Informal Networks within Index Insurance: Randomizing Distance in Group Insurance

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Abstract

We study the effect of offering index insurance to groups versus individuals on individual's savings and insurance decisions in a lab experiment in the field, which offers real index insurance. We also look at how the network relationships among dairy farmers in the Dominican Republics affects the demand for group index insurance. Individuals offered group insurance are exogenously grouped according to a distance measure reflecting what individuals know about one another's assets (number of productive cows) in their dairy farmer association. We find that individuals who are offered group insurance (as well as those who end up purchasing the group insurance) purchase less index insurance on average. This finding is line with theory demonstrating that group purchase encourages individuals to internalize the additional risk taking that formal insurance might allow. We also find that groups in which individuals are closer, are *less* likely to purchase insurance as a group, and also contribute less of their endowment to insurance.

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1 Introduction

Climate change is an increasing threat to the developing agricultural world. Greater variance and uncertainty, particularly with respect to temperature and rainfall onset, makes it increasingly difficult for farmers to insure themselves against losses. For idiosyncratic risks, farmers can often turn to their informal networks for support. For covariate risks affecting all villagers simultaneously, heterogeneity in risk preferences, as well as variation in wealth among villagers can support some level of informal insurance (Chiappori et al., 2014). Namely, for a given wealth, more risk averse farmers can insure less risk averse farmers, or for a given level of risk, wealthier farmers can lend to poorer farmers. However, as Angelucci et al. (2009) show, informal risk-sharing can break down for very large shocks. One salient reason for this is that village networks may not be complete[1], and individuals may not belong to the right networks that would enable consumption smoothing (Sadoulet et al., 2005).

The theoretical literature provides some reasons for why networks may incomplete, including a coordination issue in which individuals do not consider the negative externalities of breaking links (Bramoullé and Kranton, 2007). Ambrus et al. (2014) show that informal insurance is more of a reality at the group level, where different sub-groups insure one another, and act as a complete network, even though any two individuals from those sub-groups may not be connected.[2]

Index Insurance is a financial instrument that can be effective at insuring large covariate risks at the village level, where informal networks cannot. Based on a weather index, its payouts indemnify farmers if rainfall falls below a pre-specified threshold. Because indemnities are a function of an exogenous and publicly available rainfall index, the product removes much of the moral hazard and adverse selection associated with yield indemnified agricultural insurance.

[1]Bloch et al. (2007) show both complete, or thickly connected networks, as well as thinly connected networks are stable structures for informal insurance.

[2]That is, a village may be a described as a series of connected sub-graphs, but not as one complete network.

Thus, formal insurance can be a complementary financial tool to informal insurance networks. Informal risk sharing networks are apt at handing smaller idiosyncratic risks among farmers, while index insurance is constructed to handle large covariate risks. Træ rup (2012) argues for the importance of maintaining both sources of insurance, and warns of the danger in farmers erroneously "over-purchasing" formal insurance to cover risks that only informal networks can handle. Very recently, Mobarak and Rosenzweig (2014) show, in a large randomized control trial in India, that formal index insurance is a complement to the coverage provided by informal networks, and that formal insurance even enables farmers to take larger risks that they otherwise would not have been able to.

While formal insurance sold to individuals may complement informal risk sharing networks, it is precisely in villages with strong informal networks that purchasing of formal insurance could face coordination issues and thus low individual demand. Recent theoretical work by de Janvry et al. (2014) demonstrates how well-connected individuals can free-ride on their connections' insurance payout, resulting in a socially suboptimal level of coverage, similar to underinvestment in public goods. Thus, de Janvry et al. (2014) argue that selling insurance to groups can be a means to increasing demand for index insurance by correcting for these externalities through group coordination. Dercon et al. (2014) model a similar result of complementarity between index insurance sold to groups and informal networks, and a substitution effect between indemnity insurance and informal networks. They show that the presence of basis risk makes index insurance a complement to informal insurance networks sharing, and that the demand for index insurance should therefore *increases* when there is within group risk sharing.[3] This is because group subscription allows its members to allocate the payout according to needs, which should reduce the extent of basis risk, thereby strengthening the benefits of formal insurance.[4]

Conversely, in a more detailed theoretical model that accounts for moral hazard and

[3]Note, however, that the empirical test of Dercon et al. (2014) offers index insurance via groups, but does not offer group insurance per say.

[4]In out study, we actually give participants the option to allocate payouts by need, and take-up is still lower under group subscription.

informal risk sharing, Boucher and Delpierre (2013) show that selling index insurance to groups should *decrease* the amount of coverage purchased by each individual. While index insurance sold to individuals and informal risk sharing networks may be complements as Mobarak and Rosenzweig (2014), a greater degree of formal insurance allows for riskier choices, which informal networks must absorb, generating a negative externality on network members. Thus, when insurance is then sold to groups, the group internalizes this externality and reduces the amount of index insurance purchased. As they point out, "this outcome may contribute to explaining the low take-ups that are generally observed empirically" (Boucher and Delpierre, 2013).

The primary purpose of this article is to seek empirical support for the theoretical research on the demand for group index insurance. In a between experiment, we test whether the option of offering group insurance versus individual insurance alone increases demand for index insurance for dairy farmers in the Northwest of the Dominican Republic, who belong to farmer associations. We accomplish this by offering half of our sessions the option to purchase group insurance in randomly assigned groups of three individuals who come from the same farmer association. We chose groups of three to be able to learn more about group dynamics, rather than pairs alone, but to also keep the exercise tractable. Individuals offered group insurance can allocate their game endowment between group insurance, savings and taking the money home. They can also opt out of the group insurance and simply purchase individual insurance. As such, the experiment is not a direct comparison of the choice between only individual purchase or only group purchase. Because we were piloting insurance offerings for the first time in this region with dairy farms, it was important to our partners that the offering was not too restrictive at first and that the maximum number of farmers choose to purchase insurance. In addition we give participants the option over how the potential payouts will be allocated: evenly, proportional to losses, or to be determined in the future.[5]. Thus the appeal to farmers of a group option is the potential to have greater

[5]Note if a group chooses to share their payouts evenly this could be regarded as an equivalent to choosing individual purchase. However, not all group members entered in the same amount of money (20% of group

coverage than would otherwise be possible for some individuals, which could happen in two ways: 1) payouts are made proportional to losses or 2) unequal amounts are donated to the collective pool, but payouts are split evenly. The downside of this option is the potential coordination needed to agree on the amount donated and the eventual division of payouts.

The insurance purchased in the game pays out according to a weather index that is compared to the upcoming season. Participants are also given a choice over the months they will collectively insure[6].

