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Do tropical typhoons smash community ties? Theory and Evidence from Vietnam

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Abstract

Natural disasters trigger large inequalities between affected households and the rest of the community. The extent to which villages compensate for these shocks allegedly depends on the pressure imposed by the group of needy families. I model two major threats to redistribution - (i) the emergence of a coalition of winners willing to shy away from redistributing to their peers and (ii) the initial fractionalization of the community. Matching data on a wave of tropical typhoons with a panel household survey in Vietnam, I find less redistribution in villages where needy families are in the minority. Whereas 17 cents on average are covered through informal transfers for a relative income loss of $1, access to liquidity falls below 10 cents when heavily affected households are isolated in the commune. In line with the existing literature, minorities participate less in the resources reallocation. Despite these barriers to full insurance, risk-sharing through informal transfers is still economically significant. This result is related with the findings that communities having suffered important trauma show greater signs of resilience and cohesiveness.

Keywords: Natural disasters, informal risk-sharing, social insurance, altruism.

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I. Introduction

Natural disasters, such as earthquakes or typhoons, pose a threat to social cohesion by creating new inequalities among members of the same community. The classical allocative mechanisms come under severe tensions, and failure to accommodate these shocks can result in the emergence of anti-social behaviors. In this study, I focus on the 2005 wave of typhoons in Vietnam. These tropical storms swept across regions of Vietnam, bringing torrential rains and destroying crops. Entire villages were divided into groups of unemployed farmers and less affected households. The proportion of needy villagers might play a role in the degree of risk-sharing expected from spared members of the community. Intuitively, the pressure on those who might deliberately avoid their responsibilities should be lower in villages where needy families are in the minority. In this paper, I investigate theoretically and empirically how the balance of power between affected and unaffected villagers might affect the reallocation of resources in the community.

Relying on a model of imperfect commitment à la Ligon *et al.* [2002], I derive predictions on the evolution of informal transfers in communities after the realizations of large and simultaneous income losses. The critical assumption that limits redistribution among villagers is that the cost of shying away from supplying liquidity to needy villagers depends on the attitudes of others. A strong coalition of agents willing to break away jointly can lower the burden imposed on them by the rest of the community. The emergence of such a coalition can also be affected by the social identities of the affected villagers, which strongly influence the pressure on the unaffected lobby and determine the contributions to the contract.

I find support for the model using a representative panel household survey in Vietnam between 2004 and 2006 matched with typhoon trails. My findings indicate that the ex-post redistribution of resources across households is limited. Individual losses of $1 relatively to communal losses are covered by a net positive transfer of 17 cents in rural areas. Moreover, the weaker the pressure imposed by affected households the smaller their access to liquidity. Indeed, the average redistribution is approximately 10 cents lower in villages with a small and isolated group of needy households. This effect is comparable to the penalty of being from another ethnicity than the dominant ethnic group. Overall, however, the average amplitude of risk-sharing in Vietnam following this wave of typhoons is far from being negligible. An explanation is that repeated exposure, as is the case with periodic typhoons, leaves a community with a greater capacity to implement enforcement mechanisms. I find support for this idea in the fact that villages having suffered important trauma in the recent past show greater signs of resilience in 2005: the average compensation reaches there 40 cents, a feature partly explained by a greater capacity to secure interactions independently of the social identities of contractors.

Vietnam is plagued by tropical typhoons forming in the warm waters of the West-Pacific basin. More than once every 5 years, the equivalent of a category 4 hurricane[1] hits the Vietnamese coasts, and milder tropical storms occur every season between June and October. Only the southern part - too close to the equator - and the mountainous northern zone are relatively spared. As Vietnam is still an agrarian economy, income fluctuations due to the passage of typhoons and associated disasters (mudslides, floods...) are important. Despite this predictable vulnerability, there are no formal institutions designed to smoothen large and correlated shocks such as natural catastrophes. The devolution of tasks to people's committees illustrated by the decree 29 of May 1998 on "Grassroots Democracy" has led to much less responses from the central government. The interventions of regional authorities, NGOs, firms or public organizations do not always reflect real losses in terms of amplitude and often come with a penalizing delay. At last, credit constraints rule out the possibility for households to smoothen consumption by contacting institutional lenders.

As a substitute for these failing macroeconomics responses, households reallocate resources within villages (see the riveting article by Townsend [1994]). Rural inhabitants in Vietnam make an extensive use of gifts and informal loans as risk-pooling instruments. This reliance on informal transfers for consumption-smoothing has been emphasized in other rural economies (see the seminal papers of Rosenzweig [1988] and Coate & Ravallion [1989]). Nonetheless, imperfect commitment appears to substantially constrain the extent of these risk-sharing networks: part-

[1] maximum sustained winds between 210 and 249 km/h.

ners are supposed to be relatives and friends; or neighbors and colleagues (Foster & Rosenzweig [2001], Fafchamps & Lund [2003], Fafchamps & Gubert [2007a]). Inopportunely, occupational activity of friends and relatives are often close to the household's. The scope of classical informal insurance networks relying on relatives and friends then makes agents particularly vulnerable to geographically and occupationally co-moving shocks. In short, households are not able to fall back on these insurance networks in the aftermaths of a typhoon. The present project questions the possibility of risk-sharing mechanisms at the village level to alleviate this issue and investigates how households coordinate on the redistribution of resources.

Informal insurance at the village level is not the only mechanism for reducing the exposure to income shocks. Off-farm employment and precautionary savings[2] allow farmers to untangle consumption dynamics from agricultural revenues. The lack of work opportunities and the use of savings for peculiar purposes with a strong cultural connotation (dowries, bequests...) tend to limit in practice the use of those two instruments in Vietnam. Finally, migrants have been identified as risk-sharing partners in many studies (see Yang & Choi [2007] in the context of rainfall shocks in the Philippines). Foreign and urban migrations are very limited in Vietnam; only a very small fraction of rural families rely on remittances.

Higher level of altruism in the wake of important traumas have been highlighted by another strand of literature. The early work of Douty [1972] remarks that residents affected by a natural disaster are inclined to be more charitable toward other members of the community. This feature is explained by coordination organized by pre-disaster leaders. This work has recently found an echo in the economic literature. Individuals whose households have been directly affected by a civil conflict are more likely to show a community feeling, participate in community meetings, join political groups (see Bellows & Miguel [2009] focusing on the 1991-2002 Sierra Leone civil war). More indirectly, the variability of climate over centuries seems to be a determinant of trust in European regions through the consolidation of community links [Durante, 2009]. The evidence in the present paper is in line with those observations. Agents seem to revise their beliefs about the social contract after having

[2] see Kochar [1999] for the importance of off-farm activities and Paxson [1992] for savings.

experienced a situation where inequalities arise mainly because of circumstances and not efforts or merits.

To my knowledge, this project is the first paper focusing on coordination and informal arrangements at the village level after large natural disasters. A major stumbling block is the absence of micro-economic datasets combining both information of links between households and a sufficient number of observed villages. The present paper uses peculiar features of a representative household panel survey conducted between 2004 and 2006 on 2000 villages of rural Vietnam. The estimation strategy rests upon the construction of a virtual network composed of a random subsample of villagers for each village. In parallel, accurate and objective data on cyclones are used to construct the local impact of the 2005-2006 season on each village and the propensity of being hit. The empirical identification relies then essentially on two treatments: a treatment constructed at village level and different vulnerabilities to this common treatment in each village. The individual vulnerability of a villager to the passage of a typhoon is captured by the occupations and assets of each household before the catastrophe. Intuitively, I compare the evolution of the gap between protected villagers and vulnerable families in affected villages compared to unaffected villages with the same average exposure to typhoons.

I present in section II. a theoretical model on the enforceability of informal contracts in a village divided into pre-shock groups or casts and post-shocks coalitions. Then, I discuss the strategies to construct a consistent dataset and document the magnitude of tropical typhoons in section III.. In section IV., I present the empirical strategies to construct income losses due to the passage of typhoons and the main results. Extended results using pre-disaster community background, the structure of the village and additional indicators of social identity of potential risk partners are discussed in section V.. Section VI. provides insights on the importance of past traumas as a catalyst for implementing redistribution.

II. Theoretical model

A. Hypotheses

The model will be voluntarily oriented toward risk-sharing issues. Yet the risk-sharing contract can equally be considered as a social contract and transfers as donations. The economy will be limited to a closed village, composed of N households. Villagers live two periods and earn y^k at period 0, y^k_s at period 1 depending on the state of nature s. Ω describes the finite set of potential outcomes. Y and Y_s are the resources gathered by all the villagers at period 0 and 1. A state s will occur with a probability p_s and the uncertainty in the community can be represented by a mapping[3] S attributing to any villager k a certain income in state s. S can be considered as a representation of natural hazards as it depicts the ex-ante set of potential outcomes.

$$S : \begin{array}{rl} (k,s) & \mapsto y^k_s \\ \{1,...,N\} \times \Omega & \mapsto [\underline{y}, \overline{y}] \end{array}$$

Households only value their consumption and not directly the level of transfers they receive or give. Their utility u is strictly increasing and concave. I will denote β the time discount. As savings and other stocking technologies are not available in the economy, the consumption c^k will be the residual of the income once deducted or added the potential informal transfers or access to liquidity τ^k. The presence of legally-enforced contingent assets is excluded. Yet, informal sharing of resources is unconstrained in the group of households and any reallocation is theoretically possible. From this perspective, the risk-sharing contract can be thought as a process organized by a central planner, gathering and redistributing the fruits of the community labor conditional on the participation of households at both periods. Departing from Bramoullé & Kranton [2007] and Bloch *et al.* [2008], the network structure of the village will not be detailed and links will effectively exist between each pair of villagers but commitment issues tend to weight down the value each member might extract from those links.

[3]as these functions are defined over a finite set, it is extremely easy to create a distance and associate to these functions a metric space.

Two **guilds** $g \in \{m, f\}$ form an exogenous partition $G_m \cup G_f$ of the community, the Merchants and the Farmers grouping respectively N_m and N_f households[4].

The timing of the game is the following: at period 0, the community agrees ex-ante on a contract redistributing income at both periods. The ex-ante payments are made and each household consume. At period 1, after the realization of the sate of nature, agents decide to deviate or enforce the contract, once observed the contingent payments τ_s^k they have to make. Deviations incur a private cost, which will be discussed below. The exiters will make the contract null and void with a probability $\frac{i+j}{N_m+N_f}$ depending on the number of exiters $i+j$. If the contract breaks, the community is back to autarky; otherwise, the distribution of resources will be in line with the contract terms. Agents then consume and doomsday occurs.

The agent's decision to enforce the contract at period 1 will be represented by the following function (where 1 corresponds to a deviation):

$$d_k : \begin{array}{ll} s & \mapsto d_k(s) \\ \Omega & \mapsto \{0, 1\} \end{array}$$

Before listing the properties of the defaulting costs, notice that punishment can not come from the threat of being excluded from risk-sharing arrangements. As the punishment is a sunk cost, ex-post renegotiation would be always optimal if the network links are threatened. This model relies then on the assumptions that default triggers a cost even in a static framework and that the community can commit not to renegotiate a contract with households reluctant to give the specified transfers during a period even if period 1 is the last period of the game. The cost will represent here indistinguishably a punishment or the guilt for disavowing fairness norms. I do not intend to favor one or the other interpretation in this theoretical framework.

In line with the concept of fragility developed in Bloch *et al.* [2007], stressful circumstances can here tighten some enforcement constraints and a group of unaffected households might obtain endogenously the opportunity to break away and

[4]In this framework, some states of nature might be associated with the over-representation of a certain caste in the group of losers, reflecting the strong correlation between fraternity formation and type of activity. Incidentally, following some shocks full insurance within castes might be utterly inefficient.

refuse the redistribution of resources. Namely, when agents deviate simultaneously with other agents, they reduce the punishment the community tries to impose on them.

Consider $V(s) = (V_k(s))$ the set of utility derived from the contract for all agents after the realization of s. Before introducing the restrictions imposed on the punishment threat, let me define two sets of mathematical objects $d^i(.)$ and $V^i(.)$ which will prove useful[5] and let us drop temporarily the subscript s:

$$\begin{cases} \forall V, i \in 1, \ldots, N, x \in \mathbb{R}, V^i_j(x, V) = V_j \mathbb{1}_{i \neq j} + x \mathbb{1}_{i=j} \\ \forall d, i \in 1, \ldots, N, D \in \{0, 1\}, d^i_j(D, d) = d_j \mathbb{1}_{i \neq j} + D \mathbb{1}_{i=j} \end{cases}$$

Here, non-deviating agents costlessly exert a punishment constant across exiters from the same guild ψ^g. The functions $(V, d) \mapsto \psi^g(V, d)$ verify the following conditions:

$$\forall V, d, i, g,$$

$$\psi^g(V, d^i(0, d)) \geq \psi^g(V, d^i(1, d)) \qquad (i)$$

$$\forall x > V_i, \begin{cases} \psi^g(V^i(x, V), d^i(0, d)) \geq \psi^g(V, d^i(0, d)) \\ \psi^g(V^i(x, V), d^i(1, d)) \leq \psi^g(V, d^i(1, d)) \end{cases} \qquad (ii)$$

$$i \in G_g, \begin{cases} \psi^g(V, d^i(0, d)) - \psi^g(V, d^i(1, d)) \geq \psi^{\neg g}(V, d^i(0, d)) - \psi^{\neg g}(V, d^i(1, d)) \\ |\psi^g(V^i(x, V), d) - \psi^g(V, d)| \geq |\psi^{\neg g}(V^i(x, V), d) - \psi^{\neg g}(V, d)| \end{cases} \qquad (iii)$$

(i) reflects the fact that exiters do not participate as much as non-exiters in the global reprimand imposed on the defaulting group. (ii) reinforces this idea, as increasing the value of the contract for a non-exiter increase the burden on the coalited group, this non-exiter contributing more to the global punishment. On the opposite, an increase in this value for an exiter tends to reduce the weight of the community resentment. Finally, (iii) complements these hypotheses by specifying that (i) and (ii) are even more acute for exiters of the same guild than for foreigners, reflecting either the increased monitoring abilities or the higher level of altruism within guilds. Households are more sensitive to punishments incurred by agents with the same social identity or show more altruistic sentiments toward their peers.

[5] This allows to modify a single component of the vectors of decisions and utility and analyze some properties along a single dimension.

A credible contract should be robust to three constraints. First, it should respect the resources constraints imposed by the absence of stocking technologies; aggregate consumption should be lower than aggregate income at each period. Second, the households should be willing to enter into the contract at period 0. Third, following any state of nature, households should coordinate on a Nash equilibrium where nobody deviates. The following section determines the conditions ensuring that no Nash equilibria with potential breach of contract exist (**strong** enforcement).

The rest of the theoretical part is organized as follows: first, I establish how agents coordinate on deviations once a state of nature has been realized and deduce important properties of the anticipated punishment threat. Then, I derive the optimal contract and finally establish testable predictions.

B. Coordination on deviation

Consider a contract defined by consumptions at period 0 and following any state of nature, $\left\{c^k, \left\{c_s^k\right\}\right\}$. Take the realization of s as given. Each agent observes s and can compute her net welfare of having the contract enforced $V_k(s) = U_k(s) - A_k(s)$ (where $U_k(s) = u(c_s^k)$ is the welfare derived from having the contract enforced at period 1 and $A_k(s) = u(y_s^k)$ the autarchy welfare). Sorting the households by their guilds and their utility from having the contract enforced in state s,

$$\begin{cases} V_{f_1}(s) \leq V_{f_2}(s) \leq ... \leq V_{f_{N_f}}(s) & f_n \in G_f \\ \\ V_{m_1}(s) \leq V_{m_2}(s) \leq ... \leq V_{m_{N_m}}(s) & m_n \in G_m \end{cases} \tag{I}$$

Lemma 1. *In any Nash equilibrium, the decisions are necessary monotonous within guild, i.e.*

$$\forall g \in \{m, f\} \quad \left(n < n^{'} \Rightarrow d_{g_n}(s) \geq d_{g_{n'}(s)}\right)$$

Proof. In the appendix. □

As a direct consequence of this lemma, Nash equilibrium can be characterized by pivotal households in both guilds (i.e. households dividing both guilds between exiters and non-exiters). The following theorem echoes this intuition.

