INFORMAL INSURANCE, SOCIAL NETWORKS, AND SAVINGS ACCESS: EVIDENCE FROM A LAB EXPERIMENT IN THE FIELD

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ABSTRACT. Social networks are understood to play an important role in smoothing consumption risk, particularly in developing countries where formal contracts are limited and financial development is low. Yet understanding *why* social networks matter is confounded by endogeneity of risk-sharing partners. This paper, first, examines the causal effect of close social ties between individuals on their ability to informally insure one another. Second, we examine how the interaction of social proximity and access to savings affects consumption smoothing. Theoretically, they could be complements or substitutes. Savings access may crowd out insurance unless social proximity is high, in which case it benefits the highly connected. Or savings may crowd out risk sharing among the highly connected while helping the less connected smooth risk intertemporally. By conducting a lab experiment in the field in Karnataka, India, we study the relationships between inability to commit to insurance, ability to save, and social proximity. We find that limited commitment reduces risk sharing, but social proximity substitutes for commitment. On net, savings allows individuals to smooth risk that cannot be shared interpersonally, with the largest benefits for those who are weakly connected in the network.

JEL codes: C91, D85, D86, O16

1. INTRODUCTION

Individuals in developing countries face large amounts of risk (weather, health, prices, etc.). Interpersonal insurance can potentially play an important role in buffering this risk, but evidence suggests that it is incomplete: not all idiosyncratic risk is insured. Interpersonal insurance will be incomplete if individuals who receive positive income shocks are tempted to renege on their obligation to share with those who receive negative shocks—that is, if there is limited commitment (Ligon et al. 2002).[1] The ability of a group of individuals to overcome this lack of commitment may depend on the strength of social ties between them. Individuals more tightly linked within a network may be able to better sustain cooperative behavior despite not having access to contracts or other formal enforcement mechanisms.[2]

The amount of consumption smoothing individuals achieve will also depend on access to financial instruments such as savings. However, the sign and magnitude of savings' effect are not clear: although savings allows individuals to smooth uninsured risk, it may also restrict interpersonal insurance. Insurance will be restricted if people can use savings even after they renege[3] on their insurance obligations, since the ability to save makes leaving the insurance agreement more tempting when income is high. This "crowdout" effect reduces the benefit of savings access and can even mean that overall, consumption smoothing is worse with access to savings than without, if interpersonal insurance is crowded out more than one-for-one (Ligon et al. 2000).

When commitment is limited, both savings' benefits (smoothing uninsured risk) and costs (crowding out insurance) may vary with individuals' position in social networks. The dimensions of social network position we consider in this paper are network distance[4] to other individuals, and eigenvector centrality, a recursive measure of importance.[5] Social connectedness—that is, being close to others on average—and access to formal savings may be either complements or substitutes. If savings access crowds out insurance unless social

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[1]This is not the only explanation for incomplete insurance, although evidence suggests it is important. Other explanations include moral hazard, adverse selection, and hidden income. We consider the possibility of hidden income in another paper (Chandrasekhar et al. 2012).

[2]This may be for a variety of reasons including, but not limited to, altruism or repeated interactions. The aim of this paper is not unbundling these forces. Leider et al. (2009) and Ligon and Schechter (forthcoming) addresses this issue.

[3]Throughout the paper we refer to players implementing a lower transfer than the one they initially planned to make as "reneging" or "defecting." We use this terminology because it is standard in limited commitment models. However, to mimic the informal nature of real-life informal insurance systems, during our experiment we emphasized to players the transfers they initially announced were not binding, and that they could change their mind after seeing their income draw. We present evidence below that players did not view these announcements as cheap talk.

[4]The social distance between i and j is given by the geodesic, or the shortest path between them through the social network. So, for example, if i is connected to k who is connected to j, the social distance between i and j is 2.

[5]Appendix D provides details on the construction of social distance and eigenvector centrality.

proximity is high enough to limit crowdout, then savings access will benefit those with high social connectedness (low average social distance) most. If, on the other hand, savings crowds out risk sharing among highly connected individuals while helping those with few social connections smooth risk intertemporally, saving will benefit those with low social capital most. Similarly, individuals with high importance may capture more of the gains of savings access than those who are less important.

To shed light on these issues, we ran a laboratory experiment in the field, i.e., Indian villages, in which participants played risk-sharing games, each with a randomly assigned, but non-anonymous, partner from the same village. Our design allowed us to switch features of the economic environment on and off: the ability to commit to contracts and whether individuals had access to a savings technology. Using detailed social network[6] data collected prior to the experiment, we are also able to assign players to play the games with partners of different social distance and different importance, where importance is measured recursively using eigenvector centrality.[7] Players faced significant stakes and could not use transfers outside the game to smooth in-game risk[8], so the behavior we observe in the lab is informative about risk-sharing behavior outside the lab. By comparing how much risk sharing occurs between socially close vs. socially distant pairs, we can understand the role of social distance in enabling risk sharing. By comparing how much risk sharing occurs between pairs of equal vs. unequal importance, we can understand how the ability to influence and share information with others affects risk sharing when commitment is absent. What's more, we can measure the extent to which the ability to commit to contracts and the ability to save affect the ability to share risk, and how these features interact with social proximity and importance.

The risk-sharing games were structured as follows: in each round, one partner was randomly chosen to receive a large positive income (INR 250) while the other partner received no income (INR 0).[9] In every round, before income was realized, individuals decided on state-contingent transfers to their partner for that round. The transfers allowed participants to smooth their consumption in the face of income risk. Every individual played all three versions of the game. In one version, individuals had access to full commitment contracts

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[6]The social network is an abstraction which describes a collection of relationships between individuals, in this case inhabitants of a village.

[7]We do not manipulate the social distance or eigenvector centrality difference between a given pair. Instead, we assign randomly-selected pairs to interact in the experiment.

[8]While we cannot prevent transfers outside the lab, in section 3.2 we discuss why such transfers would not be effective in smoothing risk in this setting.

[9]Rs 250 is approximately $5 at market exchange rates, or $25 at purchasing power party-adjusted exchange rates. For comparison, the daily wage in Karnataka paid by the National Rural Employment Guarantee Act (NREGA) is Rs. 74.

without savings, meaning that in each round an individual had to make the transfer that was decided on before the realization of income. However, the individuals had no ability to save in this version of the game. In two other versions of the game, we allowed for limited commitment instead. After seeing their realized income, participants had the opportunity to renege on the transfers they initially decided. The limited commitment games were played in two ways: without savings and with savings. We implemented the limited commitment with savings treatment by allowing participants to save their income across rounds, in addition to being able to make transfers with their partners.[10] This treatment allowed us to capture the interaction of limited commitment and access to savings. Across all versions, players had an incentive to smooth consumption because they knew that they would be paid their chosen consumption from just one round, randomly chosen from all the rounds they played.

In brief, our results are as follows. First, limited commitment matters: consumption is 22% more variable when players cannot commit ex ante to a risk-sharing agreement than when they can. Second, this effect varies with social distance in a way which shows that social proximity substitutes for commitment. For the socially closest pairs, limited commitment does not bind, i.e., consumption variability does not increase when commitment is removed. But, as social distance increases, limited commitment is increasingly important. Each unit of social distance causes an increase in the variability of consumption equal to roughly 7% of the full commitment level when commitment is removed. The most distant pairs, who are unconnected via the social network, see consumption variability increase by an amount equal to 80% of the full commitment level when commitment is removed. We also find that, conditional on social distance, limited commitment binds more when partners are of asymmetric eigenvector centrality.

Our third finding is that savings access does not appear to crowd out informal insurance on average. That is, transfers do not fall significantly when savings are available. However, players paired with a more distant partner use savings more than those with a socially close partner. This is because limited commitment leaves distantly-connected pairs with more risk that is not insured interpersonally, and savings are used to partially smooth this risk. We do, however, find crowdout for pairs in which one partner is much more important than the other (in the sense of eigenvector centrality), consistent with the fact that limited commitment is most binding for these pairs. Finally, we find that savings access improves

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[10]Savings were observable by the partner. There is no private information in any of the games. We consider the issue of private information in another set of experiments, described in Chandrasekhar et al. (2011)

welfare:[11] it allows individuals to intertemporally smooth some of the income risk that is not insured interpersonally, so individuals achieve greater consumption smoothing when savings are available.

These findings are relevant for several reasons. From a policy perspective, understanding if and how network relationships mitigate market incompleteness can inform attempts to harness these relationships through, e.g., microfinance (as in as in Feigenberg et al. 2011) or community-allocated aid (as in Alatas et al. 2012). Furthermore, access to formal savings and other banking products is growing rapidly in developing countries, although the current level is quite low (Chaia et al. 2009). Therefore, it is important to understand the extent to which financial access affects informal insurance: if financial development undermines informal insurance, then better savings access should be coupled with improved formal safety nets, such as work guarantee programs or food aid. Moreover, our results inform the question of *who* benefits most from access to formal savings when commitment is absent: does savings benefit individuals whose income turns out to be high while hurting those whose income turns out to be low, or affect the lucky and unlucky equally? Does savings most benefit those with dense social networks or those who are socially isolated—or impact both groups equally? The answers to these questions are important for understanding how financial development will affect various dimensions of inequality.

To be sure, our experiment remains an abstraction from reality, and we do not claim that the precise magnitudes of the effects we identify would translate exactly to another setting. Our goal is to disentangle the roles of limited commitment, access to savings, and network characteristics (social distance and centrality/importance in the network). This allows us to study the relative effect of networks in mitigating limited commitment and mediating the effect of savings. The sign and significance of these effects, if not their precise magnitudes, are likely to generalize, particularly to other rural, developing country settings. Even real-world risk-sharing relationships are not simple objects in a dynamic risk-sharing contract, but are embedded in a broader set of repeated interactions and norms. By measuring the effect of social network characteristics in our experiment, we can say something about how real-world risk sharing is sustained.[12]

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[11]Due to the fact that our experimental setup keeps expected consumption (nearly) constant across models, consumption smoothing can be used as a measure of welfare.

[12]Our findings across social distance contribute to the literature providing direct evidence against the standard exchangeability of actors assumed in many economic models (e.g. Karlan et al. 2009, Ligon and Schechter forthcoming). If we had used an anonymous experiment, we would likely have obtained misleading estimates of the size of the effects we study. Depending on how anonymous pairs interact vis-a-vis as socially distant pairs, an anonymous experiment may have overstated the role of limited commitment, since among non-anonymous pairs it is mitigated by social

We are interested in settings where people have pre-existing relationships that may influence the way they behave. Therefore, we make use of network data previously collected for the villages we study to tease out the effects of social networks as part of the production function that maps individuals and resources into economic outcomes. As villagers often interact in many arenas of their lives without formal contracts, and therefore sustain various informal arrangements through relational contracts, understanding how the social fabric affects their ability to maintain high levels of cooperation is of great interest. For example, a collection of villagers of different castes may have to decide how to finance the building of a well, or farmers of varying occupations or varying ethnic groups may attempt to sustain informal risk sharing relationships or participation in ROSCAs.[13] Villagers may be required to cooperate with each other for all sorts of reasons, and those with whom they need to cooperate in a given instance may vary in their relative position in the social network. Thus in our experiment we deliberately moved away from anonymity by going from a standard laboratory experiment to a lab experiment in a field setting.[14]

The causal interpretation of our findings relies on the ability to carefully control the economic environment and partners' social network characteristics while holding the income process constant. None of this would be possible without conducting an experiment in a laboratory setting. Natural and field experiments can address the fact that access to savings is potentially correlated with many other factors that affect the sustainability of informal insurance, such as migration opportunities, wealth, social networks, or the nature of the income process. However, even exogenous variation in availability of, e.g., banks arising from a natural or field experiment would not isolate the effect of savings access that works through risk-sharing, because savings access may also allow investment, changing the income process.[15] Moreover, "under-the-mattress" savings are impossible to preclude in a field experiment. Also, natural and field experiments are not able to manipulate the social network characteristics of risk-sharing partners, so studying the causal effect of social proximity and relative importance is not possible. In a lab setting, we are able to observe

distance. Also, an anonymous experiment may have mis-stated the usage and benefits of savings access, since savings usage is concentrated among socially distant pairs. These findings are relevant as laboratory and framed field experiments become increasingly common in development, labor, contract economics and other fields.

[13]Rotating savings and credit arrangements.

[14]In the terminology of Harrison and List (2004), our experiment would be called a framed field experiment—a laboratory experiment conducted with a nonstandard population (i.e., not university students) with "field context in either the commodity, task, or information set that the subjects can use" (p 1014). In our case, subjects can use information about the partners they are paired with, as well as their experience with day-to-day risk sharing. We have chosen "lab experiment in the field" since it conveys the key elements of the setup.

[15]There is a growing body of evidence on this channel, from natural experiments (e.g., Burgess and Pande 2005, Kaboski and Townsend 2011); structural models (e.g., Gine and Townsend 2004); and field experiments (e.g., Dupas and Robinson 2009 and Brune et al. 2010).

the same individual paired with partners of differing distance and importance, and this allows us to distinguish the effect of these characteristics from the fact that those with more social ties may also be more cooperative, altruistic, etc.

Our results contribute to a recent literature which uses laboratory or lab-in-the-field experimental settings to answer questions relating to financial development. One part of this literature aims, as we do, to test predictions of the limited commitment model. Barr and Genicot (2008) and Barr, Dekker and Fafchamps (2008) use lab-in-the-field settings in Zimbabwe, while Charness and Genicot (2009) use a university laboratory setting to test the limited commitment model. Attanasio et al (forthcoming) use a framed experiment in Colombia to study the role of risk preferences for group formation in the context of risk sharing. Glaeser et al. (2000), Leider et al. (2009) and Ligon and Schechter (2010, 2011) use lab experiments in the field to study the role of social ties in trust and dictator games. Several other papers use lab-in-the-field experiments to study aspects of financial development which are related to our focus on savings. For instance, Giné et al. (2010) and Fischer (2010) use lab experiments in the field in Peru and India, respectively, to test implications of joint-liability lending models.[16] Landmann et al. (2012) study the interaction between insurance and the ability to hide income using a lab experiment in the field in the Philippines, but they study static, rather than dynamic contracts, their setup does not allow smoothing consumption over time with savings, and they do not study the effect of social distance. While the experimental literature on financial development is actively growing, to our knowledge ours is the only paper which explicitly combines interpersonal smoothing (transfers), intertemporal smoothing (savings), barriers to insurance (limited commitment) and social networks, in either standard or field-based laboratory setting. This results in a game that is more realistic than settings with interpersonal or intertemporal smoothing only, and which uniquely allows studying the role of social ties in facilitating informal insurance.

The rest of the paper is organized as follows: Section 2 reviews the predictions of informal insurance with and without access to an intertemporal technology, and discusses how social networks affect informal insurance. Section 3 details our experimental protocol and data. Section 4 describes the tests we use to gauge how well each model fits the experimental data, and presents the results. Section 5 concludes. Figures, tables, and additional details are in the appendices.

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[16]Joint liability, in turn, has been advocated as a solution to limited commitment vis-a-vis loan contracts (Ghatak and Guinnane 1999).

2. Framework: Insurance without commitment

The theory of interpersonal consumption insurance without commitment (and without a savings technology) was developed by Coate and Ravallion (1993), and extended to a dynamic framework by Kocherlakota (1996) and Ligon et al. (2002). Ligon et al. (2000) show that access to savings may possibly make the village as a whole better off, by allowing better smoothing of originally uninsured individual and aggregate risk; or worse off, by increasing the temptation of lucky households to walk away. Here we review the predictions of two models—limited commitment without savings and limited commitment with savings which are retained after defection—to highlight the comparative statics that are predicted by each model of informal insurance, and the comparisons that will allow us to study the interaction of insurance and savings access. We also discuss how these models are affected by the presence of direct defection costs which are a function of social distance and relative centrality/importance. A full characterization of these problems is provided in Appendix C.

2.1. **Limited commitment, no savings.** The key feature of limited commitment models is that individuals cannot bind themselves to participate in the insurance agreement. As a result, an individual with a high income realization may prefer to renege on the agreement, rather than make the transfer to other insurance members that she previously agreed to. The benefit of reneging is the ability to keep more income today. The pecuniary cost is exclusion from or reduced access to insurance in the future. There may also be social sanctions and loss of the nonmonetary value of the relationship, which we discuss below. Thus, ceteris paribus, individuals expecting less future surplus from the insurance agreement will be more tempted to renege. The amount of future surplus an individual expects can be summarized by a single parameter, her "promised utility" (Spear and Srivastava 1987).

Kocherlakota (1996) and Ligon et al. (2002) characterized the optimal dynamic insurance contract subject to limited commitment: when an individual is tempted to renege, her current consumption and promised future surplus are increased to make her exactly indifferent between leaving and staying. Because the temptation to renege only arises when income is above average (requiring net transfers to be made to others in the insurance network), high incomes will be associated with increases in consumption. This generates a positive co-movement between consumption and income if the participation constraints bind. This is in contrast to the full insurance allocation in which, conditional on aggregate consumption, there is zero co-movement between consumption and income.

2.2. **The role of savings.** One of our goals in this paper is analyzing the welfare impact of introducing access to a savings technology in a limited commitment relationship.[17] Ligon et al. (2000) note that access to savings has a twofold impact on the constrained-efficient risk-sharing contract. On one hand, access to savings increases the utility that individuals enjoy after the violation of a contract, because they are no longer required to live hand-to-mouth in the absence of interpersonal transfers. By increasing the temptation to renege, this effect reduces the amount of interpersonal insurance which can be achieved in equilibrium. On the other hand, if full insurance is not feasible without access to a savings technology, savings can help to smooth over time the risk that cannot be spread interpersonally.[18] Overall, the effect of savings access on individuals' risk sharing and welfare is ambiguous and depends on the initial level of risk sharing. In order to illustrate this, Ligon et al. (2000) consider two extreme examples (both without aggregate risk). First, if full risk sharing is possible without savings, when the possibility of savings is introduced, full insurance may no longer be possible due to the tightened participation constraints; then, savings access reduces welfare. Second, it is possible that without savings almost no risk sharing is achieved. Then, access to savings allows individuals to smooth intertemporally some of the risk that they could not insure interpersonally, increasing welfare.

So far we have argued that *ex ante*, individuals may be better or worse off with access to savings. Further, there may be distributional effects. Namely, *ex post* unlucky (low-income) individuals, who are net recipients of insurance transfers, will be affected most adversely by a reduction in the amount of insurance.[19] Distributional effects are relevant for policy recommendations, since weak institutional capacity in many developing countries limits feasible transfers from "winners" to "losers," and governments and policy makers often put particular weight on the welfare of the poorest and most adversely affected.

2.3. **The role of social proximity.** The literature on risk-sharing and social networks often finds that, ceteris paribus, individuals are more likely to share risk with friends and family than with strangers (e.g., Hayashi et al. (1996), Fafchamps and Lund (2003), Angelucci and DeGiorgi (2009)). Individuals may behave differently when sharing risk with people at varying levels of social distance for many reasons. First, an individual sharing risk

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[17]Savings were fully observable by the partner. There is no private information in any of the games. We consider the issue of private information in another set of experiments, described in Chandrasekhar et al. (2012)

[18]In a setting with aggregate risk, savings may be helpful even if full insurance of idiosyncratic risk is attained without savings.

