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RRH: SHARING AS RISK POOLING IN A SOCIAL DILEMMA

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Abstract

In rural economies with missing or incomplete markets, idiosyncratic risk is frequently pooled through informal networks. Idiosyncratic shocks, however, are not limited to private goods but can also restrict an individual from partaking in or benefitting from a collective activity. In these situations, a group must decide whether to provide insurance to the affected member. In this paper, we describe results of a laboratory experiment designed to test whether a simple sharing institution can sustain risk pooling in a social dilemma with idiosyncratic risk. We test whether risk can be pooled without a commitment device and, separately, whether effective risk pooling induces greater cooperation in the social dilemma. We find that even in the absence of a commitment device or reputational considerations, subjects voluntarily pool risk thereby reducing variance in individual earnings. In spite of effective risk pooling, however, cooperation in the social dilemma is unaffected.

JEL Classifications: C92, D81, O13, Q20

I. Introduction

Vulnerability to risk is a defining characteristic of poverty. Shocks to assets and income can undermine asset accumulation that allows households to escape poverty and can impose hardships that cause other households to collapse into poverty. People living in remote rural regions can be particularly vulnerable to risk. Subsistence communities, in low-income and high-income countries alike, rely on the yields of natural resources that are susceptible to both covariate shocks (e.g., droughts, floods, etc.) and idiosyncratic shocks (e.g., illness, disabled equipment, etc.). Although incomplete insurance and credit markets limit the ability of households to insure against risk and impose a significant constraint on the prospects of welfare improvements, meaningful risk sharing does arise through informal mechanisms both within and across communities. While covariate shocks are difficult to insure locally, idiosyncratic risk can often be pooled within communities and a variety of informal risk sharing mechanisms have been documented in remote rural communities around the world, including gift-giving, food sharing, remittances, rotating savings and unstructured loans (Fafchamps, 2003).

A growing body of literature within development economics explores the theoretical and empirical dimensions of risk sharing arrangements that protect against idiosyncratic risk.[1] Research has found that a large share of intra-village risk is pooled and standard theory suggests that self-enforcing agreements, under which an individual's gain from defection is less than the long-term benefits of cooperation, are critical to the success of these risk sharing networks (Posner, 1980; Kimball, 1988; Fafchamps and Lund, 2003; Genicot and Ray, 2003; Fafchamps and Gubert, 2007; Dercon and DeWeerdt, 2007). Under full insurance, a commitment device must be strong enough (e.g. through heavy punishment or a legal option) to maintain self-enforcing agreements, creating a risk pooling network that is immune from individual defection. With only limited commitment, however, theory predicts a second-best outcome of partial risk sharing and less than full insurance (Posner, 1980; Kimball, 1988; Ligon, Thomas, Worrall, 2002).[2] Evidence from empirical studies is generally consistent with limited commitment models as a high degree of partial consumption smoothing is often observed but informal mechanisms, including risk sharing, fail to provide full insurance (e.g., Townsend, 1994; Udry, 1994; Jalan and Ravallion, 1999; Ligon, Thomas, and Worrall, 2002; Fafchamps and Gubert, 2007).[3]

These and other efforts have informed the understanding of informal risk sharing and its ability to insure against shocks to private assets and income, but shocks are not limited to private goods. In hunter-gatherer societies, for instance, participation in collective activities and the associated food sharing has been well documented (Kaplan and Hill, 1985); indeed, there is archeological and ethnographic evidence indicating a long history of public good provision in foraging communities (Hawkes, 1993). Likewise, in farmer-organized irrigation systems, participation of "tailenders" is essential to successful collective action (Ostrom, 1996), and in the collective agrarian arrangements in West Africa, output is pooled and distributed among members of the collective as needed (West, 2010). In more mixed economies, such as the Russian Far East and in parts of remote Alaska, individuals belong to distinct networks which harvest fish and hunt mammals. Food is then distributed to network members, as well as to members outside of the network (Gerkey, 2010; Argetsinger and West, 2009; Magdanz et. al., 2002). An individual's ability to participate in, or to receive the benefits from, a collective action can be affected by idiosyncratic shocks, such as illness or mechanical problems, and the group must decide whether to provide insurance through sharing. For example, a member of the network may make preparations to fish with the group but may be unable to participate in the harvest due to illness, or an animal may enter camp and destroy a household's store of harvested food. As with private goods, the idiosyncratic shock introduces risk to individuals which can be pooled over the group. But, unlike private goods, a shock within a social dilemma can affect the aggregate level of resources. Because idiosyncratic shocks can affect a member's ability to contribute to the production of public benefits, it complicates the strategic environment of the collective action and potentially undermines cooperation by all members. Therefore, when idiosyncratic risk exists within a social dilemma, voluntary risk sharing can not only smooth individual income levels, but can also maintain cooperation to avoid a reduction in aggregate income. Questions arise whether groups can effectively pool risk to smooth income when the income is derived from public resources, and whether risk sharing can overcome the adverse effects of risk on the collective production of those public resources.