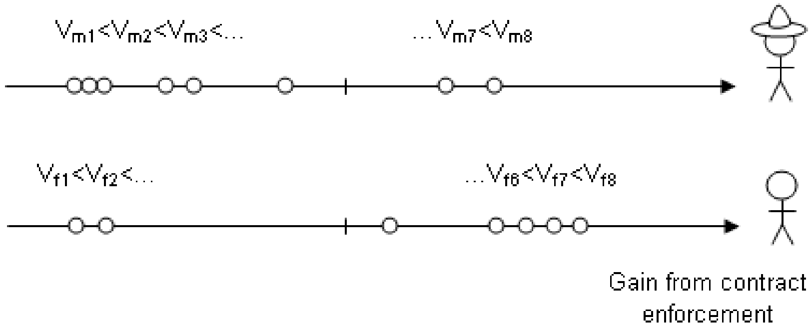


Figure 1: An example of dispersion of gains from contract enforcement in a state where the affected households are mainly farmers (no hat)

Theorem 1. *A necessary and sufficient condition for the existence of an interior Nash equilibrium, i.e. a Nash equilibrium with deviations, is the following:*

$$\exists i, j, \quad \begin{cases} V_{f_i}(s) \leq -\psi^f(V, d^*(V,i,j)) \\ V_{m_j}(s) \leq -\psi^m(V, d^*(V,i,j)) \end{cases}$$

where

$$d_k^*(V,i,j) = \begin{cases} 1 & if\ f_k \leq f_i \\ 0 & if\ f_k > f_i \end{cases}, k \in G_f \ \ or \ \begin{cases} 1 & if\ g_k \leq g_j \\ 0 & if\ g_k > g_j \end{cases}, k \in G_m$$

Proof. In the appendix. □

Accordingly, when defining the terms of the contract, the central planner should break any potential coalition by discouraging at least one of the sub-group in each guild. It is sufficient to ensure that at least one of the inequality is violated for each potential pair of pivotal households. The following corollary allows to provide a convenient description for the set of enforceable contracts prior to the optimization. Let us consider for simplicity $\Psi^g_{i,j}(V) = \psi^g(V, d^*(V,i,j))$, the punishment for guild g associated with monotonous strategies implying pivotal households i and j.

Corollary 1. *A necessary and sufficient condition for* ***strong enforcement*** *is:*

$$\forall (i,j) \in G_f \times G_m, \exists \iota_s^{i,j} \quad \begin{cases} \iota_s^{i,j}\left(V_i(s) + \Psi_{i,j}^f(V(s))\right) + (1-\iota_s^{i,j})\left(V_j(s) + \Psi_{j,i}^m(V(s))\right) \geq 0 \\ 0 \leq \iota_s^{i,j} \\ \iota_s^{i,j} \leq 1 \end{cases}$$

Some features of the initial properties of the punishment function resist to the strategic choices of agents. The monotonous lemma ensures that the punishment on the coalition is higher when a non-exiter sees her value of having the contract enforced increased (and lower if the increase concerns an exiter). In addition, this impact is higher on the members of the coalition who belong to the same guild as the agent concerned by a change of utility.

Proposition 1. *The credible punishment threats $\Psi_{i,j}^g(V)$ verify the following properties:*

$$\forall V, i \in G_f, j \in G_m, k \in G_f,$$
$$\forall W' \geq W > V_i,$$
$$\forall g, \begin{cases} \Psi_{i,j}^g(V^k(W',V)) \geq \Psi_{i,j}^g(V^k(W,V)) & (i) \\ |\Psi_{i,j}^f(V^k(W',V)) - \Psi_{i,j}^f(V^k(W,V))| \geq |\Psi_{i,j}^m(V^k(W',V)) - \Psi_{i,j}^m(V^k(W,V))| & (ii) \end{cases}$$
$$\forall V_i > W' \geq W,$$
$$\forall g, \begin{cases} \Psi_{i,j}^g(V^k(W',V)) \leq \Psi_{i,j}^g(V^k(W,V)) & (i) \\ |\Psi_{i,j}^f(V^k(W',V)) - \Psi_{i,j}^f(V^k(W,V))| \geq |\Psi_{i,j}^m(V^k(W',V)) - \Psi_{i,j}^m(V^k(W,V))| & (ii) \end{cases}$$

The equations hold inverting the role of guilds m and f.

Proof. In the appendix. □

Increasing the value of the contract for a potential non-exiter increases the equilibrium burden on the group reluctant to pay (i). This effect is larger on the members of this group with the same identity as the potential non-exiter (ii).

An important caveat of the model appears here: the punishment levels Ψ might not be continuous, even less differentiable. A natural assumption would be that each non-exiter exerts a constant threat on each member of the deviating group. In this case, Ψ will be discontinuous (especially at a point V where some households of the same guild share the same net utility). For computational purposes, I will impose

- and this is rather ad-hoc - that the functions Ψ are continuously differentiable quasi-concave functions (H_c). In the appendix, a particular form of those functions is discussed, which allows to grasp the degree to which the hypothesis of continuity and quasi-concavity might be restrictive.

C. Optimization

Replicating Ligon *et al.* [2002], the value function for the first household will be:

$$U^1(Y) = \max_{\{c^k\}_i, \{c^k_s\}_{s,k}, \{\iota^{i,j}_s\}_{i\in G_f, j\in G_m, s\in\Omega}} \left\{ u(c_1) + \beta \sum_s p_s u\left(c^1_s\right) \right\} \tag{V}$$

under an ex-ante constraint for every household to sign the contract,

$$(\lambda_k) \quad u(c^k) + \beta \sum_s p_s U^k_s \geq u(y^k) + \beta \sum_s p_s u(y^k_s), \forall k \in G_f \cup G_m \tag{EaC}$$

an ex-ante resources constraint imposed by the absence of a stocking technology,

$$(\theta) \qquad \sum_{k\in G_f\cup G_m} c^k \leq Y \tag{RC0}$$

ex-post constraints for exit strategies implying agents $i \in G_f$ and $j \in G_m$ as pivotal households to be impossible,

$$\begin{aligned} &\forall (i,j) \in G_f \times G_m, s \in \Omega, \\ &(\beta p_s \varphi^{i,j}_s) \quad \iota^{i,j}_s \left(V_i(s) + \Psi^f_{i,j}(V(s))\right) + (1 - \iota^{i,j}_s)\left(V_j(s) + \Psi^m_{j,i}(V(s))\right) \geq 0 \end{aligned} \tag{EpC}$$

ex-post resources constraints,

$$(\beta p_s \theta_s) \qquad \sum_{k\in G_f\cup G_m} c^k_s \leq Y_s, \forall s \in \Omega \tag{RC1}$$

and two constraints on the choice parameters $\iota^{i,j}_s$:

$$\begin{array}{ll} (\beta p_s \underline{\nu}^{i,j}_s) & 0 \leq \iota^{i,j}_s \\ (\beta p_s \overline{\nu}^{i,j}_s) & \iota^{i,j}_s \leq 1 \end{array}, \forall (i,j) \in G_f \times G_m, s \in \Omega$$

Lemma 2. *Under the assumption (H_c), the set of enforceable contracts is a convex set and a solution will verify the Kuhn-Tucker first-order conditions.*

Proof. The objective function is concave. All but the ex-post constraints verify the Slater conditions by convexity arguments (the ex-ante constraints because u is concave, the other constraints being linear). Since the intersection of convex sets is also a convex set, it is sufficient to prove that each constraint defines a convex set (true under the hypothesis (H_c)) to ensure that the Slater conditions are verified. □

The reader can jump to the appendix and check the computations of the first-order conditions. Let me come to the basic point: as long as the transfers which would maintain the ratios of marginal utilities equal across time do not violate the enforcement conditions, the ratios of marginal utilities are kept constant. Once a marginal ratio is potentially too low, the payment might be too important and some households might have the incentives to coordinate on a deviation. The optimal contract readjusts the targeted ratio downward to the limit where the contract remains enforceable. Denote $\Lambda^{k,k'}$ and $\Lambda_s^{k,k'}$ the ratios of marginal utilities between any households k and k' at period 0 and after the realization of s.

$$\Lambda^{k,k'} = \Lambda_s^{k,k'} \frac{1+\phi_s^k}{1+\phi_s^{k'}} \quad \forall k, k', s$$

The presence of the constraints weights ϕ_s induces imperfect insurance. More accurately, each weight is a combination of two separate effects: first, the incentives for the household k to be the pivotal household in its own guild and deviate with another pivotal household j will be directly affected by an increase of utility. Second, it will affect the balance of power in the village between affected and unaffected households.

$$\phi_s^k = \begin{cases} \frac{1}{\lambda_k}\sum_{i\in G_f, j\in G_m} \varphi_s^{i,j}\left[\iota_s^{i,j}\frac{\partial \Psi_{i,j}^f}{\partial V_s^k} + (1-\iota_s^{i,j})\frac{\partial \Psi_{j,i}^m}{\partial V_s^k}\right] + \frac{1}{\lambda_k}\sum_{j\in G_m}\varphi_s^{k,j}\iota_s^{k,j}, & k\in G_f \\ \\ \frac{1}{\lambda_k}\sum_{i\in G_f, j\in G_m} \varphi_s^{i,j}\left[\iota_s^{i,j}\frac{\partial \Psi_{i,j}^f}{\partial V_s^k} + (1-\iota_s^{i,j})\frac{\partial \Psi_{j,i}^m}{\partial V_s^k}\right] + \frac{1}{\lambda_k}\sum_{i\in G_f}\varphi_s^{i,k}\iota_s^{i,k}, & k\in G_m \end{cases}$$

D. Predictions derived from the theoretical discussion

In this section, I focus mainly on two cases. The first extreme situation arises when full ex-post transfers (associated with the welfare $F_i(s)$) are not even sufficient to raise a lobby of exiters in a state $\underline{s}$ in an environment associated with the mapping $\underline{S}$. Namely:

$$\forall i \in G_f, j \in G_m, \begin{cases} F_i(\underline{s}) - A_i(\underline{s}) > -\Psi^f_{i,j} \\ \\ F_j(\underline{s}) - A_j(\underline{s}) > -\Psi^m_{i,j} \end{cases} \tag{H1}$$

The second situation arises when, in a certain state $\overline{s}$ associated with a certain mapping $\overline{S}$, deviations from farmers are not credible and do not affect the contract in any manner. Unaffected farmers have no opportunities nor incentives to deviate even if all merchants were inclined to do so and the contract was the full-insurance contract. On the opposite, a coalition of J merchants is the only threat to the ex-post redistribution.

$$\forall i \in G_f, \begin{cases} F_i(\overline{s}) - A_i(\overline{s}) > -\Psi^f_{i,N_m} \\ F_J(\overline{s}) - A_J(\overline{s}) < -\Psi^m_{0,J} \\ F_K(\overline{s}) - A_K(\overline{s}) > -\Psi^m_{0,K}, K \neq J \end{cases} \tag{H2}$$

Theorem 2. *Under the assumptions (H1) and (H2), there exists neighborhoods $\underline{V}$ and $\overline{V}$ around the extreme mapping $\underline{S}$ and $\overline{S}$, such that:*

For environments in the neighborhood $\underline{V}$,

i. the marginal ratios between two households are independent of their respective guilds in state $\underline{s}$ and, at first order, denoting $z^k_{\underline{s}}$ the unexpected component, $\tau^k_{\underline{s}}$ the net transfers received by the household, the contract specifies the following pattern of informal transfers:

$$\tau^k_{\underline{s}} = -z^k_{\underline{s}} + \frac{1}{N^k}\sum_{k'=1}^{n} z^{k'}_{\underline{s}} \tag{S1}$$

where $N^k = \sum_{k'=1}^{n} \frac{y^k \sigma^{k'}}{y^{k'} \sigma^k}$ and $\sigma = \frac{yu''(y)}{u'(y)}$ the local risk aversion.

For environments in the neighborhood $\overline{V}$,

ii. the first-best contract can not be enforced and

$$\Lambda^{k,k'} = \Lambda_{\overline{s}}^{k,k'} \frac{\lambda^k + \varphi_{\overline{s}}^{0,J}(\frac{\partial \Psi_{J,0}^m}{\partial V_{\overline{s}}^k} + \mathbb{1}_{k=J})}{\lambda^{k'} + \varphi_{\overline{s}}^{0,J}(\frac{\partial \Psi_{J,0}^m}{\partial V_{\overline{s}}^{k'}} + \mathbb{1}_{k'=J})}$$

iii. introducing another household k'',

$$\Lambda_{\overline{s}}^{k,k''} - \Lambda^{k,k''} = \beta_{k,k'}^{k,k''} \left[\Lambda_{\overline{s}}^{k,k'} - \Lambda^{k,k'}\right] \tag{S2}$$

where $\beta_{k,k'}^{k,k''} = \frac{\left(\frac{\partial \Psi_{J,0}^m}{\partial V_{\overline{s}}^{k''}} + \mathbb{1}_{k''=J}\right) - \left(\frac{\partial \Psi_{J,0}^m}{\partial V_{\overline{s}}^{k}} + \mathbb{1}_{k=J}\right)\Lambda^{k,k''}}{\left(\frac{\partial \Psi_{J,0}^m}{\partial V_{\overline{s}}^{k'}} + \mathbb{1}_{k'=J}\right) - \left(\frac{\partial \Psi_{J,0}^m}{\partial V_{\overline{s}}^{k}} + \mathbb{1}_{k=J}\right)\Lambda^{k,k'}}.$

Proof. In the appendix. □

The first equation will be referred to as specification (S1) in the rest of the paper and this case can be considered as illustrating idiosyncratic shocks. The interpretation is straightforward: without a coalition threatening the redistribution, transfers offset completely the relative losses of the household k compared to losses underwent by other households. N^k can be interpreted as the number of households weighted by their expected marginal gains from insurance and would be equal to the total number of households had they been homogeneous. This specification can thus provide a test for the hypothesis of infinite violation costs. In the literature, similar specifications have already been tested extensively.

The system of equations (S2) can be interpreted as measuring the heterogeneity of redistribution patterns in the economy. $\Lambda_{\overline{s}}^{k,k''} - \Lambda^{k,k''}$ stands for the distance from full-insurance for the pair (k, k'') considered separately. $\beta_{k,k'}^{k,k''}$ captures then how close the couple (k, k'') is close to full-insurance relatively to the couple (k, k'). The ratios of marginal utilities will covary in the village, depending on the role of each household in the deviation sub-game. The estimation of $\beta_{k,k'}^{k,k''}$ allows us to capture the relative distance to full insurance as a function of the identities of contractors. To my knowledge, this specification has never been tested in the literature.

Let us dig further into the redistribution patterns which are revealed through β. In this regard, I rank households by their utility extracted from having the contract enforced and see how transfers attitudes between the most affected - 1 - household and the least affected - 3 - household covary with those between 1 and 2. The properties of the punishment function implies that $\beta_{1,2}^{1,3}$ will be higher when the least and most affected households do not belong to the same guild. In other words, the unaffected household will participate less in the redistribution when the needy villagers in the community are from the other guild. The last effect will be more salient the stronger and more coherent is the potential coalition group. In other words, both the ex-post and ex-ante cohesiveness of the defaulting group would contribute to a higher $\beta_{1,2}^{1,3}$. Heavily fractionalized societies[6] are expected to present a even higher reluctance to ensure redistribution from the unaffected guild. Additionally, another prediction embedded in the expression of $\beta_{1,2}^{1,3}$ is that household 3 gives particularly less than household 2 the closer the latter from the former. In other words, the differences of attitudes toward the contract across guilds is particularly salient for unaffected households. This effect reflects the easier constitution of coalition within guilds than across.

In conclusion, shocks create sub-groups with correlated incentives to coordinate and default jointly. The decision to default on a contract does not result from an insufficient threat exerted by a principal but might emerge endogenously from the distribution of values that agents derive from the contract. The opportunity for the unaffected members to form a lobby limits the degree of redistribution. Under the assumption (H1), informal transfers are unconstrained, independent of the structure of the community and should verify the equation (S1). Things are quite different if agents collude and reduce the burden imposed by the rest of the community. The level of transfers will be strongly affected by the guild a household belongs to and its role within this guild.