[19]With serially correlated income, an offsetting effect is possible: if there is little insurance even without savings, unlucky individuals may benefit the most from the ability to keep a buffer of savings, because today's low income suggests low income in the future and increases the motive to save (Deaton 1991). However, with i.i.d. incomes this possibility does not arise.

with a socially closer person versus socially farther person may have different incentives. Individuals may be able to exact greater network-based punishments upon those closer to their social circles (Bloch, Genicot, and Ray 2008). For instance, they may meet socially closer individuals more often and therefore the threat of ostracism by a socially distant individual may be less severe. Second, there may be directed altruism. If, for instance, people closer on the network interact more often, and therefore place more weight on each others' consumption, this would induce differential levels of altruism as a function of the network location of the two partners, as emphasized by Leider et al. (2009). In general, there may be less at stake for people who are more socially distant.

There are many models that could be used to capture these forces. However, distinguishing them is not our goal in this paper. Instead, we take an admittedly reduced-form approach to introduce social networks into our framework. We want to capture the idea that punishments or other costs of defecting against socially closer partners may be greater. Therefore, as a reduced-form representation capturing all of the above possibilities, we assume that an individual who has reneged on the risk-sharing agreement with her partner pays a non-pecuniary cost $f(\cdot)$ that is larger, the greater the social proximity between the individual and her partner. That is, the cost is a decreasing function of social distance, γ, but is weakly positive for all distances:

$$(2.1) \qquad f(\gamma) > f(\gamma') \ \forall \ \gamma < \gamma', \ \gamma, \gamma' \in \mathbb{N}, \text{ and } f(\gamma) \geq 0 \ \forall \ \gamma \in \mathbb{N}.$$

We assume that, if i reneges on his or her promises to j, a one-time cost $f(\gamma(i,j))$ is paid by i.[20] We discuss in Section 4 how the presence of the term $f(\gamma(i,j))$ affects risk-sharing, and how its importance can be tested empirically.

It is worth emphasizing that the role we suggest here for social proximity in relaxing participation constraints is distinct from the idea that people get utility or warm glow from making transfers to those who are socially close to them. Such a warm glow would predict that, even under full commitment, people might transfer more to socially close partners than socially distant partners. We of course allow for such an effect in our estimation, but this effect does not identify the role of social proximity in relaxing participation constraints. Instead, social proximity's ability to substitute for commitment is identified from the relative effect of social proximity when commitment is absent, compared to when commitment is available.

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[20]This cost is conceptually similar to the costs $P_i(s)$ in Ligon et al. (2002); relative to their setting, we specify these costs to depend on i's social distance to his or her partner.

Other network characteristics may also come to bear on the level of informal insurance that is achieved. For instance, a growing body of literature suggests that eigenvector centrality–a recursive measure of importance in which i's importance in proportional to the sum of the importances of i's network neighbor's, as defined in Appendix D–may be important in settings where information diffuses through a community.[21] In particular, we hypothesize that the relative eigenvector centrality of the parties in a risk-sharing arrangement may affect their ability to overcome lack of commitment. In various models, higher-centrality individuals are more likely to encounter other individuals in the village, and and therefore these individuals' opinion of one's reputation may matter more. More generally, the continuation value of relationship with these high-centrality individuals is worth more, while relaionships with low-centrality individuals are less valuable. This creates two possible effects: for a high-centrality individual, the continuation value of the relational contract relationship with a given partner will be lower than it would be for a less-central individual. Thus, an agent who is of higher centrality will tend to place low weight on the continuation value of a relationship with a less-central partner, and therefore be more tempted to behave opportunistically. On the other hand, an unlucky low-centrality agent will have an incentive to cede surplus to a lucky partner. These effects will both manifest themselves when the higher-centrality partner is lucky: they will be willing to transfer less to their partner/the unlucky partner will accept the smaller transfer. In the setup above, an unlucky individual who is less central than her partner has a weaker punitive device to deter defection: a lower $f(\cdot)$.[22]

In this section we noted the key differences among the regimes we consider—full commitment, limited commitment without savings and limited commitment with savings—in terms of levels of average insurance and welfare, and possible distributional differences. We now describe our experimental setup, designed to mimic these regimes.

3. Experimental Details and Data

3.1. **Setting.** Our experiment was conducted in 34 villages in Karnataka, India. The villages range from 1.5 to 3 hours' drive from Bangalore. The average village, according to our census data, contains 164 households, comprising 753 individuals. These particular villages were chosen as the setting for our experiment because village censuses and social network

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[21]See, for instance Jackson (2008) for an extensive discussion of eigenvector centrality in network models, and Banerjee et al. (2012) and Breza et al. (2012) for empirical evidence.

[22]In this case, instead of $f(\gamma)$ we would have $f\left(\gamma, \zeta_i - \zeta_j\right)$, where ζ is a vector capturing household-level network characteristics. When ζ represents eigenvector centrality, we predict $\partial f\left(\gamma, \zeta_i - \zeta_j\right)/\partial \zeta_i - \zeta_j < 0$: the more central an agent relative to her partner, the smaller the defection penalty she pays, ceteris paribus.

data were previously collected on their inhabitants, as described below and in more detail in Banerjee at al. (2011). This gives us uniquely detailed data, not just on our experimental participants and their direct connections to their partners, but also on indirect linkages between partners, e.g., through mutual friends. South India is an ideal setting for our experiment because South Indian villages have historically been characterized by a high degree of interpersonal risk-sharing, as demonstrated by Townsend (1994) and others for the ICRISAT villages, and because rural South India is currently experiencing rapid growth in the availability of savings, but from a low base.

In each village, 20 individuals aged 18 to 50 were recruited to take part in the experiment. As an incentive to attend, participants were paid a show-up fee of INR 20, and were told they would have the opportunity to win additional money. In total, 648 individuals participated in the experiment. The average age was 30, 56% of players were female, and the average education was 7th standard.[23] Over 98% of pairs in our sample could reach each other through the social network, meaning there exists a path of relationships connecting them. Among those who could reach each other, the average social distance was 3.67 and the median was 4, meaning that the members of a median pair were "friends of a friend of a friend of a friend." Tables 1a and 1b show summary statistics for the individuals and pairs that participated in the experiment.

3.2. **Overall game structure.** The purpose of our games was to harness the incentives to share income risk that exist in real life, but to do so in a way that can be implemented in an experimental session lasting a few hours. For external validity, individuals should have strong incentives to smooth risk and to think carefully about their choices. A timeline, illustrating the structure of each game and the full experiment, is shown in Figure 1.

Consumption smoothing has both intertemporal and interpersonal components. We create an interpersonal component by pairing individuals into groups of two (shown at left of the top timeline panel). In all games, the members of a pair can make transfers to each other. To simulate the intertemporal smoothing motive, individuals play many rounds during the experiment (18 rounds—six per game—on average), but are paid their "consumption" for one randomly-selected round.[24] To make this salient, income takes the form of tokens that represent INR 10 each, and each consumption realization is written on a chip and placed

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[23]The sample of villagers who took part in our games is not a random sample of the village as a whole: we informed local leaders that we would be coming to the village on a certain day, and looking for individuals to participate in a series of games. All comers aged 18-50 who could be located in the census data were considered for the experiment. Selection into the experiment poses no problems for internal validity, since all participants play all the games (with randomly chosen partners), and individual-fixed effects control for individual heterogeneity.

[24]This is standard in the literature, e.g., Charness and Genicot (2009) and Fischer (2010).

in a bag that the player keeps with him or her during the entire experiment. At the end of the experiment, an experimenter draws one chip from the bag, and the individual is paid the amount shown on the selected chip.

In our setting, this payment structure has the crucial implication that players cannot use transfers after/outside the experiment to insure the risk they faced during the experiment. First, outside transfers have the shortcoming that all players could get paid for rounds in which their income was low, or vice versa. Additionally, while income was observable during the experiment, it was no longer fully observable outside the experiment, since selection of a round for payment and the actual payout were done in private. Finally, since each player was paired with three different partners, there was no guarantee of being paid for a round played with a particular partner. Thus, players had strong incentives to engage in risk sharing within the experiment–and the data show that they did so.

Incomes are risky: as in our theoretical setup,[25] there is a high income level (INR 250), and a low income level (INR 0). Moreover, to simulate the (possibly unequal) wealth individuals have at the time when they enter into an insurance relationship, before round 1 of each game one partner is randomly chosen to receive an endowment of INR 60; the other receives INR 30. The games are described in the context of a farmer who may receive high income because of good rains this season or low income because of drought. (The experimental protocol, translated into English, appears in Appendix E.) Discussions with participants indicate that they understood the risk they faced and the data show that both transfers and savings are used to smooth this risk.

To replicate an interaction that may extend indefinitely into the future, induce discounting and avoid a known terminal round, the game ends with 1/6 probability at the end of each period, determined by drawing a ball from a bag that has five red balls and one black ball. Participants are told before each game that the game will end when the black ball is drawn, and that therefore at any point when the game has not ended, it is expected to continue for 6 more rounds. Once a game ends, individuals are re-paired. The order of the games is randomized, and we control for game order in our regressions.

The options allowing players to decouple consumption from income vary by game. However, in all treatments, at the beginning of each round before incomes are realized (but after the endowment is realized in round 1), partners may decide on an income sharing plan.[26] (This is shown as the leftmost entry of the lower timeline panel in Figure 1.) That is, partner 1 chooses how much 1 will give 2, if 1 gets INR 250 and 2 gets 0 (τ_t^1), and 2 chooses

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[25]See Apprendix C for details.

[26]Time constraints prevented us from conducting a treatment with access to savings but not to transfers.

how much 2 will give 1, if 2 gets INR 250 and 1 gets 0 (τ_t^2). This plan may be asymmetric ($\tau_t^1 \neq \tau_t^2$) and time-varying ($\tau_t^i \neq \tau_{t'}^i$). Communication between the partners was allowed while they made these decisions, to mimic real-life interactions, but one partner did not have veto power over the other's announced transfer.

The details of each treatment are as follows:

(1) **Full commitment, no savings:** Partners announce an income sharing plan for the round.[27] Once incomes are realized, the experimenter implements the transfer that the lucky player announced ex ante. There is no opportunity for the lucky player to change her mind. Each individual then "consumes" by placing all of her tokens, net of any transfers, into a consumption cup. The experimenter removes the tokens, writes the consumption amount on a chip, and the chip is placed in the consumption bag. A random draw determines whether the game will continue. If it continues, before the next round, partners make a new sharing plan (which can be the same or different than the prior one).

(2) **Limited commitment, no savings:** Partners announce an income sharing plan as before. However, after seeing their income, the lucky individuals can reassess how much to transfer to their unlucky partners. (This is indicated by the timeline entry in a dotted box in Figure 1.) They may choose to transfer a different amount than the one announced *ex ante*, including transferring nothing. Individuals are told they will have the option to change their minds *ex post* before they decide their sharing rules. After any reassessment, the transfer is implemented, and each individual then places all her tokens, net of any transfers, into her consumption cup. The experimenter takes the tokens, writes the amount on a chip, and the chip is placed in the consumption bag.

(3) **Limited commitment, with savings:** As in game 2, the lucky individual may renege on her announced transfer after seeing her income. In addition, each player has access to a "savings cup." Once transfers are made, players can consume tokens by placing them in the consumption cup, or save them by placing them in the savings cup. (The savings decision is indicated by the timeline entry in a dashed box in Figure 1.) Tokens saved in previous rounds can are available to consume or to transfer to one's partner in later rounds, but are lost when the game ends. If an individual reneges on transfers she announced *ex ante*, she keeps her savings.

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[27]For instance, this could be: "Player 1 will give Player 2 Rs. 100 if Player 1 gets the Rs. 250 payout, and if Player 2 gets the Rs. 250, she will give Player 1 Rs. 80."

3.2.1. *Information structure of games.* The games were characterized by full information. As noted above, incomes were common knowledge during the experiment, due to the perfect negative correlation in partners' incomes and the fact that payments were visible to both members of the pair. Savings, when available, were also fully observable by the partner: saved tokens were stored in transparent plastic cups. Transfers, too, are fully observable: a player knew if her partner defected against her by transferring less than promised.

As with some other aspects of the experiments, this full information structure represents an abstraction from reality: players could not hide income or savings, or claim to have made transfers when they could not. We deliberately shut down information asymmetries to isolate the effects of limited commitment and access to savings. Moreover, many significant risks faced by poor households are quite observable, such as a harvest failure, an illness, the death of livestock, etc. In ongoing work (Chandrasekhar, Kinnan, and Larreguy 2012) we are investigating the impact of introducing hidden income and hidden savings into limited commitment settings.

3.3. **Regression specifications.** Randomization ensures that many of our hypotheses of interest can be answered by simple comparisons of the mean of a particular outcome across games. We want to assess whether the limited commitment model is a good description of players' behavior, measure the effect of different treatments on the magnitude of interpersonal insurance and on welfare, and study how these cross-treatment differences respond to the strength of social proximity. Our main estimation specification take the following form for outcomes defined at the individual-game-round level:

$$(3.1) \qquad \omega_{ivgr} = \alpha + \beta_g D_g + X'_{vg}\eta + \phi_i + Z'_{ig}\zeta + \varepsilon_{ivgr}$$

where ω_{ivgr} is an outcome for individual i in game g, round r; D_g is a game indicator (commitment, no commitment without savings, etc.), so β_g measures the average effect of that game on the outcome; X_{vg} includes characteristics of the game as played in that village (i.e., order-of-play and surveyor effects); ϕ_i is an individual-fixed effect, and Z_{ig} includes an indicator for whether i and i's partner j in game g are connected in the village social network, and, if connected, the distance between i and j.[28] The individual-game-round

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[28]We have also estimated specifications omitting individual-fixed effects and controlling for characteristics of the individual (education, wealth, and individual-level network characteristics measuring an individual's "importance" in the network). As well, we can control for pair characteristics beyond geodesic distance, i.e., an indicator for being of the same caste and the difference in roof types (a proxy for wealth differences). These individual and pair-level characteristics enter with the expected signs and do not change the between-game comparisons we find in the baseline specifications. (Results available on request.)

level outcomes we consider are absolute deviations of consumption from the overall average for that game, $|c_{ivgr} - \bar{c}_g|$; and savings, s_{ivgr}. We also examine transfers, τ_{ivgr}, made from the lucky ($y = 250$) to unlucky ($y = 0$) individual in each round; for these regressions the sample is restricted to individual-game-round observations on lucky individuals.

The estimation errors (ε) in our regressions may be correlated across individuals within a given game in a particular village, due, for instance, to slight idiosyncrasies of game explanation, disruptions in the experiment venue, etc. Therefore all regression standard errors are clustered at the game-village level.

3.3.1. *Capturing the effect of social distance and network importance.* To examine how social distance affects lack of commitment when the outcomes are the amount the lucky partner transfers to the unlucky partner, and the absolute consumption deviations of both partners, we run regressions of the form:

$$(3.2) \qquad \begin{aligned} \omega_{igr} \; &= \; \alpha + \beta_1 D_g + \eta_1 \rho(i,j) + \eta_2 \gamma(i,j) \\ &\quad + \delta_1 D_g \cdot \rho(i,j) + \delta_2 D_g \cdot \gamma(i,j) \\ &\quad + \phi_i + Z'_{ig} \xi + \varepsilon_{igr} \end{aligned}$$

where ω_{igr} is an outcome for i in game g, round r, D_g is an indicator for a particular treatment (limited commitment without savings or limited commitment with savings), $\gamma(i,j)$ is the social distance between i,j (with infinite distances set to zero), and $\rho(i,j) = 1\,(\gamma(i,j) \neq \infty)$ is an indicator that i and j are reachable through the network.[29] As outcomes, we consider absolute deviations of consumption from the overall average for that game, $|c_{igr} - \bar{c}_g|$, and savings, s_{igr}. We also examine transfers, τ_{igr}, made from the lucky to unlucky individual in each round.

The term ϕ_i is an individual-fixed effect, and Z_{ig} includes pair-level covariates. When the outcome is transfers made from the lucky to unlucky individual in each round, the sample is restricted to individual-game-round observations on lucky individuals.

Thus when D_g is an indicator for limited commitment without savings, the coefficient β_1 is the regression-adjusted effect of moving from full commitment to no commitment for unreachable (i.e., socially unconnected) pairs. The sum $\delta_1 + \delta_2$ is the differential no-commitment effect for closest pairs (of distance 1), and δ_2 is the additional differential effect for each additional unit of geodesic distance between the members of the pair. Since the

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[29]We have examined whether the effects of social distance differ according to whether distance is defined through financial transactions (e.g., borrowing or lending), or non-financial transactions (e.g., visiting one another's homes), or either. We do not find differing effects, consistent with the findings of Banerjee et al. (2012). In these villages, financial and non-financial networks are highly overlapping.

reference category in these regressions is full commitment, the coefficient η_2 is the effect of increasing social distance by one unit in the full commitment treatment. When D_g is an indicator for limited commitment with savings, the coefficients measure the analogous effects of introducing savings access, relative to limited commitment without savings.

We run similar regressions to test for heterogeneous effects of limited commitment and savings access by the relative eigenvector centrality of the two partners, conditional on their social distance[30]:

$$
\begin{align}
(3.3) \quad \omega_{igr} &= \alpha + \beta_1 D_g + \psi\left(\zeta_i - \zeta_j\right) + \varphi D_g \cdot \left(\zeta_i - \zeta_j\right) \\
(3.4) \quad &\quad + \eta_1 \rho(i,j) + \eta_2 \gamma(i,j) + \delta_1 D_g \cdot \rho(i,j) \\
&\quad + \delta_2 D_g \cdot \gamma(i,j) + \phi_i + Z'_{ig}\xi + \varepsilon_{igr}
\end{align}
$$

When the outcome is transfers, since the sample is restricted to individual-game-round observations on lucky individuals, the term $\left(\zeta_i - \zeta_j\right)$ measures the difference between the lucky player's eigenvector centrality, ζ_i, and her (unlucky) partner's eigenvector centrality, ζ_j. Due to the inclusion of individual-fixed effects ϕ_i, variation in $\left(\zeta_i - \zeta_j\right)$ is identified by variation in the centrality of the partner i is paired with. Thus, when D_g is an indicator for limited commitment, β_1 is the regression-adjusted effect of moving from full commitment to no commitment when relative eigenvector centrality is zero, and the coefficient φ measures the additional effect of limited commitment when relative eigenvector centrality increases by one standard deviation.

3.4. **Use of smoothing mechanisms.** Because we want to use the results of our experiment to study how interpersonal and intertemporal consumption smoothing interact, we need to show that the players understand and are willing to use interpersonal transfers, and, when available, savings. Table 2, column 1 shows average transfers by game. Average transfers are INR 92.35 in the full-commitment treatment, about three-quarters of the INR 125 that would be associated with full insurance. (Even if one individual always consumes more than the other due to a higher bargaining weight, average transfers will still equal half of aggregate income of INR 125 per round, as discussed below.[31]) Table 2, column 5 shows that average savings levels in the limited commitment with savings game are INR 22.65.

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[30]We also run regressions including relative eigenvector centrality, but not social distance. Here we only show the regression specification when social distance is included.

