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Natural disasters and informal risk sharing against illness: networks vs. groups

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Abstract

Using original household panel survey data collected in rural Fiji, this paper demonstrates how informal risk-sharing institutions upon which poor people heavily rely in times of illness are vulnerable to natural disasters. First, household private cash-inkind transfers do not serve as insurance against illness in the relief phase (several months after the disaster); they do so only after pooled resources are recovered in the reconstruction phase (a few years later) (i.e., the resource effect). Second, risk-sharing arrangements are dependent on the history of labor-time transfers corresponding to housing damage: Only disaster non-victims are insured against illness, because victims have already received labor help for their rehabilitation from non-victims (i.e., the reciprocity effect). The paper also reveals that resource/reciprocity effects exist in endogenously formed networks and pre-formed groups, as risk-sharing pools to a similar degree. Not only do private transfers exchanged among households serve as insurance, but also, household contributions directly made to groups – such as ritual gifts and religious donations – contain risk-sharing components against illness among group members. Although the former finding is commonly evident in the literature, the latter is new. Network formation is directly related to pre-formed groups, especially kin and religious ones.

I. Introduction

Informal risk-sharing institutions are critically important in poor populations (see, e.g., Alderman and Paxon 1994; Morduch 1999; and Dercon 2002 for reviews of informal insurance). They are particularly important for health shock, because neither health insurance nor public safety nets are available among the poor (see Strauss and Thomas 1998 for their extensive review of the health-development nexus). Numerous studies have shown that informal risk sharing against idiosyncratic shocks, such as illness, is available in developing areas, although it is far from complete (e.g., Townsend 1994; Kochar 1995; Dercon and Krishnan 2000; Gertler and Gruber 2002; Asfaw and von Braun 2004). In contrast, such informal institutions are considered to be ineffective against covariate shocks, such as natural disasters, because shocks are highly correlated over space. Although extant works on risk sharing against natural disasters are scarce, recent studies provide evidence for such arrangements against household-level disaster shocks (e.g., Sawada and Shimizutani 2008; Mozumder et al. 2009). Of course, disaster relief plays a central role as a safety net. Post-disaster management is a time-consuming process, consisting of relief, recovery, and reconstruction phases (de Ville de Goyet 2008). This paper addresses a question that researchers have not yet explored but is critically important for post-disaster development: How does a natural disaster affect informal risk sharing against illness over time? Although adverse effects of natural disasters on various dimensions of well-being, such as consumption, child nutrition, and public health, have received much attention from researchers (e.g., Noji 1997; Skoufias 2003), no previous works explicitly address the link between natural disasters and informal risk sharing against health shocks.

I hypothesize two links. First, the degree of sharing cash and inkind (e.g., food) to smooth consumption against illness (*non-labor sharing*) depends on the amount of pooled resources that can be shared among people, i.e., the *resource effect*. In the relief phase right after the disaster, risk sharing against illness is weak or even nonexistent, simply because the covariate disaster shock greatly reduces pooled non-labor resources. As rehabilitation progresses, pooled resources and thus risk sharing make a recovery.

Second, in the risk-sharing arrangement with limited enforceability, current transfers are dependent on the past history of transfers, i.e., the *reciprocity effect* (Ligon, Thomas, and Worrall 2002). The simulation analysis of Foster and Rosenzweig (2001, p390) demonstrates that "the existence of binding imperfect commitment constraints implies that households that have made net transfers in previous periods are less likely to provide subsequent transfers, given the current state of the world, than are households that have been net recipients of transfers" (they call this the *transfer asset effect*). La Ferrara (2003) theoretically and empirical examines the reciprocity effect in credit transactions among kin members in Ghana.

Natural disasters can elicit the reciprocity effect as follows. Although a natural disaster is a region-wide covariate shock, it may contain significant idiosyncratic components at a local level; for example, a tropical cyclone may damage some, but not all dwellings within villages. Imagine a situation where there are disaster *victims* and *non-victims* within villages and in the relief phase non-victims help victims' rehabilitation by providing labor time (*labor sharing*). Note that even if the resource effect precludes non-labor sharing against the disaster damage, labor sharing can still work unless the disaster significantly lowers labor endowment among villagers (e.g., casualties, disease outbreak, out-migration). Thus, the reciprocity effect suggests that victims are less insured against illness than non-victims are.

As such, natural disasters may adversely affect informal risk sharing not only for all contemporaneously, but also for some in a persistent manner; in particular, disaster victims may suffer from a lack of private safety nets against illness over time. Then, even if disaster-induced public-health problems are not a major issue, “hidden” health problems exacerbated by the disaster – through endogenous adjustments in informal risk-sharing arrangements – can be considerable. Using original household panel survey data collected in rural Fiji, the paper shows that a tropical cyclone has strong resource and reciprocity effects: Sick persons are insured in the reconstruction phase, but not in the relief phase; sick non-victims are insured, but sick victims are not.

To test the reciprocity effect, the paper directly analyzes household private transfers; distinct from many extant studies of risk sharing that focus on consumption smoothing, it thus explores *how* people share risk, in the same spirit as Udry (1994) and Fafchamps and Lund (2003). Although economists have extensively studied private transfers exchanged *among* households (*across-household transfers*) (see, e.g., Cox and Fafchamps 2008 for a review), transfers exchanged *directly* with groups to which the household belongs – such as ritual gifts for kin groups, village communal work, and church donations (*household-group transfers*) – have received very limited attention.[1] This is a significant lacuna in the risk-sharing literature, because household-group transfers may contain a significant risk-sharing component, such that group members

[1] This is especially so in developing countries; in developed countries, in contrast, transfers to community institutions in general (e.g., charitable giving) have been well studied (see, e.g., Schokkaert 2006 for review).

with adverse shock contribute less than others do. As a unique feature, the Fijian data include comparable household information about these two forms of transfers, enabling their direct comparison. Osili, Deb, and Okten (forthcoming) conduct a similar comparison using Indonesian Family Life Surveys, though risk sharing is not their focus. The paper finds resource and reciprocity effects of the cyclone in both transfers.