[6]societies in which the punishment incurred from deviating is significantly higher within guilds than across.

E. Comments

The critical assumption of the model that create an endogenous pressure on the contract and the constitution of default groups is the unambiguously positive externalities that each default exerts on others' cost of defaulting. These feature can partly reproduce two different mechanisms. First, the capacity for a potential principal to enforce a contract might depend on the influence of the defaulting group members. In particular, if we think of the principal as the village leader, he might be concerned by reelection issues. Second, the number of agents adopting a certain behavior might change the perception of fairness norms in a village and agents may be much more influenced by the attitude of their most immediate peers.

The model incorporates many restrictive hypotheses. Some of them might be relaxed without changing the qualitative results. For instance, the model is not very sensitive to the hypotheses regarding the availability of stocking technologies. Similarly, it is possible to get rid of the enforce-or-default assumption and model the lobbying in favor of contract breach as a continuous function of some effort. Regarding the decision to default, the hypothesis of common cost within a same guild can be slightly relaxed. The results would have been similar had the deviation costs been separable into individual and common components with this common punishment entailing completely both the spillover and guild effects. Note that individual differences in their attachment to their guild or in their sensitivity to peer attitudes would make the analysis far more complicated but would probably not change the results qualitatively. Lastly, I rule out potential corruption or collusion.

This model can be extended to a multi-period framework with a dynamic contract. Yet, the core of the model is salient in the two-period framework. Besides, two main issues arise as a consequence of the repeated game structure: what is the outside option and how do punishment costs evolve through time? When an endogenously-constituted group decides to default, they might decide to renegotiate a contract among themselves. In addition, a multiple-period contract adds to the preexisting set of constraints the constraint of renegotiation-proofness.

III. Description of the data

In this article, I use the Vietnam Household Living Standards Surveys which were carried out in 2004 and 2006 by the General Statistics Office. These surveys reproduce quite faithfully a first wave of surveys organized with a tight monitoring of the World Bank but depart from them by including an expenditure module to the initial questionnaire. A panel is conducted between the two waves of 2004 and 2006 and the structure of the questionnaire remains stable. As shown in figure 2, the surveys covers almost the 600 districts of Vietnam, with 3 to 36 households by districts and geographical indicators are sufficiently precise to locate each commune in a district despite numerous changes in nomenclature since 2000. This study is representative of the whole population, and weights are supplied so as to correct for the over-representation of rural and deprived areas. The sampling is part of the empirical strategy: 2500 communes[7] are drawn; in each commune, an enumeration area is drawn and 3 households are randomly interviewed in this area. To sum up, the dataset is composed of approximately 2500 small conglomerates of 3 households living in a very restricted geographic area, i.e. 2500 potential risk-pooling networks or small communities in which a social contract is very likely to exist. These households provide a partial but unbiased picture of risk-pooling within the hamlet. I discuss later the implications of these features on the identification strategy. Some traits of the datasets compensate largely for the small number of households interviewed in each village. Firstly, the household section of the survey covers a large spectrum of household characteristics[8]. Investment in social capital as described in

[7] A commune is composed of several small villages (1600 households on average, from 500 to 5000 for the more important). Enumeration Areas were determined during the 1999 census so as to divide communes or wards into units composed of approximately 100 households. Intuitively, enumeration areas are close to hamlets. In the rest of the paper, for simplicity, I might refer to the surveyed households as living in the same commune instead of EA/hamlet.

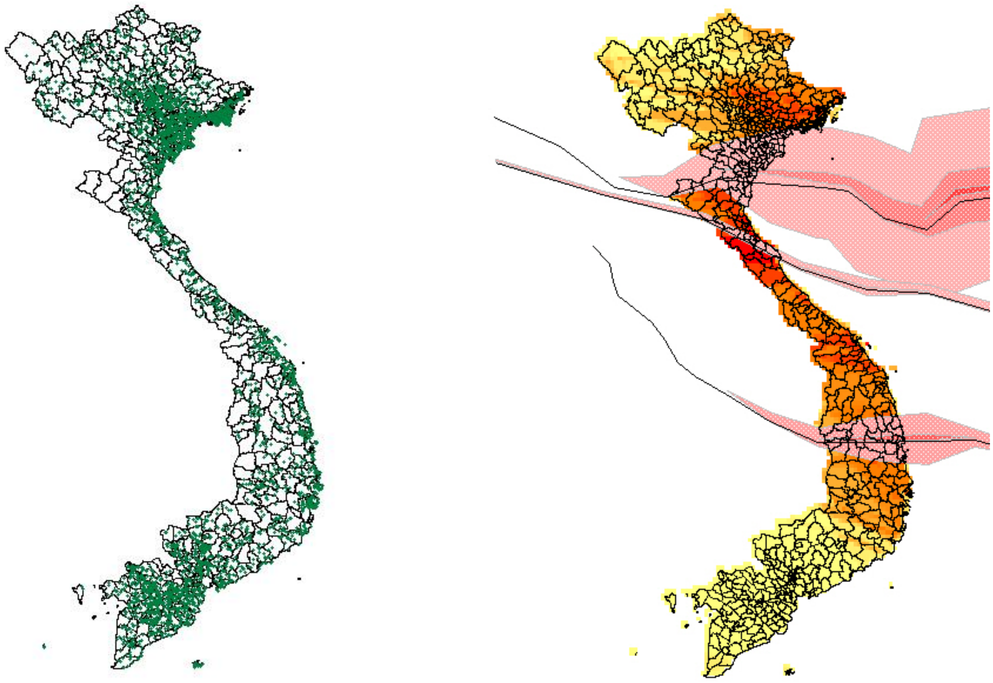
[8] education, health, housing conditions, employment, type of self-employed activities and income related to each of these occupations, expenditure, remittances, and credit access. Unfortunately, the questionnaire is not as detailed as the General Social Surveys concerning membership in social groups. It is also impossible to define precisely risk-sharing potential partners and reconstitute the friends and relatives networks. Similarly, the module on migration is not available in 2004 and 2006. Furthermore, the study has been conducted during several months (mostly during June and September), generating difficulties when determining the relative exposure to a certain event occurring contemporary to the survey.

the introduction can be precisely controlled with the expenditure module. Gifts, donations, investments in funds or inflows such as domestic remittances are well documented. Secondly, the commune section complements the individual questionnaires and documents living standards, eligibility to reforms, natural disasters and potential relief, activities, credit barriers and infrastructures in the hamlet chosen for these waves.

As developed in the appendix, the access to formal loans seems to be restricted and does not respond to consumption needs but to capital investments and long-term projects. The presence of ex-post transfers organized by regional or national authorities seems to be correlated with the institutional environment more than immediate needs. On the opposite, informal risk-sharing arrangements - gifts, transfers, remittances and loans - are highly present. The collected data are aggregate inflows and outflows (in-kind and cash) over the past year, except for the loan section for which each transaction is recorded with the partner type. 90% (resp. 15%) of households have given (resp. lent) to another household in the past year. In the rest of the paper, I will aggregate gifts and informal loans and consider that they both reflect access to liquidity when needed and participation in a social contract.

From Joint Typhoon Warning Center, I extract best tracks of tropical typhoons between 1980 and 2006 having landed or generated torrential rains on Vietnamese coasts. Wind intensity, pressure, precise location, form and size of the eye are precisely documented every 6 hours. This allows me to reconstruct the trails and the wind structure. I then consider the potential average dissipated energy per km^2 along the path of cyclones for each of the 600 districts composing Vietnam. The figure 2 shows the wind structure of a selected panel of cyclones between 2004 and 2005 (Vicente, Damrey and Chanthu) and an index of the historical exposure to tropical typhoons. In order to account for the floods associated with tropical typhoons, I create a band whose width depends on the pressure reported by JTWC along the path of the cyclone. As a control for the potential exposure to such events, I use the Global Cyclone Hazard Frequency and Distribution data which complements the constructed exposure over the 25 years of data collected.

Figure 2: Left panel: location of surveyed households. Right panel: potential exposure to the passage of typhoons and 3 occurrences: Vicente, Damrey (2005) and Chanthu (late 2004)



Using the weights provided by VHLSS, I compute a rough estimation of the influence of each tropical typhoon considered in this study and provide an estimation of direct and indirect damages at country level. I can then compare the predictions with estimations of direct damages recorded in the EM-DAT[9] database. Unsurprisingly, the measure differs from EM-DAT estimations. While EM-DAT reports approximately \$ 900 millions of losses due to the tropical typhoons between 2004 and 2006 and \$ 300 millions for the typhoons that belong entirely to the surveyed window[10], the weighted index predicts \$ 580 millions of losses over the surveyed window, approximately 1% of the Gross Domestic Product of Vietnam in 2005. Beside measurement errors implied by the estimation or declaration biases from officials, the difference can easily be explained as EM-DAT provides direct capital losses essentially. Indirect effects are not taken into account. On the opposite, the computed

[9]EM-DAT: The OFDA/CRED International Disaster Database (www.emdat.be), Université Catholique de Louvain.

[10]Xangsane having occurred in September 2006, some households surveyed before October have not been affected by the cyclone at the time of the survey.

measure accounts mainly for indirect and long-term effects; unreplaced capital losses are very likely to be under-reported.

None of the tropical typhoons studied here were considered particularly dreadful. As such, they had a similar counterpart in the late nineties and, as shown in table T2, affected districts are risky-prone areas. From this viewpoint, such catastrophes landing on Vietnam is not a particularly unlikely event. That being said, the frequency of being hit by a typhoon for a **certain** district is quite low even in the central parts of Vietnam. Prevention and immediate mitigation are not very developed. Accordingly, capital losses have been significant. Affected districts present higher levels of expenditures on repaired assets and new assets. In addition, the disruption of agricultural activities created severe under-employment in entire regions. A dozen of districts have lost up to 20% of their usual predicted annual income following the passage of Damrey. Districts affected successively by Chanthu in 2004, Kai-tak in 2005 and Xangsane in the late 2006 underwent similar losses. The amplitude of the shock is thus quite important, especially since it has not been well-distributed over the population and has affected mainly farmers growing crops. As expected, this sudden inequality in affected villages has been accompanied by some redistribution. Table T2 documents a higher recourse to informal instruments in regions affected by a disaster.

IV. Empirical strategies and first results

This section will be organized as follows. I will describe the empirical strategy to estimate specification (S1) and extract the average degree of redistribution in villages affected by a typhoon. I will assess the role of the whole distribution of vulnerability in the village as a determinant of ex-post transfers. Specification (S2) is then used to infer the influence of social position on the participation to ex-post transfers. Finally, I discuss potential biases induced by the empirical strategies.

A. Average redistribution at the village level

Using typhoon trails, I identify an **individual treatment** T_t^i composed of the interaction of a **district treatment** T_t^d (the energy dissipated along the typhoon paths between late 2004 and early 2006) and an **individual vulnerability** A_{t-1}^i (assets owned by the households and activities of its members in 2004). Intuitively, the identification relies on the idea of double differences. Depicting a country with protected and endangered families, I compare how much the latter lose compare to the former in **treated** villages (where a natural disaster has occurred). Unaffected villages with the same initial propensity to be affected and the same composition are the **control** group. The propensity score P^d of being hit by a typhoon as predicted in 2004 reflects 25 seasons of tropical typhoons and is normalized such that the worst predicted outcome coincide with the worst realized outcome. The individual propensity to be affected is composed of the interaction of this score with the variables accounting for individual exposure. As such, it represents potential individual losses had a tropical typhoon affected the district in which the household lives.

More formally, in a first stage, I predict the level of income[11] in t, given observables $X_{t-1}^k, P^d, A_{t-1}^i$ in $t-1$ and the treatment $T_t^d \times A_{t-1}^i$. I do not impose any structure on the control variables X_{t-1}^k and construct bins grouping households with similar characteristics in $t-1$ (10 categories of income, age and education of the head, occupation, rural/urban areas grouped so as to balance sub-groups). The method relies on a two step process and the second stage is the estimation of specification (S1) using net informal transfers τ_t^i and income losses predicted for all villagers during the first stage.

$$\begin{cases} y_t^i = \beta_T T_t^d \times A_{t-1}^i + \beta_A A_{t-1}^i + \beta_P P^d \times A_{t-1}^i + \beta X_{t-1}^i + \nu^d + \varepsilon_t^i, \quad \forall i & \text{(stage 1)} \\ \tau_t^i = \gamma \hat{y}_t^i + \overline{\gamma} \hat{y}_t^c + \delta_A A_{t-1}^i + \delta_P P^d \times A_{t-1}^i + \delta X_{t-1}^i + \nu^d + \mu_t^i & \text{(stage 2)} \end{cases}$$

The construction of the individual vulnerability reflects anecdotal observations on the nature of income losses in the aftermath of a disaster. Leaving aside physical

[11] Income in 2006 and 2004 is constructed here as raw income extracted from job activities. Non-contractual transfers are ruled out. Replacement of damaged assets are included in the expenditures related to the job activity.

Table 1: Hypothetical first stage with different choices of activities

	Income level in 2006						
	individual				**communal**		
Specifications	OLS	OLS	OLSfe	OLS	OLS	OLSfe	OLS
Wind × crops	-.25	-.23	-.24		-.31	-.56	
	(.11)*	(.09)*	(.12)*		(.14)*	(.24)*	
Wind × renting	-.03	-.03	-.03		-.05	-.06	
	(.01)**	(.01)**	(.01)**		(.02)**	(.02)*	
Wind × index				-.25			-.57
				(.07)**			(.17)**
Other activities	Yes						
Propensities	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Extended controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District FE			Yes			Yes	
Observations	6794	6794	6794	6794	2439	2439	2439

Significantly different than zero at † 90% confidence, * 95% confidence, ** 99% confidence. Only the variables of interest are displayed here. The results are shown omitting the coefficients for the set of dummies grouping age, education, activity of the head, level of income in 2004, risky activities and the district propensity to be affected by a typhoon interacted with the risky activities. Risky activities are proxied by the percentage of income earned in 2004 by growing crops, renting out, an index $V = V(crops) + \frac{1}{10}V(renting)$ and, in the first column, subsidies, wages, crops, livestocks, agricultural services, hunting or fishing, forestry, aquaculture and businesses other than those evoked above. The results are robust to the addition of district fixed effects.

injuries and temporary disabilities, a household might be hurt through 3 channels during and after the passage of a tropical typhoon. First, the destruction of public goods might lead to higher local taxes collected as compulsory public labor for instance. I do not control for these potential losses as the reaction of the community leaders might be endogenous to social interactions and coordination in the commune. Second, physical assets might be destroyed. Third, activities could be disrupted for a long time, resulting from the destruction of physical capital, long-term crops and the absence of other job opportunities. The prevalence of a specific economic activity[12] is approached by the income brought by this occupation in 2004 and captures both potential assets losses and business disruptions. The values of land and houses decomposing between those kept for personal usage and those rent to other households stand up for capital vulnerability. The cautious reader can re-

[12]subsidies, wages, crops, livestocks, agricultural services, hunting or fishing, forestry, aquaculture and businesses other than those evoked above.

fer to the appendix for more detailed comments on the explanatory power of the treatment in different hypothetical[13] first stages. Let us focus here on the influence of energy dissipated by the wind interacted with the individual exposure on individual income in 2006. Table 1 documents losses mainly for households growing crops and for households renting out houses or land. In particular, it seems possible to construct a one-dimension vulnerability index composed of reliance on crops and renting. These results are consistent with the interpretation that households living from crops are more affected than employees and owners of non-agricultural businesses. In parallel, revenues on renting out land decrease as a consequence of the disruption of lessees' activities. Income extracted from renting out captures also partly the physical capital owned by a household[14].