In addition to testing the group option on take-up, we further consider whether the existing connections between individuals within our exogenously assigned insurance groups play a significant role in take-up and the amount of coverage purchased as a group, particularly because many farmer association members already informally assist each other in times of need. Previously cited literature has studied whether formal insurance and informal insurance are substitutes or complements, as well as how the structure of informal networks affects this tradeoff. In this paper we look at how the existing distance between association members within exogenously assigned group affects individual contributions (demand) to index insurance. We measure distance by what individuals know about the asset distribution (number of productive cows) in their dairy farmer association. This approach was informed by Alatas et al. (2012), in which individuals' knowledge of their fellow villagers' income resulted in a good proxy for how close any two individuals are. The natural corollary to income for dairy farmers is the number of productive cows, a potentially less noisy figure to capture than income. We also asked respondents to rank association members according to how well they knew each other, e.g. like family, as friends, as acquaintances, or only via the association. However, this method proved to be much more confusing for respondents. Our facilitators found that if respondents knew a fellow association member they would in fact say "I know

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purchasers chose to to this) into the insurance pool when they were in their group, even if they were still dividing the potential payout equally.

[6]February through March, April through June, and July through September. Note that there is an additional treatment of offering monthly insurance versus cumulative insurance, which we control for through out but do not discuss here. January was not insured as the offering took place only at the end of January.

X person and she has Y number of cows." Thus this question appeared to be more salient to our participants in terms of indicating their familiarity with a person.

To our knowledge, this is the first time that group insurance has been tested in a lab experiment in the field, and where the network composition of the group is studied as well.[7] Dercon et al. (2014) offers insurance via groups to existing informal insurance networks in their study (but not group insurance), however, without a control group that does not receive the group option, they cannot identify the demand effects of offering group insurance. Additionally, they do not look at the effect of existing ties between individuals who are offered index insurance as a group and how those relationships might affect demand. Finally, research by Goette et al. (2006) shows that randomly assigned groups lead to the formation of stronger social ties and higher cooperation rates within groups as opposed to between groups; however, their random group assignment is not based on existing ties between individuals, and thus relies on the formation of social ties to identify higher cooperation rates.

We find that over 60% of the participants who are offered group insurance purchase insurance within their groups.[8] Next, we find that group purchasers allocated less of their endowment to insurance on average than individual purchasers.

We find that groups in which individuals knew of one another's assets were less likely to purchase their insurance within a group. We also find that the closer individuals are in terms of knowing about one another's assets, the less insurance they contribute to the collective insurance.[9] Closer-knit groups also leave the division of payouts (equal, or proportional to losses) until the potential time of a payout rather than determining the division at the time of the game. Thus another reason that there is low subscription to group insurance where distance is higher could be the result of low trust, as payouts are less likely to be specified in advance.

[7]Munro (2014) does offer group insurance in a lab experiment, but does not exogenously vary the network structure within the group.

[8]Note that all participants in the game purchased insurance, therefore, we can only study the effects of our treatments: offering of game insurance, and the randomization of distance, on the amount of insurance purchased, namely, the extensive margin.

[9]Individuals could only purchase insurance in a group or individually, not both.

A possible explanation for these results is provided by Boucher and Delpierre (2013) who show that farmers who share idiosyncratic risks should have lower demand for index insurance if they internalize the moral hazard problem, which is more likely in the case of group subscription. Indeed, in our sample, farmers turn to their association members (33%) as frequently as to their banks (34%) when their crop fails, and thus share idiosyncratic risks with farmer association members.

Formal insurance may encourage additional risk taking, creating residual idiosyncratic risks that the group will incur. Examples of such increased risk taking can include investments in improved pasture, and increasing their herd size in conjuction with reducing their off-farm labor.[10] When insurance is sold in groups, these negative externalities in terms of greater risk taking are internalized by the group and the overall demand for insurance is lower. In a related finding, Exelle and Verschoor (2013) show that investments in risky activities are lower with lower distance to their assigned pair, because investors prefer to avoid becoming indebted towards others for risks.[11]

There is a related body literature looking at the interaction between index insurance and informal networks more generally, which we do not draw on in this paper, but briefly mention here. Barr et al. (2014) show in a lab experiment in the field that demographics, such as age and gender, and social proximity, with respect to marriage and religion, affect risk sharing, while community membership is a less binding social commitment, unless those relationships can be externally enforced. Caria and Fafchamps (2014) show in an artefactual field experiment that network formation is often less than efficient as individuals tend to form homopholous networks, while risk sharing can best occur among individuals with heterogeneous risk profiles. Looking more closely at network effects and insurance, Cai et al. (2013) find in a controlled field experiment that social networks enable diffusion of information around formal insurance and increase the likelihood of adoption, particularly when

[10]Farmers often supplement their dairy farm revenue with hourly wage jobs or side businesses selling sugar cane

[11]Note in this paper closeness is predetermined by pairing individuals from the same or from different village.

spreaders are more central in the village network. In a lab experiment in the field, Chandrasekhar et al. (2014) also find that the degree to which individuals insure one another informally is inversely related to their relative centrality and decreasing in their distance.

Section 2 details the contextual background of dairy farmers in the Dominican Republic. Section 3 describes the satellite index used in the index insurance design. Section 4 details the game. Section 4.2 describes how distance between farmers was calculated during a session. Section 5 presents the results, Section 6 concludes.

2 Dominican Republic and Farmers

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. 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. The 2011 drought is remembered as one of the most severe years, which caught producers off guard, as the previous years production had been profitable. Productive cows perished, and production levels fell almost to zero. Since then, producers in the region are, at the very least, aware of the necessary preventative actions they must undertake in order to cope with the yearly dry season, and to be prepared for the occasional, but reoccurring, severe drought. Producers have been taking preventative actions in recent years, which have reduced the impact of the most recent severe droughts of 2013 and 2014. Preventative risk management mechanisms include experimenting with alternative feed options, such as improved pasture and sugar cane, and developing rainwater management solutions with wells and lagoons.

The regions in the DR where dairy production is concentrated are Santiago Rodriguez, Dajabon and Valverde Mao. Previous to 2004, economic activity in the Northwest of the Dominican Republic focused on the production of cash crops, such as tobacco and ground nuts. Since then, milk production has become the main productive activity in the region, as producers began to manage more land and purchase an increased amount of milking cows. According to DR dairy farmers, droughts occur every one to three years, during November to May, while the worst droughts tend to happen on a ten-year cycle. However, since 2007, the drought cycle has shortened to about four to five years. As the amount of cows per hectare increased, producers began to experience more intense drought-related impacts in the region, due to a decrease in pasture area per head of cattle. With an increase in the probability of severe drought, producers are now faced with increasing risks to milk production.