Although economists often highlight the village as a risk-sharing pool because of its information and enforcement advantages (e.g., Townsend 1994; Ligon, Thomas, and Worrall 2002), recent works directly address the question of *among whom* people share risk. Some researchers focus on pre-formed groups other than village, such as kin, caste, and ethnic groups (e.g., Grimard 1997; Morduch 2005; Munshi and Rosenzweig 2009), while others study the formation of risk-sharing groups and networks (e.g., Murgai et al. 2002; Fafchamps and Lund 2003; De Weerdt and Dercon 2006). The paper examines not only which pre-formed groups serve as risk-sharing groups in household-group transfers, but also how those groups form household transfer networks and what networks serve as risk-sharing networks in across-household transfers. The findings reveal that kin and religious networks and groups are important.

The rest of the paper is organized as follows. Section II describes the study area, the cyclone, and health shock. Section III explains household private transfers. Section IV develops empirical strategies to test the resource and reciprocity effects, which is followed by the results in Section V. The last section concludes.

II. Data, cyclone, and health

A. Study area and data

On January 13, 2003, Cyclone Ami swept over the northern and eastern regions of the Fiji Islands.[2] Seven native Fijian villages on the coast in the northern region, with distinct environmental and economic conditions, were intentionally chosen for the survey.[3] After being stratified for each of the selected villages by the smallest kin group unit (defined shortly), as well as by a combination of leadership status (e.g., kin leader) and major asset holdings (e.g., shops), households were randomly sampled in each stratum. Household interviews were conducted between late August and early November 2003, collecting information about demographics, assets, production, income, shocks, relief, and transfers (but not consumption). As such, like other post-disaster surveys (e.g., Morris et al. 2002), the survey collected disaster information retrospectively (I will discuss retrospective errors in Section IV). In July-September 2005, the second wave of the survey was implemented. Analyses in this paper are conducted for 226 households with complete panel data. All monetized values presented in the paper are real values, with 2003 as the base year.

B. Cyclone shock

All seven sample villages experienced damage to their structures and facilities, and housing damage and crop damage are the two major damages that individual households experienced. According to respondents' subjective assessments, the cyclone

[2] Ami was the only cyclone in the northern region from 1991 through 2005 (McKenzie, Prasad, and Kaloumaira 2005). The total damage caused by Cyclone Ami across the country is estimated at F$104 million, of which housing damage is F$22 million and crop damage is F$40 million (National Disaster Management Office 2003).

[3] Two other villages were also surveyed in 2003, but not in 2005. Four and three villages, respectively, are located on Vanua Levu and Taveuni Islands, the second- and third-largest islands in the country, which significantly lag behind the largest island, Viti Levu, where the state capital, two international airports, and most tourism businesses are situated. Fiji is divided almost evenly between native Fijians and Indo-Fijians. The study focuses on native Fijians.

damaged 58% of residents' houses: 9% were completely destroyed and 49% were partially damaged (see Table 1). Households with and without damaged housing did not significantly differ from each other in their crop damage (discussed next), earned incomes, asset holdings, and other household characteristics at the time of interviews in 2003 (nor were they different before the cyclone, Takasaki forthcoming-b). Among households that experienced housing damage, 36% became refugees who stayed in others' residences in the same village (permanent migration was nonexistent). About two thirds of those refugees lived with households in the same kin group; that is, kin networks served as a major risk-sharing pool. Households without damaged housing also helped others' rehabilitation (I return to this below).

Almost all households engaged in cropping (and fishing),[4] and 82% experienced crop damage. The mean value of damaged crops was F$44 per capita (1 Fiji dollar = US$.60), which was 11% of the mean annual crop income at the time of interviews in 2003 (crop damage was calculated based on the quantity damaged for each major crop, as reported by respondents).[5] Distinct from housing rehabilitation, households individually rehabilitated cropping by collecting harvestable damaged crops, cleaning fields, and planting seeds with no labor sharing involved. Annual total earned income in 2003 was about half of that in 2005; thus, aggregated resources that could be shared among households were limited after the cyclone.

[4] Farming and fishing, respectively, accounted for 50% and 27% of total earned income in 2003 and 55% and 14% of total earned income in 2005. Households employ traditional farming practices, using no mechanized equipment or animal traction to produce taro, cassava, coconut, and kava plants, and engage in artisanal fishing, using lines and hooks, simple spear guns, or rudimentary nets.

[5] Correlations of housing damage with crop damage and crop-damage value are .041 and .079, respectively, with no statistical significance.

Variance of the household-level cyclone-damage measures is decomposed into year, village, and household levels by allowing for year-level or time-varying village-level means.[6] Apart from the major contribution of the year-level variance to the total variance for the cyclone-damage dummies, most variance exists at the household level (57-90%). In contrast, the contribution of village-level variance to the total variance is negligible (less than 3%). This is because as the survey covers only the northern region in the small island state, variations in village-level shocks in the study area are limited. As such, although the cyclone is a region-wide covariate shock, household-level cyclone damages in 2003 are largely idiosyncratic within villages.