Table 2: Informal transfers flows following natural disasters

Specification (S1)

	Informal net transfers in 2006							
Specifications	2SLS		2SLSfe		2SLS		2SLSfe	
Own shock	-.155	(.041)**	-.154	(.041)**	-.171	(.036)**	-.176	(.037)**
Shock on others	.088	(.054)†	.031	(.056)	.114	(.050)*	.106	(.051)*
District FE			Yes				Yes	
Sample	Total		Total		Rural		Rural	
Observations	6794		6794		5058		5058	

Significantly different than zero at † 90% confidence, * 95% confidence, ** 99% confidence. Only the endogenous variables are displayed here. The results are shown omitting the coefficients for the set of dummies grouping age, education, activity of the head, past level of income, assets owned by the family and neighbors, individual and neighbors' propensity to be affected by a typhoon and district potential exposure. These controls are also included in the first stage. The instruments are the effective exposure to typhoons (energy dissipated by the wind and flood) crossed with assets and activities in 2004 for the household and its neighbors.

The second stage evidences that informal arrangements have played a role after this wave of typhoons. As shown in table 2, a loss of 1$ relatively to the rest of the community has been offset on average by positive net transfers accounting for approximately 15 cents. The elasticity is slightly higher when restricting the sample

[13] the real first stage is the joint estimation of income losses for each household in the village.

[14] Unreplaced capital losses are less likely to be reported by households, which could lead to a systematic under-estimation of the amplitude of the economic damages during the first stage.

to rural areas only, reaching then 17 cents. As highlighted in table T6, this effect can be decomposed into two components: loans contracted with friends account for 10 cents in the access to liquidity while gifts represent 6 cents of these informal flows. Note that the decomposition is stable when considering rural areas only and the results are robust to the addition of district-level fixed effects and other controls than those used in X_{t-1}^{j} (age, education, income of the head...). As shown in the appendix, the spectrum of activities chosen for estimating this vulnerability does not drive these coefficients.

Let us depart from the benchmark and assess the influence of the balance of power in the village on participation to the ex-post redistribution. A shown in figure F2, the distribution of vulnerabilities to natural disasters is highly skewed: there is a high proportion of potentially protected households. The possibility for those spared households to shy away from their obligations should endanger the social contract. To capture the weight of this threat, I construct a skewness index, function of the distance between the median household and the average household in terms of vulnerability[15]. Notice first that the position of the median household relatively to its peers matters (table 3). Reducing the exposure of the median household relatively to the average exposure affects negatively the amplitude of the redistribution at the village level (i). The closer the median household is to the most affected one, the higher the amplitude of the ex-post redistribution. The additional specifications (ii) and (iii) break the symmetry and document that the effect is essentially present in villages where scales tip toward the exiters. Moving the distribution of losses toward one of the extremes has an effect only if it offers to the least affected villagers the possibility to free-ride on the social contract. Diminishing the distance between the median household and spared families reduce the average compensation up to 11 cents while the symmetric move in direction of the affected families does not

[15] Focusing on communes with at least 3 surveyed households, I define V^j as the reliance on a risky activity and define a measure d_c such that a village where the median household is infinitely more (resp. less) exposed than the average household is associated with $d_c = 1$ (resp. $d_c = -1$) and such that the lower percentile and the upper percentile coincide roughly with $d = -1/2$ and $d = 1/2$.

$$d_c = \frac{med(V^j) - mean(V^j)}{A + med(V^j) - mean(V^j))}$$

improve risk-pooling significantly. These results are robust to specifications where the skewness in favor of spared families is approached by the proportion of households for which the vulnerability is 0 (see table T15). 10% additional spared households reduces the average compensation by 2 cents. A concern is that the few observations at the village level might give a very sketchy picture of the real distribution of losses and bias the results. Nonetheless, both specifications - either the distance mean/median and the fraction of spared households - give the same results when the distribution is considered at district level rather than at the village level. Similarly, as shown in table T15, the results are the same where the distribution of vulnerabilities is calculated using crops (or renting) only, or when the weight is extracted from subjective questions in the commune questionnaire. In a nutshell, this body of corroborating evidence hints toward the strength of the potential exiters as a major determinant of ex-post redistribution.

The fact that, in certain specifications, the coefficient for the shock affecting the rest of the community is not exactly the opposite of the coefficient for the individual fluctuations implies that this specification might not fully fit the specification (S1). Potentially, it could reflect a classical attenuation bias. Measuring the real level of income losses in the network with only 3 to 12 observations should spark off this level of asymmetry[16]. A concern is that this measurement error could not only bias downward the coefficient on the aggregate shock but also the direct elasticity. From this viewpoint, the elasticity might be a lower bound of the true level of redistribution. Second, it could come from external interventions. Domestic remittances are included in our measure of gifts and some networks might expand their ramifications outside the village. Naturally, households forming a link with outsiders will not be influenced by the average village shock in addition to its own. In particular, the observation that the two coefficients are not opposed as they should be for gifts is in line with potential biases induced by domestic remittances. Along with

[16]Under the hypotheses that (i) y_i and $\sum_j x_j$ follow a bivariate normal and (ii) the error on $\bar{x}$ is independent from ε_i, estimating $y_i = a + \alpha \sum_j x_j + \varepsilon_i$ instead of $y_i = a^* + \alpha^* \bar{x} + \varepsilon_i$ generates a regression dilution:

$$\alpha = \alpha^* \frac{\sigma_{\sum_j x_j}}{\sigma_{\bar{x}-\sum_j x_j} + \sigma_{\sum_j x_j}}$$

Table 3: Informal flows depending on the position of the median household in terms of exposure

Specification (S1)

	Informal net transfers in 2006					
Specification	**(i)**		**(ii)**		**(iii)**	
Distribution using	com.	dis.	com.	dis.	com.	dis.
Own shock × distance	.296	.323	.034	.087	.215	.283
	(.104)**	(.110)**	(.053)	(.157)	(.088)**	(.116)*
Own shock	-.175	-.166	-.131	-.130	-.183	-.218
	(.035)**	(.032)**	(.031)**	(.037)**	(.035)**	(.034)**
Shocks on others	Yes	Yes	Yes	Yes	Yes	Yes
District Fixed-effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4895	4895	4895	4895	4895	4895

Significantly different than zero at † 90% confidence, * 95% confidence, ** 99% confidence. Only the endogenous variables are displayed here. The results are shown omitting the coefficients for past level of income, assets owned by the family and neighbors, individual and neighbors' propensity to be affected by a typhoon and district potential exposure. These controls are also included in the first stage. The instruments are the effective exposure to typhoons (energy dissipated by the wind and flood) crossed with assets and activities in 2004 for the household and its neighbors (in addition, I use the previous instruments crossed with the distribution variable). The different specification of the distance in exposure between the median household and the average are the following: (i.): $(med - avg)/(A + (med - avg))$, (ii.): $(med - avg)^+/(A + (med - avg)^+)$, (iii.): $-(med - avg)^-/(A + (med - avg)^-)$ constructed using the households in the same communes or the same districts. The sample is limited to rural areas in which 3 households are surveyed per commune.

the same lines, results are more satisfying with informal loans and in rural areas where the probability to be in a migrant-stayer relationship is lower. This issue is of particular concern and I discuss extensively the importance of migration as a consumption-smoothing instrument at the end of this section.

Before diving into the estimation of specification (S2), let me emphasize three side results. First, commune leaders declaring disunity and conflict as a thorny issue in the village experience less redistribution. The compensation decreases by almost 8 cents (table T15). Second, table T7 establishes that savings adjustments (withdrawal of savings, sales of fixed assets, gold or jewelry or formal loans) do not offset income losses, contrary to informal transfers. This surprising observation gives some credits to the theoretical assumption; households might be reluctant to make a dent in dowries or sell jewelry. Third, the reader concerned by the exact motives behind redistribution in the village can refer to the appendix. Although preliminary, this analysis tends to point that transfers incorporate ex-ante risk but might also reflect purely altruistic motives. These observations question the interpretation of further results: are informal transfers purely determined by insurance purposes, or do they illustrate altruistic sentiments and fairness ideals? This paper does not aim at answering this question as the test for reciprocity and time consistency would be far more demanding to the data. Let us assume reciprocity in the access to liquidity, willingness to enforce the contract ex-ante and turn to the specification (S2).

B. Heterogeneity in the participation to the social contract

For this part, the estimation will rely heavily on the sampling strategy and the survey design: I restrict the sample to communes where exactly 3 households are interviewed which roughly exclude all urban wards, I then aggregate the observations at the village level, sort the households by their vulnerability[17]and create series of effective marginal ratios between the surveyed households at date t and $t-1$, using a CARA utility function $\frac{(y+\tau)^{1-\sigma}}{1-\sigma}$. The utility function will be constructed using the raw income corrected by the access to additional liquidity. In line with the theoretical model, the absence of stocking technologies and investment opportunities justifies that current reserves approach the level of consumption. In short, the observations are now villages for which we observe two ratios of marginal utilities - between 1 and 2, and 1 and 3 - reflecting the heterogeneity of ex-post redistribution at hamlet level. Interpreting the difference between the effective marginal ratio and the past ratio as the distance to perfect insurance, $\beta_{1,2}^{1,3}$ determines how well the couple $(1,3)$ achieves insurance compared to the couple $(1,2)$.

$$\beta_{1,2}^{1,3} = \frac{\Lambda_s^{1,3} - \Lambda^{1,3}}{\Lambda_s^{1,2} - \Lambda^{1,2}}$$

[17]households are ranked along the index presented in the alternative specifications - $V = V(crops) + \frac{1}{10}V(renting)$, household 1 is potentially the surveyed household with the largest intrinsic exposure in the survey/hamlet. Only wards for which the 3 households can be ranked unambiguously are kept in the final sample. The results are not influenced by this sample selection.

The empirical counterpart can be estimated under the following form:

$$\ln \Lambda^{1,3} = \alpha \widehat{\ln \Lambda_s^{1,3}} + \beta \widehat{\ln \frac{\Lambda^{1,2}}{\Lambda_s^{1,2}}} + \delta_A A_{t-1}^i + \delta_P P^d \times A_{t-1}^i + \delta X_{t-1}^i + \varepsilon_{v,t} \qquad \text{(stage 2)}$$

I will consider β as a function of I_t, the social identity of households 3 relatively to households 1 and 2.

$$\beta = \zeta + \gamma I_t + \mu_t$$

Ratios of marginal utilities are functions of income, it is possible to consider instruments for these ratios built upon instruments used for specification (S1). The best instruments would be the values of marginal ratios conditional on our initial treatments $E[\Lambda|T]$. Here, the computations of these quantities are not obvious and I will rather rely on Amemiya [1975] and approximate the conditional ratios with squares and cross-products of components of the raw instruments $T_t^v = (T^d \times A_t^j)_{j\in v}$ controlling for the propensities $P_t^v = (P^d \times A_t^j)_{j\in v}$.

$$\begin{pmatrix} \ln \Lambda_s^{1,3} \\ \ln \frac{\Lambda^{1,2}}{\Lambda_s^{1,2}} \end{pmatrix} = T_t^v \kappa_1 + T_t^{v'} T_t^v \kappa_2 + \delta_A A_{t-1} + P_t^v \kappa_1^p + P_t^{v'} P_t^v \kappa_2^p + \delta X_{t-1}^i + \varepsilon_{v,t} \quad \text{(stage 1)}$$

Interpret the explained variable as the targeted full-insurance ratio: this **unobserved** quantity (which can be approached by the ratio at date $t-1$) shapes the current level of redistribution and can then be inferred from the **realized** quantities Λ_s. I compare how much informal transfers offset distortions created by typhoons and pattern disposable income compared to the full-insurance level. In line with specification (S1), the identification relies heavily on the fact that the vulnerability interacted with district treatment predicts efficiently the ex-post distribution of income in the commune. Controlling by the district propensity to be affected allow to create a real counterfactual in unaffected districts.

The first results using this specification in table T8 confirm the intuition displayed by specification (S1); the average access to liquidity following a catastrophe is far from full-insurance. In the baseline (1), there is some reluctance to supply liquidity from the least affected household 3. Introducing indicators of social identity, the specification points out correlations between certain social characteristics and the access to liquidity. In this benchmark, I will define merchants as households earning some income from small businesses[18] and social identity will be considered along this occupational dimension. Naturally, the presence of this activity does not rule out the possibility that some household members grow crops in parallel. This definition does not draw cleanly a social frontier in these rural villages but additional measures of social identity will be discussed in the next section. The degree to which 3 reallocates its resources depends on its social identity. First, when the least and most affected households do not belong to the same social class (2), β increases significantly. Being from another guild draws away household 3 from its peers. This feature is particularly salient when the median household is close to the least affected in terms of exposure (3). This feature should be less explicit if the median household is of the same cast than the least affected one (4). The coefficient is then indeed negative but not significant. In a final attempt to fit the theoretical model, I use the importance of business activities in the village as a proxy for the strength of a potential coalition constituted of merchants. The existence of a coalition threat draws away household 3 from household 1 particularly when the former belong to another guild (5). This feature evidences a lighter social pressure in favor of redistribution between castes when the unaffected caste is coherent and influent enough.

To conclude, both individual statuses of households in the village and the strength of those statuses seem to matter when it comes to taking part to the redistribution process following the passage of typhoons. The results are partly consistent with the theoretical model developed earlier. Nonetheless, the results rely heavily on the definition of castes. The findings might be explained by a self-selection into business activities from agents predisposed to form links. I explore thus the influence of additional dimensions in the next section. Yet, none of those specifications will allow us to disentangle the advantage brought by adherence to a group from the unobserved ability of members to form links.

[18]the other significant activity beside agriculture.

C. Robustness checks

The evidence of heterogeneity in the participation to the redistribution might call into question the interpretation of the results on the role of the losses' distribution. Indeed, the community effect identified on the number of potential exiters might just be driven by the fact that individuals considered as potential exiters give far less in any community. Imagine that all villages are similar in composition. Yet, different samples of villagers are drawn in every village. With individual heterogeneity of participation, heterogeneous responses will be recorded. In particular, if the individual heterogeneity is related to the position relatively to the peers - unaffected villagers do not participate for instance - , differential effects might be found for similar villages and attributed to the presence of a large conglomerate of spared villagers. Two observations might mitigate this alternative explanation. First, a huge heterogeneity should be observed to explain results found in table 3 and exist along both the dimensions "relying on crops" and "relying on renting" as the results are the same when restricting our vulnerability index to one or the other dimension (see table T15). The fact that only farmers participate in the redistribution would not be sufficient to generate the observed features. Second, subjective reports by commune leaders depict heterogeneous communes in terms of activity: communes for which agriculture is declared as the major activity by far and where the proportion of spared households should be lower are more efficient at reallocating resources.

To control for potential differences between treated districts and the control group with the same ex-ante propensity to be hit, I replicate the tests (S1) presented above with the pre-disaster informal transfers. As shown in table T11, the affected districts are not initially different than their control group in terms of informal redistribution. Similarly, the estimation of the system (S2) in table T12 indicates that the natural disasters have no effect on the distance to full-insurance computed with ex-ante transfers, confirming that affected districts are not initially different than their counterparts and that our results are driven by ex-post redistribution alone. There are no real and satisfying tests for the exclusion hypothesis but these placebo tests indicate that nature has not discriminated districts by their initial dependence on informal transfers. This placebo experiment also controls for potential systematic biases created by the estimation method. Placebo tests will be replicated for each regression presented in this paper.

Another issue is the selection bias induced by panel attrition. Households and communes which disappear from the panel might precisely be those affected by a catastrophe and suffering from a lack of coordination. Natural disasters might "eliminate" households for which our measure of community link is temporary low. Attrition issues is mitigated by a couple of observations derived from the data: communes losing households between 2004 and 2006 are not particularly affected by typhoons or different from the others by the level of initial informal transfers. Naturally, these communes are more concerned by turnovers, but attrition is independent from the interaction of turnover and natural disasters.

Finally, the effect captured here could be explained by remittances from migrants in the wake of a typhoon having affected their relatives, rather than from the local community. As explained earlier, the datasets do not disentangle local gifts from domestic remittances of urban migrants. The results could then illustrate temporary migration to the cities for unemployed farmers during the harvest season following the passage of typhoons.

