of 17 tokens (425 DOP). In addition, farmers received a set of practice sheets and game sheets to record their decisions.[9] Facilitators engaged dairy producers in a discussion intended to familiarize them with the different concepts of index insurance: introduction to index insurance, technical details such as contract windows, premium costs, index measures (satellite vegetation greenness), and basis risk. Additionally, facilitators explained the experiment instructions in detail, including descriptions of endowment and allocation options.

The game protocol was modified in the sessions where group insurance was offered. Participants were first randomly assigned to a high or low distance groups, consisting of 15 individuals each. They had no knowledge of this assignment. Participants then filled out a survey about the other 14 individuals in their group. In the survey each producer recorded the number of productive cows that he or she thought the other individuals in the group owned. This survey was not conducted in the individual sessions, as participants in those sessions were not offered the option to purchase group insurance. This survey did extend the

[6] Note that the choice was not between allocating funds either into savings or into insurance, as the expected return to insurance in any given year would not exceed the returns to our savings account. However, conditional on the probability of drought being positive it is always in the farmer's interest to purchase some insurance.

[7] Farmers receive approximately 20 DOP (before accounting for handling fees) for each liter of milk sold, and yield an average of 10 liters per day during the rainy season.

[8] Note: the interest rates do not reflect the real market rates in the Dominican Republic. Further, a 3x payout reflected an index that would pay a full payout approximately once every six years, mimicking several active index insurance projects in the developing world and the expectations for the upcoming commercial implementation in the Dominican Republic.

[9] The majority of participants were literate. In a few cases, we had an additional facilitator assisting illiterate farmers in recording their choices.

length of the meeting, but was completed comparatively quickly (approximately 15 minutes).

Participants allocated their endowments in one practice round before the final round. For the practice round, participants revealed their preferences by allocating the 17 (25 DOP each) tokens across the different options on their game sheets. For the practice round two orange Ping-Pong balls (representing severe drought) and 10 white Ping-Pong balls (representing a normal season) were placed in an opaque bag. The balls represented the actual severe drought probabilities in the region. During the practice round, a participant randomly selected 1 out of 12 Ping-Pong balls to mimic a climatic realization of the season. For the seasonally cumulative insurance sessions the ball was selected three times (one for each of 3 seasons) to determine if there would be a hypothetical payout. Payouts were then added up and checked by facilitators.

Following the practice round, participants were asked to make their final allocation decision with the understanding that their choices were now binding. Any insurance purchased in the final round would be paid out according to the weather realization in the upcoming season and its impact on vegetation greenness.[10] Insurance paid 3x the insurance premium in the case of bad weather and nothing in case of a normal season. The insurance payout was calculated to account for farmers receiving two full payouts in a twelve-year period. During each round participants recorded their allocations on practice sheets or game sheets. Following their allocations, participants completed exit surveys on demographics and assessment of their comprehension of index insurance. Facilitators collected worksheets and surveys, and paid participants who chose to take any of their endowment home. Savings and insurance payouts would be administered on a return visit.

5 Treatments

We included two separate treatments in the design: (1) a monthly compared to a seasonally cumulative index option, and (2) a group versus individual purchasing option. Our primary interest is with the latter treatment, but we control for the index type throughout.[11]

[10] The upcoming season was from February to September 2014. Unlike the practice round, the insurance outcome in the final round was determined by the upcoming season's pasture conditions and was not based on the outcome of a hypothetical draw.

[11] Participants given the monthly index option could choose the particular months to be insured during the dry run period of February to September. Participants could allocate their tokens (425 DOP, 10 USD) to one month or allocate their tokens throughout all or some months. For example, if participants invested one token (25 DOP) in one month and another token to a different month, and if both months were dry enough to trigger the index, producers would receive a 3-token (75 DOP) insurance payout for each month that triggered.