C. Relief and reconstruction

The Red Cross, other nongovernmental organizations, and governments provisioned relief, and interviews in 2003 were conducted at the end of the relief phase. Almost all households received emergency food aid, and the mean amount per capita was F$95, which was more than twice the mean crop damage; in contrast, only a small proportion of victims received tarpaulins that could be used as emergency shelters and for temporary dwelling repair. At the time of interviews in 2003, refugees were almost nonexistent and about two thirds of households with damaged housing had completed rehabilitation: 12% had built a new house and 52% had completed repairs. As the government provisioned most construction materials from 2004, these housing rehabilitations were accomplished through people's mutual help. By the time of interviews in 2005 in the late reconstruction phase, construction materials had been

[6] In practice, the year-level variance (percent of total variance) is the R-squared of a regression on a year dummy; the village-level variance is the R-squared of a regression on a full set of village-time dummies, minus the year-level variance.

provisioned to one quarter of households in the sample. Takasaki (forthcoming-a; forthcoming-b) details and analyzes allocations of reconstruction and relief funds, respectively.

D. Health shock

Respondents were asked each household member's health conditions over the past year. In both 2003 and 2005, about one third of households had one or more sick members – 72% and 84% of those had one or more sick adults, respectively – and 12% of households experienced illness in both years (Table 1). According to the variance decomposition, household-level illnesses are mostly idiosyncratic shocks within villages. Public-health problems were not a major issue after the cyclone in the sample villages – respondents reported no casualties and very limited injuries and illnesses directly caused by the cyclone. Illness, however, was more common among households with damaged housing than others in 2003 (with a .13 correlation);[7] the prevalence of illness was almost the same for refugees and non-refugees. Although illness was not more pervasive in 2003 than in 2005, housing damage, not refugee status, may have caused some health problems; housing damage did not cause chronic illnesses though, because these two variables were uncorrelated for 2005.

III. Household private transfers

A. Groups

Apart from the village, kin, religious, and social groups play major roles in Fijians' life. First, each native Fijian belongs to a lineage of the *vanua-yavusa-mataqali-*

[7] Illness was less common among households with damaged crops than others (with a -.14 correlation); there was no significant correlation between illness and crop damage value.

tokatoka hierarchy: Vanua consists of several yavusa; yavusa consists of several mataqali; and mataqali consists of several tokatoka (Ravuvu 1983). Although vanua ranges over several villages, there is just one yavusa in each of the sample villages (i.e., village formation is based on yavusa); mataqali and tokatoka are village subgroups (the sample covers 22 mataqali and 35 tokatoka). Many ritual activities, such as funerals and weddings, are organized by mataqali and yavusa.[8] Second, Christianity underlies Fijian society, and church donations are quite significant, as shown below. A religious group formed for each church, which often covers more than one nearby village, is available in all villages in the sample – 3.9 church groups per village on average – and almost all households are members. Third, social groups consist of women's, school, and youth groups in all villages (market-oriented groups such as cooperatives are almost nonexistent). Although membership is fixed for kin and religious groups (without conversion to another religion),[9] participation in social groups is based on individual decisions among the eligible – determined by gender, child schooling, and age – and 86% of households belong to at least one social group. When these pre-formed groups are considered as potential risk-sharing groups, group formation is irrelevant.

B. Transfer data

[8] The dominant symbol of Fijian culture is kava (a beverage infused from the root of a pepper plant, *Piper methysticum*), and kava rituals frequently involve exchanges of ceremonial goods, such as food, mats, and bark cloth (Turner 1987). Land is communally owned by mataqali (about 83% of the country's total land is communal), and customary rights for coastal fishing are held by vanua or several yavusa.

[9] Marriage across different kin groups is common. This paper focuses on the kin groups to which households currently belong; if the kin groups to which individuals used to belong prior to marriage are considered, transfer networks concentrate more on own kin groups (especially tokatoka) than what is shown below.

In both 2003 and 2005 surveys, respondents were asked not only about *each* major transfer received from and given to other households, but also the transfers they contributed to and received directly from *each* kin, religious, and social group to which they belonged, as well as the village, in the past year. Three caveats are noted. First, distinct from extant studies in the Pacific region (Bertram 1986), overseas remittances are almost nonexistent.[10] Second, although transfer measures capture not only cash and inkind, but also labor time in 2005, labor-time transfer data in 2003 are limited to communal labor contributed to groups. Third, although the transfers that the household offers to groups include all the resources it contributes, those it receives from the group capture only partial benefits, excluding those of local public goods that the group provides, such as social activities and village upkeep. Measuring such benefits is very difficult, because they often include unobservable, non-economic benefits and can be realized over a long time horizon (Clotfelter 1992). Reflecting this imbalance, transfers given to groups are much more common and greater than those received from groups. In contrast, the across-household transfer data are balanced in coverage between receipt and giving.

Proportion of participation in and mean amounts of annual transfers received and given per capita in each year are reported in Table 2 – cash-inkind in panel A and labor time in panel B (labor time is monetized based on men's daily wage in each village, the

[10] In contrast, according to the household survey conducted in five major towns and nine villages in Viti Levu in 2005 by the World Bank (2006), 26% of 211 native Fijian households have overseas migrants and 34% received overseas remittances. This indicates a potentially significant difference in Fijians' transfer patterns between the main island and other islands and between urban and rural areas (cf. note 3). This issue deserves more research.

mean of which is about F$14).[11] Household-group transfers are quite significant, especially in 2005: Gross cash-inkind and labor-time transfers contributed to groups are 2.8 and 7.4 times, respectively, those given to other households.