The direct estimation of the theoretical model gives empirical support for the importance of the strength and social identities of the spared households as limits to risk-pooling following natural disasters. The next section proposes several tracks to build up on the idea that social identity and the village structure strongly influence the participation in the ex-post redistribution.

V. Structure of the village and social identity

Individuals associate themselves to social identities along several dimensions - inherited or resulting from choices. From this perspective, trading goods is hardly sufficient to ensure group cohesion and be associated with a clear-cut definition of oneself. More problematically, this definition calls upon choices rather than inherited features. Households decide to invest in activities and merchants might be fundamentally different than farmers regarding social attitudes. In this section, I consider other indicators of social identities and establish other limits to resource-pooling.

Table 4: Informal flows following natural disasters depending on having moved or having welcomed recent neighbors

Specification (S1)

	Informal net transfers in 2006		
Specifications	2SLSfe	2SLSfe	2SLSfe
Own shock × having moved recently	.193		.192
	(.045)**		(.046)**
Own shock × turnover		.077	.093
		(.046)†	(.044)*
Own shock	-.083	-.194	-.126
	(.033)**	(.037)**	(.038)**
Controls for shocks on others	Yes	Yes	Yes
District Fixed-effects	Yes	Yes	Yes
Observations	4702	4702	4702

Significantly different than zero at † 90% confidence, * 95% confidence, ** 99% confidence. Only endogenous variables are displayed here. The results are shown omitting the coefficients for past level of income, assets owned by the family and neighbors, individual and neighbors' propensity to be affected by a typhoon and district potential exposure. These controls are also included in the first stage. The instruments are the effective exposure to typhoons (energy dissipated by the wind and flood) crossed with assets and activities in 2004 for the household and its neighbors (in addition, I use the previous instruments crossed with turnover and the dummy 'having moved'). Communes for which information on turnover is available are essentially rural. Turnover is the number of newcomers and leaving households during the last year relatively to the total population of the commune. Having moved recently is a dummy equal to 1 for households having moved in between 1995 and 2004 and coming from another commune.

First, we can identify time spent in the commune as a factor influencing the individual belonging to the village risk-sharing group. Recent movers' monitoring capacities should be lower than those of settled families. Reciprocally, the credibility of a threat exerted by the rest of a potential risk-sharing group might be lower on new entrants and incorporating them might endanger the network sustainability. As a consequence, we would expect smaller reliance on informal contracts from households having settled in the village slightly before 2004 and for villages whom future composition is uncertain. The table 4 confirms that households having settled between 1995 and 2004 are excluded from risk-pooling in the wake of a typhoon.

The compensation for a relative income loss of $ 1 is 19 cents lower for movers. It is not possible to reject that the correlation between individual shocks and informal transfers is different from 0 for new entrants whether restricting our sample to rural areas or not. Extending the analysis at village-level, new entrants and households knowing that they will move in the next future represent a danger for an established risk-sharing group. Communes in which the turnover is high display lower risk pooling through informal loans or donations. As shown in table 4, this effect at commune level is not completely explained by surveyed households having moved for the past few years. Having newcomers as neighbors for well-established households generates also less risk-pooling at commune level. An additional 5% turnover per year in the commune reduces the compensation by 9 cents[19].

In the same vein, if I follow Fafchamps & Gubert [2007a], geographical distance attenuates the grip one household might have on the rest of the network. The table 5 illustrates this idea. The greater the dispersion of households between small hamlets in a commune controlling for size effects, the lower the level of risk-sharing. Geographic dispersion stands for the number of small hamlets in the commune or ward. 2 additional hamlets in a commune decrease the compensation by 3 cents for each dollar lost relatively to the rest of the commune. Distance to the closest road illustrates the same idea of geographical dispersion. Each km further from the main road is associated with a lower compensation of 0.9 cents. Cultural distance should matter as monitoring and altruistic behaviors both depend on the frequency a household get into contact with another. In the same table, I report the results from the basic regression with a dummy differentiating households in the local dominant ethnic group and minorities. Controlling from the local ethnicity and the ethnicity of the household, I find that households in a local ethnic minority participate significantly less to risk-pooling in the aftermath of a typhoon. Half of the average compensation (8 cents) is lost for a household in a different ethnic group than the dominant group in the commune. These results do not rely on ethnic factors as they are robust to the addition of a set of dummies for the household's ethnicity and

[19]this figure might seem particularly large but only the last decile of communes have more than 5% turnover per year.

Table 5: Informal flows following natural disasters depending on geographic dispersion and being in an ethnic minority at commune level

Specification (S1)

	Informal net transfers in 2006					
Specifications	2SLS	2SLS	2SLS	2SLS	2SLS	2SLS
Own shock × geo. disp.	.019	.017				
	(.007)*	(.008)*				
Own shock × road to hamlet			.009	.010		
			(.003)**	(.003)**		
Own shock × eth. minority					.085	.083
					(.045)†	(.046)†
Own shock	-.279	-.259	-.174	-.170	-.166	-.168
	(.060)**	(.064)**	(.036)**	(.039)**	(.038)**	(.038)**
Shocks on others	Yes	Yes	Yes	Yes	Yes	Yes
Size and district FE		Yes		Yes		
Dummies for ethnicity						Yes
Observations	4738	4738	4738	4738	6625	6625

Significantly different than zero at † 90% confidence, * 95% confidence, ** 99% confidence. Only the endogenous variables are displayed here. The results are shown omitting the coefficients for past level of income, assets owned by the family and neighbors, individual and neighbors' propensity to be affected by a typhoon and district potential exposure. These controls are also included in the first stage. The instruments are the effective exposure to typhoons (energy dissipated by the wind and flood) crossed with assets and activities in 2004 for the household and its neighbors (in addition, I use the previous instruments crossed with geographic dispersion and the dummy 'ethnic minority'). Communes for which information on geographic dispersion is available are essentially rural. Geographic dispersion is the number of hamlets in the commune, controlled by the size of the commune. Road to hamlet indicates the distance between the hamlet and the nearest road. Being in the ethnic minority is a dummy equal to 1 if the household does not belong to the main ethnic group as reported by the commune leader. Dummies controlling for ethnicity group both the main commune ethnic group and the ethnicity of the household.

the main local ethnic group. On average, turnover and fractionalization discourage redistribution after the realization of the state of nature.

Based upon specification (S2), table T9 brings support to the importance of social integration as a requirement to have access to a higher layer of risk-sharing. First, in line with results found with specification (S1), the distance with full-insurance is higher when either the household 1 or 3 is a new entrant in the commune (a). This raw effect is supported by the second specification capturing similar attitudes of settled households 2 and 3 toward 1 when the latter has been living in the village for less than ten years (b). Unsurprisingly, turnover and new entrants seem to remain a stumbling block for establishing hamlet-level risk-sharing groups. In a second time, I define castes along the ethnicity dimension. The simple test (c) focusing on the ethnicity of households 1 and 3 shows a surprising independence between risk-sharing attitudes and the ethnic identities of partners. While this result contradicts the theoretical model, another definition of ethnicity centered on the major ethnic group gives insights consistent with the predictions. When household 3 belongs to the major ethnic group in villages where at least a second major ethnic group exists (d), being from one of those under-represented ethnic groups for household 1 draws household 3 even further away.

To conclude, three dimensions along which social groups tend to define themselves have been tested - occupation, local settlement and ethnicity. The higher capacity for households to form links within a social group does not necessarily reflect discrimination issues in the village. The existence of extended family in which the social indicators covariates a lot would also generate these patterns of redistribution.

VI. Influence of past shocks

Departing from the theoretical model, this section provides insights behind the relatively high level of insurance found in section IV.. In some communities having overcome recently dreadful natural disasters, potential defaults do not constrain as much the level of ex-post transfers. In line with anecdotal evidence, natural disasters funds might centralize transfers and ensure forcibly coordination in the village. Formalizing informal instruments after having experienced large shocks can be the best way to alleviate monitoring issues. A second explanation involves altruism toward peers and fairness ideals. The community might extricate from a severe shock with different norms regarding these issues. This increased resilience is attractive as it relates the present work to Alesina & Angeletos [2005] or Durante [2009], and the foundations of the welfare state or the determinants of trust in societies.

I have computed the trails of 3 tropical typhoons (Eve, Wukong and Kaemi) hav-

Table 6: Informal flows following natural disasters depending on past exposure

Specification (S1)

	Informal net transfers in 2006			
	1999-2000		**1997-2000**	
Specifications	2SLS	2SLSfe	2SLS	2SLSfe
Own shock × recently exposed	-.189	-.190		
	(.093)*	(.096)*		
Own shock × recently exposed			-.217	-.216
			(.093)*	(.095)**
Own shock	-.161	-.167	-.159	-.163
	(.031)**	(.032)**	(.030)**	(.031)**
Controls for shocks on others	Yes			
Dummies for provinces fixed-effects		Yes		Yes
Observations	4895		4895	

Significantly different than zero at † 90% confidence, * 95% confidence, ** 99% confidence. Only the endogenous variables are displayed here. The results are shown omitting the coefficients for past level of income, assets owned by the family and neighbors, individual and neighbors' propensity to be affected by a typhoon and district potential exposure. These controls are also included in the first stage. The instruments are the effective exposure to typhoons (energy dissipated by the wind and flood) crossed with assets and activities in 2004 for the household and its neighbors (in addition, I use the previous instruments crossed with past exposure). Past exposure are dummies equal to 1 if the district has been exposed to a dreadful cyclone in the late nineties (1999-2000 and 1997-2000). A province groups roughly a dozen of districts.

ing occurred in the late 90's. Unfortunately, the same precision for Thelma (1997) is not available. As a consequence, I use the precise wind structure for the formers and being close to the trajectory of the eye for the latter. The choice of recent cyclones rather than the average exposure for the past 30 years rests upon two important remarks: first, as shocks are estimated so as to account for district exposure, the effect on the crossed variable is much more difficult to analyze. Second, even when part of the set of possibilities, the potential passage of typhoons might not have been accompanied by the creation of structures unless recent cyclones have left a mark on a community. It is reasonable to think that communities do not compute their exact exposure using a long time interval but update their beliefs using recent events, discounting past observations. The identification relies here on affected communes which, for a similar potential exposure, have been affected recently by eventful typhoons compared to spared communities. The first results indicate that recent exposure could influence current responses to catastrophes. Having experienced a large trauma in the late nineties is associated with a huge increase of 20 cents for the net compensation associated to a $ 1 relative loss. In resilient communities, the average compensation reaches 38 cents. The same regression considering assets' transfers and formal instruments do not display the same learning pattern. An issue remains unchallenged: is this effect related to a higher degree of cohesion in the community or is this an average effect driven essentially by an increased awareness in the village without any reinforced interactions between households? The table T10 brings to the fore the first explanation. The impediments related to social identity tend to disappear in recently affected communes. The effect of 1 and 3 being of different identities (i.) and the additional effect which draws away 3 from its peers with similar exposure (ii.) are offset in communes having suffered from dreadful typhoons between 1997 and 2000. These results are consistent with anecdotal evidence; certain communes have indeed institutionalized natural disaster funds in the Delta, responding to previous traumas. Such coping mechanisms prove useful in exceptional situations and might ensure redistribution between sub-groups with weak interactions. The fact that transfers described as donations to funds including natural disasters funds increase in those exposed villages is consistent with this interpretation. This view is shared by Douty [1972] relying on anecdotal evidence: natural disasters provoke the creation of a structure headed by pre-disaster leaders, enforcing centralized transfers which would not be sustainable with a decentralized process.

Lastly, turnover seems to impede risk-sharing whatever the experience of the commune in terms of recovery. Having been exposed to a recent wave of typhoons does not affect the participation of new entrants (iii.). Newcomers in the commune are a particular group as they might potentially not benefit fully from an improvement of the legal environment. Similarly, following a trauma, the community may set a higher norm for altruism and reinforce bonds but newcomers might not be part of the enhanced social contract.

VII. Conclusion

This paper has explored theoretically and empirically the intuition that large and covariate shocks might be associated with the constitution of a coalition willing to exit from the extended group of informal risk-sharing in rural villages. The model departs from the classical principal-agent framework as it allows multiple agents to form a lobby and exert a pressure on a virtual principal. This division between spared and needy villagers adds to the initial partitions (ethnic groups, settled families against newcomers...) and limits the redistribution of resources.

On a more optimistic note, the average amplitude of risk-sharing is economically significant. Compared to other findings, the elasticity seems surprisingly high. The explanation could be partly related to the fact that repeated exposure to the passage of typhoons induces a community to reinforce its capacity to monitor contract enforcement. The evolution of altruistic sentiments or a shift of ideals would also be consistent with this observation. The present work might illustrate on a small scale some mechanisms already discussed in the literature. Traumas may induce agents to reinforce their social capital and lead to demands for a welfare state.

To conclude, one might consider the findings as reassuring. A couple of remarks may mitigate this impression. First, there is a major difference between typhoons at the focal point of this study and dreadful catastrophes such as the cyclone Nargis in Myanmar. A breakpoint may exist above which it is difficult to ensure a fair reallocation of resources among villagers. No conclusions can be drawn on the ability of small communities to overcome any sort of disasters. In particular, as the redistributive process relies essentially on coordination, a small uncertainty on the attitudes of others might shift every villager to enforce the autarkic equilibrium. Second, ideal insurance would imply exchanges between communes, districts or even provinces. The reasons behind the absence of efficient redistribution at macroeconomic level, even for supposedly well observed shocks, are not addressed here. Similarly, NGOs interventions are astonishingly unrelated to the gravity of the shock. This study then hints toward the creation of relatively efficient informal means but only as substitutes for failing mechanisms.

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A Complements - Theoretical model

A.1 Technical appendix

Proof. Lemma 1.

The proof of the lemma is straightforward: let us assume that $n < n^{'}$ and $d_{g_n} = 0$ while $d_{g_{n'}} = 1$. This means that the n-th household in guild g is better off enforcing the contract and the $n^{'}$-th better off deviating. This translates immediately into the following inequalities:

$$\begin{cases} V_{g_n}(s) > -\psi^g(V, d) \\ V_{g_{n'}}(s) \leq -\psi^g(V, d^{'}) \end{cases}$$

where $d(s)$ and $d^{'}(s)$ only differ by the fact that $d^{'}_{n'}(s) = 1$ and $d_{n'}(s) = 0$. Consequently, $\psi^g(V, d) \leq \psi^g(V, d^{'})$, which contradicts the inequalities (I). □

Proof. Theorem 1.

If an interior Nash equilibrium exists, there exist also pivotal households i^* and j^* in both guilds who should be better off trying to make null and void the terms of the contract.

Suppose now that there exists a pair $(i_0, j_0) \in \{1, ..., N_f\} \times \{1, ..., N_m\}$ of households willing to deviate once persuaded that the households having a greater interest in deviating than them will also deviate. In this case, consider the following strategy Σ_0: households having a greater interest in deviating than i_0 and j_0 deviate and the others respect the contract. The condition (*) directly expresses that, taking this strategy as given, a deviation is optimal for i_0 and j_0 and undoubtedly for other households with a higher raw welfare from deviation. Yet, $i_0 + 1$ or $j_0 + 1$ might also consider deviating. If both $i_0 + 1$ and $j_0 + 1$ are better off respecting the contract, the households $i_0 + 2, ..., N_f$ and $j_0 + 2, ..., N_m$ will extract a higher welfare from having the contract enforced and Σ_0 is a Nash equilibrium. Accordingly, let us define $\Sigma_1 = \Sigma_0$. Otherwise, either $i_0 + 1$ or $j_0 + 1$ are better off deviating. In the first case, a farmer will be added to the set of exiters and Σ_1 is defined as the strategy where the pivotal households are $i_1 = i_0 + 1$ and $j_1 = j_0$. In the second case, the strategy Σ_1 will add another deviating merchant ($i_1 = i_0$ and $j_1 = j_0 + 1$). Let us remark two important features. First, the new pair of pivotal households also verifies the condition (*). Second, in both cases, an exiter is added to the set of exiters and thus the households willing to deviate under Σ_0 will be even more inclined to deviate under Σ_1. Following the same process, we can construct a sequence $\{\Sigma_n\}$ of strategies implying pivotal households i_n and j_n. As the sequence (i_n, j_n) is increasing, bounded and takes a finite number of values, this sequence converges and either stops because the households right after the pivotal households are better off enforcing the contract or because the set of exiters encompasses the whole village. In both case, the limit Σ^*, i^*, j^* will be a Nash equilibrium (each agent supplies her best response taking Σ^* as given) with at least one deviation. □

Proof. Proposition 1.