[31]Individuals receive extra income in the first round, in the form of the initial endowment. However, since this income is revealed before insurance agreements are made, the endowment should not be "insured." We test this prediction below.

Significant levels of transfers in savings and non-savings treatments, and use of savings when savings are available, suggest that meaningful consumption smoothing is occurring.

3.5. **Measuring the degree of insurance.** To examine the magnitude of interpersonal insurance, we examine average transfers made by individuals with high income realizations to those with low income realizations. The following lemma allows us to do so:

Lemma 1. *Because Pareto weights are orthogonal to the in-game income process, under full risk-sharing average transfers will equal half of average income. If players insure, on average, fraction α of their idiosyncratic risk, average transfers will equal a fraction $\frac{\alpha}{2}$ of average income.*

(All proofs appear in Appendix C.) This gives us a measure of the amount of interpersonal risk-sharing which does not rely on knowing the relative bargaining power or Pareto weights. Moreover, these comparisons do not rely on the assumption that individuals are on the Pareto frontier; merely that they are risk averse.

We can therefore interpret changes in transfers when moving from full commitment to limited commitment without savings as the change in interpersonal insurance due to binding participation constraints; and we can interpret changes in transfers when moving from limited commitment without savings to limited commitment with private savings as the change in interpersonal insurance due to savings access affecting participation constraints.

3.6. **Measuring welfare implications.** Examining transfers as an outcome tells us about the degree of interpersonal insurance. However, we are also interested in the implications for welfare. In particular: Is welfare higher (or lower) with savings access than without, and by how much? How much do binding participation constraints reduce welfare, relative to the full commitment case?

In general, the effect of different treatments on welfare would be comprised of an effect on the level of consumption and an effect on the variability of consumption. However, because the income process was fixed across treatments, there will be no difference in average consumption between the full commitment (FCNS) and limited commitment (LCNS) games. Table 2, column 2 shows that this is indeed the case—average consumption is INR131 in both games.[32] Because savings are lost when the savings games end, consumption is very slightly lower in the LCWS games (INR 2).

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[32]Consumption is higher in round 1 of each game, where players receive Rs. 30 or Rs. 60 as an initial endowment. Because there were random variations in how long each game lasted, consumption is an insignificant Rs. 0.31 higher in the LCNS game than in FCNS.

In thinking about the external validity of the findings of this experiment in terms of insurance and welfare, three points are worth noting. First, the amounts of money involved are substantial. Average expected earnings in the experiment are about INR 130. To put this into perspective, the National Rural Employment Guarantee Act (which guarantees 100 days of work per year to anyone able and willing to do manual labor) pays a wage of INR 74 for a day's work in rural Karnataka (NREGA 2011). Thus, individuals face strong incentives to think carefully about how to maximize the benefit they can derive from playing the games, by aiming for consumption choices that are stable across rounds.

Second, great care was taken in designing the physicality of the games and the framing with which we presented them, in order to make them both easy to understand and similar to real life. In explaining the games to the participants, it was explained that the games that they play are much like the decisions they make in every day life. In each round they receive some income and (depending on the game) they are able to make decisions to consume, save for the future, or share money with their partner. Many players spontaneously noted the parallels between the games and real-life decisions.[33] Finally, using social network data, we can control for and study the interactions of the participants outside the experiment which may affect the incentives created by an experimenter. We discuss this below in detail.

3.7. **Randomization and the role of social networks.**

3.7.1. *Randomization.* Our randomization was unique in that it stratified against the social network in real time in the field. To that end, we made use of a unique dataset containing information on all 34 villages in which our experiment was conducted. We have complete censuses of each of the villages as well as detailed social network data. The network data was collected for Banerjee et al. (2011) in which they conducted a survey about social linkages for a random subset of the population. For a village, the graph (or multi-graph), represents individuals as nodes with twelve dimensions of possible links between pairs of vertices. These dimensions include relatives, friends, creditors, debtors and advisors, among others. (See Appendix D for details.) For our purposes, we work with an undirected, unweighted graph which takes the union of these dimensions, following Banerjee et al. (2011). In our villages, the multiple dimensions are highly correlated so the union network captures latent information. (Moreover, any weighting method would be rather *ad hoc* in nature.) Henceforth, we refer to this object as the social network of the village. Using this social

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[33]One player told us "The games were very interesting, especially for those who have some education... They help us think about how much we really should save and give to our friends in times of hardship." Furthermore, in two villages, after the experiment village leaders inquired about the possibility of having an microfinance institution come to their village, because they saw links between the games and the possibility of having actual savings.

network, we construct a variable $\gamma(i,j)$ that represents the length of the shortest undirected path between i and j. We refer to this as i and j's social distance. If i and j are connected directly (e.g., they are friends), their social distance is $\gamma(i,j) = 1$; if i is not connected to j directly, but is connected to some k, who is connected to j, $\gamma(i,j) = 2$, etc. Then, i and j are said to be reachable ($\rho(i,j) = 1$) if there exists any path from i to j. We construct i's eigenvector centrality, a recursive metric which measures the importance of a node as proportional to the sum of its neighbors' importances. We provide a more detailed description of the construction of these variables in Appendix D.

It should be emphasized that we are working with sampled networks—approximately 50% of households within each village completed the social network questionnaire. Links including the other, unsampled 50% will be observed only when one member of the dyad was sampled. This means that some ties between participants will be unobserved (e.g., if i is connected to j who is connected to k, the indirect tie between i and k will be missed if j is not surveyed). This has the effect of upward-biasing our measure of social distance, and attenuating our estimates of the effect of social distance, making our findings lower bounds on the true significance of social networks (Chandrasekhar and Lewis 2011).

Since most social networks exhibit small-world phenomena, even if a random subset of villagers took part in our experiments, randomly chosen *pairs* would tend to be fairly close in social distance. This tendency would be exaggerated if people tend to come to the experiment with their friends or relatives, which was the case for many people who took part in our experiment. Therefore, the distribution of social distances will be left-skewed, and simply randomly assigning partners would mean that more often than not, people would be paired with near-kin. This would limit the statistical power of our data to reveal how socially distant pairs play the games, yet the behavior of socially distant pairs is important to allow us to study how behavior across games changes with social distance. Therefore, to make the distribution of social distances between our pairs more uniform in our sample, we used the network data to oversample the right tail of the distance distribution. This was done in the field, once the experimental participants had been located in the village census data. Figure 2 shows the distributions of social distances for 3 villages: the full distribution and the distribution of assigned pairings in the experiment. The comparison between the full distribution and the distribution of assigned pairings reveals that we were successful in oversampling the right tail of the social distance distribution: the distribution of pairings used in the experiment has more mass at greater distances, particularly distances of 5 and 6, than the full distribution.

3.7.2. *The role of social networks.* Detailed social network data enable us to do several things. Because we have exogenous variation in social distance and relative eigenvector centrality[34], our results are informative for studying how limited commitment relationships and the insurance that they can support are affected by social proximity. By comparing the change in transfers when moving from full commitment to limited commitment (no savings) for socially close versus socially distant pairs, we can examine how the ability to maintain high levels of interpersonal insurance in the absence of commitment is affected by the network relationships of risk-sharing partners. By comparing the changes in transfers and savings when moving from limited commitment (no savings) to limited commitment with savings for socially close versus socially distant pairs, we can study whether the extent to which savings crowds out interpersonal insurance depends on social distance, and whether socially distant pairs use savings with differing intensity due to different levels of uninsured risk. We can also test analogous hypotheses for relative eigenvector centrality.

If, instead of a setup with randomly-assigned but non-anonymous pairs, we had conducted an anonymous experiment or allowed players to choose their own partners, the average level of risk sharing in the experiment would not generalize to other settings, and we would not be able to estimate the effect of social distance. Moreover, with data on social distance we are able to estimate and control for the effect of relationships outside the experiment. In any non-anonymous experiment, as in non-experimental interactions, partners' actions may be affected by other dimensions of the relationship which extend beyond the game at hand. Including social distance in our regressions allows us to control for outside-the-game effects, something which, to our knowledge, is unusual for an experiment conducted in the field.

Understanding how lack of commitment and access to savings are mitigated by social networks is of interest for several reasons. First, these effects comprise an important element of the production function that maps individuals/households, their social embedding, endowments and shocks into outcomes. Understanding the role of social distance helps to answer questions such as: to what extent can the observed tendency toward interacting with similar individuals (homophily) be explained by ease of sustaining cooperation among socially closer individuals, and what magnitude of gains in terms of better diversification are being left on the table to obtain this greater cooperation? Moreover, situations frequently arise wherein individuals are constrained to interact with a subset of their social network (e.g., village leaders, families whose children are the same ages as theirs, or certain occupations

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[34]As noted above, we do not assign the social distance or relative eigenvector centrality to a dyad: the social distance between i and j is given. Instead, among the potential dyads of participants in the experiment, we chose certain dyads to be paired.

such as a moneylender or doctor), or with a stranger (e.g., when migrating to a new area where no social network members reside). Of course, within these subsets individuals will prefer certain individuals over others, but nevertheless our estimates provide comparative statics as to how much more cooperation can be sustained if the relevant subset is socially closer or more distant. This would not be possible without random assignment of pairs to play different treatments, in which case network characteristics (distance, importance) would be omitted variables.

Of course, in many instances of risk sharing, individuals are not randomly assigned a risk-sharing partner, but instead, choose a partner or partners. Our experiment deliberately abstracts from endogenous partner selection to obtain causal estimates of the effect of having a socially closer or more distant partner, in the same way as researchers who wish to estimate the effect of teacher quality or class size look for random assignment of these characteristics, although they are not typically randomly assigned. Estimates obtained from random assignment are informative about the underlying production function in a way that estimates contaminated by selection would not be. In ongoing work, we have conducted experiments involving endogenous pairing in order to compare the effect of endogenously- and exogenously-assigned partners of the same social distance (Chandrasekhar, Kinnan, and Larreguy 2012).

We now turn to discussing how the implications of the models map into testable predictions across the different versions of our experiment, and also how these testable predictions should be affected by social networks.

4. Testable implications and results

Our discussion of the testable implications of the models ("propositions"), and effects which are theoretically ambiguous but can be signed empirically ("empirical questions"), is divided into two parts. We begin in section 4.1 by discussing implications and questions that apply to the model without a role for social distance–or alternatively, averaging over all values of social distance in our dataset. We begin by showing evidence that limited commitment matters in reducing transfers and consumption smoothing. Then we demonstrate that information revealed before sharing plans are made is not insured, consistent with transfers being used for insurance motives, and show that players "punish" their partners when they deviate from their sharing plans, indicating that these plans are not merely cheap talk. In the final parts of this section, we show that the average impacts of savings access on consumption smoothing is positive, and then examine whether access to savings

has distributional consequences for those who experience bad income draws vis-a-vis those who receive good income draws, arguing that savings access benefits both fortunate and unfortunate players.

Then, in section 4.2 we discuss implications and questions for how transfers, consumption smoothing, defection rates and savings behavior varies across treatments for pairs with different levels of social distance. We first show that limited commitment's impacts on transfers and consumption smoothing are essentially eliminated among partners who are directly socially connected, and that the effect increases with social distance. Next we show that players save more when paired with socially distant partners, due to facing more uninsured risk, and finally, that defection occurs much more often among pairs that are socially distant.

4.1. **Commitment, savings and smoothing.** Comparing the limited commitment model (without savings) to the full commitment model yields the following implications and questions:

4.1.1. *Transfers and consumption smoothing.* To test the validity of the full and limited commitment models as a description of experimental subjects' behavior, we check whether the following comparative statics hold for transfers and consumption smoothing:

Proposition 1. *When comparing full commitment no savings (FCNS) vs. limited commitment no savings (LCNS), if participation constraints bind, transfers will be lower and consumption variability higher under LCNS as compared to FCNS.*

Figure 3 shows levels of transfers by round of the game, plotted separately for each game. The level of transfers is higher under full commitment than under limited commitment in each round, as predicted by Proposition 1. No time trend is apparent, although transfers under FCNS are slightly lower in the first and second rounds, while under LCNS they are slightly higher.[35] This is consistent with players understanding the setup of each game from the beginning, and understanding the games' stationary structure.

Figure 4 shows averages of consumption absolute deviations across rounds of the game, again plotted separately for each game. In the no-savings treatments, FCNS and LCNS, consumption variability is markedly higher in round 1 than in later rounds–this reflects the fact that the initial endowment of INR 30 or 60 was not insured across players and, when savings was not available, was consumed in round one. We return below to the non-insurance of the initial endowment, which is consistent with our predictions. After round

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[35]All results are robust to dropping rounds 1 and 2. (Results available on request.)

one, consumption variability is always lower under FCNS than under LCNS, consistent with Proposition 1.

Table 3 shows results testing Proposition 1 via regression, estimating equation (3.1), using as outcomes transfers and absolute deviations of consumption from its mean.[36] To understand the value of commitment, the relevant comparison is between the full commitment treatment (FCNS) and limited commitment treatments (LCNS and LCWS). Column 1 shows results for transfers. Consistent with Proposition 1, transfers are significantly lower in the two no-commitment treatments. Relative to the full commitment treatment, transfers are INR 9 (10%) lower under limited commitment-no savings, and INR 11.3 (12%) lower under limited commitment with savings, indicating reduced interpersonal consumption smoothing due to limited commitment.

Column 3 shows results for consumption smoothing. The measure of consumption variability we use is the absolute deviation of consumption in a given round from the player's total average consumption in that game.[37] Proposition 1 predicts that consumption smoothing worsens when commitment is removed. Consistent with this, moving from FCNS to LCNS leads to a INR 9 increase in the absolute deviation of consumption, significant at the 1% level. This effect is equal to almost 20% of the average absolute deviation in the FCNS game, an economically as well as statistically significant increase.

These comparisons are derived assuming that individuals are on the constrained Pareto frontier. However, if there is an additional cost or constraint to making interpersonal transfers (e.g., due to contemplation costs of calculating the appropriate transfer, an endowment effect which makes it unpleasant to surrender money one has won, etc.), then there may be less-than-full insurance even when participation constraints *per se* do not bind. We are able to estimate the extent of such costs of engaging in full risk sharing using the FCNS case. In the case that we see positive variance of consumption under FCNS, it suggests that forces other than participation constraints limit risk sharing. Even if individuals are not on the Pareto frontier parsimoniously defined by the limited commitment model, comparisons across the treatments are still informative. In the case that they are not on the Pareto frontier, while we would not be able to map our empirical findings into statements about parameters in a limited commitment problem (e.g., magnitudes of Lagrange multipliers on

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[36]All p-values are from regressions controlling for individual-fixed effects, reachability and distance between partners, surveyor and team effects, and order and round of play, and adjusting for clustering at the village-by-game level. As expected, due to randomization, regression adjustment does not change the magnitude of the estimated effects, but does improve precision.

[37]Using squared deviations, variances and standard deviations yields similar results. The absolute deviation of consumption is in units of rupees and therefore easy to interpret.

particular constraints), the comparison of the LCNS treatment versus the LCWS treatment will still help us to address the empirical questions that this paper proposes: namely, do individuals achieve better overall consumption smoothing with or without access to savings; and, how is this affected by social networks? Thus:

Empirical question 1. *Is there positive variability of consumption under FCNS?*

Table 3, column 3 shows that the average consumption deviation under full commitment is INR 40.9. Thus, individuals do not fully smooth consumption when there is no issue of limited commitment. This suggests that there is an additional cost or constraint to making interpersonal transfers. However, the comparative statics that we discuss below are on the whole consistent with the hypothesis that individuals are on the constrained Pareto frontier, subject to this additional cost of engaging in full risk sharing (i.e., a cost not derived from the participation constraints of the limited commitment model).

4.1.2. *Defection and punishment.* Although the constrained-optimal insurance arrangement under limited commitment will not feature defection in equilibrium since every efficient insurance contract has an efficient continuation contract after every history (Ligon et al. 2002), in reality binding enforcement constraints may be manifested through players actually changing their minds, i.e., defecting.[38] Table 6 presents the results on defection probabilities, revealing that binding participation constraints manifest themselves through defection, i.e., players transferring a different (almost always lower) amount than they promised.[39] Defection, defined as transferring less than promised, occurs in 23% of limited-commitment rounds.[40] The left-hand panel of Figure 5a shows the distribution of defection amounts, when defection occurs. The average defection amount is INR 46, the 25th percentile is INR 20 and the 75th percentile is INR 75. Defection amounts ranging from INR 10 to INR 250 are observed. The right-hand panel of Figure 5a shows the distribution of defection amounts, expressed as a percentage of the initial promise. Conditional on defecting, the average defector transfers 43% less than promised. The 25th percentile is 20% and the 75th percentile is 55%.

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[38]In the context of an optimizing, forward-looking model, this can be modeled as additive error term, v, unforecastable by the individual (and unobserved by their partner), in the value of reneging on a particular promise. The probability of defection when y_H is realized is then the probability that v exceeds the surplus the lucky individual had anticipated when receiving y_H and making the promised transfer τ.

[39]In a small fraction of rounds, the lucky player transfers *more* than she promised. We do not consider this defection in our analysis. Results defining defection to have occurred only when the transferred amount was less than the promised amount by Rs. 20, the 25th percentile defection size, are similar (available on request).

[40]The participants in our games mention changing their minds about how much to transfer to their partner because after seeing their income, they were unwilling to transfer what they had initially promised, suggesting that binding participation constraints that were not perfectly forecast ex ante result in defection.

Since we observe defection, we can also observe what type of post-defection responses individuals actually use, and what consequences they have for consumption smoothing. Table 7 shows how transfers are affected in the rounds following defection. Transfers are significantly reduced, by about INR 12, in the first round post-defection, returning to the level that prevailed before defection occurred after 4 rounds. We illustrate this graphically in Figure 5b. During the maximal punishment phase, transfers fall by roughly 15%. While the level of punishment imposed is a far cry from permanent reversion to autarky, the (off equilibrium) punishment assumed in most models of limited commitment, the fact that punishment is inflicted shows that players' statements about what they promised to transfer to their partner are not simply cheap talk—as does the fact that, 77% of the time in the limited commitment treatments, the promised transfer was actually made.

We now turn to examining how the effects of limited commitment and savings access vary for risk-sharing groups with different amounts of social proximity.

4.1.3. *Savings, insurance and welfare.* We now turn from focusing on the effect of commitment and the lack thereof, to examining the effects of introducing savings into a limited commitment environment. First, players do use savings when available: Figure 6 shows the level of savings in the limited commitment setting with savings access (LCWS). Average savings start at INR 28.8 and trend downward by an average of INR 1.75 per round. On average, in the final round of a game with savings, players have INR 17.87 in savings. This amount is lost because the game ended after that round. The fact that individuals are still holding almost INR 20 when the game ends suggests that they correctly understood the stationarity of the game and were not attempting to fully dissave in later rounds. What dissaving does occur reflects individuals' smoothing of the initial endowment.