C. Relief vs. reconstruction phases

A comparison of the relief period 2003 with the reconstruction period 2005 reveals a sharp contrast between cash-inkind and labor-time transfers. On the one hand, non-labor resources that could be shared among households were limited: Cash-inkind transfers received from other households and given to groups in 2003 were much less common and smaller than those in 2005 (cash-inkind transfers given to other households were similar over time, mainly because of large transfers made for funerals in 2003). On the other hand, group members contributed significant labor time to rehabilitate group facilities, such as village facilities (e.g., community halls), churches, and schools (i.e., labor sharing against group-level covariate shock): Labor-time transfers given to the village and religious and social groups in 2003 were more common and much greater than those in 2005; the converse holds true for kin groups, as no kin groups owned or managed group facilities, and ritual transfers to them increased in 2005.[12] Although the cyclone significantly reduced pooled, non-labor resources, labor-time endowment was largely intact, because of no cyclone-induced casualties and permanent migration and limited cyclone-induced diseases. Along with the patterns of housing rehabilitations

[11] Informal loans were much smaller than gifts, and when informal loans are added to private transfers, results are almost the same as what are presented here.
[12] Kin-group transfers include those made with yavusa, mataqali, and tokatoka, because comparable data for vanua are lacking for 2003 (transfers with vanua were minor in 2005).

discussed above, this suggests that across-household, labor-time transfers in 2003 were also more common and greater than those in 2005.

D. Transfer networks

Respondents were also asked about the characteristics of each household with which transfers were made. Major transfer networks are in-village, kin, and religious ones (Fafchamps and Gubert 2007 obtain similar findings in the Philippines): Cash-inkind transfers received from other households in the village, in the same tokatoka, and in the same religious group are more common and much greater than those out of the village, in other tokatoka, and in other church groups, respectively, in both 2003 and 2005 (disaggregated data by religion are lacking in 2003); this is also mostly true for labor-time transfers in 2005. Although transfer networks are endogenously formed by individual households, their network formation is directly related to kin and religious groups they cannot choose.

IV. Econometric specification

A. Base model

I start by estimating the across-household transfer equation using the following standard, fixed-effects specification:

$$y_{it} = \alpha h_{it} + \sum_{k} \eta_k X_{itk} + V_t + u_i + e_{it}, \qquad (1)$$

where y_{it} is household i's net transfer received from other households in time t; h_{it} is a dummy for illness among any household members; X_{itk} is a series of household-level factors that affect transfer decisions; V_t is time-varying village dummies, which capture village-level covariate shock; u_i is household heterogeneity; and e_{it} is a time-variant error term that is individually and independently distributed. This base specification is the same as equation (1) in Gertler and Gruber (2002), although their focus is not on private transfers. Fafchamps and Lund (2003) derive equation (1) from a full risk-sharing model (Cochrane 1991; Mace 1991; Townsend 1994). The fixed-effects estimator controls for all household and village fixed effects. If private transfers are ex-post, risk-sharing arrangements among villagers with given pooled resources in the village, households with illness receive more transfers, i.e., $\alpha > 0$.

B. Resource and reciprocity effects

Theoretically, under imperfect labor and housing-market conditions, people seek to smooth utility determined by consumption, leisure, and housing quality (a decrease in housing quality because of the disaster is a preference shock), and risk sharing consists of non-labor sharing to smooth consumption against illness (income shock) and labor sharing for housing rehabilitation. I extend equation (1) in the following four steps.

First, I add household-level disaster damage, in particular, housing damage (dummy), d_{it}, as a control.[13] The panel data consist of relief period 1 and reconstruction period 2, and $d_{i2} = 0$ for all i (no disaster in period 2). In period 1, households are either disaster victims or non-victims, and in the labor sharing against housing damage, victims receive labor-time transfers from non-victims, i.e., $\beta_1 > 0$, where β_1 is a coefficient of d_{i1}. Second, I allow heterogeneous responses of private transfers to illness over time, by replacing α with α_t. The resource effect suggests that non-labor sharing against illness better works in period 2 than in period 1; it is ineffective in period 1 if pooled resources are sufficiently low, i.e., $0 \leq \alpha_1 < \alpha_2$. Third, I make transfer responses to shocks in period 1 – cash-inkind transfers to illness and labor-time transfers to disaster damage –

[13] If illness is correlated with housing damage (as found above), omitting the latter causes bias in the estimated α.

heterogeneous by adding an interaction term, $h_{i1}d_{i1}$. This captures the contemporaneous link of household-level disaster damage with risk sharing against illness.

Last, to capture the reciprocity effect, I allow transfer responses to illness in period 2 to vary, depending on the disaster damage experienced in period 1, by adding an interaction term, $h_{i2}d_{i1}$. The final model is

$$y_{it} = \alpha_t h_{it} + \beta_1 d_{i1} + \gamma_1 h_{i1} d_{i1} + \gamma_2 h_{i2} d_{i1} + \sum_k \eta_k X_{itk} + V_t + u_i + e_{it} . \qquad (2)$$

This reduced-form specification does not identify how the history of transfers affects the current transfer; a lack of labor-time transfer information in period 1 in the Fijian data precludes a structural-form specification – using y_{i1} as a determinant of y_{i2} with cyclone damage d_{i1} as an excluded instrument. Equation (2) assumes that risk sharing against illness in period 2 depends on the outcome of risk sharing against disaster damage, not illness, in period 1; that is, it captures the potential reciprocity effect of disaster damage only. Since researchers cannot observe the complete history of transfers, this empirical strategy is practically attractive if they know what particular shocks can cause the reciprocity effect. An advantage of this reduced-form specification is that the history of risk sharing is inclusive, capturing all forms of mutual help among households, including those that are not measured by standard transfer data, such as co-residence for refugees.

The reciprocity effect suggests that risk sharing against illness in period 2 works better among non-victims than victims, i.e., $\gamma_2 < 0$; the marginal effects of illness in period t are α_t for non-victims and $\alpha_t + \gamma_t$ for victims, and in an extreme case, risk sharing against illness is still ineffective among victims in period 2, i.e., $\gamma_2 = -\alpha_2$. I also estimate equation (2) for the non-victim (N) sample and the victim (V) sample separately (d_{i1}, $h_{i1}d_{i1}$, and $h_{i2}d_{i1}$ vanish); the reciprocity effect suggests that $0 \leq \alpha_2^V < \alpha_2^N$.