In this paper, we focus on the sharing of idiosyncratic risk without commitment in a social dilemma setting. Related experimental studies include Charness and Genicot (2009) and Selton and Ockenfels (1998) who explore risk sharing in a two player solidarity game in which one player randomly receives a positive shock in each round and each player is allowed to "share" with the other player. They find strong evidence for risk sharing, or solidarity, in the absence of an explicit commitment device and note that increasing the potential for direct reciprocity significantly increases risk pooling. In a related study, Barr and Genicot (2008) test the effects of different levels of commitment in a game in which individuals can pool outcomes from a risky gamble; risk in this study, however, is not explicitly idiosyncratic or exogenous. They vary levels of commitment and find that limiting commitment reduces the frequency with which individuals pool earnings from the gamble.

There is also a large experimental literature that focuses on covariate, or aggregate, risk in a social dilemma. Much of this research focuses on a common pool resource environment and generally finds that increased environmental uncertainty leads to lower levels of cooperation (see

Gangadharan and Nemes, 2009, for a review). Of these, the most closely related to our study is Gangadharan and Nemes, 2009, who introduce an aggregate shock into a public goods game. Treatments varied whether this shock was associated with the private or the public good, and whether the probability distribution was known ("risk") or unknown ("uncertainty"). They find that individuals will avoid investing in a risky private account, preferring the strategic uncertainty associated with the group account. However, when the group account faces a possible shock, and therefore includes both environmental and strategic uncertainty, cooperation drops significantly.

Compared to existing research, our study differs along the commitment dimension, the nature of the shock, and the strategic environment. Using a standard linear public goods environment, we introduce a negative idiosyncratic shock that eliminates the individual's contributions to, and returns from, the group account, along with an opportunity for other players to share with the player receiving the shock. Because individuals can avoid the shock by shifting allocation decisions from the group account to the private account, we can decompose the welfare loss into two components: the direct loss due to the shock and the indirect loss due to changes in cooperative behavior. Like Charness and Genicot (2009), we introduce sharing without commitment, but in contrast, we eliminate all opportunities for individual reciprocity and test whether the information about sharing affects investment in a public goods game.

We find that risk not only increases the variability of individual earnings, but also induces significant earnings losses due to less cooperative behavior. Contrary to theory, however, we find near Pareto optimal levels of risk pooling without commitment and without the possibility for direct reciprocity. Surprisingly, while individuals cooperate in pooling risk, information on the availability of insurance appears to have no effect on cooperation in the public goods game. That is, cooperation in removing idiosyncratic environmental risk doesn't facilitate increased group investment in the social dilemma.

II. Experimental Design

To investigate the impact of idiosyncratic risk in a social dilemma and the elements of risk sharing arrangements that might mitigate any adverse effects, we construct a set of four treatments that are summarized in Table 1: a Baseline to provide a clear internal and external benchmark, a Shock treatment that introduces idiosyncratic risk and sheds light on the impact of risk in a social dilemma, and two sharing treatments that vary levels of information about sharing. <INSERT TABLE 1>

Baseline. The Baseline treatment is a standard linear public goods game in which individual earnings are $\pi_i = (e - x_i) + (m/n)\sum_i x_i$, where m=2 is the multiplier on contributions to the group account, n=5 is the number of subjects in a group, e=20 is the initial endowment, and x_i is the amount individual *i* allocates to the group account. The marginal per capita return (MPCR) from the group account is m/n=0.40. These parameters are identical in all treatments. After all subjects completed their allocation decisions, the results were announced. Subjects received information about their own allocation decisions and earnings. Subjects were also informed about the aggregate allocations to the group account, but the individual decisions of the other four group members were not revealed. While standard theory predicts that nothing will be allocated to the group account, experimental evidence consistently shows positive, though less than socially optimal, allocations that decline over time (Ledyard, 1995). We expect to observe this well-documented behavior in the Baseline treatment.

Shock Treatment. The Shock treatment parallels the Baseline, but introduces idiosyncratic risk by randomly selecting one group member to receive a shock after all allocation decisions have been made. The idiosyncratic shock results in the entire loss of the individual's allocation to the group account, but has no impact on the individual's allocation to his private account. In addition, the shock prevents the individual from receiving any returns from the group account. Instead, the group returns are equally distributed among the remaining $n-1$ group members who did not receive the shock. The identity of the person shocked is not announced; instead group members are individually informed about whether they are affected by the shock. Expected earnings in the shock treatment are $\pi_i = [(n-1)/n] \cdot [(m/(n-1)) \cdot \sum_i (x_i - x^s) + (e - x_i)] + (1/n) \cdot (e - x_i)$, where x^s is the group allocation of the subject who incurs the shock. The expected MPCR remains unchanged at 0.40.

The potential for a negative shock to eliminate an individual's return from the group account introduces an additional disincentive to allocate resources to the group account. In addition to the usual strategic risk that defines the collective action problem, group members also face an environmental risk due to the potential idiosyncratic shock. More specifically, in the no-shock Baseline treatment, earnings from an individual's allocation to the group account are $(m/n) \cdot x_i > 0$, whereas the Shock treatment introduces a $1/n$ chance that these earnings will instead be zero. This implies that an individual who is predisposed towards cooperation and invests fully in the group account (x_i=e) risks earning nothing. Shifting allocations from the group account to the private account avoids both the strategic and the environmental risk and guarantees that earnings will be at least e. Therefore, we expect to find that, relative to the no-shock Baseline, the Shock treatment will have lower contributions to the group account, lower individual and group earnings, and greater variance in individual earnings.