In the seasonally cumulative index insurance, participants were free to allocate their game endowment across three different periods: (1) February and March, (2) April, May and June, and (3) July, August and September. (January was excluded as the games took place from January 28th to January 31st, 2014.) For example, if participants put one token on period 1 and another token on period 2, and both 3-month periods were dry enough to trigger the index, then producers would receive 3-token insurance payout for each of the

5.1 Monthly compared to Seasonally Cumulative Index Option

Half of the sessions were randomly chosen for the monthly index insurance product, while the other half were offered the seasonally cumulative index insurance product. Farmers did not choose which index they were offered. Guy Carpenter and Risk Managers to the Caribbean (CaribRM) created the two indices as part of the USAID DR CRII project. The indices reflect the driest periods for the Northwestern Dominican Republic at monthly or thee-month scales, using MODIS NDVI as a proxy for pasture greenness.

5.2 Groups versus Individual Contracts

The notion of group contracts was first popularized with micro-loans (Baland et al., 2013; Besley and Coate, 1995; Chowdhury, 2005). A long debate ensued over the efficacy of group lending and questioned whether members should be subject to joint liability (Ghatak, 2000; Ghatak and Guinnane, 1999; Giné et al., 2010; Paal and Wiseman, 2011; Quidt et al., 2016; Tassel, 1999). Joint liability reduces default rates for the lender, but can increase the likelihood of moral hazard and free riding. Studies subsequently questioned what type of member characteristics could help reduce the incidence of free riding, and, therefore, default. For instance, Cassar et al. (2007); Fafchamps and Gubert (2007); Ghatak and Guinnane (1999); Tassel (1999) all show, broadly, that social homophily and trust matter for group lending repayment rates. Although these findings are useful, they may not carry over to group insurance. First, with group insurance, those who enter into a group contract contribute a premium and payout distribution in advance; thus the same concerns over free riding on repayments do not exist. Second, trust in others is difficult to develop in the short term, and is often correlated with familial of friend proximity, of which there was little in our farmer groups.

Our first treatment of interest is the offering of group insurance. First, we randomly selected which sessions were offered the group index insurance. Within group sessions, participants were then placed into randomly assigned groups of three - the minimum number to form a group, which maximized the number of groups.[12] Figure 2 depicts the timing of decisions in a group contract. Participants were still permitted to purchase insurance individually if they opted out of the group insurance. Thus, in some cases, groups of three became groups of two. Groups were given the option on how they would like to divide payouts: divide potential payouts evenly or proportionally to individuals' losses. This was done so that groups would arrive at the optimal sharing rule for them, and this would likely change for heterogenous versus homophilous groups.[13] In the remaining individual sessions, participants were only given the option to purchase insurance individually, and participants did not communicate

different periods.

[12] It is likely that group take-up would change with group size - a question we do not address here.

[13] Note that farmers could defer this decision to the time of any eventual payouts in the season, although the majority (79%) chose to make this decision upfront.

with one other in these sessions.

5.3 Perceptions of Wealth

For each association offered the group insurance option, we divided individuals randomly into two sub-groups of approximately 15 individuals: "low" and "high" distance. Participants were not told at any time whether they were assigned to the "low" or "high" distance groups. At the start of each session respondents completed surveys listing the number of cows that they owned, and the number of cows they believed each individual among the 15 owned. Individuals in the "low" group were assigned to groups where they believed the other two individuals had a similar number of cows, homophilous groups, while individuals in the "high" group were assigned to groups where they believed the other two individuals had a dissimilar number of cows, heterogenous groups.

The distance between two individuals is measured as d_{ij} from $i's$ perspective: $d_{ij} = \frac{|t_i - g_{ij}|}{t_i}$, where g_{ij} is what i believes j owns, and t_i is what i truly owns. We divide by t_i to normalize for the fact that an error in distance for large number of assets may differ from an error in distance for a small number of assets. Each i farmer has beliefs about the two individuals that he or she was paired with. The overall belief of a farmer about his or her group with farmer j and farmer k is simply $\bar{\text{Distance}}_i = \frac{d_{ij}+d_{ik}}{2}$. [14] After participants completed the surveys, the data were used to randomly assign participants to groups of three based on distance.[15]

6 Empirical Results

Our randomization design allows us to test two hypotheses: Offering group insurance does not change the amount of insurance purchased; and heterogeneity in group wealth has no effect on purchasing group insurance, both on the intensive and extensive margins.