The proof of this proposition relies essentially on the fact that we can find an open neighborhood Ξ around W and W' which does not include V_i. Accordingly, in Ξ, the coalition of exiters is unchanged and d is fixed. The inequalities verified by ψ translate then immediately to their counterparts $\Psi_{i,j}$. □

Proof. Theorem 2.

Continuity arguments derived from the implicit function theorem ensure that there exists a neighborhood $\underline{V}$ around the extreme mapping $\underline{S}$, such that $(H1)$ is verified for state $\underline{s}$. Similarly, there exists a neighborhood $\overline{V}$ around the extreme mapping $\overline{S}$, such that (H_2) is verified for state $\overline{s}$.

Specification (S1)

Linearizing the transfer function,

$$\Lambda_s^{k,k'} = \frac{u'(y^k) + u''(y^k)(z_s^k + \tau_s^k)}{u'(y^{k'}) + u''(y^{k'})(z_s^{k'} + \tau^{k'})} \quad \forall k, k'$$

As a consequence,

$$z_s^{k'} + \tau_s^{k'} = \frac{1}{u''(y^{k'})}\left[\frac{u'(y^k)}{\Lambda_s^{k,k'}} - u'(y^{k'})\right] + \frac{u''(y^k)}{\Lambda_s^{k,k'}u''(y^{k'})}[z_s^k + \tau_s^k] \quad \forall k, k'$$

$$\sum_{k'=1}^{n}[z_s^{k'} + \tau_s^{k'}] = \sum_{k'=1}^{n}\frac{1}{u''(y^{k'})}\left[\frac{u'(y^k)}{\Lambda_s^{k,k'}} - u'(y^{k'})\right] + \sum_{k'=1}^{n}\frac{u''(y^k)}{\Lambda_s^{k,k'}u''(y^{k'})}[z_s^k + \tau_s^k]$$

As the sum of transfers in the risk-pooling group should be 0,

$$\tau_s^k = -z_s^k + \frac{1}{N^k}\sum_{j=1}^{n} z_s^j - \left(\frac{u'(y^k)}{y^k u''(y^k)}\right)y^k + \frac{1}{N^k}\sum_{k'=1}^{n}\left(\frac{u'(y^k)}{y^k u''(y^{k'})}\right)y^k$$

where N^k is defined as:

$$N^k = \sum_{k'=1}^{n}\frac{u''(y^k)}{\Lambda_s^{k,k'}u''(y^{k'})}$$

Under the assumption (H1), $\Lambda_s^{k,k'} = \Lambda^{k,k'} = \frac{u'(y^k)}{u'(y^{k'})} \quad \forall k, k'$.

As a consequence, N can be written as a function of local risk aversions $\sigma = \frac{yu''(y)}{u'(y)}$ and the last terms of the expression of transfers cancel out.

Specification (S2)

A direct consequence of the assumptions is that the only constraints susceptible to bind concern deviations of the J less affected merchants:

$$\varphi_{\overline{s}}^{i,j} \neq 0 \Leftrightarrow i = 0, j = J$$

As such,

$$1 = \Lambda_{\overline{s}}^{k,k'} \frac{\lambda^k + \varphi_{\overline{s}}^{0,J}(\frac{\partial \Psi_{J,0}^m}{\partial V_{\overline{s}}^k} + \mathbb{1}_{k=J})}{\lambda^{k'} + \varphi_{\overline{s}}^{0,J}(\frac{\partial \Psi_{J,0}^m}{\partial V_{\overline{s}}^{k'}} + \mathbb{1}_{k'=J})}$$

Introducing another household k'',

$$1 = \Lambda_{\overline{s}}^{k,k''} \frac{\lambda^k + \varphi_{\overline{s}}^{0,J}(\frac{\partial \Psi_{J,0}^m}{\partial V_{\overline{s}}^k} + \mathbb{1}_{k=J})}{\lambda^{k''} + \varphi_{\overline{s}}^{0,J}(\frac{\partial \Psi_{J,0}^m}{\partial V_{\overline{s}}^{k''}} + \mathbb{1}_{k''=J})}$$

From these two equations, it is possible to replace $\varphi_{\overline{s}}^{0,J}$, which triggers:

$$\frac{\Lambda_{\overline{s}}^{k,k''} - \Lambda^{k,k''}}{\left(\frac{\partial \Psi_{J,0}^m}{\partial V_{\overline{s}}^{k''}} + \mathbb{1}_{k''=J}\right) - \left(\frac{\partial \Psi_{J,0}^m}{\partial V_{\overline{s}}^{k}} + \mathbb{1}_{k=J}\right)\Lambda^{k,k''}} = \frac{\Lambda_{\overline{s}}^{k,k'} - \Lambda^{k,k'}}{\left(\frac{\partial \Psi_{J,0}^m}{\partial V_{\overline{s}}^{k'}} + \mathbb{1}_{k'=J}\right) - \left(\frac{\partial \Psi_{J,0}^m}{\partial V_{\overline{s}}^{k}} + \mathbb{1}_{k=J}\right)\Lambda^{k,k'}}$$

Immediately,

$$\Lambda_{\overline{s}}^{k,k''} = \Lambda^{k,k''} + \beta_{k,k',k''}\left[\Lambda_{\overline{s}}^{k,k'} - \Lambda^{k,k'}\right]$$

where $\beta_{k,k',k''} = \frac{\left(\frac{\partial \Psi_{J,0}^m}{\partial V_{\overline{s}}^{k''}} + \mathbb{1}_{k''=J}\right) - \left(\frac{\partial \Psi_{J,0}^m}{\partial V_{\overline{s}}^{k}} + \mathbb{1}_{k=J}\right)\Lambda^{k,k''}}{\left(\frac{\partial \Psi_{J,0}^m}{\partial V_{\overline{s}}^{k'}} + \mathbb{1}_{k'=J}\right) - \left(\frac{\partial \Psi_{J,0}^m}{\partial V_{\overline{s}}^{k}} + \mathbb{1}_{k=J}\right)\Lambda^{k,k'}}$. □

A.2 An example of punishment function

Imagine a probabilistic punishment which derives not from the exact number of households with lower incentives to deviate but from these non-deviating households weighted by a subjective factor. If one wishes to justify the intuition behind this hypothesis, one may start by considering that the community decides on a punishment for exiters accounting for a subjective propensity to belong to this deviating group. How much circumstances could have driven me into behaving as these exiters with my current level of welfare? Households very close to the pivotal household will not place a burden on others except if they judge their circumstances exceptionally bad. On the opposite, heavily affected households will not likely find excuses for exiters and will hardly think of situations where they would have been better off in the coalition of exiters. Finally, let me introduce α a discount on the punishment exerted by a foreigner relatively to an insider. Each household considers then a counterfactual utility $\tilde{V}_j(s)$ dependent on a random variable $\varepsilon_j(s)$ when deciding on the common sanction and provide incentives for obedience with the contract,

$$\tilde{V}_j(s) = V_j(s) + \varepsilon_j(s), \quad \varepsilon_j(s) \hookrightarrow F \in C^2$$

Assume that the $\varepsilon_j(s)$ are drawn independently and identically in the village. $\varepsilon_j(s)$ can be thought as circumstances which might justify the decision of other households relatively to j's viewpoint. Household j decides on sanctions once corrected for this individual bias. To ensure differentiability, I impose also that only non-deviating households with a higher welfare extracted from the contract exert a positive punishment on the coalition depending on their positions relatively to them. Note that the introduction of fuzzy punishment does not change dramatically the reasoning under a constant punishment framework[20].

Lemma 3. *Under the assumption that* $F(0) = f(0) = f^{'}(0) = 0$*, the fuzzy punishment as expected by a coalition built upon pivotal households* $i \in G_f$ *and* $j \in G_m$ *is of class* C^2*. Besides, it can be written:*

$$\begin{cases} \Psi^f_{i,j}(V(s)) = \pi \left[\sum_{i^{'} \in G_f} F\left(V_i(s) - V_{i^{'}}(s)\right) + \alpha \sum_{j^{'} \in G_m} F\left(V_j(s) - V_{j^{'}}(s)\right)\right] \\ \\ \Psi^m_{j,i}(V(s)) = \pi \left[\sum_{j^{'} \in G_m} F\left(V_j(s) - V_{j^{'}}(s)\right) + \alpha \sum_{i^{'} \in G_f} F\left(V_i(s) - V_{j^{'}}(s)\right)\right] \end{cases}$$

Proof. Knowing perfectly the circumstances $\varepsilon_j(s)$ of other villagers, the individual pressure exerted by a non-deviating household on the pivotal household i would be $\mathbb{1}_{V_i(s) > \tilde{V}_{i^{'}}}$ or $\alpha \mathbb{1}_{V_i(s) > \tilde{V}_{i^{'}}}$ (depending on their respective guilds). This punishment is conditional on household $i^{'}$ willing to enforce the contract, i.e. $V_i(s) < V_{i^{'}}$.

The punishment expected from farmers i can easily be written as the sum $\sum_{i^{'} \in G_f} \mathbb{1}_{V_i(s) < V_{i^{'}}} \mathbb{1}_{V_i(s) > \tilde{V}_{i^{'}}}$ over the other households of the same guild. The total punishments will thus be:

$$\begin{cases} \Psi^f_{i,j}(V(s)) = \pi E\left[\sum_{V_i(s) < V_{i^{'}}(s)} \mathbb{1}_{V_i(s) > V_{i^{'}}(s) - \varepsilon_i(s)} + \alpha \sum_{V_j(s) < V_{j^{'}}(s)} \mathbb{1}_{V_j(s) - \varepsilon_j(s) > V_{j^{'}}(s) - \varepsilon_{j^{'}}(s)}\right] \\ \\ \Psi^m_{j,i}(V(s)) = \pi E\left[\sum_{V_j(s) < V_{j^{'}}(s)} \mathbb{1}_{V_j(s) - \varepsilon_j(s) > V_{j^{'}}(s) - \varepsilon_{j^{'}}(s)} + \alpha \sum_{V_i(s) > V_{i^{'}}(s)} \mathbb{1}_{V_i(s) < V_{i^{'}}(s) - \varepsilon_i(s)}\right] \end{cases}$$

As the functions under the integral are continuous for almost all $(\varepsilon_1, ..., \varepsilon_N)$ and almost all $(V_1, ..., V_N)$ and , $\Psi^f_{i,j}(V(s))$ and $\Psi^m_{j,i}(V(s))$ exist. Developing the previous equations, we compute the formula expressed above. Remark that the functions on the right-hand side are of class C^2, once imposed $F(0) = f(0) = f^{'}(0) = 0$. □

In addition to the previous hypotheses, if the absolute risk aversion of agents is sufficiently high, the fuzzy punishments are then at least quasi-concave and the set of feasible

[20]the main difference involves off-equilibrium strategies as fuzzy punishments imply that the most affected household could deviate costlessly - which is certainly not the case with the constant punishment framework. Yet the equilibrium strategies are in both cases monotonous and the only influence of this change of representation on equilibrium concerns the weights attributed by households slightly above the pivots.

contracts will be a convex set. Denoting $v(x,y)=u(x)-u(y)$,

$$\forall x,y,\begin{cases} f^{'}\left(u(x)-u(y)\right)\left[u^{'}(x)^2+u^{'}(y)^2\right]+f\left(v(x,y)\right)\left[u^{''}(x)+u^{''}(y)\right]\leq 0\\ \left[f^{'}\left(v(x,y)\right)+\frac{u^{''}(x)f(v(x,y))}{u^{'}(x)^2}\right]\left[f^{'}\left(v(x,y)\right)+\frac{u^{''}(y)f(v(x,y))}{u^{'}(y)^2}\right]-f\left(v(x,y)\right)^2\geq 0\end{cases}\tag{Hcc}$$

Lemma 4. *In addition to the previous hypotheses, under the hypothesis (Hcc), the set of feasible contracts defined by the previous corollary is a convex set.*

Proof. Let us show that (Hcc) is sufficient for ensuring that each component of $\Psi: c\mapsto \Psi\left(V(c(s))\right)$ is concave. Without loss of generality, let us get rid of the subscripts and write each component of the punishment function as $F\left(u(x)-u(y)\right)$. The Hessian matrix associated with this function of class C^2 can be written as follows:

$$\begin{pmatrix} \frac{\partial^2 F(u(x)-u(y))}{\partial x^2} & \frac{\partial^2 F(u(x)-u(y))}{\partial x\partial y} & 0 & \dots & 0\\ \frac{\partial^2 F(u(x)-u(y))}{\partial x\partial y} & \frac{\partial^2 F(u(x)-u(y))}{\partial y^2} & 0 & \dots & 0\\ 0 & 0 & 0 & \dots & 0\\ \vdots & \vdots & 0 & \dots & 0\\ 0 & 0 & 0 & \dots & 0\end{pmatrix}$$

This matrix is negative-semidefinite if and only if the sub-matrix M is negative-semidefinite, which is equivalent to:

$$\forall x,y,\begin{cases} Tr(M)\leq 0\\ Det(M)\geq 0\end{cases}$$

This system is equivalent to $\Psi: c\mapsto \Psi\left(V(c(s))\right)$ is thus concave as a sum with positive weight of concave functions. Since Ψ is concave, Ψ is a fortiori quasi-concave and the set of feasible contracts defined by the previous corollary is a convex set. ☐

A.3 Optimization

The Lagrangian can be written as follows ($\lambda_k=1$):

$$\begin{aligned}\mathcal{L}=&\sum_k \lambda_k[u(c^k)+\beta\sum_s p_s u(c_s^k)-u(y^k)-\beta\sum_s p_s u(y_s^k)]\\ &-\theta\sum_k\left(c^k-y^k\right)-\beta\sum_{k,s}\theta_s p_s\left(c_s^k-y_s^k\right)-\beta\sum_{i\in G_f,j\in G_m,s\in\Omega}p_s\iota_s^{i,j}\left[\overline{\nu}_s^{i,j}-\underline{\nu}_s^{i,j}\right]\\ &+\beta\sum_{i\in G_f,j\in G_m,s\in\Omega}\varphi_s^{i,j}p_s\left[\iota_s^{i,j}\Psi_{i,j}^f(V(s))+(1-\iota_s^{i,j})\Psi_{j,i}^m(V(s))+\iota_s^{i,j}V_i(s)+(1-\iota_s^{i,j})V_j(s)\right]\end{aligned}$$

Considering $\lambda_1 = 1$, the first order conditions give us:

$$\begin{cases} \lambda_k u^{'}(c^k) = \theta \quad \forall k \\ \lambda_k u^{'}(c_s^k) - \theta_s + u^{'}(c_s^k) \sum_{i,j} \varphi_s^{i,j} \left[\iota_s^{i,j} \frac{\partial \Psi_{i,j}^f}{\partial V_s^k} + (1 - \iota_s^{i,j}) \frac{\partial \Psi_{j,i}^m}{\partial V_s^k} \right] + \sum_j \varphi_s^{k,j} \iota_s^{k,j} u^{'}(c_s^k) = 0 \quad \forall k, s \\ \varphi_s^{i,j} \left[\Psi_{i,j}^f(V(s)) - \Psi_{j,i}^m(V(s)) - V_i(s) + V_j(s) \right] + \left[\overline{\nu}_s^{i,j} - \underline{\nu}_s^{i,j} \right] = 0 \quad \forall i \in G_f, j \in G_m, s \in \Omega \end{cases}$$

Let us denote:

$$\phi_s^k \lambda_k = \begin{cases} \sum_{i \in G_f, j \in G_m} \varphi_s^{i,j} \left[\iota_s^{i,j} \frac{\partial \Psi_{i,j}^f}{\partial V_s^k} + (1 - \iota_s^{i,j}) \frac{\partial \Psi_{j,i}^m}{\partial V_s^k} \right] + \sum_{j \in G_m} \varphi_s^{k,j} \iota_s^{k,j}, \quad k \in G_f \\ \\ \sum_{i \in G_f, j \in G_m} \varphi_s^{i,j} \left[\iota_s^{i,j} \frac{\partial \Psi_{i,j}^f}{\partial V_s^k} + (1 - \iota_s^{i,j}) \frac{\partial \Psi_{j,i}^m}{\partial V_s^k} \right] + \sum_{i \in G_f} \varphi_s^{i,k} \iota_s^{i,k}, \quad k \in G_m \end{cases}$$

As a consequence, the marginal utilities can be written as follows:

$$\begin{cases} \lambda_k u^{'}(c^k) = \theta \quad \forall k \\ \lambda_k u^{'}(c_s^k)(1 + \phi_s^k) = \theta_s \quad \forall k \in G_f \cup G_m, s \end{cases}$$

Finally, $\Lambda^{k,k^{'}}$ and $\Lambda_s^{k,k^{'}}$ will be the ratios of marginal utilities between households k and $k^{'}$ at period 0 and after the realization of s.

$$\Lambda^{k,k^{'}} = \Lambda_s^{k,k^{'}} \frac{1 + \phi_s^k}{1 + \phi_s^{k^{'}}} \quad \forall k, k^{'}, s$$

B Complements - Descriptive statistics

Table T1: Descriptive statistics

	rural	urban
general		
Annual income (USD 2004)	1382	2511
location		
Delta	.53	-
Hills and mountains	.37	-
Coastal areas	.10	-
presence of formal instruments		
Life insurance	.04	.10
Health insurance	.35	.52
Non-life insurance	.05	.09
Formal loans	.30	.22
Loans for non-durable	.02	.02
presence of informal instruments		
Foreign remittances	.04	.11
Domestic remittances	.83	.84
Informal loans	.14	.12
Zero-rate loans	.11	.10
Loans for non-durable	.04	.04

Except for the income measure, the table displays the unweighted proportions of households.