C. Cash-inkind vs. labor-time transfers

Ideally, I would conduct complete tests of my conjectures by estimating equation (2) for cash-kind and labor-time transfers separately, but this is infeasible with the lack of a complete panel of labor-time transfers in Fiji. All I can do is test the resource and reciprocity effects on non-labor sharing against illness; I cannot test whether labor time is shared against disaster damage in period 1. I compare housing damage and crop damage (another income shock) as a source of the potential reciprocity effect (β_1 and γ_t are vectors). I conjecture that the reciprocity effect of housing damage is stronger than that of crop damage. This is because labor-sharing against housing damage is stronger than that against crop damage (the latter was actually nonexistent). Put differently, if the strong reciprocity effect of housing damage is found despite the absence of non-labor sharing against housing damage, this gives indirect evidence for strong labor sharing against housing damage in period 1, as I conjecture.

D. Household-group transfers

I analyze household-group transfers in a way comparable to the analysis of across-household transfers. If household-group transfers in period 2 – mainly for local public-goods provisions – are risk-sharing arrangements against illness among group members, those with illness contribute less to groups than others do. If groups are the same as villages, group-level covariate shocks, as well as all time-variant, group-level factors, are captured by village-time dummies, and equation (2) can be directly used to test the resource/reciprocity effects on household-group transfers. In addition to net transfers received from groups, I also estimate gross transfers contributed to groups separately, because decisions about transfers received from and given to groups are made by different agents and what these two cover is unbalanced in the transfer data.

The reciprocity effect on household-group cash-inkind transfers can occur in two ways. First, household-group labor-time transfers in period 1 – mainly for group-level rehabilitation – may also serve as risk-sharing arrangements against household-level disaster damage. This reciprocity *within groups* can be tested by estimating equation (2) for gross labor-time transfers given to groups. Second, across-household labor-time transfers in period 1 – for housing rehabilitation – may affect non-labor sharing among group members in period 2. This type of reciprocity is likely if household risk-sharing networks significantly overlap pre-formed groups. In Fiji, because major transfer networks consist of kin and religious affiliations, that the reciprocity effect exists mainly in kin and religious networks *and* groups provides evidence for this reciprocity *between networks and groups*, which suggests that the formation of not only transfer networks in general, but also risk-sharing networks are directly related to pre-formed groups.

E. Covariates

Household-level disaster damage d_{it} is captured by a dummy for housing damage, the value of crop damage per capita, and their interaction. Household crop damage is endogenous, because unobservable household and village characteristics, such as land quality, farming skills, and market and environmental conditions, which affect household pre-cyclone cropping decisions and thus crop damage, can be correlated with its transfer decisions. Most of these unobservable factors are fixed effects, which can be controlled for by the fixed-effects estimator. Housing quality, such as construction materials and micro location within villages, which might influence housing damage, may be correlated with household transfers; such pre-cyclone housing quality is also a fixed effect. Time-variant household characteristics X_{itk} are captured by household size.[14] Village-time dummies capture all village-level factors: time-variant market and environmental conditions, village-level shocks to housing and crops (which are shown above to be small), damage to village structures and facilities, and relief and construction materials received by the village.[15] For disaggregated transfers, alternative specifications are employed to better capture network- and group-level covariate shocks, as detailed in the next section. A time dummy controls for region-level covariate shocks, seasonality, and other common events or trends.

F. Measurement errors

Although errors in the measurement of housing damage are minimal, because relief officers used the same categories for their damage assessments (the damage status of each house was common knowledge among villagers), errors in the value of crop damage could be considerable and systematic. I repeated the analyses using the crop-damage dummy, the errors of which should be minimal, finding qualitatively the same results; dropping the crop-damage variable (and its interaction terms) does not significantly alter the remaining results, either. Although the subjective health measure, which is commonly used in household surveys, can contain significant measurement errors because of heterogeneous definitions of illness among respondents and their

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[14] As an alternative specification, I use land and fishing capital holdings as additional controls, finding results very similar to those presented below. Though these productive assets could be endogenous if they are adjusted to shocks (Rosenzweig and Wolpin 1993), the results suggest that this is unlikely to be the case.

[15] Relief and construction materials received by individual households are not included as explanatory variables, because they are endogenously determined as part of private risk sharing within villages (Dercon and Krishnan 2005; Takasaki forthcoming-a, b).

systematic misreporting (Strauss and Thomas 1998), the fixed-effects estimator helps reduce these problems.

The correlation of recall errors in private transfers with household-level shocks can cause bias. Specifically, a positive (negative) correlation – households with larger shocks tend to report higher (lower) net private transfers received than actual transfers – causes upward (downward) bias. If such a potential correlation with illness does not change significantly over time, it is controlled for by the fixed-effects estimator, and the estimated positive α_2 (resource effect) should be robust. This correlation still matters for disaster damage that occurred only in period 1. Unless the correlation is negative and large in magnitude, estimated negative γ_2 (reciprocity effect) should be qualitatively robust; its robustness is further buttressed by consistent results of the subsample analysis.

V. Estimation results

A. Aggregated transfers

The fixed-effects estimates of determinants of annual net cash-inkind transfers received per capita from other households and groups are shown in Table 3 (village-time dummies are used as controls and robust standard errors are reported). When cyclone damage is ignored (equation 1), transfers positively respond to illness, but the result is not statistically significant (column 1). When cyclone-damage variables are added, the estimated coefficient for illness does not change and no cyclone-damage variables yield significant results (column 2); that is, non-labor sharing was ineffective against housing and crop damage. The resource effect strongly holds: Although transfers were insensitive to illness in 2003, they significantly responded to illness in 2005 (the estimated marginal effect is F$100, or equivalently about two thirds of the mean gross transfers received) (column 3). None of the interaction terms of illness in 2003 with cyclone damage yielded significant impacts (column 4); that is, household-level cyclone damage does not contemporaneously affect risk sharing against illness. The reciprocity effect of housing damage is strong: In 2005, transfers responded to illness among households without damaged housing (about F$250 marginal effect), but not among others (the joint significance test for $\alpha_2 + \gamma_2 = 0$ is insignificant); other interaction terms with crop damage are insignificant (column 5). This finding is consistent with my working hypothesis that housing damage distinguished between recipients and donors in labor sharing in period 1.