Turning to how savings are predicted to affect risk-sharing, recall that the limited commitment model predicts that savings access crowds out interpersonal transfers, since the value of defection (i.e., opting out of the insurance agreement) with savings is higher than without savings, living hand to mouth (Ligon, Thomas, and Worrall 2000). Therefore:

Proposition 2. *Participation constraints will be tightened by the introduction of savings (LCWS), crowding out interpersonal insurance. Hence, transfers under LCWS will be lower than under LCNS.*

Table 3, Column 1 shows that transfers in both LCNS and LCWS are significantly different from transfers in FCNS at the 1% level, and the point estimate suggests that transfers

fall by almost 25% more under LCWS than LCNS (11.2 vs. 8.9), the reduction in transfers under LCNS is not significantly different than under LCWS ($p = .295$). Thus, we find only weak support for Proposition 2.

When comparing limited commitment no savings vs. limited commitment with savings, the comparison for consumption smoothing is theoretically ambiguous. On one hand, access to savings will tighten participation constraints. This implies that interpersonal transfers will be reduced (crowded out). On the other hand, savings access allows individuals to (partially) smooth income risk over time that cannot be smoothed interpersonally. Therefore, the net impact could be positive or negative. If the effect of tightening participation constraints outweighs the effect of savings access allowing intertemporal smoothing, then aggregate consumption smoothing will worsen and the variance of consumption will increase. If instead, interpersonal insurance is reduced by less than intertemporal smoothing is increased, the variance of consumption will decrease. This gives us:

Empirical question 2. *Does savings' beneficial effect of allowing intertemporal smoothing or its negative effect of tightening participation constraints dominate? Is average consumption smoothing better under LCNS or under LCWS?*

Table 3, Column 3 shows that moving from FCNS to LCWS increases the absolute deviation of consumption by INR 5 ($p < .01$), indicating that full commitment (FCNS) induces significantly more smooth consumption patterns than limited commitment with savings (LCWS): access to savings does not fully make up for the loss of insurance due to limited commitment. However, LCWS results in significantly smoother consumption than LCNS, by INR 4 ($p < .01$). That is, when savings access is introduced to a limited commitment environment, the ability to smooth some risk intertemporally that cannot be smoothed using interpersonal transfers outweighs any crowdout of transfers. As noted above, conditional on sustaining the same level of consumption, consumption variability is a sufficient statistic for welfare implications. Therefore, we can interpret our results as saying that limited commitment (with or without savings) induces a welfare loss relative to the full commitment no savings case. However, the introduction of savings to the limited commitment game significantly *increases* welfare, relative to the limited commitment-no savings case.

4.1.4. *Distributional consequences.* As well as its effect for the average member of a risk-sharing network, savings access may have distributional consequences. When inter-household risk sharing is augmented by the ability to smooth risk across time, the average household

may be better off (our results show they are), but households that experience especially poor luck may suffer more than they would under a mutual insurance-only system (Platteau 2000). Those suffering negative shocks may derive little direct benefit from savings, as they have no excess income to save, while receiving reduced transfers from more fortunate members of the village, who are willing to transfer less because reduced future insurance is less painful when they can rely on a buffer of savings:

Empirical question 3 therefore asks how the effect of access to savings differs across the distribution of ex post income realizations.

Empirical question 3. *Does savings' pro-insurance effect or its anti-insurance effect dominate for those with "bad luck," i.e. is consumption smoothing for those with low income realizations better under LCNS or under LCWS?*

Table 4 shows how the effects of limited commitment (with and without savings) differ according to how income is distributed between the members of a pair. We find that limited commitment binds more when income is unevenly distributed[41]: in games where one player has a realized income in the lowest tercile of the income distribution, that player's consumption smoothing is much worse in LCNS relative to FCNS—the absolute deviation of consumption increases by INR 16 (column 1). When both players' income realizations are in the middle tercile, the increase in absolute deviation of consumption when moving from FCNS to LCNS is only INR 4 (column 2).

Comparing the coefficients on LCNS and LCWS shows that the benefit of savings (in terms of consumption smoothing) is greatest in games where one player has a realized income in the lowest tercile of the income distribution: column 3 shows that the lucky individual's consumption is smoother in LCWS than LCNS: the absolute deviation falls by INR 9 ($p < .01$). Notably, the *unlucky* individual also benefits from savings access: their absolute deviation falls by INR 5.5 ($p = .07$). This is because there is little crowdout of transfers from the high-income partner, and access to savings allows intertemporal smoothing. These results are counter to the hypothesis that those individuals with the worst series of income realizations ("bad luck") would do worse when their partners have access to savings, because their more fortunate partners would prefer to save their income rather than repeatedly make

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[41]All series of income distributions are drawn from a process in which each player can expect to be lucky 50% of the time. However, due to random variation, the realized income distribution over the short games (averaging 6 rounds) will sometimes be quite unequal.

transfers to the unlucky partner. Thus the answer to Empirical question 3 is that individuals across the income distribution benefit from savings access.[42]

4.1.5. *The role of ex ante wealth.* An implication of insurance (i.e., transfers made to smooth risk as opposed to transfers made for other reasons) is that a shock revealed before the insurance contract is signed cannot be insured, because its realization does not represent future risk that can be diversified away. If individuals are in fact making insurance agreements with each other, rather than simply sharing with each other due to altruism, social norms, etc., any shock revealed before pairs make their insurance agreements should not be insured, in any of our treatments. The initial endowment is such a shock. Therefore, if players share risk due to insurance motives, we should see that an individual's realization of the initial endowment feeds into individual consumption to a greater degree than subsequent income, which is realized after insurance agreements are made.[43] In the case of fully self-interested, i.e. non-altruistic or other-regarding behavior, the initial endowment should feed fully into individual consumption.[44] Thus:

Proposition 3. *If players share risk due to insurance motives, an individual's realization of the initial endowment before the insurance contract is signed should not be insured. As such, the high endowment individual should consume at least INR 30 more than the low endowment individual.*

Table 5, columns 1 and 4 test the prediction of Proposition 3 by regressing total consumption over the course of the game on an indicator for whether the player received the high or the low endowment (INR 60 vs. INR 30). The results reveal that individuals who receive the high endowment of INR 60 consume almost exactly INR 30 more than individuals who received only 30 INR; that is, the endowment shock is not insured at all, consistent with Proposition 3. The effect does not vary across games, suggesting that even in the game where individuals can commit, they do not use transfers to equalize *ex post* a shock that was revealed before the contract was made. This is suggestive evidence that, at least in part, players are using transfers out of true insurance motives and not out of pure or directed

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[42]In a setting where individuals have heterogeneous income processes which are initially private information, so that individuals are learning about their partners' income process, it is possible that individuals with a series of low income realizations would see a larger drop in insurance going from the no savings to savings treatments than in the full information, i.i.d. income setting we consider.

[43]Of course, if players viewed the endowment income as different than the later income, e.g., subject to different experimenter demands, or different mental accounting, then the extent to which the endowment is insured would not be solely determined by non-insurance motives. Therefore, we view these results as suggestive rather than conclusive.

[44]In fact, the high-endowment player may consume even more than Rs. 30 more than the low-endowment player if the utility function exhibits decreasing relative risk aversion, because the low-endowment player would prefer smoother consumption, at the cost of lower consumption levels (Genicot 2006).

altruism (à la Leider et al. 2009 and Ligon and Schechter 2010), or as part of a larger risk-sharing agreement that might exist between the pair members (à la Ambrus et al. 2010, or Karlan et al. 2009), or due to demand effects from the experimental setup. Columns 2-3 and 5-6 show that the INR 30 increase in total game consumption comes partially from a drop in transfers made and partially from an increase in transfers received. Combined with the evidence that transfers are higher under full commitment than limited commitment, the evidence on the endowment suggests that players insure risk when they can, but that inability to enforce contracts limits this.

4.2. **The role of social networks.** The results discussed so far indicate that the participants in the experiment are risk-averse and diversify away the risk they face in the experiment to the extent possible. However, the results also show that limited commitment impairs their ability to fully insure this risk. If pairs of players with closer social ties are more able to overcome the commitment problem, we should see that socially closer dyads are less affected by limited commitment than those who are socially distant. The fact that participants were randomly assigned to play with partners of varying social distances allows us to interpret such a finding as the causal effect of social distance in mitigating commitment problems.[45]

4.2.1. *Proximity and limited commitment.* The prediction of how social networks should matter in moving from full commitment to no commitment comes from the fact that closer social proximity lowers the utility individuals get from reneging on their risk-sharing relationship, because they pay a higher penalty for doing so. This implies that, *ceteris paribus*, in a pair with closer ties the players will face less temptation to renege for given income realizations. Hence moving from full commitment to limited commitment (without savings) should lead to a lower reduction in transfers and consumption smoothing in pairs with closer social proximity. This gives the following implications of the limited commitment model with social distance:

Proposition 4. *Average transfers are lower under limited commitment (without savings), the more socially distant the pair.*

Figure 7 summarizes the fall in transfers (i.e., interpersonal insurance) across games, by social distance, in bar chart form. We group distances 1 and 2; distances 3 and 4; and

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[45]All of our results examining the effect of social distance are robust to controlling for partners' similarity in terms of wealth (proxied by the difference in their roof types) and caste. This suggests that the effects measured here for social distance are capturing social proximity per se, as opposed to homophily. (Results with wealth and caste controls available on request.)

distances 5 and greater (including unreachable pairs). When partners are of social distance one or two, the fall as commitment is removed is relatively slight, approximately INR 6. When partners are of distance three or four, the fall is somewhat more, INR 8.5. Finally, when partners are of distance five or greater, the fall in transfers due to limited commitment is much greater, INR 13.4. This is what Proposition 4 predicts. (We discuss the portion of the figure corresponding to limited commitment with savings below.)

We can test Proposition 4 in a regression framework where social distance, conditional on reachability, enters linearly by estimating equation (3.2) on data from the FCNS and LCNS games only, where the outcome is transfers. Table 8 presents the results. Column 1 shows estimates of equation (3.1), the specification without the social distance interaction, on the sample FCNS and LCNS data, replicating the results of Table 3, column 1. Column 2 shows the specification corresponding to (3.2) where the outcome is transfers. The coefficient β_1 is the effect of moving from full commitment to no commitment for unreachable (i.e., socially unconnected) pairs. The estimated β_1 is 31.77, so for unreachable pairs, removing commitment is associated with a drop in transfers of almost one third. The sum $\delta_1 + \delta_2$ is the differential effect for closest pairs (of distance 1). We estimate $\delta_1 + \delta_2$ equal to positive 2.69 (not significantly different from zero), so for pairs of distance 1, the closest possible, the reduction in insurance due to limited commitment is essentially zero, and insignificant. Then, δ_2 is the additional differential effect for each additional unit of geodesic distance between the members of the pair. We estimate $\delta_2 = -2.996$, i.e. each additional unit of social distance increases the amount that transfers fall in response to limited commitment by INR 3 (significant at 10%).

The main effects of reachability (η_1) and social distance (η_2), are the effects of reachability and social distance in the full commitment treatment. The point estimate on the main effect of social distance is small and not statistically significant, indicating that under full commitment, players do not transfer more to a socially close partner than to a socially distant partner, conditional on being able to reach their partner through the network. In the limited commitment model with social sanctions, social distance only matters via the likelihood of binding participation constraints, so this finding is consistent with the model. However, the main effect of the reachability indicator, η_1, is significant and negative when the outcome is transfers, and significant and positive when the outcome is consumption smoothing, implying that unreachable pairs achieve more insurance than reachable pairs under full commitment. However, since only 1.3% of pairs are not reachable (see Table 1b), this may be purely due to sampling variation.

The limited commitment model also predicts that consumption smoothing will be more severely reduced when commitment is removed (in the absence of savings), the more socially distant is the pair:

Proposition 5. *Consumption smoothing under limited commitment (without savings) is worse, the more socially distant the pair.*

Figure 8 summarizes the increase in the variability of consumption across games, by social distance, in a form analogous to Figure 7 for transfers. When partners are of social distance one or two and commitment is removed, consumption variability increases by approximately INR 4. When partners are of distance three or four, the increase is larger, INR 8. When partners are of distance five or greater, consumption variability increases by INR 12 due to limited commitment. This is consistent with Proposition 5.

To test Proposition 5 via regression, we estimate (3.2) where the outcome is $|c_{igr} - \bar{c}_g|$, the absolute deviation of i's consumption in round r of game g from average consumption in game g. Table 8, Column 3 replicates the results of Table 3, column 3 on the sample FCNS and LCNS data. Column 4, shows that for unreachable pairs, removing commitment involves a INR 39 increase in the average absolute deviation of consumption, an increase of almost 150% over the full commitment mean of INR 27. However, for pairs of distance 1, there is no increase in consumption variability: the point estimate of $\beta_1 + \delta_1 + \delta_2$ is negative, small and insignificant. Though not statistically significant, the estimate of δ_2 suggests that each additional unit of social distance increases the amount of additional consumption variability in response to limited commitment by INR 7. Therefore the regression results are also consistent with Proposition 5.

In summary, these results confirm implications of the model of limited commitment with social networks derived in section 2: limited commitment leads to the largest reductions in interpersonal insurance and consumption smoothing for the most socially distant individuals, while social distance does not play a significant role when individuals can commit.

4.2.2. *Proximity and savings access.* To illustrate the role of social networks when moving from limited commitment without savings to limited commitment with savings, it is helpful to decompose the effect of savings into two parts: raising the value of autarky, and smoothing originally uninsured risk. The effect of raising the value of autarky is to make participation constraints bind more often, reducing the amount of interpersonal risk-sharing that can be sustained and crowding out transfers. This effect operates at all levels of social distance with two exceptions. First, for high social proximity it might be that, even with access to savings

in autarky, participation constraints never bind. Second, for very high social distance, it may be that very little risk sharing is achieved in the absence of savings. Turning to the second effect, the scope for savings to smooth uninsured risk should increase with social distance by Proposition 5. Consequently, theory does not yield a sharp prediction about how the change in transfers between limited commitment without savings and limited commitment with savings should vary with social distance. Thus:

Empirical question 4. *How does the degree to which interpersonal transfers are crowded out by savings access vary with social distance?*

To answer this question empirically, we run regressions of the form of specification (3.2), but focus on data from the LCNS and LCWS games only—holding lack of commitment constant and varying access to savings. Table 9 shows the results. We do not observe significant social distance effects on how transfers and consumption variability respond to limited commitment. (The fall in transfers across games and social distance can be seen graphically in Figure 7.) The lack of a significant coefficient on the main effect when the outcome is transfers, and the significant negative coefficient on the main effect of savings access when the outcome is consumption variability, replicate our earlier findings that, on average, savings access does not crowd out interpersonal insurance, and improves consumption smoothing throughout the ex post income distribution.

The sharp prediction that does emerge from the limited commitment model with social sanctions is that individuals in more socially distant pairs should use savings more, because limited commitment leads to more uninsured income variation for these pairs, and consequently, increases the scope for savings to smooth this uninsured risk:

Proposition 6. *Socially distant pairs use savings more than socially close pairs.*

Because we only observe each individual playing one game with savings, Table 10 omits individual fixed effects to look at how use of savings varies with social distance. We see that the more distant i is from her partner, the more i uses savings, by INR 0.80 per unit of distance, significant at 1%. This offers further evidence that limited commitment binds more at greater social distances, and that savings allow these pairs to smooth some of the resulting uninsured risk.

We now turn to examining whether and how often players defect—that is, transfer less to their partner than they agreed when receiving high income. As noted above, if individuals'

forecasts of the value of reneging are subject to an additive error term v, the probability of defection when high income is realized is then the probability of a binding participation constraint, times the probability that v exceeds the surplus the lucky individual had anticipated when receiving high income and making the promised transfer. The probability of a binding participation constraint is decreasing with social proximity, because socially closer pairs get more surplus, *ceteris paribus*, from maintaining their relationship. Therefore the likelihood of defection should be reduced by social networks, thus:

Proposition 7. *Defection (lucky individuals reneging on the transfers they promised to their partners) should occur less in pairs with greater social proximity.*

Table 11 tests this in our data, showing how defection varies with social distance. To improve statistical power, we split pairs into high (median and above) and low (below-median) bins rather than using a linear measure of social distance. We find that Proposition 7 is confirmed. Under limited commitment without savings, defection occurs 10 percentage points more often when the pair members are distant than when they are close (significant at 10%). On the other hand, moving from limited commitment without savings to limited commitment with savings, there is neither an overall increase in defection, nor a differential increase by social distance. This is unsurprising because we find little evidence that access to savings tightens participation constraints on average.

4.2.3. *Centrality, limited commitment, and access to savings.* In addition to social distance, the relative importance of nodes in the network may affect their ability to sustain cooperative behavior. There are several different notions of network importance, or centrality, used in the graph-theoretic literature (discussed below). Various network transmission models show that the centrality of a node reflects its importance in information transmission; nodes with higher centrality tend to both acquire more and propagate more information. Thus, when paired with peripheral individuals, central individuals may either fear reputational punishment less, or expect to interact less frequently with the peripheral partner outside the game (thereby essentially valuing the future relationship less).

From graph theory we have at least three metrics to capture the centrality of a node: degree, betweenness centrality, and eigenvector centrality. The degree of a node is the number of links it has. The betweenness centrality is the fraction of all shortest path between two other nodes that pass through a given node. Eigenvector centrality, as discussed above, measures importance of a node as proportional to the sum of its neighbors' importances.[46]

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[46]It is intimately connected to, for example, Google PageRank.

In what follows we focus on eigenvector centrality, as it captures the best importance when information percolates through a network along the edges, and also due to the recent evidence of its importance in the literature (see, e.g., Banerjee at al (2012), Elliott and Golub (2012), Jackson (2008)). Thus we have:

Proposition 8. *Limited commitment will bind more, lowering transfers, the greater the relative eigenvector centrality of the high- vs. the low-income realization player. Thus, access to savings will crowd out transfers to a larger extent the greater the relative eigenvector centrality difference of the two players.*

We define player i's relative eigenvector centrality as i's eigenvector centrality minus her partner's, $\zeta_i - \zeta_{-i}$. For ease of interpretation, eigenvector centrality is normalized to have a standard deviation of one. Table 12a shows the effect of relative eigenvector centrality on lack of commitment. It presents the results of comparing full commitment to limited commitment without savings. The first column shows the effect of relative eigenvector centrality on transfers, without conditioning on social proximity. Recall that only lucky individuals are included in the transfers regressions, so relative eigenvector centrality is the centrality of the lucky player minus that of the unlucky player. In this specification, the interaction between relative eigenvector centrality and limited commitment is negative, suggesting that limited commitment causes a larger fall in transfers when the lucky player is more central than the unlucky player, but this effect is not significant. However, in column 2, which conditions on social proximity, the additional fall in transfers under limited commitment associated with a 1 standard deviation increase in relative eigenvector centrality, INR 1.67, is significant at the 10% level, consistent with Proposition 8. The effect of social distance (i.e., a larger fall in transfers due to limited commitment when the partners are more distant) remains similar in magnitude and significance to that seen in Table 8, column 2. Thus, the effects of social distance discussed above were not proxying for relative eigenvector centrality.[47] Columns 3 and 4 examine the interaction of relative eigenvector centrality and limited commitment when the outcome is consumption smoothing. In column 4, conditional on social proximity, a 1 standard deviation increase in relative eigenvector centrality causes an additional drop of INR .804 when commitment is removed, significant at the 10% level. Again, the effect of social distance retains magnitude and significance similar to that seen in Table 8, column 4.