Sharing Treatments. The remaining two treatments allow the $n-1$ individuals who are unaffected by the shock to share a percent of their returns from the group account, $s_i \in [0\%, 100\%]$, with the individual that was shocked.[4] In both treatments, all agents make sharing decisions simultaneously without knowing the sharing decisions of other players. Treatments differ in that information about the binding sharing commitment is disclosed prior to investment in one treatment but not in the other. In both sharing treatments, expected individual earnings are: $\pi_i = [(n-1)/n] \cdot \left[(1-s_i) \cdot \left((m/(n-1)) \cdot \sum_i (x_i - x^s)\right) + (e - x_i)\right] + (1/n) \cdot \left[(e - x_i) + \sum_{j \neq i} s_j \cdot \left((m/(n-1)) \cdot \sum_{j \neq i} x_j\right)\right]$.

In the No Information treatment, all *n* subjects simultaneously make both an allocation and a sharing decision. After all subjects submit both decisions, results are announced. Subjects are informed of the aggregate group contributions and the average sharing decision of the other $n-1$ group members, $[1/(n-1)] \sum_{j \neq i} s_j$, which represents the percent of the returns from the group account that would be provided to individual *i* if he were shocked.

In the Full Information treatment, each subject first commits to sharing a percentage of returns from the group account, which are unknown at the time of the sharing decision. All individual sharing decisions are made simultaneously, and after the average sharing decision of other group members is announced, each member submits his allocation decision. Thus, prior to the allocation decision, each subject knows exactly what percent of the group returns he will receive if shocked, which reduces the riskiness of the group account and should encourage more contributions to the group account relative to the Shock treatment.

While each sharing mechanism provides an opportunity for group members to pool idiosyncratic risk, standard theory predicts no sharing in the absence of a commitment device. While Charness and Genicot (2009) have demonstrated the possibility for risk pooling without commitment, we go a step further in that our design removes the possibility for individual reciprocity. In both sharing treatments, it is impossible for subjects to gain information about the individual allocation or sharing decisions of other players. We test the null hypothesis of no sharing, but considering the substantial literature on cooperative behavior and partial risk pooling, we expect to observe risk sharing, which might positively impact group contributions, income smoothing and aggregate welfare.

Sharing at least some of the returns from the group account mitigates the adverse impacts of the idiosyncratic shock. As a result, if sharing is used as insurance, then we expect that providing more information about the reduced environmental risk would increase contributions to the public account. This implies that investment should be higher in the Full Information treatment relative to the No Information treatment. Also, if we observe non-trivial rates of sharing, we expect that relative to the Shock treatment, both sharing treatments will have more money allocated to the group account, greater individual and group earnings, and less variation in individual earnings.

Experiment details. One hundred and twenty undergraduate students were recruited from the student body at the University of Alaska Anchorage to participate in the experiment. All sessions were programmed and conducted using software developed specifically for this research project.[5] Upon entering the lab, participants signed a consent form acknowledging their voluntary participation and agreeing to abide by lab rules. The computerized instructions included both graphical and written explanations, and concluded with an interactive quiz that required correct responses before proceeding to the decision environment.[6] Figure 1 shows an example of the subject computer screen from the Baseline treatment. <INSERT FIGURE 1>

The four treatments were conducted over 12 sessions, with each treatment repeated in three sessions. In each session, 10 subjects were randomly divided into two groups of five and subjects remained in the same group for all T=15 periods. There were a total of N=120 unique subjects, and G=24 unique groups evenly divided among the four treatments. We therefore collected a total of 360 group-level and 1,800 individual-level observations.

To avoid risk pooling over periods, individual cash earnings were determined by a single randomly selected period.[7] At the end of the session, subjects were called one at a time to be paid privately in cash. Lab dollars were converted to US$ at $1 per experiment token. Average individual cash earnings were $24.77 ($\sigma$=0.64) plus an additional $5 for showing up on time.

III. Results

The experimental findings are organized around two topics. First we review the treatment effects on allocations to the group account, income levels and income smoothing. We discuss how idiosyncratic risk affects cooperative behavior and how the sharing mechanisms can mitigate these impacts. We then investigate the different sharing mechanisms further to examine how the level of information about sharing decisions influences the underlying individual behavior that leads to the treatment effects. The aggregate results section provides a basic overview of the key results using summary statistics; the hypotheses are then tested using the panel models presented in the conditional results section.

Aggregate Results. Figures 2 and 3 present the mean individual allocation to the group account and sharing decisions over time by treatment. Table 2 complements the figures by providing summary statistics for all periods combined. In the Baseline treatment, which establishes the benchmark earnings and group contribution levels without idiosyncratic risk or sharing, mean individual allocations to the group account is 10.4 tokens (52% of the 20-token initial endowment). Group allocations in the first period average 13.1 tokens (65%), decaying to 7.0 tokens (35%) in the final period. This general pattern of moderate levels of cooperation in the early rounds, which then decay over time, is typical in a standard public goods experiment.