In the remaining disaggregated analyses, I use the interaction term of illness in 2005 with the housing-damage dummy only (γ_2 is a scalar) to increase the degrees of freedom. Results of the estimated coefficients for illness in 2005 (α_2) and its interaction with housing damage (γ_2) in the whole sample and for illness in 2005 among households without damaged housing (α_2^N) and among those with damaged housing (α_2^V) are reported in Table 4. Potential selection bias in this subsample analysis is unlikely to be a major concern, because early descriptive findings suggest that housing damage is considered largely exogenous. Results for the aggregated transfers are almost the same as those in column (5) of Table 3, and the subsample analysis confirms that disaster non-victims are insured against illness, but victims are not (panel A1 of Table 4).

B. Disaggregated transfers

The resource and reciprocity effects hold not only in across-household transfers, but also in household-group transfers: When these two are estimated separately,[16] results

[16] In almost all disaggregated analyses discussed here, most households participate in transfers received or given in either 2003 or 2005 (Table 2); the only exception is transfers with social groups simply because 14% of households are not their members.

for the two effects are qualitatively the same, and marginal effects of illness in 2005 for non-victims (α_2 or α_2^N) are similar to each other (panel A1).

It appears that the reciprocity effect on household-group transfers exists between networks and groups, and not within groups, for the following reasons. First, labor sharing within groups does not serve as risk sharing against housing damage: Gross (monetized) labor-time transfers given to groups are neutral to all household-level shocks (column 6 of Table 3); this is also true for disaggregated groups.

Second, risk-sharing against illness through across-household transfers is mainly arranged in in-village and kin networks: Disaggregated results for in-village and tokatoka networks are similar to those for the aggregated networks, and the estimated marginal effects of illness in 2005 for non-victims are 70-83% of those for the aggregated networks (in proportion to the shares of in-village/in-tokatoka transfers in 2005) (panel A2 of Table 4). Although a similar analysis is infeasible for religious networks (with a lack of disaggregated panel data), the share of in-church transfers in 2005 is at a comparable level (Table 2). Replacing village-time dummies with tokatoka-time dummies for tokatoka networks does not significantly alter the results. Note that tokatoka-time dummies fully capture covariate shocks in the tokatoka networks, including out-of-village ones; on the other hand, village-time dummies fully capture covariate shocks in the in-village networks, but not in the aggregated networks, including out-of-village ones.

Third, among pre-formed groups, kin and religious groups are major risk-sharing ones: Although results for the village and kin, religious, and social groups are

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When transfers with social groups only among members are considered, the results are very similar to those for the whole sample presented here.

qualitatively the same as those for the aggregated groups (with the exception that the estimated γ_2 for the village is non-negative), the estimated marginal effects of illness in 2005 for non-victims are considerable only for kin and religious groups (34-50% of those for all groups combined, which is greater than their shares in the aggregated group transfers given in 2005, 25-29%), and only those for religious groups are statistically significant (panel A3). Village-time dummies fully capture covariate shocks in the village, but not other groups. Using tokatoka-time dummies, which fully capture covariate shocks in kin groups (tokatoka is the smallest unit in the hierarchical kin structure), does not significantly alter the results. Similar results for religious groups are obtained under two alternative specifications: one using church-time dummies (three church dummies are defined for Methodist, Catholic, and other small sects combined) and another using village-church-time dummies (they are coarser and finer, respectively, than local church groups, which are formed for each church across nearby villages). It is not straightforward to construct group dummies for social groups that consist of women's, school, and youth groups with overlapping memberships.

All results for gross cash-inkind transfers given to groups are similar to those for net transfers received, with opposite signs (panel B), though the marginal effect for aggregated transfers in the subsample analysis is smaller in magnitude, with weaker statistical significance. Hence, risk-sharing arrangements against illness take place mostly in household contributions to groups.

VI. Conclusion

Using original household panel survey data collected in rural Fiji, this paper demonstrated how informal risk-sharing institutions upon which poor people heavily rely when experiencing illness are vulnerable to natural disaster. First, household private, cash-inkind transfers do not serve as insurance against illness in the relief phase (several months after the cyclone); they do so only after pooled resources recover in the reconstruction phase (a few years later) (i.e., the resource effect). Second, risk-sharing arrangements depend on the history of labor-time transfers corresponding to housing damage: Only disaster non-victims are insured against illness, because victims already received labor help for their rehabilitation from non-victims (i.e., the reciprocity effect).

The paper also revealed that the resource/reciprocity effects exist in endogenously formed networks and pre-formed groups, which serve as risk-sharing pools, to a similar degree. Not only do private transfers exchanged among households serve as insurance, but also, household contributions made directly to groups – such as ritual gifts and religious donations – contain risk-sharing components against illness among group members. Although the former finding is common in the literature, the latter is new. Network formation is directly related to pre-formed groups, especially kin and religious ones.

These findings lead to the following policy and research implications. First, although it is crucial to better design and implement disaster relief/reconstruction (Amin and Goldstein 2008) and public-health programs to combat disaster-induced diseases (Noji 1997), these are not enough to prevent chronic health poverty. Policymakers need to strengthen broad public safety nets as a substitute for weakened private safety nets over extended post-disaster periods. Such efforts are necessary even if public health does not appear to be a major problem after the disaster; in fact, they may be even more necessary then, because available public-health programs are limited in such cases.