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[47]If additionally we control for relative degree (the number of network links each partner has) the effects of relative eigenvector centrality and social proximity remain significant; however the effect of relative degree is not significant. (Results available on request.) Thus, the effect of relative eigenvector centrality we identify here is not simply proxying for "number of friends," but instead is measuring an effect of having friends who themselves are more important.

Table 12b shows the effect of relative eigenvector centrality on the introduction of savings into a limited commitment environment. It presents the results of comparing limited commitment without savings to limited commitment with savings. We focus on the effect of relative eigenvector centrality on transfers, conditional on social proximity. The interaction between relative eigenvector centrality and savings access is negative, a fall of INR 1.52 per standard deviation of eigenvector centrality, and significant at the 5% level. Thus, under limited commitment, savings crowds out transfers when the lucky partner is much more central than the unlucky partner, consistent with Proposition 8. For the pair in our data with the largest difference in eigenvector centrality (6.33 standard deviations), savings access is predicted to crowd out transfers by $6.33 \times (-1.52) - 4.98 = -14.60$ rupees.[48] Columns 3 and 4 examine the interaction of relative eigenvector centrality and savings access when the outcome is consumption smoothing. The estimated effect of eigenvector centrality is not significantly different from zero. Thus, low-centrality players with more-central partners receive less transfers when savings is available, but use of the savings technology means that their consumption does not become more variable on net.

5. Conclusion and future directions

Our results, from a unique laboratory experiment in the field, show that when individuals attempt to share risk, limited commitment matters: consumption smoothing, and welfare, are significantly lower when players cannot commit ex ante to a risk-sharing agreement than when they can. Further, this effect varies with social distance: for the socially closest pairs, limited commitment does not bind but as social distance increases, limited commitment is increasingly important. Because interpersonal insurance leaves a significant amount of risk uninsured and savings access is found not to crowd out this insurance, savings access is beneficial, allowing individuals to smooth intertemporally some of the income risk that is not insured interpersonally.[49] Pairs that are more socially distant face more uninsured risk, and use savings more. When more important (higher eigenvector centrality) individuals are paired will less important partners, access to savings crowds out insurance transfers. If economic development weakens social ties between individuals, our results for socially

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[48]INR 4.98 is the estimated fall in transfers due to savings when relative eigenvector centrality is zero. It is not significantly different from zero.

[49]Because we can use consumption variability as an ordinal measure of relative welfare, this comparison does not require assumptions about the utility function, beyond risk aversion: more consumption variability implies lower welfare. However, to get a sense of the magnitude of the welfare differences across the settings we study, we can plug our results for changes in consumption variability into a particular utility function. Assuming a CRRA utility function with a coefficient of relative risk aversion of 2 implies that the move from full commitment (no savings) to limited commitment (no savings) reduces average in-game welfare by 2.7%. Adding savings access to the limited commitment setting cuts the welfare loss in half, to 1.3% lower than under full commitment.

distant/unequally important pairs may be relevant in forecasting how well income risk can be insured and what role financial access might play in improving consumption smoothing.

These findings yield several new insights. First, the comparisons across social distance and eigenvector centrality show that networks matter substantively in dynamic contracting environments. Social proximity mitigates contracting frictions and facilitates efficient behavior, while unequal levels of importance lead to more opportunistic behavior. Moreover, the way the "game outside of the game," i.e., players' other relationships, enters into our experiment is analogous to how it affects real life interactions in a village, since all risk-sharing relationships among villagers are not isolated objects in a dynamic risk-sharing contract, but are embedded in a broader set of repeated interactions. Thus, the roles we measure for social proximity and importance are likely to translate to other settings, while not in exact magnitude, in sign and significance.

We introduced the role of social proximity in facilitating risk sharing to our experiment with a bundled approach: to the extent that they affect continuation values, altruism, reciprocity, peer pressure, etc. may all underpin the results we find for social distance. The importance of eigenvector centrality may reflect reputational concerns, renegotiation-proofness constraints, etc. Unpacking the bundle of forces in the social network was not the goal of this paper, but is an important avenue for future work. There are at least two strategies that might allow for this. First, one could use methods used by Karlan et. al (2009), Leider et al. (2009) and Ligon and Schechter (2012). This would require framed experiments in which partners engage in interpersonal transfers with varying levels of anonymity (e.g., one partner knows the other's identity, both know each other's identity, neither knows the other's identity) to distinguish between altruism and reciprocity. However, as one may imagine, this would be logistically difficult to execute directly in the field in rural villages while playing dynamic risk-sharing and savings games. Second, one could use methods of random assignment to networks (e.g., classroom or loan group assignment) or shock the network to generate exogenous variation, as in Feigenberg et al. (2011). However, this approach raises the question of whether the shocked network generates the same depth of social ties as pre-existing network links.

Given the important role of social networks, a natural question is whether and how networks endogenously form to mitigate agency problems. For instance, do individuals choose to rely on socially close friends and relatives for insurance and credit, despite the likelihood of covariate shocks, in order to reduce the risk of opportunistic behavior? We are examining endogenous pair formation in ongoing work (Chandrasekhar et al. 2012).

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Appendix A. Figures
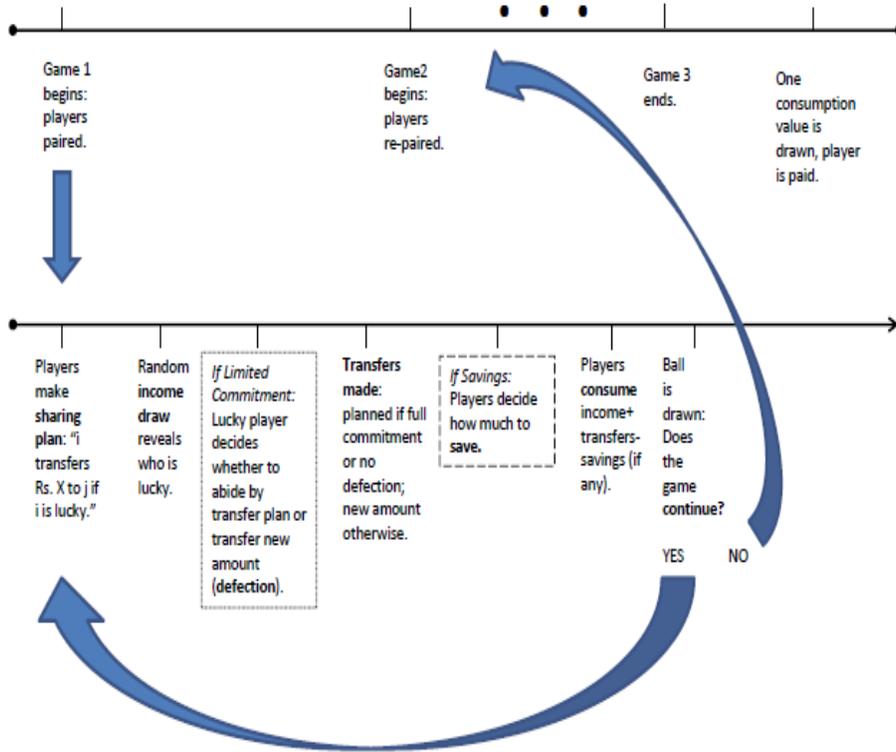
Figure 1: Experiment timeline

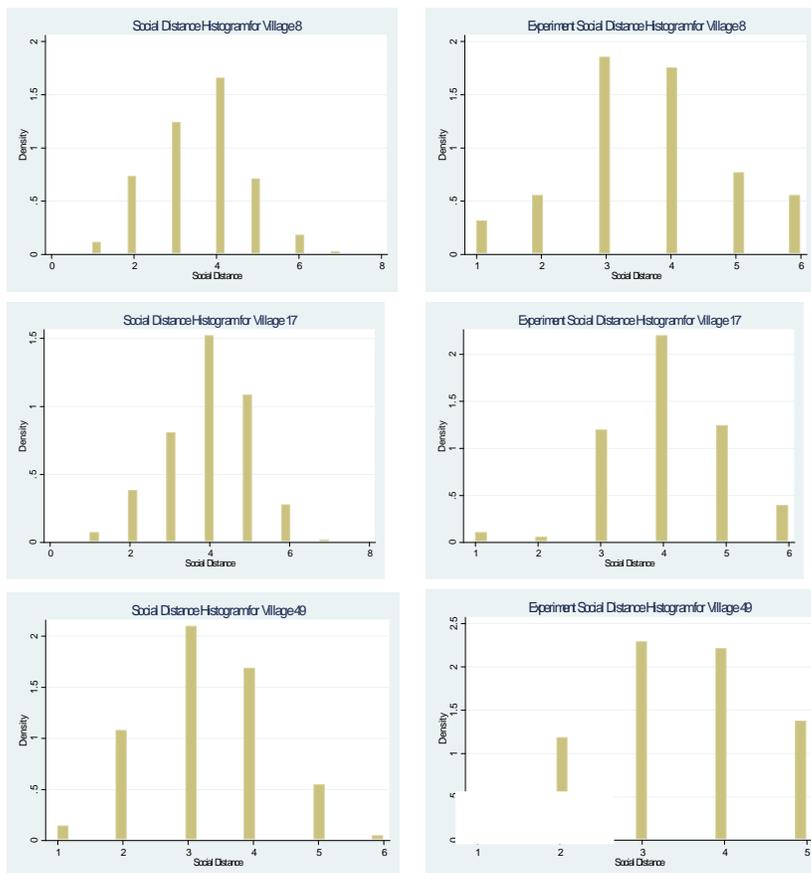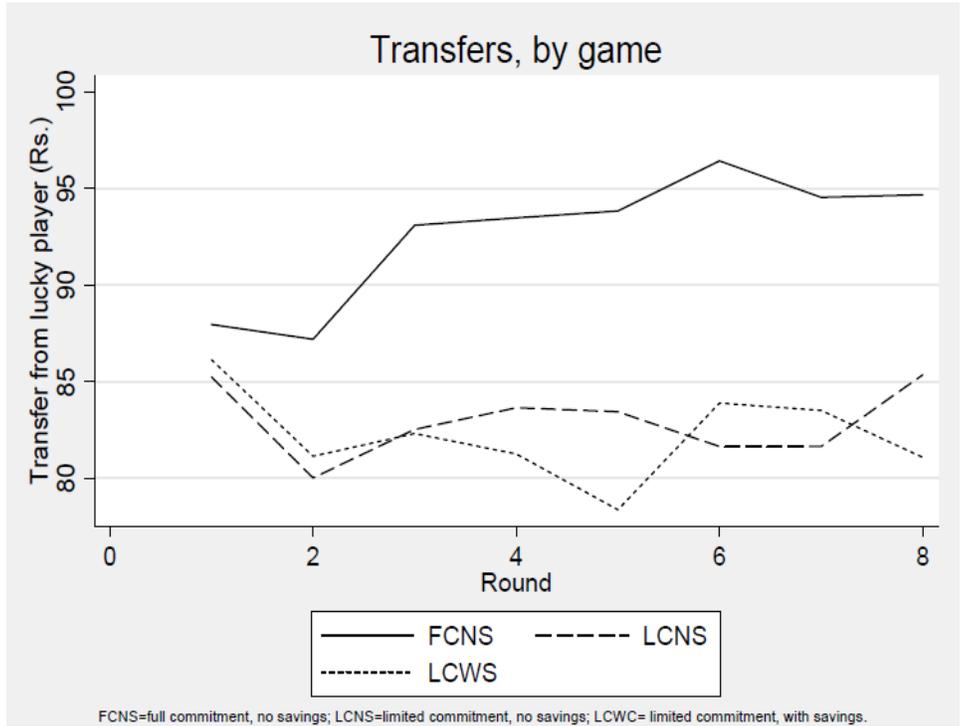Figure 2: Sampling from the tail of the distribution

Figure 3: Transfers by game and round
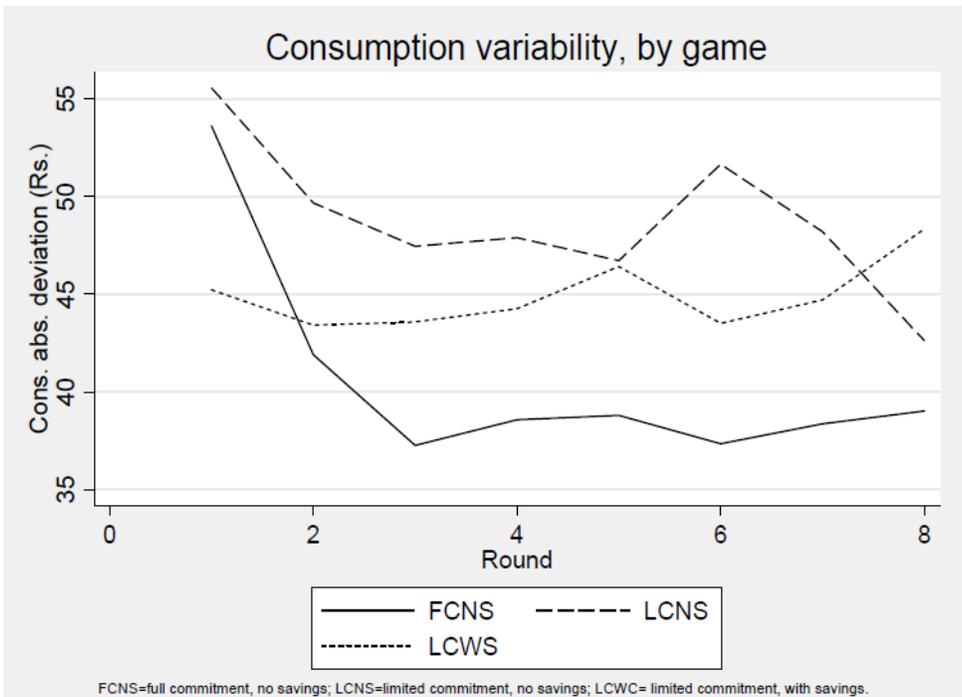
Figure 4: Consumption variability by game and round
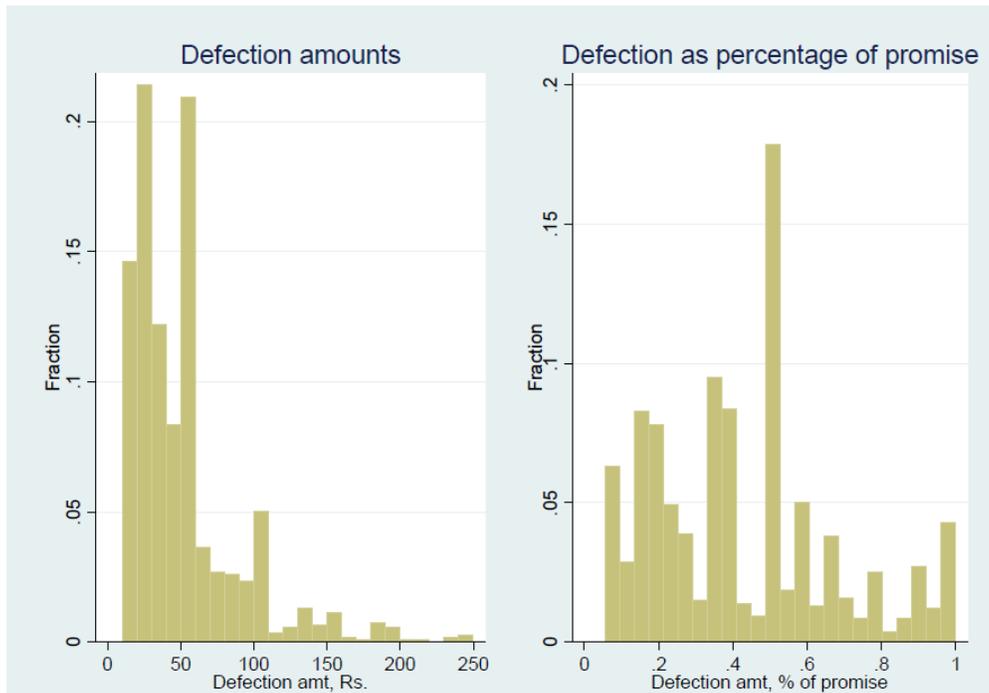
Figure 5a: Defection amounts, conditional on defection
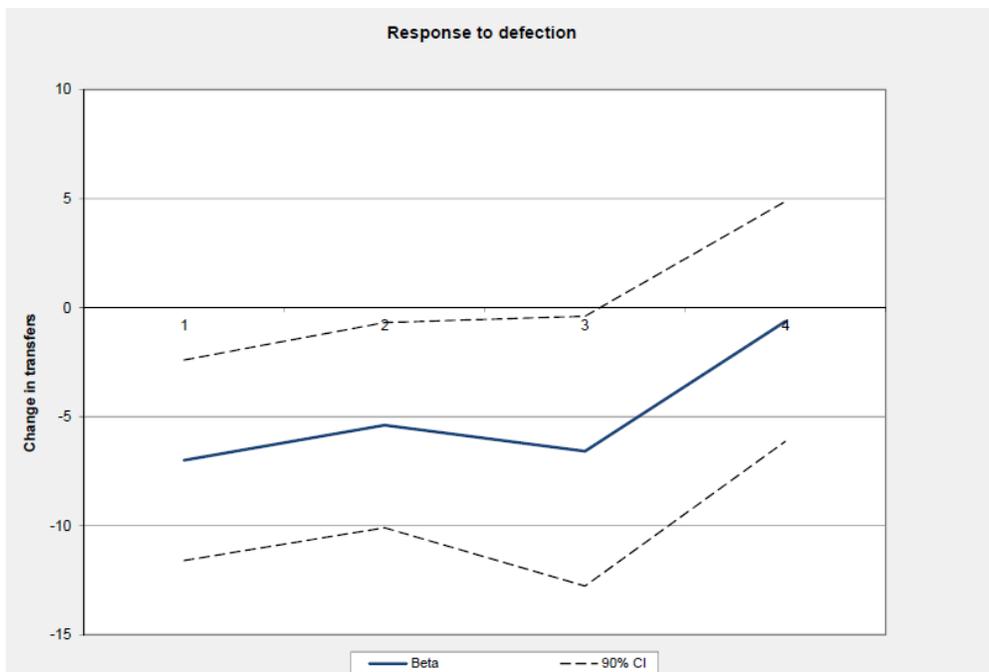
Figure 5b: Response to defection
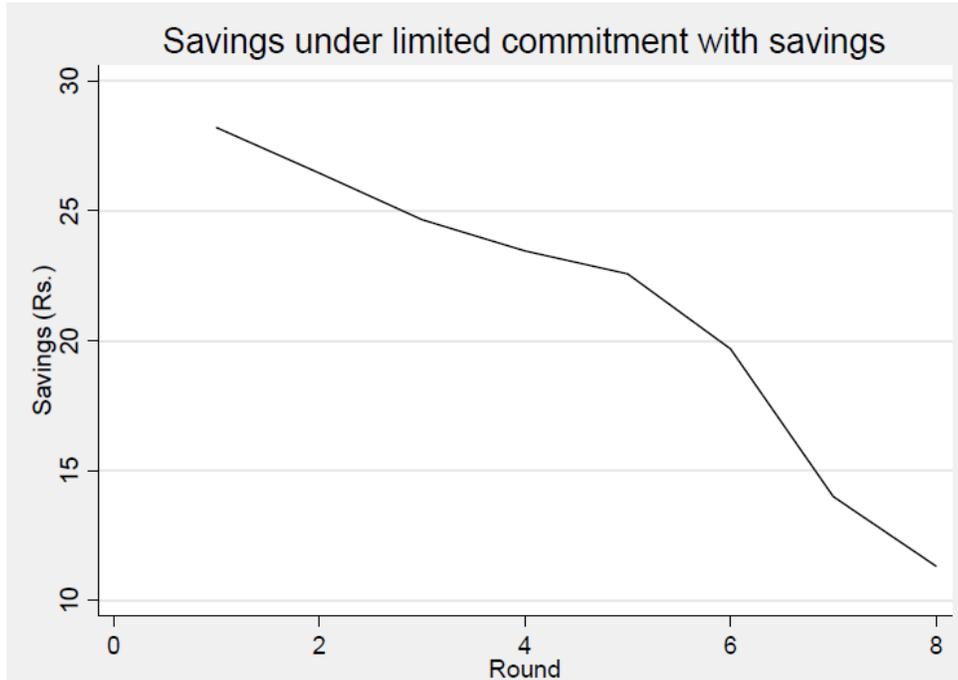
Figure 6: Savings under limited commitment, by round
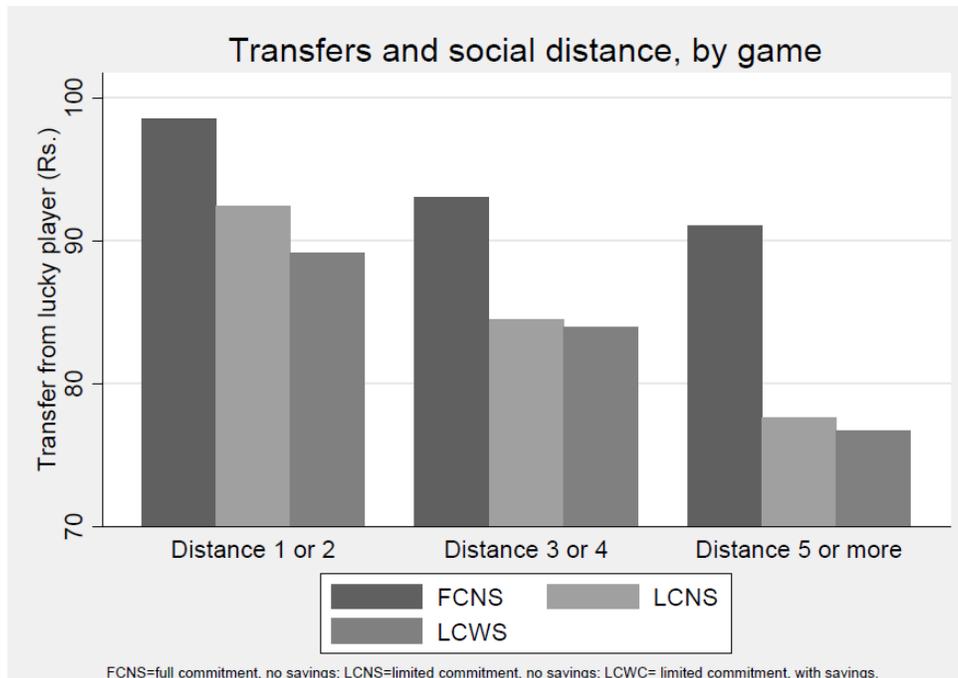
Figure 7: Transfers by social distance and game
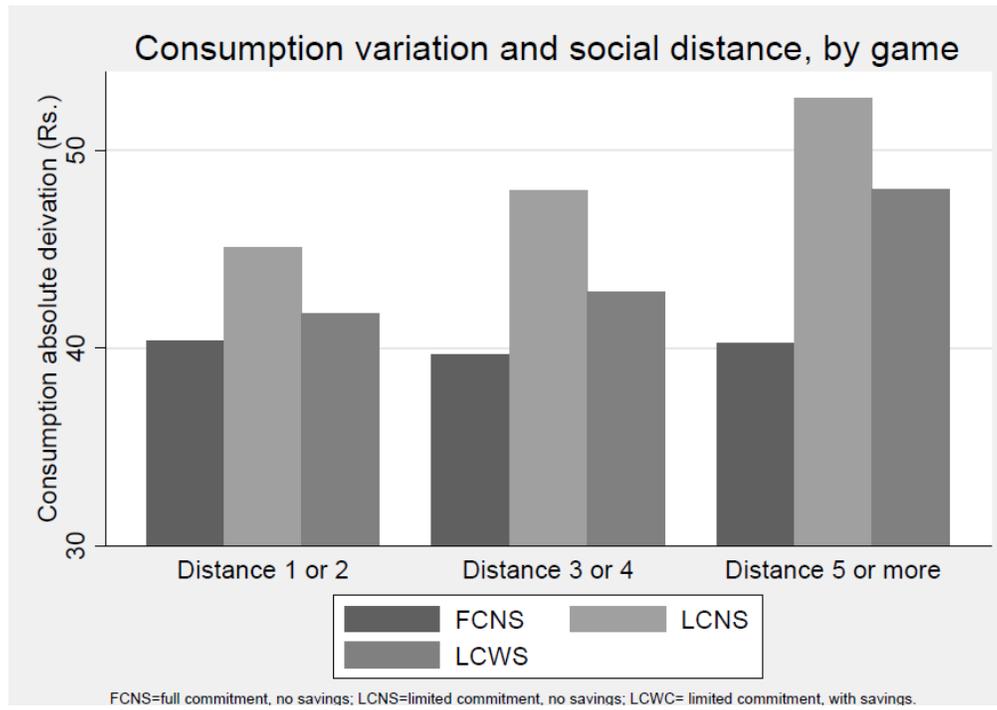
Figure 8: Consumption variability by social distance and game