[14] Note that in an earlier version of this paper we used a different distance measure, and this is the measure that was used to group farmers. That measure was a more complicated measure that did not reflect personal beliefs, but averaged across beliefs. Based on a reviewer's suggestion we are now using this more simple and straightforward measure of homophily. However, the two measures are significantly correlated (t = 5.41) and the two groups remain statistically different in terms of both the dichotomous and continuous distance measures. See Appendix for details.

[15] A greedy algorithm was used to evaluate the matrix of information values. For the "high information" group of 15 farmers, we identified the five triplets who had the most information (most correct/lowest error) about one another among $\binom{15}{3}$ pairs. For the "low information" group of 15 farmers, we identified the five triplets who had the least information about one another's cows $\binom{15}{3}$ pairs.

6.1 Who Participated

Figure 3 shows the locations of each farmer association meeting center in the Northwest of the Dominican Republic. Table 1 shows that the average participant is a male in his mid 50's, who has tertiary education, owns approximately 20 productive cows, and has 4 acres of irrigated pasture. Generally, participants were well-established farmers whose livelihoods are in agriculture.

Table 2 shows that the treatment groups are balanced on observable variables of gender, education, cows and land owned, but not for age, for which we control throughout. Table 3 shows that the treatments groups are balanced on the same observable variables except for age. A key point to note here is that the two groups are balanced on farm size. This is crucial because we can rule out any potential wealth effects that could be driving our results - for example, if heterogenous groups also had larger farms on average. Rather, it is how farmers were grouped with one other that is exogenously varying across the two groups.

6.2 Demand for Insurance

Table 4 summarizes the overall game results. Participants place 73% of their endowment into insurance, 16% into personal savings, 6% take the money home, and 5% is allotted to community savings. The allocations are significantly different across the individual (IND) and group (GR) sessions without controls; Individuals in GRP sessions purchased 34 DOP less insurance than individuals in IND sessions (p = 0.001). We now estimate the impact of offering group insurance for farmer i in session k in the following reduced form specification:

$$I_{ik} = \alpha + \beta_G \cdot GRP_{ik} + \beta_M \cdot \text{Monthly}_k + \epsilon_{ik} \tag{1}$$

where I_{ik} is a continuous variable of how much insurance each individual i purchases; GRP_{ik} is a dummy that equals one, if the individual was in a group session, and zero if in a individual session; and Monthly_k is a dummy that equals one if offered monthly insurance and zero if seasonal insurance. We control for age throughout given its imbalance across treatment and control.

Note that the estimate of β_G is an intent to treat (ITT), because participants were not required to purchase group insurance, or any insurance for that matter. Individuals could opt out of purchasing the group insurance and simply purchase individual insurance. We do not focus on the monthly versus seasonal offerings in this paper, and unlike the group versus individual options, participants were not given a choice between monthly and seasonal indices; they were simply offered one of the two indices.

Table 5 estimates equation 1. Column one compares insurance premiums purchased in group versus individual sessions (the intent to treat), without clustering standard errors. The marginal effects indicate that being offered the group insurance reduced insurance premium purchases by 39 DOP, about a quarter of a day's farm income, and are significant. Although, individual sessions could not interact, groups sessions could. As a conservative estimate we also cluster standard errors at the session level in Column two. The marginal effects remain the same but are now weakly significant.[16]

6.3 Group Distance

To better understand what is causing a reduction in insurance demanded within the group sessions, we estimate the effects that heterogeneity in wealth may have had. Table 6 summarizes the results across the two groups. We see that individuals in the homophilous group were significantly more likely to enter into group contracts, purchased significantly less insurance (in a group pool) and were significantly more likely to split potential payouts evenly (55% versus 24%) if they did remain in a group. Conversely, heterogenous groups were less likely to enter group contracts, and conditional on entering a contract, more heterogenous groups purchased more insurance on average, and divided payouts proportional to their losses. These overall findings are consistent with notion that if groups can manage idiosyncratic risk, then the demand for formal insurance would go down.
We now take our estimate to a regression framework. I_{igk} is a dichotomous variable when we estimate whether individual i selects group versus individual insurance, and I_{igk} is a continuous variable when we estimate how much insurance premium individual i purchases in group g, session k. $\bar{\text{Distance}}$ is the distance measure calculated from the perspective of farmer i. β_D, the effect of Distance, is our coefficient of interest.