The average cattle farm in the region has a size of 12 hectares with about 30 cows producing 10 liters per day during the rainy season and about 6 liters during the dry season. On average, dairy producers receive 18 Dominican Pesos (DOP), or 0.42 USD, per liter of milk after accounting for handling fees. However, production costs per cow each month range between 2,175 -3,045 DOP (50-70 USD), depending on climate conditions: dry season and rainy season, respectively. These costs typically include their expenses: supplementary feed, labor, veterinary costs, and pasture packs. Therefore, each cow's monthly production has an average profit of 5.60 USD (243 DOP) in the dry season and 76 USD (3,290 DOP) in the rainy season. During intense drought periods their production levels tend to decrease up to 60-70% from normal levels, even 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 in associations, which are structured under a federation. Dairy associations serve as procurement centers, as well as discussion forums where farmers examine their circumstances along with the best risk management strategies available to them as a community. In turn, the federation of milk producer associations in the region plays an administrative role, whereby they arrange contract opportunities for the associations with dairy processing companies, such as Parmalat Dominicana, Nestle, and the local entity, Pasteurizadora Rica. This existing organizing body facilitated the experimental setup, by using already established connections within the federation to reach out to associations of dairy farmers who would be willing to participate in the study.

The experimental site is comprised of upland, as well as coastal municipios (municipalities) including Monte Cristi, Valverde, Dajabon, and Santiago Rodriguez. These four municipios hold a significant percentage of the milk production for local consumption in the Dominican Republic nowadays. There are about 6,000 dairy producers in the region, out of the 59,000 country wide.

3 Satellite Vegetation Index

This project 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, a USAID-supported drought/famine early warning program implemented by several US Federal agencies. The raw NDVI data is a measure of the greenness of pastureland in each municipality/district averaged across a five day period. NDVI is the most widely used satellite-based vegetative index. NDVI index-based agricultural insurance programs exist in Canada, the United States, Spain, Kenya, Ethiopia, and India (Leblois and Quirion 2012). NDVI senses the greenness in a given area by comparing the radiation reflected in the visible (red) and near-infrared (NIR) bands. This provides a sense for plant photosynthesis levels, or their chlorophyll (greenness) and biomass. NDVI is a simple vegetation index, which can be used to assess whether the target being observed contains live green vegetation or not.

For this experiment, a normal rainfall year or a bad year is determined based on a vegetation index, or a measurement of the landscapes response to the arrival of (or lack of) rainfall necessary for vegetation to grow. The NDVI index provides an indication of vegetative health (greenness) at any given time in a given area and as a result reflects the crop yields and primary production of that area. The satellite-based vegetation index pays out only when the estimates of the greenness are below a pre-established level. The index is designed to provide a payout during the three worst droughts in the past ten years (or one full payout every six years). This satellite measured index uses a 13-year data set to calculate the payouts (since 2000).

4 Experimental Design

The game was played in the Northwest region of the Dominican Republic with thirteen dairy associations across eleven 4 hour game sessions, during the course of 4 days. A team of 8 facilitators formed by USAID DR CRII project stakeholders, including REDDOM, USAID and SwissRe, provided resources to support the experiment. In order to maintain control over the instructions given to participants, as well as the overall game dynamic, one of the authors was always present at each of the sessions along with other project stakeholders. The sessions were held in Spanish, the national language, and facilitated by one of the authors fluent in Spanish or by a facilitator who was trained on the protocols prior to the first session. These thirteen associations were randomly selected, within a list of treatment associations for the monitoring and evaluation segment of the wider project, and represent coastal as well as upland dairy farmer communities. These associations are organized under FEDEGANO, the Federation of Dairy Farmers of the Northwest, which facilitates the contracting process with commercial milk processors. REDDOM, the project's local implementing institution, facilitated the recruiting process in the region.

Individuals were given 17 beans (as tokens) each worth 25 DOP (60 cents USD) for a total of 425 DOP (10 USD) to allocate 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, and (4) index insurance. This setup is similar to other interactive simulation exercises around index insurance (Carter et al., 2008; Gaurav et al., 2011).

The game endowment provided to participants, 425 DOP or approximately 10 USD, equated to approximately two and a half days worth of dairy production during the rainy season. According to conversations with producers, farmers receive approximately 20 DOP for each liter of milk sold, and yield 10 liters per day on average during the rainy season. Note that the community savings option was binary. We restricted farmers to allocating only 1 bean, if they chose to, or 25 DOP to the community savings option to ensure a uniform investment across participants in each association since disbursement would be made as one payment to the association. Producers were told that they would decide after receiving the sum of money what climate risk management measures they could implement at the community level, to benefit only those who did contribute.

The insurance that participants purchased in the game were realized as vegetation greenness 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.[12]

Each game session consisted of registration, concept discussions, instructions, practice, decision-making, end surveys, and payments. Instructions were read out to participants, accompanied by a visual aid to explain the game dynamic as in Figure 2. The subject instructions are available from the authors upon request. In summary the exercise progressed as follows:

1. Each producer's initial endowment of 17 beans, representing a total of 425 DOP, was distributed in individual bags as participants registered, included a set of practice

[12]Note: the interest rates were calculated for ease of distribution of payments of 25 DOP and are not meant to reflect the real market in the Dominican Republic. Further, a 3x payout reflected an index that would pay a full payout approximately once every six years.

sheets and game sheets for participants to record their decisions.[13]

2. Participants participated in a discussion with facilitators on the different concepts of index insurance involved in the experiment: introduction to index insurance, technical details such as contract windows, premium costs, index measures (satellite vegetation greenness), and basis risk.

3. In the group purchasing option sessions, approximately 30 participants were first randomly assigned to a high or low distance group, of 15 individuals each. The participants then filled out a survey about the other 14 individuals in their group, writing down in a column next to each person's name, the number of productive cows that the person owned. This survey was not conducted in the individual purchasing option sessions, since participants were not offered the option to buy insurance in groups in those sessions.

4. Facilitators explained the experiment instructions in detail, including descriptions of endowment and allocation options.

5. Participants allocated their endowments in one practice round before the final found. For each practice round, participants revealed their preferences by allocating all of the 17 (worth 25 DOP) tokens across the different options on their game sheets. To mimic the climatic realization of the season for determining an insurance payout, the facilitator asked a participant to pick 1 out of 12 Ping-Pong balls in a bag, where 2 balls represented severe drought (orange colored balls) and 10 represented a normal season (white colored balls), in representation of actual severe drought probabilities in the region. For monthly insurance sessions, covering February to September, a Ping-Pong ball was selected eight times (one per month), and for the seasonally cumulative sessions the ball was selected three times (one for each of 3 seasons) to determine if

[13]The majority of participants were literature. In a few cases, we had an additional facilitator assisting an illiterate farmer in recording her choices.

there would be a hypothetical payout.

6. For the group sessions, before proceeding to the second and final round of decisions, participants were divided into their respective groups of threes. Individuals in the low distance group were assigned to groups which had a low symmetric distance among the members (that is, they knew one another well), while individuals in the high distance group were assigned to groups which had a high symmetric distance among the members.