Second, it is necessary to augment local safety nets *ex ante* to combat less visible, post-disaster health problems. To this end, a better understanding of informal risk-sharing mechanisms among the poor is crucial. In Fiji, though the scope of informal risk sharing is greater than normally thought, fixed social relations – not only via kinship but also through religious affiliation – underlying local institutions need to receive explicit attention.

Third, although economists have not paid much attention to informal risk sharing against natural disasters, labor sharing against their idiosyncratic components can be significant, determining subsequent risk-sharing arrangements against non-disaster shocks. More research on the link between natural disasters and informal risk sharing is needed. How much does labor sharing help rehabilitation from a disaster? How persistent is the reciprocity effect? How do people react to the reciprocity effect? These are important questions that this paper did not explore.

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Table 1. Shocks and household characteristics by housing damage.

	Household means[a]					Variance decomposition[b]		
	2003	2005	2003[c]			2003&2005		
	All	All	Housing undamaged	Housing damaged	Mean/ prop. test (p-value)	Year	Village	House-hold
Shocks:								
Housing damaged dummy	0.58 (0.49)	0.00 (0.00)	0.00 (0.00)	1.00 (0.00)	-	40.8	2.2	57.0
Crop damaged dummy	0.82 (0.39)	0.00 (0.00)	0.80 (0.40)	0.83 (0.38)	*0.537*	69.3	0.8	29.9
Crop damage value per capita (F$)	44 (107)	0 (0)	34 (57)	52 (132)	*0.235*	7.9	2.6	89.5
Illness dummy	0.35 (0.48)	0.32 (0.47)	0.27 (0.45)	0.40 (0.49)	*0.054*	0.1	11.1	88.9
Illness in 2005 dummy[c]	-	0.32 (0.47)	0.32 (0.47)	0.33 (0.47)	*0.843*	-	-	-
Household characteristics:								
Annual earned income per capita (F$)	813 (1045)	1674 (1695)	823 (818)	805 (1186)	*0.900*			
Annual public transfer received per capita (F$)	18 (81)	11 (48)	20 (87)	17 (77)	*0.784*			
Household size	6.5 (2.9)	5.8 (2.7)	6.3 (2.7)	6.6 (3.0)	*0.353*			
Age of household head	50 (14)	51 (14)	51 (14)	49 (13)	*0.228*			
Female head dummy	0.13 (0.34)	0.14 (0.34)	0.13 (0.33)	0.13 (0.34)	*0.939*			
Adult secondary education dummy	0.87 (0.34)	0.81 (0.39)	0.88 (0.32)	0.85 (0.35)	*0.522*			
Land per capita (acre)	0.92 (1.19)	0.69 (1.55)	0.95 (1.13)	0.89 (1.23)	*0.720*			
Fishing capital per capita (F$)	50 (150)	46 (228)	43 (154)	56 (148)	*0.530*			
No. observations	226	226	95	131				

[a] Household means are shown along with standard deviations in parentheses.

[b] These are percents of total variance.

[c] 2005 for illness in 2005 dummy.

Table 2. Household annual private transfers.

	2003				2005			
	Received		Given		Received		Given	
(n=226)	Partici-pation	Mean amounts (F$ per capita)	Partici-pation	Mean amounts (F$ per capita)	Partici-pation	Mean amounts (F$ per capita)	Partici-pation	Mean amounts (F$ per capita)
A. Cash-inkind transfers								
A1. Aggregated transfers								
Both	45%	43 (246)	87%	110 (172)	95%	145 (215)	100%	232 (262)
Across-household	42%	37 (240)	63%	67 (169)	94%	106 (170)	87%	61 (87)
Group-household	4%	6.0 (58)	68%	44 (61)	33%	39 (85)	99%	171 (235)
A2. Disaggregated across-household transfers								
Location:								
Same village	35%	26 (220)	54%	46 (146)	88%	59 (80)	86%	52 (74)
Other village or city	12%	11 (59)	23%	21 (77)	35%	44 (128)	15%	8.5 (37)
Kinship:								
Same tokatoka	27%	28 (236)	37%	37 (145)	86%	67 (103)	80%	47 (72)
Other tokatoka	22%	9.5 (47)	41%	29 (75)	48%	38 (125)	42%	15 (44)
Religion:								
Same religious group	-	-	-	-	80%	74 (146)	74%	49 (84)
Other religious group	-	-	-	-	26%	32 (97)	21%	12 (40)
A3. Disaggregated household-group transfers								
Village	0%	0.1 (2.1)	42%	16 (40)	12%	4.0 (18)	80%	31 (47)
Kin groups	2%	5.5 (58)	19%	7.1 (22)	31%	29 (72)	81%	42 (69)
Religious groups	1%	0.3 (4.0)	32%	11 (24)	8%	4.8 (25)	96%	49 (84)
Social groups	0%	0.1 (1.1)	36%	10 (27)	5%	1.3 (7.7)	79%	49 (106)
B. Labor-time transfers								
B1. Aggregated transfers								
Both	-	-	-	-	46%	33 (96)	80%	104 (129)
Across-household	-	-	-	-	28%	21 (75)	28%	12 (33)
Group-household	-	-	97%	198 (184)	25%	12 (44)	80%	92 (112)
B2. Disaggregated across-household transfers								
Location:								
Same village	-	-	-	-	26%	14 (41)	28%	12 (32)
Other village or city	-	-	-	-	6%	7.0 (63)	4%	0.7 (5)
Kinship:								
Same tokatoka	-	-	-	-	26%	11 (37)	26%	8.7 (25)
Other tokatoka	-	-	-	-	13%	9.9 (65)	13%	4.1 (16)
Religion:								
Same religious group	-	-	-	-	19%	9.0 (35)	20%	6.5 (20)
Other religious group	-	-	-	-	10%	12 (67)	9%	5.9 (25)
B3. Disaggregated household-group transfers								
Village	-	-	87%	99 (92)	8%	1.8 (7.8)	73%	36 (59)
Kin groups	-	-	19%	8.8 (34)	22%	6.3 (25)	56%	23 (41)
Religious groups	-	-	73%	49 (86)	5%	1.1 (10)	46%	12 (21)
Social groups	-	-	67%	42 (63)	4%	2.6 (23)	43%	21 (46)

Note - Standard deviations are in parentheses.