$$I_{igk} = \alpha + \beta_D \cdot \bar{\text{Distance}}_{igk} + \beta_M \cdot \text{Monthly}_k + \epsilon_{igk} \tag{2}$$

Recall that while we randomized individuals to high and low distance groups, the range of our continuous distance measure alone is endogenous to the sessions' participants. Namely, some sessions may have a high range of similarity and others a lower range. For this reason we instrument our continuous $\bar{\text{Distance}}$ measure with the treatment of being assigned to a high or low, High-Low, distance group.[17]

Table 7 presents the results of distance on the extensive margin, or the probability of entering into a group contract. Column 1 reports the results from an Probit regression using first only the dichotomous High-Low variable. Column 2 reports the results from using the continuous $\bar{\text{Distance}}$ variable instrumented by High-Low. Standard errors are clustered at the group level. We see that the effect of distance is significant and negative. A perceived average distance of 1 cow decreases the probability of purchasing in a group by 0.04. Knowing that the average farmer has 20 cows and 58% of individuals purchased insurance in a group in the heterogenous groups, this implies that a 5% increase in perceived similarity (1 cow) increases the probability of purchasing in a group by 6.8%.

In Table 8 we estimate the effect of distance on the intensive margin, or how much insurance was purchased. Column 1 reports the results from a OLS regression using only the

[16]Results are unchanged using wild bootstrap standard errors.
[17]Instruments are significant at the first stage but not reported here.

dichotomous High-Low variable and Column 2 reports the results from using the continuous Distance variable instrumented by High-Low. Here we see that conditional on having entered a group contract, greater perceived homophily decreases the amount of insurance purchased. A 5% increase in wealth similarity reduces the amount of insurance purchased by about 2 pesos for each member in the group, a statistically significant effect. Scaling this result up to the heterogeneity that we see in our high distance vs low distance groups explains the decline in insurance purchases within group sessions. Individuals in heterogenous groups, where the average distance in wealth was 17, would purchase approximately 34 pesos more than in individual sessions, and individuals in homophilous groups would, where the average distance was 5.7, would purchase 11 pesos less than in the individual sessions.

7 Robustness

On the extensive margin, we posited that homophily and peer effects could be one possible explanation for why individuals may be more likely to enter into a group contract with one another. However, it is possible that peer effects could also be driving purchasing behavior on the extensive margin as well and not risk sharing. Charness et al. (2007) show that peer effects are strongest the more salient group membership is; thus peer effects should be strongest in homphilous groups. If that is true then we would expect that "defectors" of homophilous groups purchase less insurance individually than individual purchasers in the individual sessions. We do observe that "defectors" of homophilous groups purchased 308 pesos of insurance while participants in individual sessions purchased 330 pesos on average, but the difference is not statistically significant (p = 0.15). Furthermore, if peer effects are driving choices then we would expect similar peer effects on other outcomes, for example comprehension of index insurance. In our exit survey we included four true or false questions regarding the basics of index insurance: "Premiums would be returned if no bad weather ever occurs"; "You can purchase insurance after a bad event occurs"; "If you have a bad year, you may not get a payment if the index measure indicates a good year"; and "Satellite based vegetation measure will always reflect the health of my own pasture." In Table 9 we see no difference in comprehension of group insurance between individuals in the group and individuals sessions. Overall comprehension of insurance was also relatively high, except for the question regarding satellite based measures. Explaining satellite based measurements is generally one of the more challenging components of index insurance, but necessary if we want farmers to understand how basis risk can arise. That said, comprehension regarding basis risk was still relatively high. Thus, while we cannot rule out peer effects they do not appear to be strongly driving our results.