7. Following the practice rounds, participants were asked to make their final allocation decision with the understanding that the choices they made were now binding, and any insurance that they purchased would be paid out according to the upcoming season's weather until September 2014 (and not from an urn as in the practice round).

8. Participants recorded their allocations on their practice sheets or game sheets, along with the participant number assigned to them at registration.

9. Participants completed exit surveys on demographics and assessment of their comprehension of index insurance.

10. Facilitators collected worksheets and paid participants who chose to take any of their endowment home.

4.1 Monthly compared to Seasonally Cumulative Index Option

We tested farmer preferences using two separate treatments: (1) a monthly compared to a seasonally cumulative index option, and (2) a group versus individual purchasing option. The monthly or cumulative index was pre-assigned to each session (i.e., farmers did not choose which index they were offered). Conversely, group insurance was an option given to half of the sessions (i.e., farmers in group sessions had the option to purchase insurance as a group or as an individual). The insurance payout (3x the premium) was calculated to account for farmers receiving two full payouts in a twelve-year period.

We randomly selected which associations were offered monthly index insurance and which ones were offered seasonally cumulative index insurance. 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. These two indices were created by Guy Carpenter and CaribRM as part of the USAID DR CRII project to reflect the driest periods for the Northwestern Dominican Republic in each month or each three-month period, respectively, using MODIS NDVI as a proxy for pasture availability.

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 beans (425 DOP, 10 USD) to one month or allocate their beans throughout all or some months. For example, if participants invested one bean (25 DOP) in one month and another bean to a different month, and if both months were dry enough to trigger the index, producers would receive a 3-bean (75 DOP) insurance payout for both months.

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 bean on period 1 and another bean on period 2, and both 3-month periods are dry enough to trigger the index, then producers would receive 3-bean insurance payout for each of the different periods.

4.2 Groups, Individuals and Distance

We randomly selected which associations were offered the group index insurance and which ones were offered only the individual index insurance. Half of the sessions were given the choice to purchase the insurance in assigned groups versus to purchase the insurance individually. Namely, group sessions could purchase insurance in groups of three. Participants who were offered the group option were still able to purchase insurance individually if they opted out of the group insurance. Thus, in some cases, groups of three became groups of two. In the remaining sessions, participants were only given the option to purchase insurance individually.

For each association with the group insurance option, individuals were randomly divided into two sub-groups of approximately 15 individuals: “low” and “high’.’ Towards the beginning of the session, respondents completed surveys asking farmers to list the number of cows they own and the number of cows they believed each individual among the 15 owned. For each person’s guess about the cows owned by another individual, we subtract the true number of cows from the number guessed. This distance value represents [how well participants ”know” their fellow member] the accuracy in a participant’s guesses about their fellow member’s productive (cow) assets.[14] Thus, for each close and far subgroup we had an adjacency matrix, which we generated by calculating the difference between the true and guessed number of cows for every pair of individuals. For example, each row of column one of the matrix would represent individual one’s guess minus the true number of cows for person two, three, four, and so on going down the column until the last person.

A python script then evaluated this matrix of distance values. For farmers who were randomly assigned to the low group of 15, the script searches for the five triplets with the lowest average distance among $\binom{15}{3}$ pairs, and lowest standard deviation across the distance scores. For farmers who were randomly assigned to the high group of 15, the script searches for the five triplets with the highest average distance between all three individuals, and highest standard deviation across the distance scores.[15] In this way individuals are randomly assigned a group distance measure and a group distance standard deviation. This is our proxy for social distance between individuals, and is what we used to group individuals during the experiment.

Then, in our estimations below, we use the average symmetric distance among group

[14]We then normalize this distance by the number of cows that the other individual owns.
[15]Python script available upon request.

members to control for distance generated and assigned during the game. As an example, suppose person A owns 10 cows, and person B owns 20. Now suppose A guesses that B has 25 cows, and B guesses that A has 8 cows. The symmetric distance can be computed as: $\frac{|20-25|}{20} - \frac{|10-8|}{10} = 0.45$. The average symmetric distance is the average of the three symmetric distance measures for each of the pairs in a group. We also minimize (maximize) the variance around the symmetric distances for low (high) distance groups. If persons A and B, B and C, and A and C have symmetric distance measures of 4, 5, 6, then this grouping is preferable to a group with distances of 3, 5, 7. Both have the same average symmetric distance (5), but the first group has a lower standard deviation (1 compared to 2). Namely, their guesses are more similar. Because the distance is determined by minimizing (maximizing) the symmetric distance and the standard deviation of that symmetric distance between members in the close (far) distance group, we include both measures in our regressions.[16]

5 Empirical Results

Our randomization design allows us to test two things: first, whether offering group insurance increases or decreases the amount of insurance purchased, and second, whether being grouped with individuals whom a participant knows well (or knows them well enough to know their assets) or does not know well affects the amount of insurance coverage contributed to the group insurance pool. Because we randomized the offering of the group insurance option at the association level,[17] and individuals' choices within an association may be correlated, we cluster all of our standard errors within each association.[18] Furthermore, because we do not have multiple observations per individual we cannot estimate a fixed effect at the

[16]We recognize that incorporating the variance in distances between group members is just one of many possibilities for generating potential triples. It created another dimension of variation in the triples than if we had matched on distance alone. It also helped created another dimension around distance to vary, as the distribution of distance in such farmer groups tends to be right skewed.

[17]Randomizing the group insurance option at the individual level within a session would have been logistically complicated, as information and instructions were given to the entire session over a loud speaker.

[18]Because there is a small number of clusters (12 associations), as recommended by **??**, we use critical values from a T distribution with G - c degrees of freedom where G is the number of clusters and c is the number of regressors that do not vary within clusters.

individual level. Therefore, to improve the efficiency of our results, we include variables for gender, age, education, the number of cows owed by the farmer, and the amount of irrigated pasture land that the farmer owns, which serve as a proxy for wealth and farm operation size. In addition, we control for the farmer's weighted eigenvector centrality computed from our weighted adjacency matrix, which measures how central the farmer is in the high or low subgroup, weighted by the distance to another farmer (namely, how well they knew the other farmer's assets).[19] The various types of farmer association networks from which these measures are derived can be seen in Figure 1.

5.1 Who Participated

Table 1 shows that the average participant is in their mid 50's, is male, has tertiary education, owns approximately 20 productive cows, and owns 4 acres of irrigated pasture. Generally, participants are well established farmers whose livelihoods have been in farming for most of their lives.

5.2 Demand for Insurance

Table 2 and Figure 3 show the overall game results, and Figure 4 shows a more detailed breakdown by association. Participants place 73% of their endowment into insurance, 16% into personal savings, 6% into taking the money home, and 5% into community savings.