<INSERT FIGURE 2 and FIGURE 3> <INSERT TABLE 2>

As expected, when the environmental risk associated with the group account is introduced in the Shock treatment (which does not allow sharing), people tend to redirect resources away from the risky group account and into the safe private account. On average, individual allocations to the group account drops by about one-third relative to the no-shock Baseline. Average allocations to the group account start at 8.8 tokens in round 1 (44%), decaying to 4.3 tokens (21%) in round 15; the average over all rounds is 7.0 (35%). As a result, relative to the no-shock Baseline, the mean earnings in the Shock treatment are 20% lower (24.2 vs. 30.4).

In Table 2, the average earnings in the Shock treatment of those who were not shocked (27.0) are lower than the Baseline (30.4) as a result of the reduced allocations to the group account. This suggests that the presence of risk in the group account has two effects on earnings: a direct effect due to the shock and an indirect effect as a result of changes in allocation behavior. Table 3 decomposes earnings into these two effects. The column labeled “Before Shock, Before Sharing” reports individual earnings before the welfare loss from the shock and before income is redistributed through sharing. A comparison of the average earnings in the Shock and Baseline treatments reveals that changes in allocation behavior accounted for just over half of the earnings decline. Specifically, of the total difference in average earnings between the two treatment (24.2–30.4= –6.2), 55 percent of the earnings loss occurred before the shock (27.0–30.4= –3.4) as a result of subjects shifting some tokens from the group account to the private account. The direct effect of the shock (from 27.0 before the shock to 24.2 after the shock) accounts for the other 45 percent of the total earnings loss. Hence, the chilling indirect effect of idiosyncratic risk on cooperation is roughly equal to the direct earnings loss resulting from the shock. <INSERT TABLE 3>

The mean standard deviation of earnings in Tables 2 and 3 is a measure of the average variability in an individual's earnings over time.[8] By definition, the idiosyncratic shock introduces volatility to an individual's earnings over time; average earnings are higher in those periods when the individual is not shocked (27.0), than when he does incur the shock (12.9). As a result, the mean standard deviation in the Shock treatment is higher than the Baseline (7.18 vs. 5.39). Before accounting for the shock, the mean standard deviation in the Shock treatment is actually lower than the Baseline (4.46 vs. 5.39); this follows from the lower contributions to the group account in the Shock treatment. However, the negative direct effect of the shock dominates, leading to an overall increase in earnings variability. These results illustrate the additional complexity that arises when idiosyncratic risk exists within a social dilemma: not only does the shock have a direct impact on earnings, but it also has an indirect impact as individuals reduce their allocations to the group account in order to lower their exposure to this environmental risk.

The two sharing treatments offer the potential to mitigate both the direct effects of the shock and the indirect effects of reduced contributions to the group account. By sharing with other group members and mutually insuring against the environmental risk, it is possible to both increase earnings and reduce earnings variability (relative to the Shock treatment). In each of the sharing treatments, fully insuring all group members against the idiosyncratic risk would require each person to share 20 percent of the group returns ($s_i = 0.20$), but the standard game-theoretic prediction is that sharing will be non-existent ($s_i = 0.00$). We do, however, observe considerable sharing in both treatments. Figure 3 shows that sharing begins around full insurance in both treatments (21% No Information and 26% Full Information), but declines over time to roughly 10% in each treatment.

This high level of sharing helps smooth income by mitigating the direct effects of the shock. If income smoothing were perfect, then individual earnings would be independent of the shock, and as a result, there would be no difference in average earnings between those who were shocked and those who were not. When the allocation and sharing decisions are made simultaneously in the No Information treatment, it appears that income smoothing does occur at near-perfect levels. Figure 4 presents the difference in average earnings over time between those who were not shocked and those who were. In the No Information treatment, this difference in any given round is modest, moreover there are nearly as many rounds (6 of 15) in which the shock victims actually earn more than their benevolent counterparts. As a result, over all rounds, Table 2 shows that average earnings of the two groups are nearly identical in this treatment.

<INSERT FIGURE 4>

Interestingly, although we do observe near-perfect income smoothing, it does not appear that this has any effect on contributions to the group account. In fact, average contributions in the No Information treatment (7.2) are about the same as the Shock treatment (7.0). As a result, average earnings in the two treatments are similar. This would suggest that, in the absence of information about how much risk will be covered by the group, the ability to share does reduce the riskiness of the group account and reduce earnings fluctuations, but it has no impact on collective action.

The sequential nature of the Full Information treatment introduces the ability to pre-commit to a sharing decision before making an allocation decision. With mean sharing around 18%, the shock has a negligible effect on earnings (24.3 without shock vs 24.1 with shock). In fact, in Figure 4, shock victims actually earn slightly more than the other group members in four of the first five rounds. However, despite perfect information about the generous sharing commitments, average contributions to the group account (6.9) are no different than the Shock (7.0) or No Information treatments (7.2). Therefore, it seems that high levels of income smoothing are possible with or without a sharing commitment mechanism, but sharing has no impact on cooperation in a social dilemma.