APPENDIX B. TABLES

Table 1a: Summary statistics from survey data

		Mean	N
Roof:	Thatch	0.0107	648
	Title	0.3088	648
	Stone	0.3648	648
	Sheet	0.1776	648
	RCC	0.1008	648
	Other	0.0399	648
Number of Rooms		2.4736	648
Number of Beds		0.9392	648
Has Electricity		0.4183	648
Owner of house		0.8977	648

Notes: Caste variables were only collected for for the random subset of individuals who completed the individual baseline survey. OBC= "other backward caste."

Table 1b: Summary statistics collected in experiment

	Mean	N
Individual-level characteristics		
Male	0.4706	648
Married	0.7324	648
Age	29.9427	648
Education	7.4948	648
Degree	10.1108	622
Eigenvector Centrality	0.0223	622
Pair-level characteristics		
Reachable	0.987	1864
Distance if reachable	3.6337	1840

Notes: See Appendix D for definitions of network variables. Reachability defined for pairs with valid network data. Distance defined for reachable pairs.

Table 3: Transfers and consumption smoothing,
by treatment and distance

	(1)	(2)	(3)
	Transfers		Consumption
	Unconditional	Conditional	Abs. Dev.
LCNS	-8.99***	-5.61***	8.87***
	[1.56]	[2.05]	[1.35]
LCWS	-11.26***	-6.21***	4.90***
	[21.71]	[1.90]	[1.37]
Reachable	-0.289	-0.323	-6.25
	[6.62]	[11.26]	[4.95]
Reachable	-1.484**	-2.18***	.894*
×Distance	[.665]	[.817]	[.467]
Constant	90.54***	87.99***	52.24***
	[7.15]	[11.14]	[5.54]
LCNS=LCWS			
F-stat	1.111	1.325	10.17
p-value	0.2945	0.2523	0.0019
FCNS mean	92.3512	93.0808	40.912
FCNS std. dev.	36.3129	36.6006	32.0513
N	6369	3845	12752
R^2	0.384	0.448	0.2923
Adjusted R^2	0.312	0.335	0.2533

Notes: Regressions at the individual-game-round level. Regressions include individual-fixed effects, reachability and distance between partners, surveyor and team effects, and controls for order and round of play. Transfer regression includes individuals with high income only. Robust standard errors, clustered at the village by game level, in brackets. Column 1 uses all rounds, column 2 uses rounds where defection has not occurred. Mean of Reachable is 0.987; mean of Reachable × Distance is 3.6337. * p<.1, ** p<.05, *** p<.01

Table 4: Consumption smoothing (absolute deviation of consumption) by in-game income terciles

	(1)	(2)	(3)
		Tercile	
	Lower tercile	Middle tercile	Upper tercile
LCNS	15.53***	4.004**	14.5***
	[3.163]	[1.907]	[2.439]
LCWS	9.968***	4.129**	5.564**
	[3.744]	[1.77]	[2.522]
Reachable	-45.48***	-6.033	16.38*
	[13.34]	[10]	[8.812]
Reach×Distance	0.9573	-0.3695	1.818
	[2.126]	[.7243]	[1.316]
Constant	81.87***	56.41***	27.94***
	[14.28]	[10.92]	[8.873]
LCNS=LCWS			
F-stat	3.255	0.0052	14.3
p-value	0.0743	0.9428	0.00026
FCNS mean	39.7506	40.8573	40.7789
FCNS std. dev.	31.2281	31.8222	31.7478
N	2562	5646	4522
R^2	0.47	0.35	0.37
Adjusted R^2	0.3912	0.2842	0.2993

Notes as in previous table.

Table 5: Transfers and total consumption by endowment

	(1)	(2)	(3)	(4)	(5)	(6)
	FCNS vs. LCNS			LCNS vs. LCWS		
	Cons.	Transfers given	Transfers rec'd	Cons.	Transfers given	Transfers rec'd
Lucky	29.24**	15.37	-13.51	28.88***	-6.64	-2.543
	[13.93]	[15.26]	[16.88]	[10.86]	[15.22]	[14.66]
LCNS	-3.235	-30.41**	-39.04***			
	[15.91]	[14.69]	[9.92]			
LCNS×lucky	-6.334	-6.307	9.613			
	[18.5]	[17.81]	[21.12]			
LCWS				-23.63	-13.06	-4.288
				[14.23]	[12.45]	[13.28]
LCWS×lucky				2.685	16.13	0.0357
				[16.84]	[21.73]	[21.45]
Reachable	4.929	-79.34	51.91	65.38*	19.58	104.7*
	[61.04]	[71.21]	[45.04]	[33.31]	[38.01]	[61.11]
Distance	15.84	-9.396	-0.2837	0.8642	13.43	-42.35***
	[17.91]	[25.92]	[18.18]	[12.01]	[15.75]	[15.71]
Constant	1067***	481.2***	312***	997.7***	254.8***	270.4***
	[58.73]	[57.86]	[38.46]	[48.54]	[30.6]	[57.93]
Reference game	FCNS	FCNS	FCNS	LCNS	LCNS	LCNS
Reference game mean	909.22	319.43	319.07	903.84	284.26	284.18
Std. dev	150.03	134.39	134.28	153.92	137.60	137.57
N	1222	1222	1222	1238	1238	1238
R^2	0.6819	0.671	0.6445	0.7508	0.6966	0.6676
Adjusted R^2	0.3078	0.2839	0.2262	0.4611	0.3439	0.2811

"Lucky" means that player received the INR 60 endowment. Remaining notes as in previous table.

Table 6: Defection rates

LCWS	-0.0207
	[.0133]
Reachable	-.3075**
	[.1205]
Distance	0.002
	[.0093]
Constant	.5078***
	[.1357]
LCNS mean	0.2375
N	4252
R^2	0.4245
Adjusted R^2	0.3183

Notes: Robust standard errors, clustered at the village by game level, in brackets.
p<.1, ** p<.05, *** p<.01

Table 7: Response to defection

	(1)	(2)	(3)	(4)	(5)
RHS variable is transfers from lucky to unlucky player					
Defection	-6.999**				-10.73**
1 Period Ago	[2.805]				[5.075]
Defection		-5.39*			-8.315**
2 Periods Ago		[2.869]			[3.727]
Defection			-6.579*		-6.714
3 Periods Ago			[3.773]		[4.778]
Defection				-0.6261	0.0999
4 Periods Ago				[3.355]	[3.34]
Reachable	11.61	14.94	20.7	17.7	-0.0368
	[8.86]	[15.27]	[17.33]	[20.04]	[18.00]
Reach * Distance	-1.707	-1.887	-1.719	-0.3321	0.1502
	[1.42]	[1.838]	[1.918]	[2.006]	[2.052]
Constant	74.87***	69.94***	63.76***	62.39***	72.08***
	[9.607]	[13.63]	[15.01]	[21.87]	[17.7]
N	1795	1500	1192	884	884
R^2	0.5716	0.6113	0.6729	0.7035	0.714
Adjusted R^2	0.4344	0.4529	0.4873	0.4476	0.4638

Notes as in previous table. Defection is defined as a high-income player transferring less thank promised to her partner.

Table 8: Social distance, consumption smoothing
and limited commitment

	(1)	(2)	(3)	(4)
	Transfers		Consumption Dev.	
LCNS	-8.491***	-31.77**	8.786***	33.00***
	[1.426]	[13.94]	[1.227]	[12.34]
Reachable	-8.504	-25.02***	-0.627	17.05**
	[7.655]	[7.705]	[6.386]	[5.99]
Distance	-1.817**	-0.3402	1.128*	-0.2454
	[.9015]	[1.115]	[.6735]	[.8771]
LCNS×Reachable		34.46**		-34.51***
		[15.04]		[12.38]
LCNS×Distance		-2.996*		2.744***
		[1.618]		[1.024]
Constant	102.2***	113.2***	43.73***	31.19**
	[7.878]	[8.014]	[6.753]	[6.180]
FCNS Mean	92.35	92.35	40.91	40.91
FCNS Std. Dev.	36.31	36.31	32.05	32.05
N	4234	4234	8485	8485
R^2	0.45	0.45	0.35	0.36
Adjusted R^2	0.34	0.35	0.30	0.30

Notes: Sample is data for FCNS and LCNS only. Remaing notes as in previous table.

Table 9: Social distance, consumption smoothing
and access to savings

	(1)	(2)	(3)	(4)
	Transfers		Consumption Dev.	
LCWS	-1.908	-4.885	-3.961***	-0.3133
	[1.338]	[16.78]	[1.063]	[14.41]
Reachable	6.436	6.291	-16.54***	-14.20
	[6.129]	[14.11]	[6.197]	[13.29]
Distance	-0.7995	-1.159	1.387**	1.339
	[.7912]	[1.147]	[.5984]	[.8598]
LCWS×Reachable		0.6575		-4.631
		[16.85]		[15.55]
LCWS×Distance		0.6497		-0.0823
		[1.289]		[.9407]
Constant	73.64***	75.06***	69.15***	66.97***
	[6.454]	[14.59]	[6.957]	[13.83]
No savings mean	82.73	82.73	49.47	49.47
Std. dev	40.5	40.5	35.79	35.79
N	4252	4252	8507	8507
R^2	0.46	0.46	0.36	0.36
Adjusted R^2	0.36	0.36	0.30	0.30

Notes: Sample is data for LCNS and LCWS only. Remaining notes
as in previous table.

Table 10: Savings by distance

Distance	.8311***
	[.3224]
Constant	28.87***
	[2.478]
Distance=1 mean	23.57
Std. dev	24.76
N	4211
R^2	0.22

Notes as in previous table.

Table 11: Defection rates by game and social distance

	(1) FCNS vs. LCNS	(2) LCNS vs. LCPS
High distance	0.0216	-0.0019
	[.0311]	[.0368]
LCNS	.1757***	
	[.0193]	
LCWS		-0.0216
		[.0188]
High distance×LCNS	.1033***	
	[.0273]	
High distance×LCWS		0.0018
		[.0267]
Reachable	-0.0295	-.3094**
	[.0657]	[.1248]
Distance	-.0213*	0.0023
	[.0125]	[.0165]
Constant	0.0376	.5303***
	[.0589]	[.1329]
Reference game	FCNS	LCNS
Reference game mean	0.0000	0.2375
N	4234	4252
R^2	0.4062	0.4245
Adjusted R^2	0.2967	0.3179

Notes as in previous table.

Table 12a: Effect of limited commitment on consumption smoothing
and transfers by relative eigenvector centrality

	(1)	(2)	(3)	(4)
	Transfers		Consumption Dev.	
LCNS	-8.554***	-31.07**	8.786***	33.28***
	[1.414]	[13.3]	[1.235]	[12.25]
E. vector centr.	-1.013	-0.3803	0.1441	-0.4887
diff.	[1.269]	[1.21]	[.8676]	[.7301]
LCNSxE. Vector	-1.409	-1.67*	0.5215	.804*
centr. diff.	[.9394]	[.9425]	[.4948]	[.4696]
Reachable		-25.58***		16.62***
		[8.019]		[6.098]
Distance		0.0361		-0.2481
		[1.108]		[.877]
LCNSxReachable		34.57**		-35.01***
		[14.47]		[12.29]
LCNSxDistance		-3.243**		2.813***
		[1.613]		[1.022]
FCNS Mean	92.35	92.35	92.35	92.35
FCNS Std. Dev.	36.31	36.31	36.31	36.31
N	4223	4223	8462	8462
R^2	0.4451	0.4483	0.3499	0.3531
Adjusted R^2	0.3428	0.3459	0.2951	0.2982

Notes: Sample is data for FCNS and LCNS only. E. vector centr. diff. is
player's eigenvector centrality minus partner's eigenvector centrality. See
Appendix D for details. Remaing notes as in previous table.

Table 12b: Effect of savings on consumption smoothing and transfers
by relative eigenvector centrality

	(1)	(2)	(3)	(4)
	Transfers		Consumption Dev.	
LCWS	-1.852	-4.981	-3.848***	0.3465
	[1.331]	[16.83]	[1.052]	[14.39]
E. vector	-0.1147	0.0267	0.8239	0.517
centr. diff.	[1.061]	[1.065]	[.6759]	[.681]
LCWSxE. Vector	-1.645**	-1.562**	0.4651	0.4189
centr. diff.	[.81]	[.7697]	[.5503]	[.5257]
Reachable		5.087		-14.04
		[13.87]		[12.81]
Distance		-0.953		1.341
		[1.119]		[.8389]
LCWSxReachable		1.033		-4.062
		[16.81]		[15.13]
LCWSxDistance		0.5912		-0.0542
		[1.262]		[.9024]
LCNS Mean	82.73	82.73	82.73	82.73
LCNS Std. Dev.	40.5	40.5	40.5	40.5
N	4244	4244	8488	8488
R^2	0.4584	0.4586	0.3555	0.3563
Adjusted R^2	0.3583	0.3578	0.3009	0.3015

Notes: Sample is data for LCNS and LCWS only. Remaing notes as in
previous table.

Appendix C. Model setups and proposition proofs

Limited commitment with and without savings

C.1. **Groups, income, and utility.** We consider risk-sharing groups composed of two individuals, $i = 1, 2$. In each period $t = 1, 2, ...$, individual i receives an income $y^i(s) \geq 0$ of a single good, where s is an i.i.d. state of nature drawn from the set $S = \{1, 2\}$. Income follows the process:

$$y^i(s) = \begin{cases} y & \text{if } i = s \\ 0 & \text{otherwise} \end{cases}.$$

The income process is i.i.d. across time, and perfectly negatively correlated $(\rho = -1)$ across individuals. In other words, in each period, one individual will earn positive income y while the other individual will earn no income, with each player equally likely to be lucky. There is no aggregate risk: total group income is y each period.