We estimate the intent to treat (ITT) for group insurance as follows, controlling for farmer characteristics and clustering standard errors at the association level.

$$d_{ij} = \alpha + \beta_g g_j + \beta_m m_j + X_{ij} + \epsilon_{ij}$$

where d_{ij} is a dichotomous or continuous variable of whether or how much insurance was

[19] Python 2.76 was used to load in the adjacency matrices, and "truth" and "guess" matrices regarding the number of cows owned. Python functions for eigenvector centrality and weighted eigenvector centrality were then used to compute these measures.

purchased by individual i in association j; g_j is a dummy that equals 1, if the individual was offered the group and individual insurance option, and a 0 if only the individual insurance; m_j is a dummy that equals 1 if offered monthly insurance and 0 if seasonal insurance; X_ij is a vector of covariates including gender, age, education, the number of cows owned by the farmer, and the amount of irrigated pasture land the farmer owns.

Note that the estimate of β_g is an intent to treat, because participants were not forced to purchase group insurance, or any insurance for that matter. Individuals could opt out of purchasing the group insurance and simply buy individual insurance. We do not focus on the monthly versus seasonal offerings in this paper, but the estimate of m_j 's effect, β_m, is not an intent to treat, as participants were not given a choice between monthly and seasonal indices; they were simply offered one or the other.

We are interested in the impact of offering group insurance, β_g. Table 3 estimates the above equation. Column one compares insurance purchased for those offered the group option and those who are not offered the group option (the intent to treat). Column 2 restricts the comparison to those who purchase the group option in the group session to those who were not offered the group option at all (treatment on the treated); of course, we cannot interpret these results as causal with the ITT. The marginal effects indicate that being offered the group insurance reduced insurance coverage by 46 DOP, and by 54 DOP if the group option was purchased, conditional gender, age, education level, herd size and irrigated pasture size . This result is in line with (Boucher and Delpierre, 2013), which shows that the group adopts a lower level of coverage than what individuals would have chosen, for any given level of premium.

5.3 The Effect of Distance

We now augment our estimates by a measure for distance to learn more about the mechanism behind group purchases by estimating:

$$d_{ij} = \alpha + \beta_g g_j + \beta_n m_j + \beta_d s_{igj} + X_{ij} + \epsilon_{ij}$$

Here, s_{igj} represents the average symmetric distance measure for person i in group g of association j.

Table 4 presents preliminary results of whether distance affects the decision to purchase group insurance or not. We can see that the high distance group, where individuals know one another "less," purchase more insurance than in the groups where individuals are closer.

Table 5 takes this result to a regression framework and controls for age, gender, education level, number of cows owned, amount of irrigated pasture[20], and association. In Column 1, we include only the average symmetric distance measure, while in Column 2 we include the average symmetric distance and its standard deviation. In Column 3 we instrument the standard deviation, as it tended to explain more of the insurance choices than the distance measure alone, with the high-low dummy variable. This dummy is the random assignment into the high or low distance group, after which an individual is randomly assigned to a group of a particular distance measure value. Overall, we see that our measure of distance has a positive effect on the the decision to buy insurance in their group versus as an individual. The "farther" away individuals are from one another in their insurance group, the more likely they are to purchase insurance in a group.

We also look at whether distance affected the amount of coverage purchased by group purchasers. Now d_{ij} is a continuous variable for level of coverage. Table 6 presents the same result as Table 5, but now the outcome variable is the individual level of coverage contributed to index insurance in group sessions. Here we see that coverage is also positively by distance, and that the "farther" away individuals are from one another in their insurance group, the more formal insurance they purchase. This result holds for when the symmetric distance measure is instrumented for with the high-low dummy variable.

Both these results support the idea that if individuals purchase in a group they will

[20]Proxies for wealth and farm size.

internalize the negative externality caused by members' increasingly risky behavior, and demand is lower. It should be stressed, that while the decision to purchase in a group is collectively discussed, an individual could opt out and purchase individual insurance alone. Furthermore, payouts for group insurance would be delivered to the group, but it was was left to the group as to how those payouts would be divided.

Overall, Table 7 shows that 63 % of the participants offered group insurance, remained in their group and collectively purchased insurance. Of those individuals, 78% made a decision about how to allocate their payouts during the game session, 54% chose to split any potential payouts from the insurance evenly among themselves, while 47% chose to allocate any potential payouts proportional to need.

In both Table 6 and Table 7, we also control for the eigenvector centrality of each individual. The eigenvector centrality is measured using the adjacency matrix between individuals in an association. It is interesting to note that the weighted (and unweighted) eigenvector centrality, which is generally an important predictor for information diffusion in social networks (Banerjee et al., 2013; Mobarak and Rosenzweig, 2014), is often not significant in explaining take-up of insurance.

6 Discussion

In this paper, we report results from offering participants the option to purchase insurance group insurance. Sessions are randomly chosen for being offered the group insurance option, and individuals in sessions that are offered the group option are randomly assigned to a 3-person group with an assigned level of distance based on existing social ties and how well individuals know one another's assets. We control for individuals' age, gender, farmer association and proxy for farmers' farm size with the number of cows that they own and the number of acres of irrigated pasture that they own, as well as cluster standard errors at the association level. We find that offering group insurance reduces the overall amount of insurance coverage purchased compared to individual purchase. We also find that groups in which individuals do not know one another's assets, are more likely to enter a group insurance contract and purchase more insurance.

We also find that our result is stronger the closer individuals are within each group, where "closeness" is defined as how well an individual knows the number of productive cows owned by others in his group. The closer individuals were (according to pre-existing ties measured by how many productive cows they knew one another owned) the less likely they were to purchase insurance in a group and the less insurance they purchased (or namely, endowment contributed to the group insurance pool) in that group.

Further work should consider several improvements to this paper including: modeling the full choice set across savings, insurance, take-home and community savings in a multivariate model; considering the robustness of the distance measure by comparing the group assignments under different allocations algorithms; and controlling for homophily by adding in group members' relative similarity in terms of age, education, gender, and farm size.

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Table 1: Summary Stats of Players

	mean	**sd**
Age	54.67	13.57
Gender	.92	.25
Education*	2.45	1.84
Cows 2014	19.76	20.74
Acres irrigated pasture	3.75	10.21

**1 Primary, 2 Secondary, 3 Tertiary*

Table 2: Risk Management Options Purchased, DR Pesos

	mean	**sd**	**max**
Insurance	311.11	80.70	425
Personal savings	70.40	60.21	400
Take home	23.68	53.30	425

Table 3: Overall Takeup of Insurance

	(1)	(2)
VARIABLES	ITT probit	TOT probit
Gr	-46.64*	-54.47*
	(-1.981)	(-2.031)
Monthly	36.23	44.23*
	(1.704)	(1.834)
Gender	42.35**	22.92
	(2.468)	(0.956)
Age	-0.0363	-0.0950
	(-0.105)	(-0.308)
Ed_level1	-3.798	-5.090
	(-1.416)	(-1.724)
Pasture_ir	-3.152**	-2.755**
	(-2.651)	(-2.576)
Cows_2014	-0.0957	0.0106
	(-0.401)	(0.0301)
Observations	263	220
R-squared	0.127	0.147

Robust t-statistics in parentheses. SEs clustered at the association level. Significance corrected for G-c degrees of freedom.