Another reason that individuals' premium purchases could decline in a group purchase is because defection is observable. Barr and Genicot (2008) show that if defection from group investment options are public this leads to lower investments in the group insurance among the remaining non-defectors. We do not observe this in our data. Defection was higher in the heterogenous groups where we saw higher average insurance purchases.

Lastly, groups may purchase less insurance in homophilous groups because groups with less wealth inequality need to insure less. This would fall in line with theory on risk aversion and the equity premium. For example, Gollier (2001) shows that if absolute risk tolerance is concave in wealth[18] then the equity premium increases with wealth inequality. Thus, homophilous groups should exhibit less risk aversion than heterogeneous groups, and we would therefore expect their demand for insurance to be lower.

8 Conclusion

It is often advocated to offer insurance contracts at the group level, as opposed to the individual level, to complement existing group risk sharing mechanisms. If groups can better manage idiosyncratic risks while index insurance covers only covariate risk then group contract could improve welfare. In particular, individuals could purchase less formal insurance if groups are better able to manage residual idiosyncratic risk. However, it is not well understood how effective informal group risk management is at addressing the idiosyncratic risk not covered by the index insurance, or what factors influence a group's ability to manage this risk. Clearly, we should understand the characteristics that allow groups to manage risk in order to develop formal index insurance products that are intended to harness group risk management.

In this paper, we empirically tested the effects of offering index insurance at the group level. We also tested the degree to which perceived similarity in farmers' own wealth affects group insurance take-up. If group index insurance is to scale then farmers interested in insuring the same covariate risks are a natural pool to market to. In our data only 10-20% of the reported connections between farmers in each association were categorized as friend of family. That leaves a considerable number of individuals who are interested in insuring against covariate risk but might not know one another to enter into group contracts.

Perceived wealth was a natural measure of variation in group composition as the network literature tells us that it is one of the key determinants of risk sharing. Individuals group with those whom they see as more like them. However, inequality in wealth can be associated with an increase in risk aversion and thus an increase in the demand for insurance. Our findings corroborate this story. Individuals randomly assigned to homophilous groups with regards to perceived wealth (productive cows) purchase less insurance on average. This suggests that offering index insurance to groups would not increase overall demand as the groups most likely to pool risk purchase less coverage.

Further, a reduction in overall demand with group contracts could be welfare improving, if group contracts encourage additional informal risk sharing within the group. For example, Takahashi et al. (2017) show that individuals paired with peers who purchase formal

[18] Whether absolute risk tolerance is concave in wealth is an empirical question, and a concurrent paper by McIntosh et al. (2015) estimate just this in the context of a lab in the field experiment in Guatemala regarding weather index insurance. They estimate preferences by allowing for absolute risk tolerance to vary non-linearly with wealth and find that absolute risk tolerance is in fact concave in wealth.

insurance tend to increase their informal risk sharing with those peers. Thus, it is possible that formal insurance may help to secure tighter contractual bonds with group members outside of the formal contract, which engenders greater informal risk sharing. This could reduce overall costs to groups, as farmers shift from more expensive index insurance to more cost effective group risk management, leading to potential welfare benefits, a goal of many insurance projects. Extensions of this work could test how overall informal risk sharing is handled in a group in the presence of group insurance contracts.

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Figure 1:

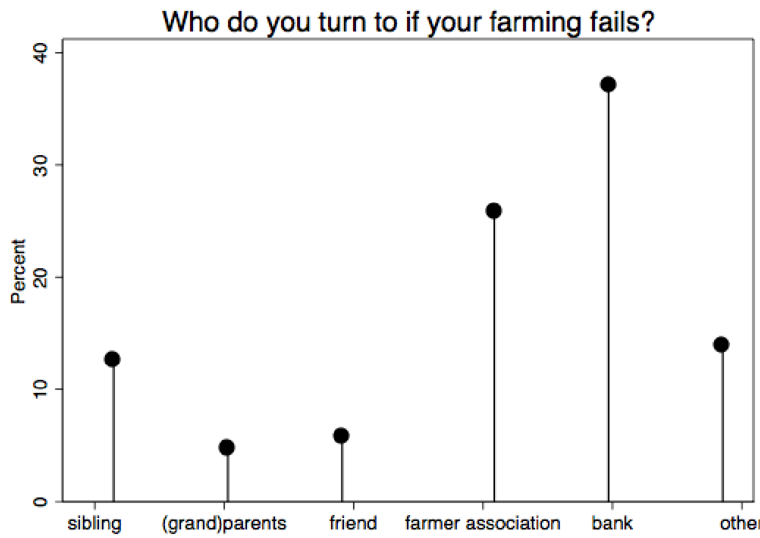

Figure 2: Timeline for Group Decisions

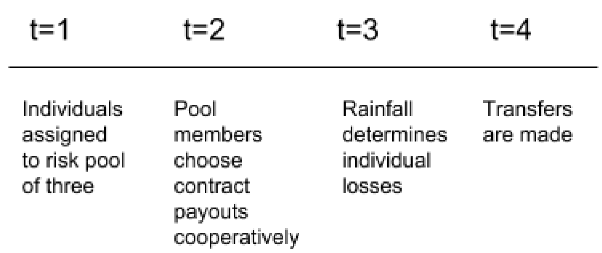

Figure 3: Location of Experiment

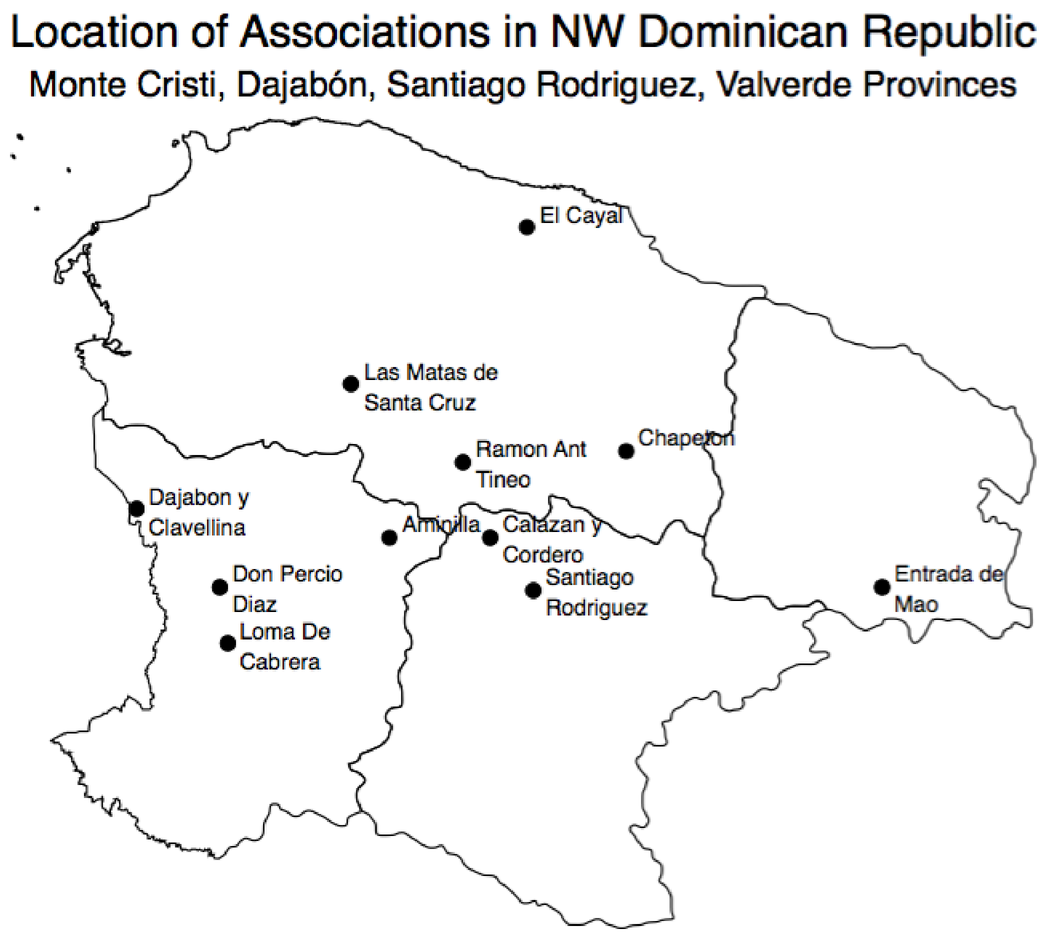

Table 1: Summary Stats of Participants

Variable	Mean	SD	
Age	54.67	13.57	340
Gender	0.92	.25	355
Education*	2.02	1.54	350
Cows 2013	21.30	22.15	320
Cows 2014	19.90	20.71	333
Acres pasture	34.80	45.57	338
Acres irrigated pasture	3.66	10.07	319
Know of Insurance	0.52	0.5	341
Know of Index Insurance	0.18	0.38	326

**1 Primary, 2 Secondary, 3 Tertiary, 5 College, 6 Beyond College*

Table 2: Balance Across Group and Individual Sessions

Variable	IND	GRP	IND SD	GRP SD	Pval	N
Age	57.19	52.72	13.11	13.58	0.0029***	328
Gender	1.93	1.93	0.25	0.26	0.74	341
Education	1.97	2.14	1.44	1.64	0.31	336
No. Cows 2013	20.49	21.75	24.19	20.49	0.62	308
No. Cows 2014	18.73	20.63	21.78	19.87	0.41	321
Pasture (acre)	34.84	34.36	39.15	51.03	0.92	326
Irrigated pasture (acre)	4.16	3.39	8.7	11.43	0.51	309
Projected Labor Costs 2014 (DR Pesos)	180,893	133,579	516,002	185,437	0.27	309
Know of insurance	0.54	0.51	0.5	0.5	0.53	328
Know of index insurance	0.2	0.17	0.4	0.38	0.53	313

Table 3: Balance Across High and Low Distance Groups

Variable	IND	GRP	IND SD	GRP SD	Pval	N
Age	54.35	50.46	11.3	15.53	0.1*	133
Gender	1.93	1.9	0.26	0.31	0.57	135
Education	2.21	2.22	1.78	1.63	0.98	134