Individuals have a per-period von Neumann-Morgenstern utility of consumption function $u(c^i)$, where c^i is the consumption of individual i. We assume that $c^i \geq 0$. Individuals are assumed to be risk averse, with $u'(c^i) > 0$, and $u''(c^i) < 0$ for all $c^i > 0$. Individuals are infinitely lived and discount the future with a common discount factor β.[50]

Individuals may enter into risk sharing agreements with their partners. A contract $\tilde{\tau}(\cdot)$ will specify for every date t and for each history of states, $h_t = (s_1, s_2, ..., s_t)$, a transfer $\tilde{\tau}^1(h_t)$ to be made from individual 1 to individual 2, and correspondingly a transfer $\tilde{\tau}^2(h_t)$ to be made from individual 2 to individual 1. For simplicity we denote $\tau^i(h_t) \equiv \tilde{\tau}^i(h_t) - \tilde{\tau}^j(h_t)$, that is, the (positive or negative) net transfer that individual i makes to individual j after history h_t.

Denote $V^i(h_t)$ to be the continuation value of remaining in the insurance agreement, that is, the expected utility of individual i from a contract from period t onwards, discounted to period t, if history $h_t = (h_{t-1}, s_t)$ occurs up to period t and s_t is already known. $V^i(\cdot)$ obeys the recursive relation (Spear and Srivastava 1987):

(C.1) $$V^i(h_t) = u\left(y^i(h_t) - \tau^i(h_t)\right) + \beta \mathbb{E}_{h_{t+1}|h_t} V^i(h_{t+1}).$$

where $\tau^i(h_t)$ follows optimally from (C.5).

C.2. **The role of savings.** In some of the cases we consider below, individuals have access to a savings technology. The gross return on savings is assumed to be

$$R = \begin{cases} 1 & \text{when saving is available} \\ 0 & \text{otherwise} \end{cases}.$$

That is, when saving is available, one unit of the consumption good saved today delivers one unit in the next period. Savings amounts are restricted to be positive: no borrowing is possible.

In the case that individuals have access to a savings technology, a risk-sharing contract will not only determine net transfers $\tau^1(s_t)$ to be made from individual 1 to individual 2 but also an amount $z^i(s_t)$ that an individual i, for $i = 1, 2$, saves from period t to period $t + 1$. For simplicity we then denote as a sharing agreement $(\tau(s_t), z(s_t)) = \left(\tau^i(s_t), z^i(s_t)\right)$ for $i = 1, 2$.

For the case that individuals have access to a savings technology $V^i(\cdot)$ is denoted as

(C.2) $$V^i\left(h_t, z^i(h_{t-1})\right) = u\left(z^i(h_{t-1}) + y^i(h_t) - \tau^i(h_t) - z^i(h_t)\right) + \beta \mathbb{E}_{h_{t+1}|h_t} V^i\left(h_{t+1}, z^i(h_t)\right)$$

where $\tau^i(h_t), z^i(h_t)$ follow optimally from (C.14) on page 59.

C.3. **Autarky.** Thus far we have assumed that individuals can make transfers with other individuals. However, individuals may choose not to make such transfers. In particular, they might initially promise to make certain transfers, but later change their minds. To characterize the payoffs to an individual who reneges on promises to his or her partner, we assume that if either party reneges upon the contract, both individuals consume autarky levels thereafter. The grim trigger or

---

[50]In our experiment the $\beta = \frac{5}{6}$, the chance the game will continue after each period, as explained in Section 3.

"autarky forever after defection" case is used for expositional clarity and because it supports the most on-equilibrium risk-sharing. In our experimental setup, players are free to choose any post-defection response. The qualitative properties of the equilibrium do not depend on the grim trigger assumption, as argued by Ligon et al. (2002).

If individuals have access to a savings technology they can smooth consumption only intertemporally. Without a savings technology, an individual in autarky will simply live "hand to mouth," consuming his or her income in each period. By choosing not to make transfers with others, an individual gives up the benefits of interpersonal consumption smoothing: the option to receive transfers from others when unlucky, in exchange for making transfers to others when lucky is lost forever. When individuals are risk-averse, such interpersonal insurance will be welfare-enhancing, and giving it up is a cost of choosing autarky instead. (We discuss below why individuals might make this choice.) There may also be other costs of choosing autarky, which we consider next.

C.3.1. *Autarky without savings.* If individuals do not have access to a savings technology, then after the violation of a contract both individuals consume their income in every period. Denote $V_{A,NS}^i(s_t)$ to be the expected utility of autarky for an individual i, who has reneged against individual j in period t, after observing s_t:

$$(C.3) \qquad V_{A,NS}^i(h_t) = u\left(y^i(s_t)\right) + \beta \mathbb{E}_{h_{t+1}} V_{A,NS}^i(h_{t+1})$$

There is no maximization because, in autarky with no savings, i simply consumes her income each period.

C.3.2. *Autarky with savings.* If individuals have access to a savings technology, and its use cannot be barred from those who have defected, then after the violation of a contract individuals are not constrained to consume their income period-by-period as they can make use of the storage technology. After the violation of a contract, both individuals keep any savings they have.

We denote $V_{A,S}^i\left(h_t, z_{t-1}^1\right)$ to be the expected utility of autarky for an individual i in period t with savings z_{t-1}^1, after observing s_t:

$$(C.4) \qquad V_{A,S}^i\left(h_t, z_{t-1}^1\right) = \max_{z^i(h_t)} u\left(z_{t-1}^i + y^i(s_t) - z_t^i(h_t)\right) + \beta \mathbb{E}_{h_{t+1}} V_{A,S}^i\left(h_{t+1}, z_t^1\right)$$

Unlike the no-savings case, i has a choice variable, namely $z^i(h_t)$, the amount of savings that will be carried into the next period.

C.4. **Risk-sharing with no commitment, no savings.** We now set up the problem characterizing the set of constrained efficient risk-sharing contracts for the case where there is no access to savings. As a risk-sharing contract can be seen as a non-cooperative equilibrium of a repeated game, and reversion to autarky is the most severe subgame-perfect punishment, this assumption allows us to characterize the most efficient set of non-cooperative subgame-perfect equilibria (Abreu 1988).

The set of efficient risk-sharing contracts for the no commitment, no savings case solves the following dynamic programming problem[51]:

$$(C.5) \qquad V^1\left(V_t^2(s_t)\right) \;=\; \max_{\substack{\tau^1(s_t), \\ \{V_{t+1}^2(s_{t+1})\}_{s \in S}}} \left\{ u\left(y^1(s_t) - \tau^1(s_t)\right) + \beta \mathbb{E}_{s_{t+1}} V^1\left(V_{t+1}^2(s_{t+1})\right) \right\}$$

s.t.

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[51]This will also be the set of decentralizable equilibrium allocations since the conditions of the 2nd welfare theorem are satisfied.

(C.6) $\qquad \lambda \quad : \quad u\left(y^2\left(s_t\right) + \tau_t^1\left(s_t\right)\right) + \beta\mathbb{E}_{s_{t+1}} V_{t+1}^2\left(s_{t+1}\right) \geq V_t^2\left(s_t\right), \forall\ s_t \in S$

(C.7) $\qquad \beta\phi_t \quad : \quad V_{t+1}^2\left(s_{t+1}\right) \geq V_{A,NS}^2\left(s_{t+1}\right) - f\left(\gamma(2,1)\right), \forall\ s_{t+1} \in S$

(C.8) $\qquad \beta\mu_t \quad : \quad V^1\left(V_{t+1}^2\left(s_{t+1}\right)\right) \geq V_{A,NS}^1\left(s_{t+1}\right) - f\left(\gamma(1,2)\right), \forall\ s_{t+1} \in S$

(C.9) $\qquad \psi_1 \quad : \quad y^1\left(s_t\right) - \tau_t^1\left(s_t\right) \geq 0, \forall\ s_t \in S$

(C.10) $\qquad \psi_2 \quad : \quad y^2\left(s_t\right) + \tau_t^1\left(s_t\right) \geq 0, \forall\ s_t \in S$

where $V_{A,NS}^i\left(s_t\right)$ is as in (C.3). We have written $\tau^1\left(s_t\right)$ and $V_t^2\left(s_t\right)$ instead of $\tau^1\left(h_t\right)$ and $V_t^2\left(h_t\right)$ because, due to the recursive nature of the problem, all previous history of the efficient risk-sharing contract is encoded in s_t. This recursivity also allows us to write $V^1\left(V_t^2\left(s_t\right)\right)$ instead of $V_t^1\left(V_t^2\left(s_t\right)\right)$, because player 1's value function will be the same whenever an amount $V_t^2\left(s_t\right)$ is promised to player 2 (Ligon et al. 2002).

Due to the strict concavity of $u\left(c^i\right)$, it follows that $V_t^i\left(\cdot\right)$ is also strictly concave for $i = 1, 2$. The set of constraints is convex (this follows from the concavity of $u\left(\cdot\right)$ and the linearity in $V^i\left(\cdot\right)$). Consequently, the problem is concave, and the first-order conditions are both necessary and sufficient.

The first-order conditions for this problem are the following:

(C.11) $\qquad \tau_t^1\left(s_t\right) \quad : \quad \dfrac{u'\left(y^1\left(s_t\right) - \tau_t^1\left(s_t\right)\right)}{u'\left(y^2\left(s_t\right) + \tau_t^1\left(s_t\right)\right)} = \lambda - \dfrac{\psi_1 - \psi_2}{u'\left(y^2\left(s_t\right) - \tau^1\left(s_t\right)\right)}, \forall\ s_t \in S,$

(C.12) $\qquad V_t^2 \quad : \quad -V^{1\prime}\left(V_t^2\left(s_t\right)\right) = \dfrac{\lambda + \phi_t}{\left(1 + \mu_t\right)}, \forall\ s_t \in S.$

Further, the envelope condition is given by

(C.13) $\qquad\qquad\qquad V^{1\prime}\left(V_t^2\left(s_t\right)\right) = -\lambda, \forall\ s_t \in S.$

The terms $f\left(\gamma(i,j)\right)$ do not enter directly into the first-order conditions since they enter the problem additively, but their presence will affect the likelihood of the continuation constraints (C.7) and (C.8) binding, as discussed below.

Ligon et al. (2002) note that a constrained efficient risk-sharing contract can be characterized in terms of the evolution of λ, the multiplier on individual 2's promise-keeping constraint, which from (C.13) measures the rate at which individual 1's expected utility can be traded off against that of individual 2, once the current state is known. (This is a measure of individual 2's relative importance or bargaining power within the relationship.) Once the state of nature for the following period s_{t+1} is known, the new value for λ is determined by equation (C.12). Furthermore, λ completely determines the current transfers (C.11) once the state of nature s_t has been realized.

The intuition for this result is the following. For simplicity assume that the non-negativity constraints never bind,[52] and hence that $\psi_1 = \psi_2 = 0$. Then, we can rewrite (C.11) as

$$\lambda = \frac{u'\left(y^1\left(s_t\right) - \tau\left(s_t\right)\right)}{u'\left(y^2\left(s_t\right) - \tau\left(s_t\right)\right)}$$

Proof of Proposition 1. The first-best risk sharing contract keeps the ratio of individuals' marginal utilities constant across states and over time. Then, if (C.7) and (C.8) never bind, λ never updates, and hence full insurance can be achieved. Then individuals each consume a constant share of the per-period endowment y where the share is given by the initial value of λ, λ_0. However, if either (C.7) or (C.8) ever bind, λ is no longer constant and full insurance is no longer achievable. Because the only player who may be constrained is the player with the high income realization, who would be required to make a transfer to the other under full insurance, binding continuation constraints will cause consumption to be positively correlated with income (Coate and Ravallion 1993). Moreover, when consumption is positively correlated with income, transfers are lower than under full insurance. $\qquad \square$

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[52]This is automatic when $\lim_{c \to 0} u(c) = -\infty$, as is the case for CRRA utility with relative risk aversion >1.

C.5. **No commitment, with savings.** As before, if either party reneges upon the contract, both individuals consume autarky levels thereafter. However, now after the violation of a contract, individuals are not constrained to consume their income period-by-period as now they can make use of the storage technology. After the violation of a contract, both individuals keep any savings they have.

The set of efficient risk-sharing contracts for the no commitment case with savings solves the following dynamic programming problem:

(C.14) $\quad V^1\left(V_t^2\left(s_t, z_{t\text{-}1}^2\right), z_{t\text{-}1}^1\right) =$

$$\max_{\substack{\tau_t^1(s_t), z_t(s_t) \in \mathbb{R}^+, \\ V_t^2(s_{t+1}, z_t^2)}} \left\{ u\left(z_{t-1}^1 + y^1\left(s_t\right) - \tau_t^1\left(s_t\right) - z_t^1\left(s_t\right)\right) + \beta \mathbb{E}_{s_{t+1}} V^1\left(V_t^2\left(s_{t+1}, z_t^2\right), z_t^1\right)\right\}$$

s.t.

(C.15) $\qquad \lambda \quad : \quad u\left(z_{t-1}^2 + y^2\left(s_t\right) + \tau_t^1\left(s_t\right) - z_t^2\left(s_t\right)\right) + \beta \mathbb{E}_{s_{t+1}} V_t^2\left(s_{t+1}, z_t^2\right)$

$\qquad\qquad\qquad \geq \quad V_t^2\left(s_t, z_{t-1}^2\right), \forall\, s_t \in S$

(C.16) $\qquad \beta\phi_t \quad : \quad V_t^2\left(s_t, z_{t-1}^2\right) \geq V_{A,S}^2\left(s_t, z_{t-1}^2\right) - f\left(\gamma(2,1)\right), \forall\, s_t \in S$

(C.17) $\qquad \beta\mu_t \quad : \quad V_t^1\left(V_t^2\left(s_t, z_{t-1}^2\right)\right) \geq V_{A,S}^1\left(s_t, z_{t-1}^2\right) - f\left(\gamma(1,2)\right), \forall\, s_t \in S$

(C.18) $\qquad \psi_{1t} \quad : \quad z_{t-1}^1 + y^1\left(s_t\right) - \tau_t^1\left(s_t\right) - z_t^1\left(s_t\right) \geq 0, \forall\, s_t \in S$

(C.19) $\qquad \psi_{2t} \quad : \quad z_{t-1}^2 + y^2\left(s_t\right) + \tau_t^1\left(s_t\right) - z_t^2\left(s_t\right) \geq 0, \forall\, s_t \in S$

where as before the problem is characterized recursively, and $V_{A,S}^i\left(s_t\right)$ is as in (C.4). Note that now the constraint set is non-convex due to (C.16) and (C.17) and consequently the problem may not be concave. To avoid such issues, lotteries can be used to convexify the problem, as in Ligon et al. (2000).

Proof of Proposition 2. As noted by Ligon et at. (2000), savings access tightens participation constraints when $V_{A,S}^i\left(s_t\right) > V_{A,NS}^i\left(s_t\right)$: when autarky with savings is preferable to autarky without savings ("hand to mouth"). If participation constraints are more likely to bind, the correlation between consumption and income is increased, and transfers fall. $\qquad\square$

Proof of Proposition 3. Since the value of the endowment is known when the sharing agreement is made, $S = 1$ (there is only one possible state for each partner: the one that was realized). Therefore, for the high-endowment partner (say, individual 1), the promise-keeping plus participation constraints require that individual 1's promised total consumption increases by INR 30. $\qquad\square$

C.5.1. *The role of social networks.*

Proof of Proposition 4. Ceteris paribus, participation constraints are less likely to bind when partners are socially close, and hence that transfers fall more under limited commitment when social distance is greater. To see this, assume that after some history, i is just indifferent between reneging and staying in the insurance agreement with j when i is lucky (when income is y), for a given promised transfer $\tau_t^i(y)$, promised utility $V_t^i(y)$, and penalty, $f(\gamma(i,j))$, meaning that i's participation constraint binds when i's income is y. Now, decrease the social distance between i and j, holding the promised transfer and promised utility fixed. Since i was just indifferent between reneging and staying at the lower penalty, when the penalty increases, i will no longer be tempted to renege. Thus, denoting as ϕ_{it} the Lagrange multiplier on i's time t participation constraint, and taking expectations over the possible states of nature at t:

$$\frac{\partial \mathbb{E}_{t-1}\phi_{it}}{\partial f(\gamma(i,j))} < 0.$$

and similarly for i's partner, j. The expected magnitude of the multiplier on the promise-keeping constraint is lower the greater the penalty for reneging, i.e., the lower the pair's social distance.

Manipulating the first-order conditions on the limited commitment no-savings problem (C.8), (C.7) and (C.13) yields the following relationship between i and j's marginal utilities, as a function of i's relative bargaining power λ_{it} :

$$\lambda_{it} = \frac{u'(y_{jt} + \tau_t^j)}{u'(y_{it} + \tau_t^i)}$$

and the following updating rule for the multiplier on i's time t promise-keeping constraint (Ligon et al. 2002):

$$\lambda_{i,t+1} = \lambda_{it} \left[\frac{1 + \phi_{i,t+1}}{1 + \phi_{j,t+1}} \right]$$

This yields the following expression for the ratio of i and j's time $t+1$ marginal utility:

(C.20) $$\frac{u'(y_{j,t+1} - \tau_{t+1}^i)}{u'(y_{i,t+1} + \tau_{t+1}^i)} = \frac{u'(y_{jt} + \tau_t^j)}{u'(y_{it} + \tau_t^i)} \left[\frac{1 + \phi_{i,t+1}}{1 + \phi_{j,t+1}} \right]$$

Therefore, the more often i or j have binding participation constraints (i.e., a positive ϕ_{it} or ϕ_{jt}), and the more binding they are (larger positive values of ϕ_{it} or ϕ_{jt}), the more each player's consumption $c_{it} = y_{i,t+1} - \tau_{t+1}^i$ is expected to vary. Thus, when participation constraints are more binding, less interpersonal insurance is possible. This implies that players will on average transfer less to each other under limited commitment when they are more socially distant. $\square$

Proof of Proposition 5. Proposition 4 implies that, under limited commitment, consumption is more strongly correlated with contemporaneous income when social distance is greater. Hence, consumption smoothing is worse under limited commitment when social distance is greater. $\square$

Proof of Proposition 6. From Ligon et al. (2000)'s equation (14), the motive to save arises from the expectation that, without savings, expected marginal rates of substitution would differ across dates. By our Proposition 5, with savings, consumption smoothing is worse, i.e. expected marginal rates of substitution differ more, the more socially distant the pair. Therefore distant pairs have the greatest incentive to save. $\square$

Proof of Proposition 7. We assume that the value of reneging on a particular promise contains an additive, mean-zero, i.i.d. error term, υ, unforecastable by the individual. In the no savings case:

$$V_{A,NS}^i(s_t) = u\left(y^i(s_t)\right) + \beta \mathbb{E}_{h_{t+1}} V_{A,NS}^i(s_{t+1}) + \upsilon_t^i$$

and similarly in the case with savings. The probability of defection when y_H is realized is then the probability that υ exceeds the surplus the lucky individual had anticipated when receiving y_H and making the promised transfer τ. In the no-savings case:

$$\Pr(defect) = \Pr\left(\upsilon_t^i > u\left(y_H - \tau_t^j(y_H)\right) + \beta \mathbb{E}_{s_{t+1}} V_{t+1}^i(s_{t+1}) - V_A^i(y_H)\right)$$

By Proposition 4, the surplus i obtains from not reneging is, ceteris paribus, decreasing in the social distance between i and j. Therefore, the probability of defection is increasing in the social distance between i and j. $\square$

Proof of Lemma 1. If players 1 and 2 fully insure their idiosyncratic risk ($\alpha = 1$), and player 1 has a Pareto weight/bargaining power factor of λ, 1 transfers an amount

$$\tau_{FI}^1 = (1 - \lambda)\,250$$

to 2 when 1 is lucky, and 2 transfers an amount

$$\tau_{FI}^2 = \lambda 250$$

to 1 when 2 is lucky. Since each player is lucky 50% of the time on average, average transfers will be

$$.5\tau^A_{FI} + .5\tau^2_{FI} = .5\left(\lambda + 1 - \lambda\right)250 = 125$$

regardless of λ. Similarly, if players 1 and 2 insure, on average, fraction α of their idiosyncratic risk, $\tau^1_\alpha = \alpha\left(1 - \lambda\right)250$ and $\tau^2_\alpha = \alpha\lambda250$, and average transfers will be

$$.5\tau^1_\alpha + .5\tau^2_\alpha = \alpha125$$

Even if transfers change over the course of the game in response to binding participation constraints, as we expect to happen in a limited commitment setting, average transfers will be $\alpha125$, where α is the fraction of risk that is insured, averaging across rounds. Note that the independence of average transfers and bargaining weights relies on the fact that the income process is independent of bargaining weights. This holds in our setting because each player has a 50% chance of being lucky or unlucky in each round. However, in non-experimental data, bargaining weights would typically be correlated with the individuals' income processes, and it would not be possible to map average transfers into the degree of insurance without knowledge of bargaining weights. $\square$

Appendix D. Network Statistics

Here we introduce basic social network terminology used in the paper. For a more in-depth introduction to these concepts see Jackson (2008). A graph or network $G := (V; E)$ consists of a set of vertices, V, and edges, E. We assume that the graph is undirected *undirected* and *unweighted*; households i and j are either connected or not and this relationship is symmetric. The graph is represented by its adjacency matrix $A := A(G)$, where $A_{ij} = \mathbf{1}\{ij \in E\}$ indicates whether i and j share an edge.