Private insurance is almost absent in our sample. Thus, only 6% of the surveyed households in 2004 have a formal non-life and not health-centered insurance contract and less than 5% when ruling out urban areas. The figures are similar for life insurance contracts (respectively 5% and 4%) while health insurance seems to be more frequent (respectively 39% and 35%) but covers extremely small amounts. 30% of rural households are currently reimbursing a loan contracted with a formal credit institution. Several households are reimbursing more than a single loan but second and third loans are mainly informal. The interest rate per week is roughly 1% for all formal credit institutions, which is extremely high. The presence of preferential credit has no influence on the whole community. Only households actually benefitting from lower interest rates borrow more. Since they have a preferential access to credit, households rely less on informal loans and when they do, they obtain milder conditions from other households (94% of zero interest loans against 83% for non-eligible households, perhaps echoing the better outside option). I include state/regional intervention and NGO's relief aid as part of the formal response to natural disasters. Indeed, these amounts are essentially destined to the commune and are used to reconstruct roads and other public goods. The fact that relief aid is often dealt by the commune leader mitigates the reach of intervention of any single household when trying to benefit directly from it. Using the commune questionnaire of VLSS and the amount and provider of relief aid, I compute the correlations between these ex-post transfers and our measure of income losses. These correlations are non significant at district level. Household-level correlation between the aid declared by the respondent and income losses due to shocks is also not different from zero. Furthermore, allowance for disaster recovery hardly reaches 1% of the household annual income in the most affected districts. Similarly, support from organizations at commune-level represent more than 1% of the income in 2 districts only and a dozen of communes.

Regarding informal transfers, the collected data are aggregate inflows and outflows (in-kind and cash) over the past year, except for the loan section for which each transaction is recorded with the partner type. Only 10% of households in rural areas had zero outflows during the past year. To confirm these data on outflows, inflows of domestic remittances and gifts are absent for only a sixth of the total sample. The average and median amounts received during the past year from other households are respectively 10% and 3% of the receiver's annual income. The average amount is biased upward compared to the outflows data and median amount reflecting that the recipients of gifts have in parrallel not benefitted from other sources of income. Unsurprisingly, foreign remittances concern a much smaller part of the population (4% of households in rural areas). The average amount when present is six times higher than the average domestic remittances and represents approximately a third of the total income perceived by the domestic household. In line with the intuition that foreign migrants support financially aging households, the receiving households are more urban, older and less active than the average household receiving domestic remittances and gifts only. They should also be less exposed to natural disasters. Regarding informal loans, 15% of households have lent to another household in the past year. Roughly in line with these results, 10%[21] of the surveyed households have borrowed the past year from other individuals at zero interest rate. An additional 4% are contracted with individuals with unknown status. In practice, they could be retailers or colleagues but also usurers offering extremely high interest rates. Interest rates of informal loans are lower than for formal loans (0 for 82% of the rural household). As regards this assumption, I do not try to assess the facial value of a loan. Furthermore, households might report differently inflows and outflows. In the rest of the paper, I will aggregate gifts and informal loans and consider that they both reflect access to liquidity when needed and participation in a social contract. Finally, the purposes of the loans differ significantly had it been contracted with formal institutions or individuals. 80% of formal loans respond

[21] The following statistics are extracted from the subsample of surveyed families living in rural areas.

to clearly identified long-term investments while the proportion hardly reaches 50% for informal arrangements.

Table T2: Correlations at district level with wind intensity

	Correlation	(p-value)
Income and expenditure		
Income	-.166	(.00)**
Expenditure on repaired assets	.068	(.10)†
Expenditure on new assets	.119	(.00)**
External support		
Insurance	-.074	(.07)†
Aid from NGOs	-.053	(.20)
Foreign remittances	-.038	(.36)
Expenditures		
Entertainment	.006	(.87)
Funeral and death anniversaries	-.068	(.11)
Informal transfers		
Contribution to funds (outflows)	.067	(.10)†
Informal loans (inflows)	.127	(.00)**
Propensity (past typhoons)		
Propensity score	.467	(.00)**

These are simple correlations without controlling for any past variables. This table displays the variables averaged on households drawn in the same district. Wind intensity is the energy dissipated in the district by the typhoons occurring between 2004 and 2006. Significances are indicated at 10%†, 5%*, 1%**.

C Charity or insurance?

Let us try to capture potential payments of premiums against insurance. Focusing on regions unaffected by any tropical typhoon between 2004 and 2006, it seems that households with risky activities in risky zones are more inclined to have informal transfers outflows. Table T3 in the appendix documents three specifications in which the level of net[22] transfers in 2006 are explained by the interaction of reliance on crops (which stands for the degree of individual exposure) with the propensity to be affected, i.e. the risk. Except in the last specification in which the identification relies on intra-province differences in exposure to wind, the coefficient is significantly negative. Passing from a safe zone to a zone with the average exposure in Vietnam is associated with an increase of informal outflows accounting for 15% of the additional income earned through risky activities. This result is not robust when considering intra-province differences in exposure and does not rely on a consistent strategy to offset potential biases. That said, the first two correlations are consistent with a model where informal transfers incorporate the risk through a premium and suggest that farmers might not be completely free-riding on a social contract.

At this point in the analysis, it is necessary to notice that transfers also seem to compensate temporarily low income whatever the reason behind individual fluctuations (whether justifiable or unjustifiable). A preliminary test (see table T4) of the equation (S1) without any instruments shows that unpredicted income of $ 1 is associated with compensating informal transfers of 7 cents, mainly explained by gifts and remittances (between 5 and 6 cents against 1 for informal loans). Considering the difference between the household income and the income of households sharing similar initial characteristics as a shock is not sufficient to identify consistently this equation. Since the differences between predicted income and effective income might reflect the graduation or the migration of a young member of the household (which are certainly expected and does not enter generally into any sort of insurance contracts), credible instruments are to be used to alleviate endogeneity biases. Even though the specification T4 without a first stage may be hardly convincing, the differences observed following typhoons might show a greater social redistribution occurring thanks to an extensive use of zero-interest loans. This fact can be partly understood on the basis of the distinction between justifiable and unjustifiable inequalities.

[22]inflows minus outflows.

Table T3: Informal transfers in non-affected zones for risky-prone agents

Specification (S1)

	Informal net transfers in 2006					
Specifications	OLSfe		OLSfe		OLSfe	
			Premiums on crops			
Interaction district/activities	-.133	(.066)*	-.182	(.077)*	-.187	(.213)
Individual risky activities	.129	(.049)*	-.045	(.285)	-.441	(.905)
Extended controls	Yes		Yes		Yes	
FE	District		District		District	
FE interacted with activities	No		Regions		Provinces	
Sample	Spared regions		Spared regions		Spared regions	
Observations	5107		5107		5107	
			Premiums on crops and agricultural services			
Interaction district/activities	-.164	(.067)**	-.223	(.076)**	-.133	(.216)
Individual risky activities	.130	(.051)*	-.065	(.282)	-.601	(.867)
Extended controls	Yes		Yes		Yes	
FE	District		District		District	
FE interacted with activities	No		Regions		Provinces	
Sample	Unaffected regions		Unaffected regions		Unaffected regions	
Observations	5107		5107		5107	

Significantly different than zero at † 90% confidence, * 95% confidence, ** 99% confidence. Only the variables of interest are displayed here. The results are shown omitting the coefficients for the set of dummies grouping age, education, activity of the head, level of income in 2004 and fixed effects. Risky activities are proxied by the percentage of income earned in 2004 by growing crops in panel 1, growing crops and supplying agricultural services in panel 2. The results are robust to the addition of variables such as the previous level of transfers.

Table T4: Redistribution and social insurance in normal times

Specification (S1)

	Informal net transfers in 2006					
	level				**difference**	
Specifications	OLS		OLS FE		OLS	
			Total			
Own shock	-.067	(.003)**	-.069	(.004)**	-.070	(.004)**
Shock on neighbors	.011	(.005)*	.016	(.006)*	.012	(.006)*
Extended controls	Yes		Yes		Yes	
District FE			Yes			
Sample	Total		Total		Total	
Observations	6794		6794		6794	
			Gifts			
Own shock	-.054	(.003)**	-.055	(.003)**	-.055	(.003)**
Shock on neighbors	.007	(.004)†	.007	(.005)	.005	(.004)
Extended controls	Yes		Yes		Yes	
District FE			Yes			
Sample	Total		Total		Total	
Observations	6794		6794		6794	
			Informal loans			
Own shock	-.013	(.001)**	-.015	(.003)**	-.015	(.003)**
Shock on neighbors	.004	(.002)*	.009	(.004)†	.007	(.004)*
Extended controls	Yes		Yes		Yes	
District FE			Yes			
Sample	Total		Total		Total	
Observations	6794		6794		6794	

Significantly different than zero at † 90% confidence, * 95% confidence, ** 99% confidence. Only the variables of interest are displayed here. The results are shown omitting the coefficients for the set of dummies grouping age, education, activity of the head, past level of income, assets owned by the family and neighbors, individual and neighbors' propensity to be affected by a typhoon and district potential exposure. Transfers are used in levels in the first and second specifications and in differences with 2004 in the third specification.

D Complements on the first stage

The statistics of the hypothetical first stages displayed above tend to show that the instrumental relevance might be an issue here. Nonetheless, following Stock and Yogo, the minimum eigenvalue statistics are sufficiently high to ensure that the hypothesis of weak instruments can be rejected with a 20%-confidence

Statistics on hypothetical first stages

Activities	**crops**	**renting**	**index**	**crops & renting**
F-statistic	6.93	9.44	17.1	8.57
Adjusted-R^2	.019	.013	.025	.025
Minimum eigenvalue statistic	7.03	10.2	14.8	7.49

Table T5: Robustness of the second stage over the choice of instruments in the first stage

Specification (S1)

	Informal net transfers in 2006				
	crops	**renting**	**crops+renting**	**crops & renting**	
Specifications	2SLS	2SLS	2SLS	2SLS	2SLS
Own shock	.158	-.181	-.178	-.179	-.336
	(.093)†	(.084)*	(.063)**	(.064)**	(.172)*
Shock on neighbors					.251
					(.190)
Extended controls	Yes	Yes	Yes	Yes	Yes
Observations	6794	6794	6794	6794	6794

Significantly different than zero at † 90% confidence, * 95% confidence, ** 99% confidence. Only the endogenous variables are displayed here. The results are shown omitting the coefficients for the set of dummies grouping age, education, activity of the head, level of income in 2004 and the district propensity to be affected by a typhoon interacted with the risky activity. Risky activities are proxied by the percentage of income earned in 2004 by growing crops, renting out, an index $V = V(crops) + \frac{1}{10}V(renting)$, and both together in the last specifications. The results are robust to the addition of district fixed effects.

E Decomposition gifts/loans

Table T6: Decomposition between gifts and informal loans flows following natural disasters

Specification (S1)

	Informal net transfers in 2006							
Specifications	2SLS		2SLSfe		2SLS		2SLSfe	
				Gifts				
Own shock	-.065	(.032)*	-.066	(.032)*	-.068	(.029)*	-.071	(.028)*
Shock on others	.013	(.043)	-.024	(.043)	.028	(.039)	.015	(.39)
District FE			Yes				Yes	
Sample	Total		Total		Rural		Rural	
Observations	6508		6508		4977		4977	
				Informal loans				
Own shock	-.090	(.020)**	-.088	(.019)**	-.104	(.018)**	-.104	(.018)**
Shock on others	.075	(.027)**	.055	(.026)†	.086	(.025)**	.091	(.025)**
District FE			Yes				Yes	
Sample	Total		Total		Rural		Rural	
Observations	6794		6794		5058		5058	

Significantly different than zero at † 90% confidence, * 95% confidence, ** 99% confidence. Only the endogenous variables are displayed here. The results are shown omitting the coefficients for the set of dummies grouping age, education, activity of the head, past level of income, assets owned by the family and neighbors, individual and neighbors' propensity to be affected by a typhoon and district potential exposure. These controls are also included in the first stage. The instruments are the effective exposure to typhoons (energy dissipated by the wind and flood) crossed with assets and activities in 2004 for the household and its neighbors.

F Transfers of assets and savings

Table T7: Transfers of assets following natural disasters

Specification (S1)

	Transfers of assets in 2006							
Specifications	2SLS		2SLSfe		2SLS		2SLSfe	
Own shock	-.011	(.061)	.005	(.053)	-.049	(.063)	.020	(.049)
Shock on neighbors			-.010	(.071)			-.043	(.066)
District Fixed-effects			Yes				Yes	
Sample	Total		Total		Rural		Rural	
Observations	6794		6794		5058		5058	

Significantly different than zero at † 90% confidence, * 95% confidence, ** 99% confidence. Only the endogenous variables are displayed here. Transfers of assets include withdrawal from savings, selling means of production, assets and jewelry. The results are shown omitting the coefficients for the set of dummies grouping age, education, activity of the head, past level of income, assets owned by the family and neighbors, individual and neighbors' propensity to be affected by a typhoon and district potential exposure. These controls are also included in the first stage. The instruments are the effective exposure to typhoons (energy dissipated by the wind and flood) crossed with assets and activities in 2004 for the household and its neighbors.

G Results - heterogeneity

Table T8: Pressure on the enforcement constraints depending on the social identity

Specification (S2)

	Targeted marginal ratio				
	(1)	**(2)**	**(3)**	**(4)**	**(5)**
Specifications	2SLS	2SLS	2SLS	2SLS	2SLS
Social overweight (γ)		.329	1.23	-.679	.796
		(.191)†	(.372)**	(.559)	(.468)†
Actual ratio (α)	.280	.239	.183	.089	.111
	(.120)**	(.102)**	(.072)**	(.049)**	(.067)**
Constrained ratio (ζ)	.379	.161	.540	.183	.317
	(.128)**	(.133)	(.198)**	(.115)	(.149)*
Partial interactions			Yes	Yes	Yes
Set of controls	Extended	Extended	Extended	Extended	Extended
Observations	1068	1068	1068	1068	1068

Significantly different than zero at † 90% confidence, * 95% confidence, ** 99% confidence (exceptionnally shown for the test $\alpha = 1$ rather than $\alpha = 0$). The results are robust to the addition of commune controls. Only some of the endogenous variables are shown here. Partial interactions between indicators of social identity are omitted as well as exogenous variables accounting for propensities to be affected. The indicators for social identity are the following: (1): none, (2): households 1 and 3 belong to different guilds, (3): households 2 and 3 have the same guild $\times$ the reversed distance between 2 and 3 in terms of exposure, (4): the interaction of (2) and (3), (5): the interaction of 1 is in one guild $\times$ 2 and 3 belong to the other guild $\times$ business activities are declared as the second source of income in the village following agriculture. The number of observations is reduced from 1855 rural wards to 1068 villages where the three households can be ranked without ambiguity.