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

Table 4: Insurance Purchased by distance

	low SD	**high SD**
Group symmetric distance	6.7	13.15
	(16.5)	(18.4)
Group symmetric sd	1.0	7.8
	(1.7)	(11.7)
Percentage purchasing group insurance	0.54	0.72
	(0.50)	(0.45)
Insurance purchased	297	333
	(67.9)	(52)

Table 5: Overall Takeup for Group Insurance

	(1)	(2)	(3)
VARIABLES	probit	probit	ivprobit
Group_sym_dis	0.0104*	0.00191	
	(1.786)	(0.467)	
Group_sym_dis_std		0.0382**	0.157***
		(2.242)	(3.691)
Monthly	-0.303	-0.254*	-1.061**
	(-1.605)	(-1.705)	(-2.635)
Age	-0.00810*	-0.00532*	-0.00824
	(-1.980)	(-1.852)	(-1.088)
Gender	-0.0269	0.0267	0.415
	(-0.212)	(0.189)	(1.252)
Ed_level	-0.0351	-0.0236	-0.0466
	(-0.621)	(-0.426)	(-0.362)
Cows_2014	-0.000921	-0.000434	0.00331
	(-0.371)	(-0.161)	(0.359)
Pasture_ir	-0.0277	-0.0204	-0.0340
	(-1.372)	(-1.070)	(-0.684)
Weighted_EV_Centrality	0.455	0.244	-0.177
	(0.557)	(0.285)	(-0.0835)
Observations	86	84	84

Robust t-statistics in parentheses. SEs clustered at the association level.
Significance corrected for G-c degrees of freedom.
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 6: Amount Purchased

	Amount Purchased		
	Marginal Effects		
	(1)	(2)	(3)
VARIABLES	reg	reg	ivreg
Group_sym_dis	0.297	-0.0757	
	(0.441)	(-0.100)	
Group_sym_dis_std		1.081**	7.340**
		(7.034)	(2.382)
Monthly	37.98	38.47	26.55
	(1.575)	(1.715)	(1.195)
Age	-0.628	-0.691	-0.00908
	(-1.162)	(-1.037)	(-0.0101)
Gend	20.55	26.58	49.86
	(0.857)	(1.072)	(1.825)
Ed_level	-11.91	-11.61	-11.54**
	(-1.652)	(-1.428)	(-2.363)
Cows_2014	-0.113	-0.0526	0.520
	(-0.304)	(-0.135)	(1.726)
Pasture_ir	-0.546	-0.625	1.521
	(-0.297)	(-0.342)	(0.661)
Weighted_EV_Centrality	-101.1	-96.45**	-128.3
	(-1.991)	(-2.426)	(-1.436)
Observations	86	84	84
R-squared	0.170	0.183	0.234

Robust t-statistics in parentheses. SEs clustered at the association level.
Significance corrected for G-c degrees of freedom.
*** p<0.01, ** p<0.05, * p<0.1

Table 7: Decisions for Individuals Offered Group Option

	mean	**sd**
% purchased in group	0.63	0.48
% chose predetermined payouts plan	0.78	0.41
% chose need-based payout plan (vs even split)	0.53	0.50