Conditional Results. The informal conclusions discuss above are confirmed using more rigorous conditional analyses presented in Table 4. We estimate three panel models that use the same basic structure: $Y_{it} = \beta_0 + \beta_1 \cdot \theta_{it} + \beta_2 \cdot t + \omega_i + \varepsilon_{it}$, where Y_{it} is the individual allocation to the group account (Model 1), sharing (Model 2), or earnings (Model 3) of subject *i* in period *t*; θ_{it} is a set of treatment indicator variables that capture the treatment effects; ω_i captures unobserved individual subject characteristics and ε_{it} represents the contemporaneous error term. Because subjects participated in multiple rounds of a single treatment, subject-specific heterogeneity is modeled as a random effect. We also use a Huber (1967) and White (1980) robust estimate of variance. <INSERT TABLE 4>

Consistent with the previous discussion of aggregate results, the allocation decision in Model 1 reveals that the introduction of idiosyncratic risk in the Shock treatment significantly reduces contributions to the group account relative to the Baseline (*p*=0.00). Surprisingly, the Full Information and No Information treatments have similar results. Both coefficients are negative and significant, and a Wald chi-square test fails to reject the joint hypothesis that allocation levels in the No Information, Full Information and Shock treatments are equal (p=0.97). Results from the sharing model (Model 2) also corroborate the aggregate findings. Individuals do exhibit significant levels of sharing in both sharing treatments. The coefficient for the intercept, which indexes the omitted simultaneous decision No Information treatment, indicates average sharing of 21% and is positive and significant. As expected, the coefficient on the Full Information treatment is not significant, indicating that there is no difference in the sharing rates between the two treatments.

Since the earnings model in Table 4 is not conditioned upon whether an individual was shocked in a given round, it provides an estimate of an individual's expected earnings and is a measure of the relative welfare impacts among the different treatments. The earnings model indicates that, in the presence of an idiosyncratic shock, the expected individual earnings are lower than the no-shock Baseline (all three treatment coefficients are negative and significant). More importantly, a joint test of the hypothesis that the three treatment coefficients are equal cannot be rejected (p=0.98), which indicates that neither sharing treatment had a significant effect on expected earnings relative to the Shock treatment.

Of course, individual earnings in a given round may be affected by the shock and the magnitude of this impact depends upon the extent to which the other group members share. Perfect smoothing implies that individual earnings are independent of the idiosyncratic shock. This follows from the fact that in a Pareto efficient outcome, marginal utilities for different individuals should be equal across good and bad states of nature (Fafchamps and Lund, 2003; Townsend, 1994; Mace, 1991). To test the income smoothing hypothesis, we modify the individual earnings model in Table 4 by adding three new explanatory variables that interact the treatments with an indicator variable (Shocked) that equals one if individual i incurred the shock in period *t*. The model in Table 5 only includes data from the three treatments that include the idiosyncratic shock, and therefore does not include the Baseline treatment. The intercept can be interpreted as referencing the earnings of an individual who was not shocked in the Shock treatment. The income smoothing hypothesis implies that each of the three interaction coefficients should equal zero (*i.e.*, for a given treatment, if the interaction term is zero, then we cannot reject the hypothesis that individual earnings are independent of the shock). <INSERT TABLE 5>

Clearly, without the ability to share in the Shock treatment, the income smoothing hypothesis is rejected; earnings of individuals who are shocked are 13.70 less than those who were not shocked. In contrast, results are consistent with the earnings smoothing hypothesis in the No Information treatment (p=0.87) and the Full Information treatment (p=0.99). In our environment, this simple sharing institution nearly eliminates the effects of idiosyncratic risk for the individual. Thus, the conditional results support the observations made using the aggregate results. Without sharing, an idiosyncratic shock has both a direct effect on the earnings of the shock victim, and an indirect effect on the earnings of the entire group due to reduced contributions to the group account. The ability to share without any commitment mechanism does smooth individual earnings, but because group allocations are unchanged relative to the Shock treatment, the indirect effects of the shock persist and, as a result, average earnings are no greater than without sharing. Group contributions, sharing and earnings in the Full Information treatment are statistically indistinguishable from the No Information treatment.

IV. Conclusion

We examine whether a sharing institution can pool risk in a social dilemma with idiosyncratic risk. A standard public goods game is augmented with a negative idiosyncratic shock and a simple sharing mechanism in which subjects make private, voluntary transfers to a fellow group member who was adversely affected by the shock. As predicted, environmental risk via the shock is found to significantly reduce average earnings. This impact on earnings can be decomposed into two effects that are roughly equal in magnitude: the reduced earnings that are a direct consequence of the shock, and the indirect effect due to behavioral changes to avoid the shock.

In contrast to basic theory, however, we find high levels of anonymous sharing in both sharing treatments. In both treatments, sharing completely removes the additional variance of individual earnings due to the shock, evidence consistent with the income smoothing hypothesis. As such, risk pooling emerges without a strong self-enforcing agreement, an assumption needed in related theoretical models. This result is similar to that of Charness and Genicot (2009), but is stronger in that risk pooling is maintained even when the possibility for direct individual reciprocity is eliminated. Although near-perfect income smoothing is observed in the sharing treatments, surprisingly, collective action measured in terms of group contributions is not improved with sharing.

In conclusion, consistent with econometric results based on survey data from rural contexts, we find that subjects successfully pool risk in an environment with idiosyncratic risk. While sharing mechanisms have unique behavioral implications, high levels of risk pooling are observed without reputation or a strong commitment device. Results suggest that in a social dilemma with environmental risk, sustained collective action may be more sensitive to the design of the risk sharing system compared to other outcomes such as income smoothing.