No. Cows 2013	24.22	18.58	22.32	18.5	0.14	119
No. Cows 2014	20.51	17.55	14.84	22.17	0.38	127
Pasture (acre)	29.34	27.82	29.37	50.05	0.84	127
Irrigated pasture (acre)	2.61	2.2	4.71	3.86	0.61	117
Projected Labor Costs 2014 (DR Pesos)	121,615	129,261	103,957	212,156	0.8	119
Know of insurance	0.46	0.54	0.5	0.5	0.38	126
Know of index insurance	0.14	0.21	0.35	0.41	0.29	125

Table 4: Endowment Allocation Across Treatments

Variable	IND	GRP	Pvalue
Insurance Purchased	330.29	296.03	0.0001
Savings	58.33	79.90	0.0008
Take Home	18.268	27.94	0.09

Table 5: Amount Insurance Purchased, Group versus Individual

Variable	(1) OLS	(2) OLSˆ	(3) OLSˆ
GR	-38.81***	-38.81*	-37.66
	(-4.753)	(-1.798)	(-1.632)
Monthly	25.61***	25.61	25.11
	(3.235)	(1.184)	(1.079)
Age			0.0984
			(0.342)
Constant	321.7***		
	(41.79)		
Observations	354	354	328
R-squared	0.067	0.067	0.067

Robust t-statistics in parentheses

Ŝtandard errors clustered at the session level

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

Table 6: Mean Values across High and Low Distance Groups

Wilcoxon-Mann-Whitney Tests

Variable	Low Distance (Homophilous)	High Distance (Heterogenous)	Pvalue
Distance	5.18	16.54	0.001
Purchased in Group	88%	55%	0.05
Premium Purchased	286	319	0.004
Chose Predetermined Payout Plan	71%	85%	0.18
Chose Even Split of Potential Payouts	55%	24%	0.03