Figure 1: All Farmer Association Networks

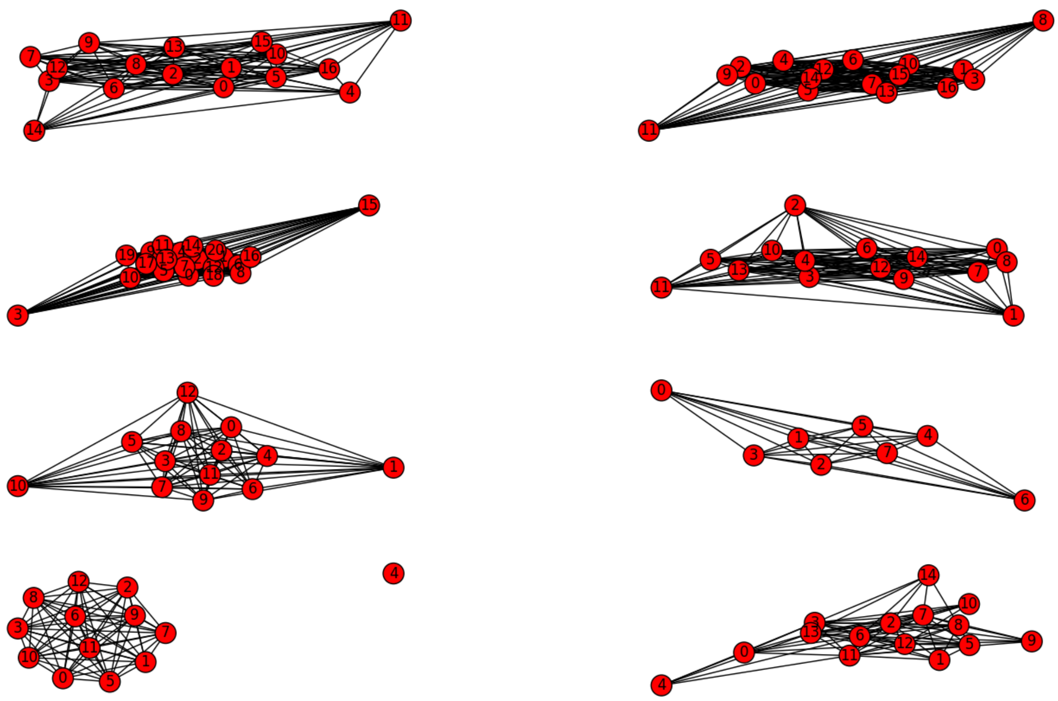

Figure 2: All Farmer Association Networks

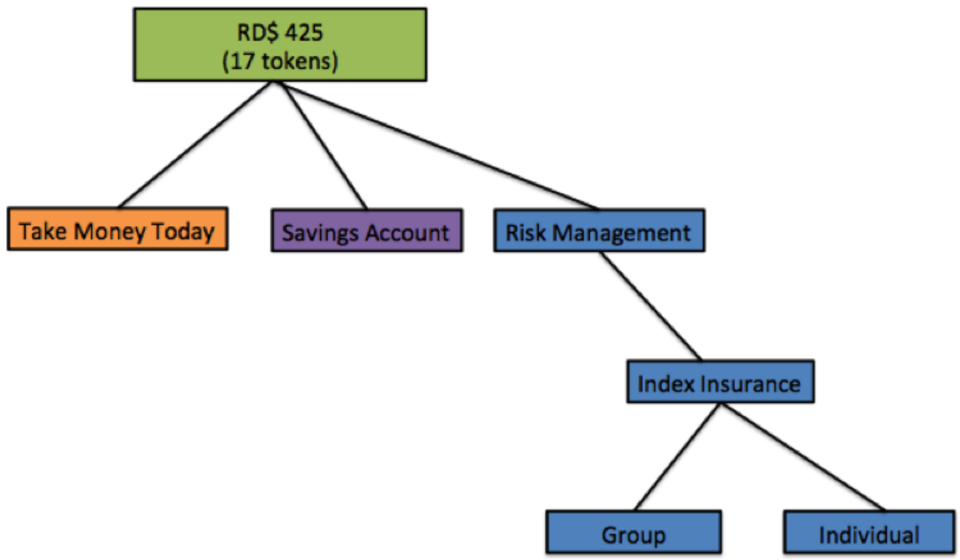

Figure 3: All Sessions

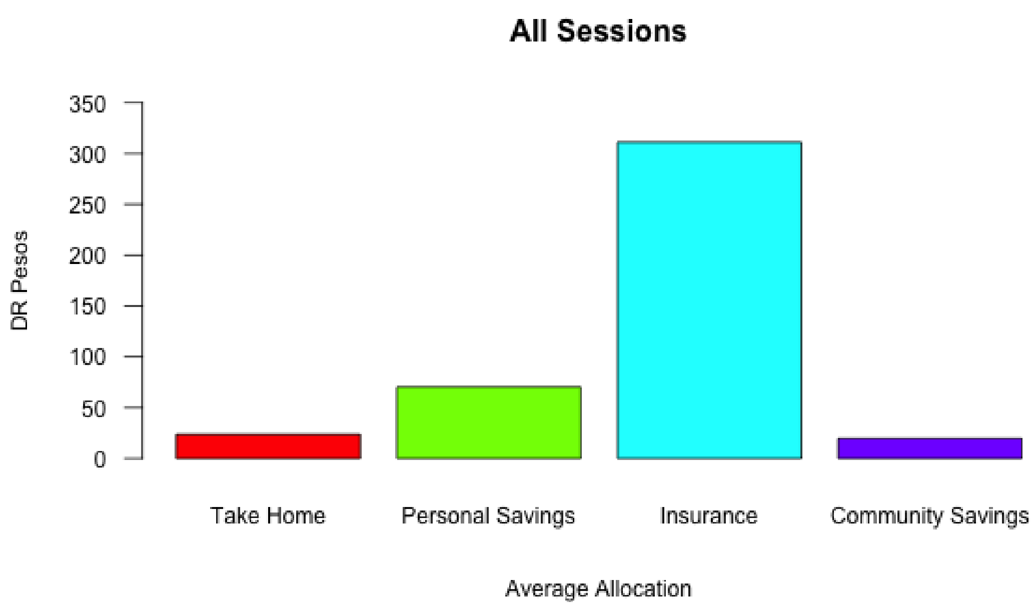

Figure 4: All Sessions

Association	MeanTakeHome	MeanPersonalSavings	MeanCommunitySavings	MeanInsurance
Aminilla	4%	4%	5%	87%
Calazan, Cordero	12%	18%	4%	66%
Chapeton	3%	17%	5%	75%
Dajabon and Clavellina	0%	16%	5%	79%
Don Percio Diaz	9%	30%	6%	55%
El Cayal	0%	8%	2%	90%
Entrada de Mao	3%	11%	5%	81%
Las Matas de Santa Cruz	7%	16%	6%	72%
Loma De Cabrera	5%	27%	5%	63%
Ramon Ant Tineo	9%	17%	3%	71%
Santiago Rodriguez	9%	23%	5%	64%
Total	6%	16%	5%	73%