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FIGURE 1
Example of the Subject Interface for the Baseline Treatment

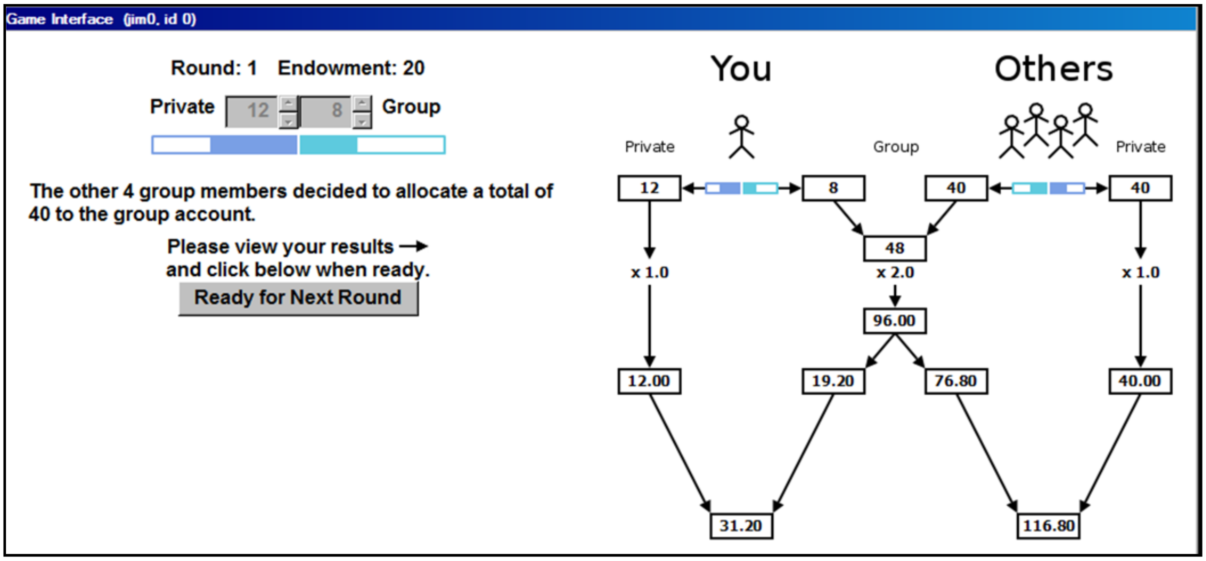

FIGURE 2
Mean Individual Allocation to the Group Account

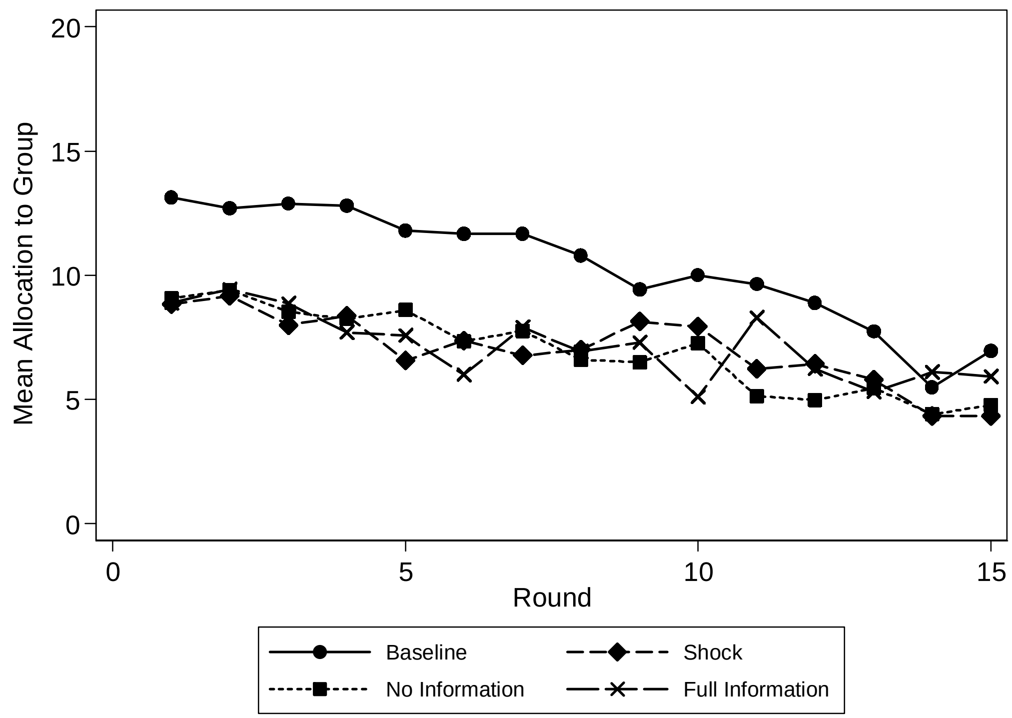

FIGURE 3
Mean Individual Percent Shared

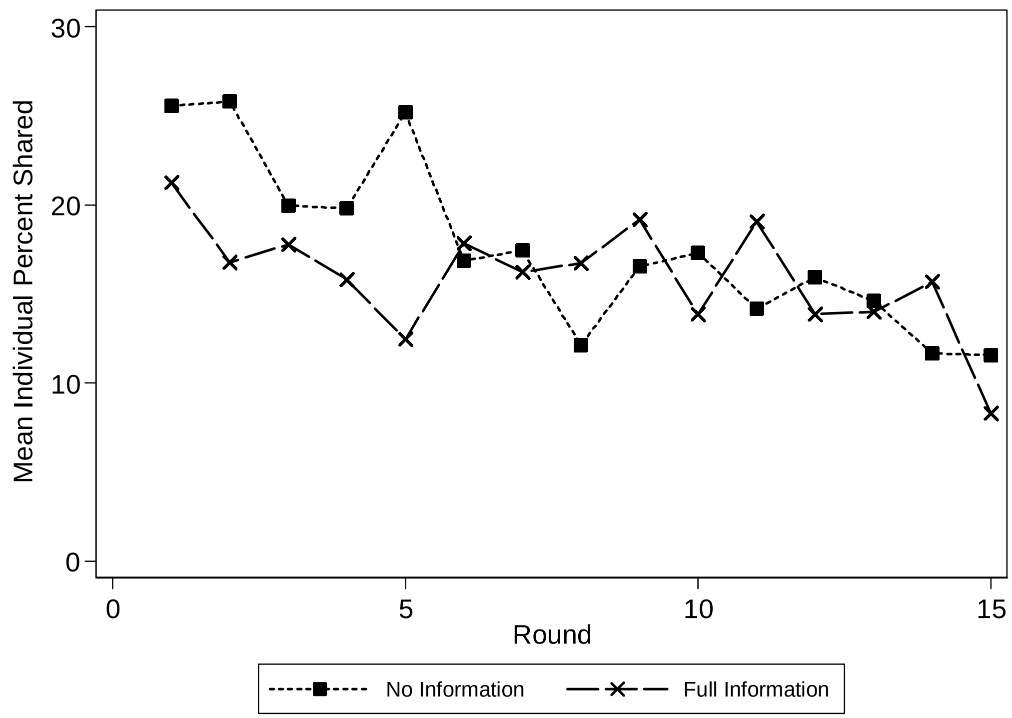

FIGURE 4
Consumption Smoothing (Average Earnings: Not Shocked minus Shocked)

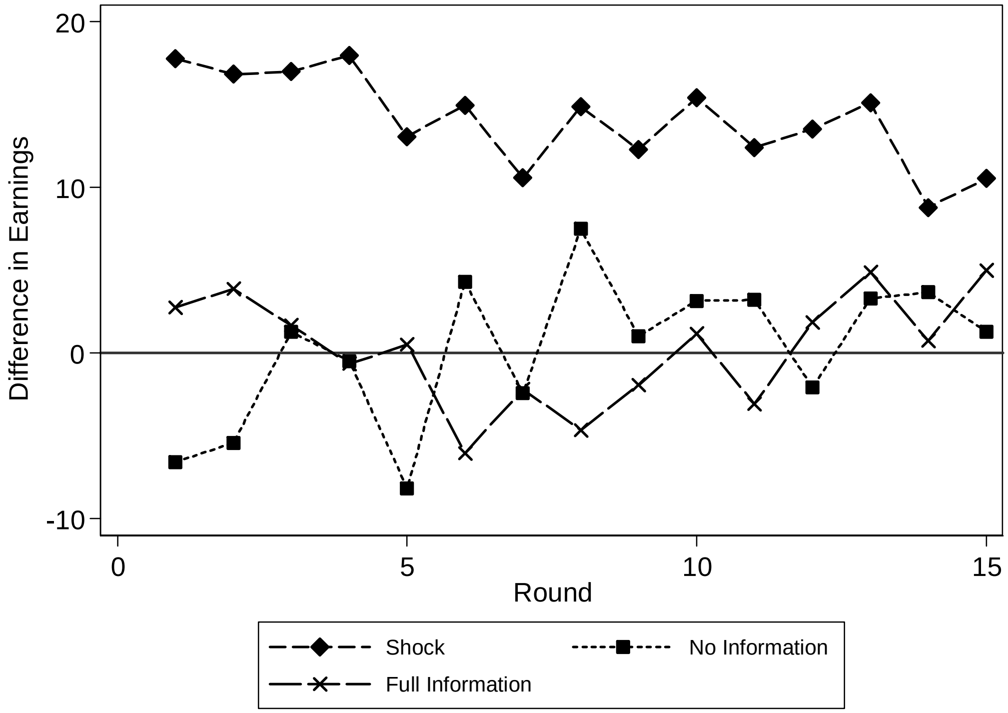

TABLE 1
Experimental Design

Treatment	Features	Summary
Baseline	Baseline	Standard VCM
Shock	Baseline + Shock	Add idiosyncratic shock
No Information	Baseline + Shock + Sharing	Simultaneously make allocation and sharing decisions.
Full Information	Baseline + Shock + Sharing	Make sharing decision. Aggregate sharing announced. Make allocation decision.

TABLE 2
Mean Individual Decisions and Earnings

Treatment	Allocation to Group Account	Sharing	Level of Earnings: Not Shocked	Level of Earnings: Shocked	Level of Earnings: All	Mean Standard Deviation of Earnings[a]
Baseline	10.4	--	--	--	30.4	5.39
Shock	7.0	--	27.0	12.9	24.2	7.18
No Information	7.2	16%	24.4	24.2	24.4	6.10
Full Information	6.9	18%	24.3	24.1	24.3	5.63

[a] Defined in footnote 8.