Table 3. Determinants of household private transfers - fixed effects.

(n=452)		Net annual cash-inkind transfers per capita received from other households and groups (1)	(2)	(3)	(4)	(5)	Gross annual labor-time transfers per capita given to groups (6)
Illness dummy	α	37.6	36.2				
		(47.9)	(49.7)				
Housing damaged dummy	β_1		-34.9	-29.9	-20.5	-99.1	31.3
			(66.8)	(66.5)	(64.8)	(75.4)	(42.9)
Cyclone damage per capita (F$)			-0.34	-0.38	-0.60	-0.60	0.22
			(0.52)	(0.52)	(0.58)	(0.67)	(0.52)
Housing damaged dummy * Cyclone damage per capita			0.55	0.54	0.61	0.68	-0.27
			(0.53)	(0.53)	(0.59)	(0.67)	(0.54)
Illness in 2003 dummy	α_1			-19.7	-24.2	-12.2	-22.0
				(71.3)	(154.8)	(158.2)	(51.3)
Illness in 2005 dummy	α_2			99.8 *	96.5 *	253.6 **	-87.1
				(52.0)	(52.2)	(119.2)	(65.7)
Illness in 2003 * Housing damaged	γ_1				-30.5	-47.1	-18.8
					(155.1)	(160.0)	(65.0)
Illness in 2003 * Crop damage per capita					0.70	0.44	0.78
					(1.25)	(1.23)	(0.66)
Illness in 2003 * Housing damaged * Crop damage per capita					-0.22	0.06	-0.95
					(1.31)	(1.28)	(0.72)
Illness in 2005 * Housing damaged	γ_2					-285.3 **	25.7
						(133.5)	(84.3)
Illness in 2005 * Crop damage per capita						-0.50	0.95
						(1.33)	(1.08)
Illness in 2005 * Housing damaged * Crop damage per capita						1.40	0.25
						(1.70)	(1.40)
R squared		0.115	0.119	0.129	0.134	0.156	0.335
F (p-value)		0.000	0.000	0.000	0.000	0.000	0.000

*10% significance, **5% significance. Robust standard errors are in parentheses. Other controls not shown here are household size, village-time dummies, time-dummy, and constant.

Table 4. Effects of illness on annual cash-inkind transfers per capita - fixed effects.

	All		Housing undamaged	Housing damaged
	α_2	γ_2	α_2^N	α_2^V
	(1)	(2)	(3)	(4)
A. Net transfers received				
A1. Aggregated transfers				
Both	237.1 **	-247.7 **	253.4 **	-10.5
	(91.8)	(102.2)	(99.2)	(47.3)
Across-household	129.0 *	-133.5	157.3 *	-4.4
	(77.7)	(87.9)	(82.0)	(33.9)
Group-household	108.1 *	-114.2 *	96.0	-6.2
	(55.0)	(67.4)	(60.5)	(39.7)
A2. Disaggregated across-household transfers				
Same village	91.1	-80.2	111.0 *	14.9
	(62.6)	(76.1)	(64.4)	(26.0)
Same tokatoka	107.7	-110.5	131.1 *	4.7
	(68.4)	(82.7)	(69.5)	(27.5)
Same tokatoka	127.7 *	-115.2	132.2	25.9
(tokatoka-time dummies)	(73.2)	(92.7)	(82.6)	(32.5)
A3. Disaggregated household-group transfers				
Village	12.0	1.5	8.4	14.0
	(11.9)	(15.3)	(12.4)	(9.5)
Kin groups	36.9	-32.0	45.2	-4.5
	(32.9)	(31.7)	(38.2)	(14.6)
Kin groups	28.8	-28.2	41.9	0.1
(tokatoka-time dummies)	(29.0)	(31.0)	(38.3)	(14.2)
Religious groups	39.4 **	-39.2 *	34.4 *	3.3
	(17.2)	(22.5)	(18.0)	(15.3)
Religious groups	38.0 **	-35.0	39.5 **	1.7
(church-time dummies)	(17.6)	(24.0)	(19.3)	(18.6)
Religious groups	31.2 *	-26.6	25.2	-1.1
(village-church-time dummies)	(16.4)	(24.4)	(15.8)	(21.1)
Social groups	19.8	-44.4	8.0	-19.0
	(17.5)	(30.5)	(16.6)	(21.8)
B. Gross transfers given to groups				
All groups	-84.5 *	90.0	-64.5	-0.8
	(45.1)	(61.9)	(46.9)	(40.8)
Village	-10.2	-2.5	-6.6	-12.4
	(10.9)	(14.9)	(10.7)	(9.7)
Kin groups	-22.7	19.0	-23.1	-10.7
(tokatoka-time dummies)	(19.6)	(23.0)	(27.4)	(11.4)
Religious groups	-33.3 **	34.1	-28.4 *	-1.3
	(15.7)	(21.0)	(16.7)	(14.8)
Social groups	-21.3	48.1	-8.7	20.6
	(17.6)	(30.3)	(16.6)	(21.7)

*10% significance, **5% significance. Robust standard errors are in parentheses. Village-time dummies are used to control for village-level covariate shocks unless otherwise noted.