The graph admits a natural metric of distance between nodes. The *social distance* between i and j is given by the geodesic, or the shortest path

$$\gamma(i,j) := \min_{k \in \mathbb{N}} \left[A^k\right]_{ij} > 0$$

which is finite if there exists a path between nodes i and j through the graph. We define *reachability* of i and j as

$$\rho(i,j) := \mathbf{1}\{\gamma(i,j) < \infty\}$$

which indicates whether such a path exists. If i and j are in the same connected component of the network, then they are certainly reachable. We caution that it is essential to control for reachability when studying sampled networks as individuals with few links, who are distant from most other households, may appear in the sampled data having only close ties where the social distance is finite. Encoded in this manner, sign switching may occur if reachability is not controlled for (Chandrasekhar and Lewis 2011).

The eigenvector centrality of a household in a village corresponds to the ith entry of the eigenvector which corresponds to the maximal eigenvalue of the adjacency matrix representing the network. Specifically, it is the solution to

$$A(G)\xi = \lambda\xi$$

where $\lambda(G)$ is the maximal (in magnitude) eigenvalue and then ξ delivers the centrality value.

The social network data of Banerjee et al. (2011) contains data from 12 dimensions of relationships: (1) visitors who come to the household, (2) households that a person visits, (3) relatives, (4) non-related friends, (5) those who provide medical advice, (6) those with whom one goes to temple, (7) those from whom one borrows material goods, (8) those to whom one lends material goods, (9) those from whom one borrows money, (10) those to whom one lends money, (11) those to whom a person gives advice, and (12) those from whom one receives advice. Instead of working with the multigraph or constructing an ad hoc weighted graph, we take the approach of Banerjee et al. (2011) and consider the union network, $G^{all} = (V, \cup_{r=1}^{R} E^r)$, where

$$A_{ij}^{all} := \mathbf{1}\left\{\sum_{r=1}^{R} A_{ij}^r > 0\right\},$$

where r indexes the dimension of the relationship. The network studied in this paper is precisely G^{all} constructed in the above manner.

Appendix E. Protocol

An English summary of the experimental protocol follows.

Protocol

Important clarification:
The text in italics is not meant to be read aloud to experiment participants. It has the explanation of what experimenters should do. The remaining text that is not in italics is meant to be read aloud to experiment participants. Words in CAPITAL LETTERS refer to physical objects which should be shown to the participants during the explanation.

Experiment

Divide the research team into two groups: team A and team B.

As participants enter the venue, team A must welcome them and locate their ID number based on their name from the individual identification list. The research team must then provide the participants with the consent forms, read the forms aloud, explain to them the contents of the forms and that the participants are free to leave at their discretion, answer any questions participants may have, and then obtain their signatures.

Then, team A conducts the Risk Aversion and Inter-temporal Choice survey with the participants.

Meanwhile, based on the turnout, team B uses pre-crafted software to create random pairings of ID numbers for each game in the experiment.

After completing the Risk Aversion Survey, a member of team A reads the following instructions to the participants while team B finishes the random pairing procedure.

Experiment begins

Welcome to this research project and thank you for your participation!

You are participating in a study on daily decision-making. Today you will play series of short games. After completing these tasks, we will ask you to answer a few short questions about your decisions throughout the games and obtain some information about you. The information gathered here will be used for research purposes only.

Overview

We will ask you to play 3 different games today, each with several rounds. In each game you will be matched with a new partner. In each round of each game you and your partner will make some decisions. The result of these decisions will determine how much money you will earn today.

The games will represent situations and decisions you make every day in your life. You earn some money, you save some money, you might give some money to your neighbors or friends if

they are having a hard time, and you use some money to buy food, school material for your kids, clothing, etc.

Payment

Let us first discuss how you will make money today. First, you will receive Rs. 20 at the end of the session, regardless of what happens in the games. And, you will be able to earn some money based on the choices you make in the games.

You will play 3 different types of games during today. In every round of each game you will get some income in the form of tokens. With this income you will decide how many tokens you want to consume.

The experimenter will write down the amount of tokens that you want to consume on what we will call a "CONSUMPTION CHIP" and put that chip in the "CONSUMPTION BAG". Further, the experimenter will take the tokens that you wanted to consume from the ones you had.

At the end of the experiment, we will draw one "CONSUMPTION CHIP" from the "CONSUMPTION BAG" without looking. This chip will correspond to the amount of consumption that you chose to have in one round of a game. We will pay you in Rs. that amount of consumption.

Demonstrate: The "experimenter" should explain that they will be playing 3 games during the day and each game will approximately last 6 rounds. Then, they should expect to play approximately 18 rounds during the whole experiment. Therefore, at the end of the experiment they should expect to have put about 18 "CONSUMPTION CHIPS" in the "CONSUMPTION BAG". Then, show them a "CONSUMPTION BAG" with 18 "CONSUMPTION CHIPS" and pick one of them.

The decisions you make in every round count but you will only be paid the consumption you choose in one randomly chosen round. Therefore it's important to think very carefully about each choice you make today.

Before I explain the first game, are there any questions?
Answer any questions that they may have.

Games

Important Note: The order of the following games will be randomized.

Now we will begin playing the games. In each of the games you will be assigned a partner that will be different in each game. Now we will read out the first partnerships.

Pair individuals according to Matlab program assignment for game 1.

We will now explain the first game you will play today.

Game 1: *Committed sharing (when it comes first)*

For this game, you have been randomly paired with a partner.

In each round of this game, you and your partner will receive some income. You can think about this as what you would have earned selling your crop. In each round, one of you will be lucky, and one of you will be unlucky. If you are lucky and you got rainfall, you receive Rs 250. If you are unlucky and you got a drought, you receive Rs 0.

Then, in every round of the game we will come to you and your partner and will randomly draw a chip from a bag containing two balls, one green and the other one brown. So forth we will call this the "INCOME BAG". The green ball means that the individual who draw the chip from the "INCOME BAG" got lucky and then earns Rs 250 in that round and that the other individual got unlucky and therefore earns Rs 0. The brown ball means the opposite. So in every round, there is an equal chance that you will get Rs. 250, or nothing.

Earnings will be represented by tokens, each with a value of Rs 10. Then, if in one round an individual is lucky, in that round the individual will be given a cup with 25 tokens that are worth Rs 250. From now on we will denote this cup the "INCOME CUP". Contrarily, if an individual is unlucky, the individual will receive an empty cup.

Demonstrate procedure, the objective you should have in mind is that individuals acquire a sense of the physicality of the game. Three members of the team of experimenters should do the demonstration. Two of them should take the role of two individuals, who will be referred to as "Individual 1" and "Individual 2". The third of them should represent itself and we will refer to him/her as the "experimenter". Assume that you are in any round of the game, the "experimenter" will go to "Individual 1" and ask him to draw a ball from the "INCOME BAG". If it is the green ball, the "experimenter" will give the cup with 25 tokens to "Individual 1" and the cup with no tokens to "Individual 2". If the brown ball is drawn, the "experimenter" will do the opposite.

What are you going to be able to do with the income you get in every period?

You will be able to choose how much you want to "consume" in that round and how much you want to "share" with your partner.

Remember that you will be paid on the basis of what you "consume" in a randomly selected round of a game. Then, consider that it could be that you are paid for any of the rounds that you will be playing during this game. It could be that the round that is chosen is a round where you were lucky, but also it could be a round where you were unlucky. You can consider sharing with your partner so that you consume something in the rounds where you were unlucky, in case one of these rounds is the one for which you get paid.

The game will be as follows. At the beginning of the game we will randomly give you and your partner either Rs 30 or Rs 60 that could be seen as previous income that you had. You could think of getting Rs 30 as having been unlucky in the past and you could think of getting Rs 60 as having been lucky in the past. In order to decide who has been lucky in the past we will come to you and your partner with a bag that has two chips, one with a "30" and the other one with a "60". So forth we will call this bag the "ENDOWMENT BAG". Then, one of you will take a chip without looking and will get the Rs that the ball she got says. The other one will get the other amount. There is an equal chance that you will get Rs. 60 or Rs. 30. This only happens at the beginning of the game, before the first round.

Now, we will explain what "sharing" means and how it can be used so that you have some consumption in every period.

In each round, before we come to you and your partner and randomly ask one of you to draw a chip from the "INCOME BAG" to determine who is lucky and who is unlucky, you and your partner can choose if you want to share and how much you want to share your income. This will works as a "SHARING AGREEMENT" that you have for this round. You are obligated to fulfill it. You can think of this agreement as making a decision about whether the partner who is lucky and gets Rs 250 will share some money with the partner who is unlucky and gets nothing, and how much to share. Once you decide the rule at the beginning of the round, you cannot change it for that round. You can make a new SHARING AGREEMENT for each round.

After you make you SHARING AGREEMENT, we will come to you and your partner and randomly ask one of you to draw a ball from the "INCOME BAG", which contains a green ball and a brown ball. The green ball means that the individual who draw the chip from the "INCOME BAG" earns Rs 250 in that round and that the other individual got unlucky and therefore earns Rs 0. The brown ball means the opposite. So in every round, there is an equal chance that you will get Rs. 250, or nothing. We will then split the money according to the "SHARING AGREEMENT" that you have decided upon for that round. Remember that you cannot change the "SHARING AGREEMENT" you agreed to before.

We will repeat this process until we select a black ball from the "ENDING BOX", which means that the game has ended. The length of a game will be random. At the end of each round, we will randomly decide whether the game will continue or not.

How do we decide whether the game continues or not?

Show the audience the "ENDING BOX" with 5 red balls and 1 black ball.

In this box, which we will call the "*ENDING* BOX", we have 6 balls – 5 are red, and 1 is black. At the end of each round, we will pick a ball from the box without looking. If a red ball is chosen, then the game continues for another round. If the black ball is chosen, then the game has ended, and there are no more rounds of that game. Therefore, at any point when the game hasn't ended yet, there is a five out of six chance that the game will continue, since the game only ends if the black ball is chosen.

Every time the game continues to a next round, before we draw a ball from the "INCOME BAG" to see which individual is lucky and who is unlucky you will have the chance to create a new "SHARING AGREEMENT" about how much the lucky person will share with the unlucky person, although you can use the same contract in each round.

Now we will demonstrate the game.

First, research team members play a demonstration round.

Are there any questions about the game?
Answer any questions they may have.

Now we will play the game.

Research team breaks up into teams and performs the game.

Game 2: *Sharing when you can change your mind (when it comes after "Committed sharing".)*

Re-pair individuals according to Matlab program assignment for game 2.

In this game both you and your partner will be allowed to "consume" and "share" your income. In this game, you will be randomly paired with a partner.

In round 1, we will randomly give you and your partner an extra income of either Rs 30 or Rs 60, which could be seen as an initial endowment that you had. In order to decide who gets the higher extra income and who gets the lower extra income, we will come to you and your partner and randomly ask one of you to draw a chip from the "ENDOWMENT BAG", which you might remember it has two balls, one with a "30" and the other one with a "60". Then, one of you will take a ball without looking and will get the Rs that the ball she got says. The other one will get the other amount.

Now, we will explain what "sharing" means and how it can be used so that you have some consumption in every period.

In each round before you see who is lucky and gets Rs 250, and who is unlucky and gets an income of Rs 0, you and your partner can choose what to do with the money in this round. You can make a plan about whether the partner gets Rs 250 will share some money with the partner who gets Rs 0, and how much to share. We will call this plan a "SHARING ANNOUNCEMENT".

In this game, you and your partner will be allowed to change your mind about your "SHARING ANNOUNCEMENT" after you see who was lucky and who was not. You can make any

"SHARING ANNOUNCEMENT", but you are not necessarily obligated to follow that announcement. If you decide to split the money according to the "SHARING ANNOUNCEMENT," the lucky individual will give the corresponding tokens to the unlucky individual. However, the lucky individual can also change his or her mind and share a different amount, or share nothing. The lucky individual will tell the experimenter how much he or she wants to share, and this is what will be shared, even if it is different than the SHARING ANNOUNCEMENT.

After you make your SHARING ANNOUNCEMENT, we will come to you and your partner and randomly ask one of you draw a ball randomly from the "INCOME BAG", which contains two balls, one green and the other brown. If the individual that is randomly chosen to draw a ball from the "INCOME BAG" draws the green ball, he is lucky and gets an income of Rs 250 and the other individual is unlucky and gets no income. The opposite holds when the brown ball is drawn. The experimenter will give the lucky individual 25 tokens and no tokens to the unlucky individual.

Then you and your partner will be able to decide whether you want to split the money according to the "SHARING ANNOUNCEMENT" that you have decided on for that round or not.
If you decide to split the money according to the "SHARING ANNOUNCEMENT" the lucky individual will give the corresponding tokens to the unlucky individual. However, the lucky individual can also change his or her mind and share a different amount, or share nothing. The lucky individual will tell the experimenter how much he or she wants to share, and this is what will be transferred, even if it is different than the SHARING ANNOUNCEMENT.

You will make a new SHARING ANNOUNCEMENT before each round. It can be the same as in earlier rounds, or it can be different.

We will repeat this process until we select a black ball from the "ENDING BOX", which means that the game has ended.

Now we will demonstrate the game so that you get a better understanding of how the game works and therefore how you can make money today.

Research team members play a demonstration game.

Are there any questions about the game?
Answer any questions they may have.

Now we will play the game.

Research team breaks up into teams and performs the game.

Game 3: *Non-committed transfers, with savings*

Re-pair individuals according to Matlab program assignment for game 3.

In this game, you will be randomly paired with a new partner. Both you and your partner will be allowed to "consume" and "share". Also, you will each be able to "save" money for the next round, or consume savings you already have. In a moment we will explain how "savings" works.

One of you will be designated as "Individual 1" and the other one as "Individual 2". Further, we will randomly give you and your partner either Rs 30 or Rs 60 that could be seen as initial income that you had. In order to decide who gets the higher endowment and who gets the lower endowment, we will come to you and your partner with a bag that has two chips, one with a "30" and the other one with a "60." Then, one of you will take a chip, without looking and will get the amount that the chip says. The other player will get the other amount.

In each round of the game we will come to you and your partner and randomly decide who is lucky and get Rs 250 and who is unlucky and gets Rs 0. For this, in every round of the game we will come to you and your partner and will randomly draw a chip from the "INCOME BAG", which contains two balls, one green and the other brown. The green ball means that the individual who drew it from the "INCOME BAG" got lucky and then earns Rs 250 in that round and that the other individual got unlucky and therefore earns Rs 0. The brown ball means the opposite.

In each round before you see who is lucky and gets Rs 250, and who is unlucky and gets an income of Rs 0, you and your partner can choose what to do with the money in this round. You can make a plan about whether the partner gets Rs 250 will share some money with the partner who gets Rs 0, and how much to share. We will call this plan a "SHARING ANNOUNCEMENT".

In this game, you and your partner will be allowed to change your mind about your "SHARING ANNOUNCEMENT" after you see who was lucky and who was not. You can make any "SHARING ANNOUNCEMENT", but you are not necessary obligated to follow that agreement. If you decide to split the money according to the "SHARING ANNOUNCEMENT" the lucky individual will give the corresponding tokens to the unlucky individual. However, the lucky individual can also change his or her mind and share a different amount, or share nothing. The lucky individual will tell the experimenter how much he or she wants to share, and this is what will be transferred, even if it is different than the SHARING ANNOUNCEMENT.

After the lucky individual decides how much to share with their partner, you each will choose how to split the money you end up with between what you "consume" and what you "save" for the next round. Remember that to consume you have to give the experimenter the tokens you want to consume. This one will write down your "consumption" for this round on a "CONSUMPTION CHIP" and put it in your "CONSUMPTION BAG". Further, in order to save for the future you will put the tokens that you do not want to consume in your "SAVINGS CUP". Note that this "SAVINGS CUP" belongs to you only. If the game continues, these saved tokens will be available for you to consume them or keep saving them in the future. However, when a black ball is chosen from the GAME ENDING BAG, any savings you have will be lost.

Now we will demonstrate this game. But before we do that, do you have any questions?
Answer any questions they may have.

Now we will demonstrate the game so that you get a better understanding of how the game works and therefore how you can make money today.

Now we will play the game.

Participants perform the actual game until a black ball in drawn from the "ENDING BOX." Information is recorded.

Explain the games are over and read the debriefing document to participants.

Payment

The last game is over. Thank you again for your participation! Now, you will be paid for your participation, and based on your choices.

Now, please line up according to your ID number and follow me.

Each participant enters the payment room alone. Confirm their ID number. Give them Rs. 20 for their participation. Then, randomly draw one chip in front of the participant. Show it to the participant. Pay him or her the amount shown on the chip, and have him or her sign a receipt (with an "X" if they cannot write) showing the total amount paid: the amount on the drawn chip plus Rs. 20.

One the participant has left, call the next ID number. Continue until everyone has been paid.