TABLE 3
Decomposition of Earnings

	Average Earnings (all subjects)			Mean Standard Deviation of Earnings[a]		
	Before Shock Before Sharing	After Shock Before Sharing	After Shock After Sharing	Before Shock Before Sharing	After Shock Before Sharing	After Shock After Sharing
Baseline	30.4	--	--	5.39	--	--
Shock	27.0	24.2	--	4.46	7.18	--
No Information	27.2	24.4	24.4	4.37	7.47	6.10
Full Information	26.9	24.3	24.3	4.26	6.82	5.63

[a] Defined in footnote 8.

TABLE 4
Conditional Estimates of Individual-Level Treatment Effects

	Model 1: Allocation to Group Account (x_{it})	Model 2: Sharing (s_{it})	Model 3: Earnings (π_{it})
Baseline Treatment	(omitted)	n/a	(omitted)
Shock Treatment	-3.36 (0.00)	n/a	-6.19 (0.00)
No Information Treatment	-3.20 (0.01)	(omitted)	-5.99 (0.00)
Full Information Treatment	-3.44 (0.00)	0.017 (0.573)	-6.07 (0.00)
Round	-0.34 (0.00)	-0.007 (0.00)	-0.27 (0.00)
Intercept	13.10 (0.00)	0.212 (0.00)	32.49 (0.00)
χ^2	73.89 (0.00)	29.23 (0.00)	60.57 (0.00)
N	1800	900	1800

p-values in parentheses calculated using robust standard errors. In all three models, "omitted" means the data are included, but the treatment dummy variable is omitted. In the sharing model, "n/a" means the data from the two treatments without sharing are not applicable and therefore not included.

TABLE 5
Conditional Estimates of Individual Earnings

	Model 4: Earnings (π_{it})
Shock Treatment	Omitted
No Information Treatment	-2.48 (0.01)
Full Information Treatment	-2.62 (0.00)
Shocked × Shock Treatment	-13.70 (0.00)
Shocked × No Information Treatment	-0.27 (0.87)
Shocked × Full Information Treatment	-0.01 (0.99)
Round	-0.19 (0.000)
Intercept	28.42 (0.000)
χ^2	370.22 (0.000)
N	1350

Model does not include Baseline treatment because it does not include a shock. p-values in parentheses calculated using robust standard errors.

FOOTNOTES

[1] Idiosyncratic risk accounts for a large share of variance in household consumption. For example, Udry (1993) reports that 42 percent of the variation in farm yields across households in rural Nigeria can be attributed to idiosyncratic risk. Based on India ICRISAT survey data, Morduch (1999) notes that idiosyncratic shocks account for most of the variation in individual household income. Even after accounting for the effects of aggregate shocks, 75% to 96% of the variance in individual household income remains.

[2] The limited commitment model of Posner (1980) and Ligon et. al. (2003) assumes that an individual perceives that a credible commitment has been made by another to reciprocate at some point in the future, hence a gift or food sharing occurs. In contrast, an enforceable promise or legal contract, backed up by formal sanctions which are strong enough to deter any defection, characterize full commitment models (Posner, 1980; Kimball, 1988; Charness and Genicot, 2009).

[3] Townsend (1994), a seminal consumption smoothing study, estimates that individual variations from average village income range from about 2% to 8% and that individual shocks have little effect on consumption. Exceptions to this general finding include Kazianga and Udry (2006) and Gertler and Gruber (2002). Kazianga and Udry (2006) find little evidence of consumption smoothing in rural Burkina Faso; they find that the effect of idiosyncratic income shocks on consumption ranges from 31% to 44%. Gertler and Gruber (2002) find that a large health shock lowers consumption by about 20% because rural Indonesian households were not able to fully insure against illness. In general, informal risk pooling networks are unable to eliminate the effects of health shocks (Banerjee and Duflo, 2011)

[4] The decision was framed as a percent of the returns from the group account, rather than a specific dollar amount, because the actual returns from the group account were unknown at the time the sharing decision was made.

[5] The experiment was programmed by Ben Saylor using Python. The related code, PEET, can be freely downloaded at: http://econlab.uaa.alaska.edu/Software.html.

[6] Experiment instructions can be viewed here http://econlab.uaa.alaska.edu/shocksharing/. The use of diagrams in the instructions was motivated by Eckel et al. 2010.

[7] At the beginning of the experiment, a subject randomly selected one of 15 cards. The number on the back of the card corresponded to the round that would count for earnings. The card was placed face down on a desk in full view of the subjects during the experiment. At the end of the experiment the card was revealed and subjects were paid their earnings for that round.

[8] The mean standard deviation of earnings ($\bar{\sigma}$) is calculated as the mean of the individual within-subject standard deviations (σ_i), specifically: $\bar{\sigma} = (1/N) \cdot \sum_{i=1}^{N} \sigma_i$, where $\sigma_i = [1/(T-1)] \cdot \sum_{t=1}^{T} (\pi_{it} - \bar{\pi}_i)^2$, and $\bar{\pi}_i = (1/T) \cdot \sum_{t=1}^{T} \pi_{it}$. N=120 individual subjects, each of whom participated in T=15 rounds.