Figure 5: All Sessions by Season

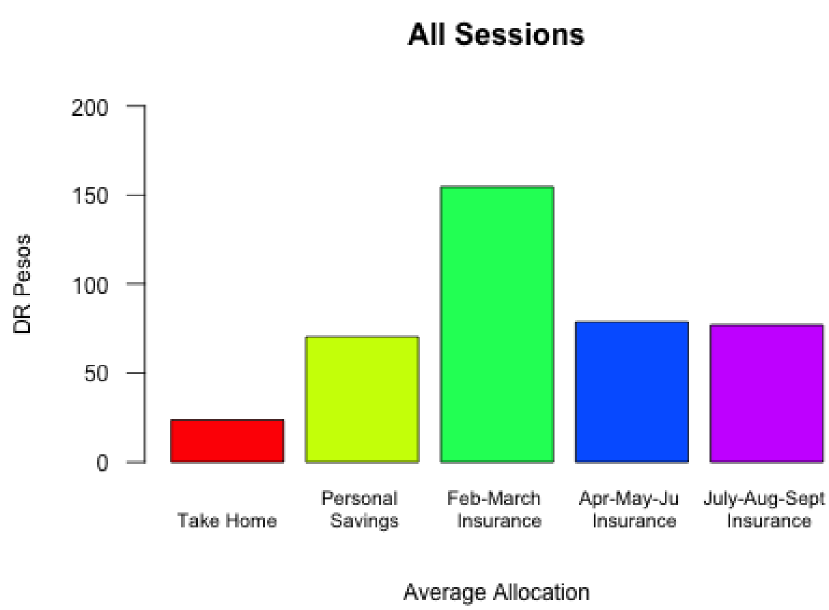

Figure 6: Cumulative Index Session

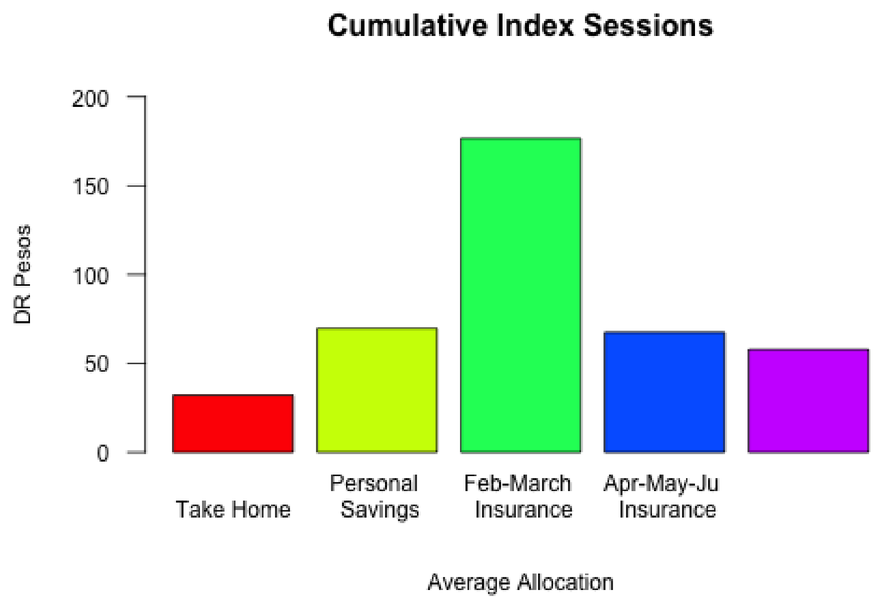

Figure 7: Monthly Index Session

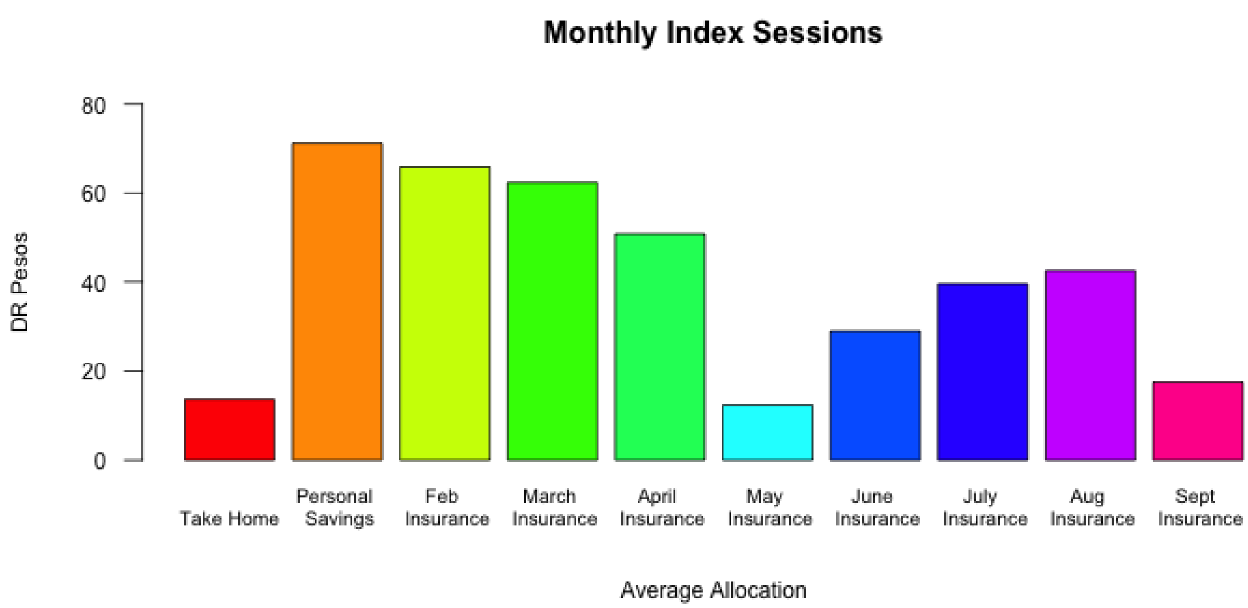

Figure 8: Individual Index Session

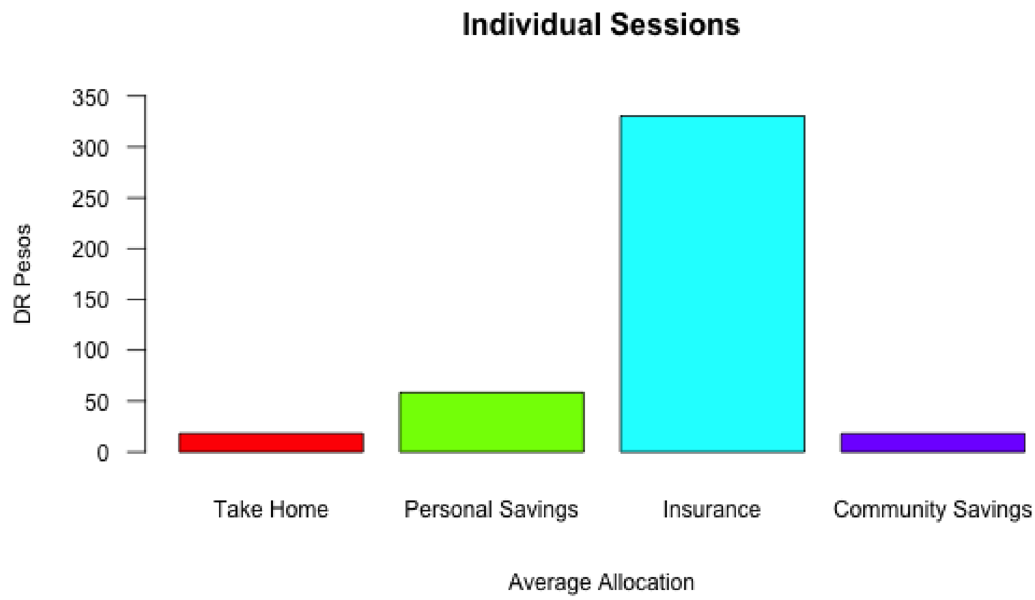

Figure 9: Group Index Session

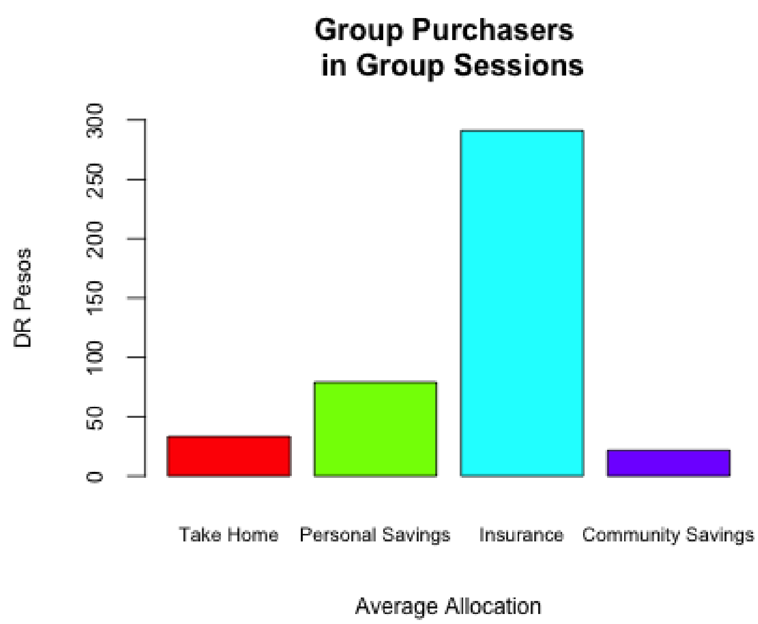

Figure 10: Group Index Session