Table 7: Effect of Distance on Takeup of Group versus Individual Insurance

Marginal Effects, Group Sessions

VARIABLES	(1) Probit	(2) Ivprobit
Monthly	-0.165	0.0622
	(-1.198)	(0.110)
Age	-0.00537**	-0.0101
	(-2.011)	(-1.329)
High-Low	-0.185	
	(-1.327)	
Distance		-0.0356***
		(-3.069)
Observations	130	130
R-squared	0.267	-0.330

Robust t-statistics in parentheses

Standard errors clustered at the group level

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

Table 8: Effect of Distance on Group versus Individual Insurance Takeup

Group Sessions

Variable	(1) OLS	(2) IV
Monthly	14.56	11.25
	(0.567)	(0.521)
Age	0.314	0.150
	(0.561)	(0.305)
High-Low	59.26**	
	(2.544)	
Distance		1.727**
		(2.245)
Observations	84	84
R-squared	0.267	0.041

Robust t-statistics in parentheses

Standard errors clustered at the group level

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

Table 9: Exit Survey Quiz on Insurance, Group versus Individual

Variable	(1) Premium	(2) After Rain	(3) Basis Risk	(4) Satellite
Gr	-0.0232	-0.0370	0.0392	0.108
	(-0.253)	(-0.528)	(0.564)	(1.288)
Monthly	-0.0266	-0.0798	-0.156*	-0.120
	(-0.283)	(-1.063)	(-2.084)	(-1.584)
Age	0.00395***	0.000640	0.000671	0.00115
	(3.127)	(0.391)	(0.368)	(0.580)
Constant	0.00633	0.208*	0.688***	0.770***
	(0.0640)	(2.021)	(5.440)	(5.585)
Observations	254	265	268	260
R-squared	0.022	0.017	0.026	0.033

Robust t-statistics in parentheses
Standard errors clustered at the session level
*** p<0.01, ** p<0.05, * p<0.1

Appendix

In an earlier version of this paper we defined d_{ij} differently, and this is the measure with which we sorted individuals. d_{ij} was defined between two individuals i and j from $i's$ perspective, where we subtract the true number of cows that j owns, t_j, from the number guessed about j, g_{ij}. This information value, $d_{ij} = |t_j - g_{ij}|$ represents $i's$ guess about their fellow member's, $j's$, productive (cow) assets. Similarly, $d_{ji} = |t_i - g_{ji}|$ represents $j's$ guess about their fellow member's, $i's$, productive (cow) assets. We then normalize each information value by the number of cows that the other individual owns, $d_{ij} = \left|\frac{t_j - g_{ij}}{t_j}\right|$, where $i, j = 1 \ldots 15$.

After participants completed the surveys, the data were used to randomly assign participants to groups of three.[19]

The group information measure was then the average information measure across each pair in the group. This metric proxied for knowledge about fellow farmers' wealth, and was used to group individuals during the experiment. Once the triplets were formed, we could compute an average information rate per group.

$$d_{ij}^{\alpha} = \left|\frac{t_j - g_{ij}}{t_j}\right| + \left|\frac{t_i - g_{ji}}{t_i}\right|$$

However, the interpretation of this measure was challenging as it was not a reflection of person $i's$ beliefs and, therefore, could not be known by individual i in making choices. A related and correlated measure was, therefore, adopted. However, because we did not sort individuals based on this measure, we show that the two are significantly correlated below, but the new measure has greater interpretability.

[19] A greedy algorithm was used to evaluate the matrix of information values. For the "high information" group of 15 farmers, we identified the five triplets who had the most information (most correct/lowest error) about one another among $\binom{15}{3}$ pairs. For the "low information" group of 15 farmers, we identified the five triplets who had the least information about one another's cows $\binom{15}{3}$ pairs.

Table 10: Correlation Between Old and New distance measure

	(1)
VARIABLES	New Distance Measure
Old Distance Measure	0.173***
	(5.414)
Constant	8.313***
	(5.085)
Observations	127
R-squared	0.190

Robust t-statistics in parentheses
Standard errors clustered at the session level.
*** p<0.01, ** p<0.05, * p<0.1