Table T9: Pressure on the enforcement constraints depending on the social integration

Specification (S2)				
	Targeted marginal ratio			
	new entrants		**ethnicity**	
Specifications	(a)	(b)	(c)	(d)
Social overweight (γ)	.556	.424	-.131	2.78
	(.258)*	(.258)†	(.155)	(.849)**
Actual ratio (α)	.203	.012	.178	.162
	(.105)**	(.065)**	(.087)**	(.100)**
Constrained ratio (ζ)	-.100	.260	.276	.097
	(.193)	(.156)†	(.114)*	(.119)
Partial interactions		Yes	Yes	Yes
Set of controls	Extended	Extended	Extended	Extended
Observations	1068	1068	1068	1068

Significantly different than zero at † 90% confidence, * 95% confidence, ** 99% confidence (exceptionnally shown for the test $\alpha = 1$ rather than $\alpha = 0$). Only second stage and the most important endogenous variables are shown here. Partial interactions between indicators of social identity are omitted as well as exogenous variables accounting for propensities to be affected. The indicators for social integration are the following: (a): either 1 or 3 is a new entrant, (b): 1 is new $\times$ 2 and 3 are settled households, (3): households 1 and 3 belong to different ethnic group, (d): 2 and 3 belong to the same ethnic group in villages with at least two significant groups $\times$ 1 is in the other group. The number of observations is reduced from 1855 rural wards to 1068 villages where the three households can be ranked without ambigity.

Table T10: Pressure on the enforcement constraints depending on recent exposure

Specification (S2)

	Targeted marginal ratio		
	activity		**entrants**
	(i.)	(ii.)	(iii.)
Recent exposure × social overweight	-.543	-.970	-.066
	(.332)†	(.499)*	(.292)
Social overweight	.462	.540	-.038
	(.266)†	(.337)	(.186)
Actual ratio (α)	.198	.178	.109
	(.075)**	(.078)**	(.65)**
Constrained ratio (ζ)	.207	.196	.194
	(.124)†	(.118)†	(.134)
Partial interactions	Yes	Yes	Yes
Set of controls	Extended	Extended	Extended
Observations	1068	1068	1068

Significantly different than zero at † 90% confidence, * 95% confidence, ** 99% confidence (exceptionnally shown for the test $\alpha = 1$ rather than $\alpha = 0$). Only second stage and the most important endogenous variables are shown here. Partial interactions between indicators of social identity and recent exposure are omitted as well as exogenous variables accounting for propensities to be affected. The indicators for social integration are the following: (i.): households 1 and 3 belong to different guilds, (ii.): households 2 and 3 have the same guild × the reversed distance between 2 and 3 in terms of exposure, (iii.): either 1 or 3 is new in the village. The number of observations is reduced from 1855 rural wards to 1068 villages where the three households can be ranked without ambigity. Past exposure are dummies equal to 1 if the district has been exposed to a dreadful cyclone in the late nineties (1999-2000 and 1997-2000).

H Robustness checks - placebo

Table T11: Placebo regressions using pre-disaster informal transfers

Specification (S1)

	Informal net transfers in 2004							
Specifications	2SLS		2SLSfe		2SLS		2SLSfe	
Own shock	.009	(.027)	-.003	(.016)	-.004	(.024)	.013	(.014)
Shock on neighbors	-.033	(.037)	.016	(.022)	-.008	(.032)	-.024	(.018)
Sample	Total		Rural		Total		Total	
Observations	6794		5058		6794		6794	

Significantly different than zero at † 90% confidence, * 95% confidence, ** 99% confidence. Only the endogenous variables are displayed here. The results are shown omitting the coefficients for the set of dummies grouping age, education, activity of the head, past level of income, assets owned by the family and neighbors, individual and neighbors' propensity to be affected by a typhoon and district potential exposure. The instruments are the effective exposure to typhoons (energy dissipated by the wind and flood) crossed with assets and activities in 2004 for the household and its neighbors.

Table T12: Pressure on the enforcement constraints depending on the social identity - placebo regressions

Specification (S2)

	Targeted marginal ratio
Specifications	2SLS
Placebo actual ratio (α)	-.319
	(.278)**
Placebo constrained ratio (ζ)	.047
	(.159)
Set of controls	Extended
Observations	1006

Significantly different than zero at † 90% confidence, * 95% confidence, ** 99% confidence (exceptionnally shown for the test $\alpha = 1$ rather than $\alpha = 0$).

Table T13: Placebo regressions using pre-disaster informal flows and commune characteristics

Specification (S1)

	Informal net transfers in 2004		
	turnover	**distance**	**ethnicity**
Specifications	2SLSfe	2SLSfe	2SLSfe
Own shock × having moved recently	-.002		
	(.018)		
Own shock × turnover	-.001		
	(.017)		
Own shock × geographic dispersion		-.000	
		(.002)	
Own shock × ethnic minority			-.022
			(.030)
Own shock	.000	-.006	-.005
	(0.015)	(.025)	(.015)
Fixed-effects	district	size	ethnic
Controls for shocks on neighbors	Yes	Yes	Yes
Observations	4702	4738	6625

Significantly different than zero at † 90% confidence, * 95% confidence, ** 99% confidence. Only the endogenous variables are displayed here. The results are shown omitting the coefficients for past level of income, assets owned by the family and neighbors, individual and neighbors' propensity to be affected by a typhoon and district potential exposure. These controls are also included in the first stage. The instruments are the effective exposure to typhoons (energy dissipated by the wind and flood) crossed with assets and activities in 2004 for the household and its neighbors (in addition, I use the previous instruments crossed with commune characteristics). Communes for which information on geographic dispersion is available are essentially rural. Geographic dispersion is the number of hamlets in the commune. Road to hamlet indicates the distance between the hamlet and the nearest road. Being in the ethnic minority is a dummy equal to 1 if the household does not belong to the main ethnic group as reported by the commune leader. Dummies controlling for ethnicity group both the main commune ethnic group and the ethnicity of the household. Turnover is the number of newcomers and leaving households during the last year relatively to the total population of the commune. Having moved recently is a dummy equal to 1 for households having moved in between 1995 and 2004 and coming from another commune.

Table T14: Placebo regressions using pre-disaster informal flows and past exposure

Specification (S1)

	Informal net transfers in 2004			
	1999-2000		**1997-2000**	
Specifications	2SLS	2SLSfe	2SLS	2SLSfe
Own shock × exposed to 99-00 typhoons	.019	.018		
	(.039)	(.040)		
Own shock × exposed to 97-00 typhoons			.020	.018
			(.040)	(.039)
Own shock	-.011	-.012	-.011	-.012
	(.013)	(.032)	(.013)	(.013)
Controls for shocks on neighbors	Yes			
Dummies for provinces fixed-effects		Yes		Yes
Observations	4895		4895	

Significantly different than zero at † 90% confidence, * 95% confidence, ** 99% confidence. Only the endogenous variables are displayed here. The results are shown omitting the coefficients for past level of income, assets owned by the family and neighbors, individual and neighbors' propensity to be affected by a typhoon and district potential exposure. These controls are also included in the first stage. The instruments are the effective exposure to typhoons (energy dissipated by the wind and flood) crossed with assets and activities in 2004 for the household and its neighbors (in addition, I use the previous instruments crossed with past exposure). Past exposure are dummies equal to 1 if the district has been exposed to a dreadful cyclone in the late nineties (1999-2000 and 1997-2000). A province groups roughly a dozen of districts.

I Robustness checks - distribution

Table T15: Informal flows depending on the distribution of exposure (robustness checks)

Specification (S1)

	Informal net transfers in 2006				
Specification	(i)	(ii)	(iii)	(iv)	(v)
Own shock × distance	.315	.252			
	(.110)**	(.102)*			
Own shock × proportion of spared			.179		
			(.056)**		
Own shock × importance of agr.				-.178	
				(.023)**	
Own shock × disunity					.078
					(.044)†
Own shock	-.170	-.106	-.167	-.081	-.195
	(.035)**	(.028)**	(.034)**	(.032)*	(.040)**
Shocks on others	Yes	Yes	Yes	Yes	Yes
Observations	4895	4895	4895	4895	4895

Significantly different than zero at † 90% confidence, * 95% confidence, ** 99% confidence. Only the endogenous variables are displayed here. The results are shown omitting the coefficients for past level of income, assets owned by the family and neighbors, individual and neighbors' propensity to be affected by a typhoon and district potential exposure. These controls are also included in the first stage. The instruments are the effective exposure to typhoons (energy dissipated by the wind and flood) crossed with assets and activities in 2004 for the household and its neighbors (in addition, I use the previous instruments crossed with the distribution variable). The different specifications are the following: (i.): distance between the median and average exposure constructed with reliance on crops only, (ii.): similar as (i.) but with renting only, (iii.): proportion of spared households in the commune, (iv.): importance of agriculture captures if other activity exist in the village, (v.): disunity is equal to 1 if the commune leader declared social conflicts in 2004. The sample is limited to rural areas in which 3 households are surveyed per commune.

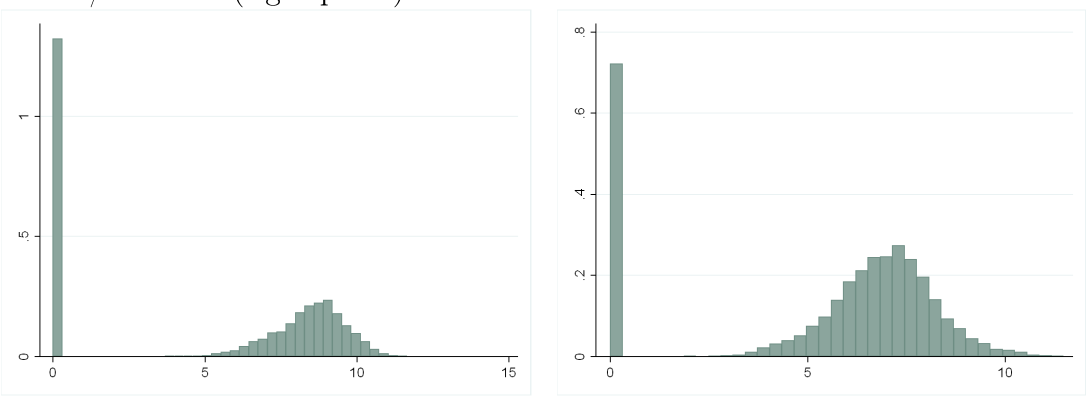
Table T16: Informal flows depending on placebo distributions of exposure to typhoons (robustness checks)

Specification (S1)

Specification	Informal net transfers in 2006: (i): wages		Informal net transfers in 2006: (ii): aquaculture, livestock	
Own shock × distance	.040	(.114)	.016	(.095)
Own shock	-.141	(.029)**	-.111	(.034)**
Controls for shocks on neighbors	Yes		Yes	
Observations	4895		4895	

Significantly different than zero at † 90% confidence, * 95% confidence, ** 99% confidence. Only the endogenous variables are displayed here. The results are shown omitting the coefficients for past level of income, assets owned by the family and neighbors, individual and neighbors' propensity to be affected by a typhoon and district potential exposure. These controls are also included in the first stage. The instruments are the effective exposure to typhoons (energy dissipated by the wind and flood) crossed with assets and activities in 2004 for the household and its neighbors (in addition, I use the previous instruments crossed with the distribution variable). The different specifications are the following: (i.): distance between the median and average exposure constructed with reliance on wages, (ii.): similar as (i.) but with aquaculture and livestock. The sample is limited to rural areas in which 3 households are surveyed per commune.

Figure F1: Distribution of the logarithm of reliance on wages (left panel) and aquaculture/livestock (right panel).



J Distribution of vulnerabilities

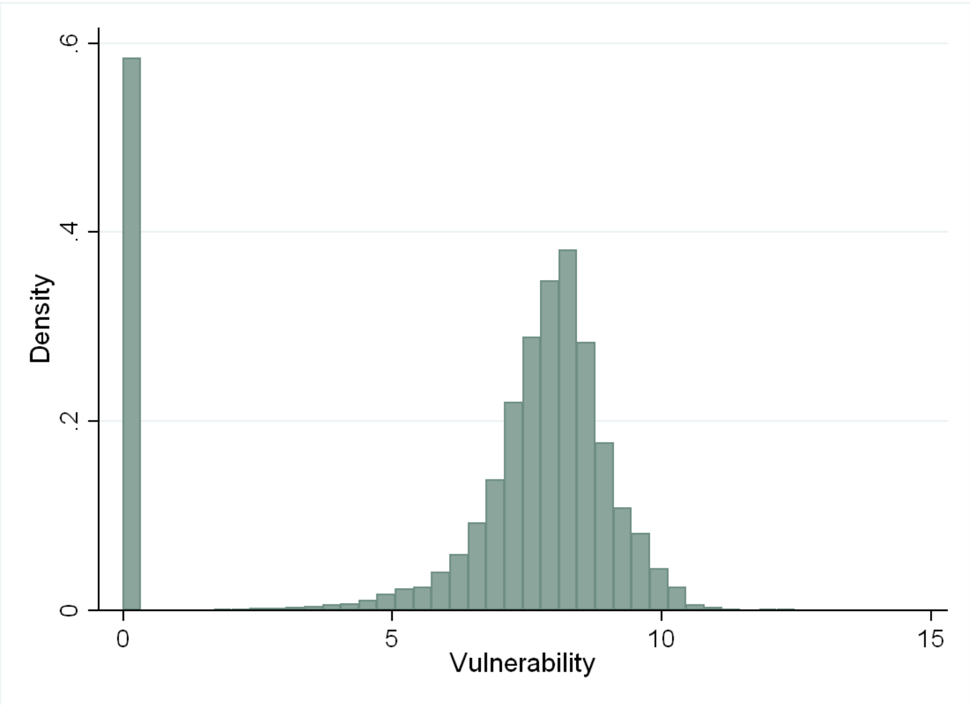


Figure F2: Distribution of the logarithm of vulnerabilities in rural Vietnam.

Figure F3: Distribution of the logarithm of vulnerabilities in two districts of Hà Tây Province, the land of hundred trades.

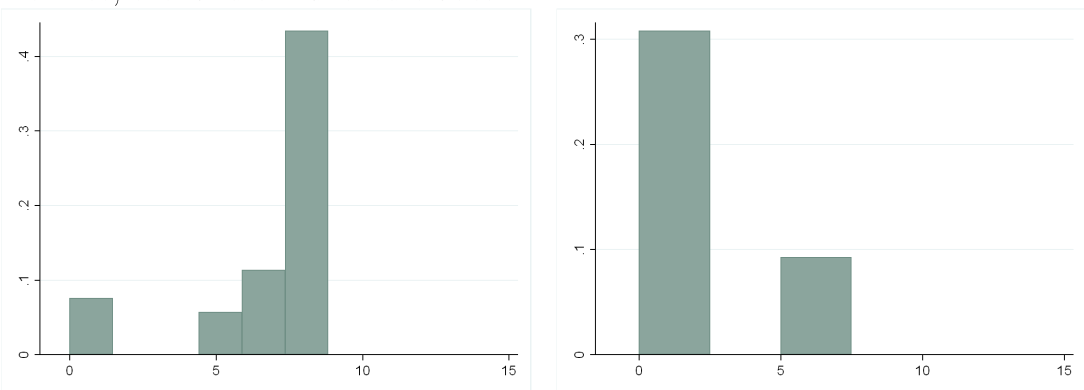


Figure F4: Distribution of vulnerabilities of the logarithm for households with (left panel)/without (right panel) a business activity.

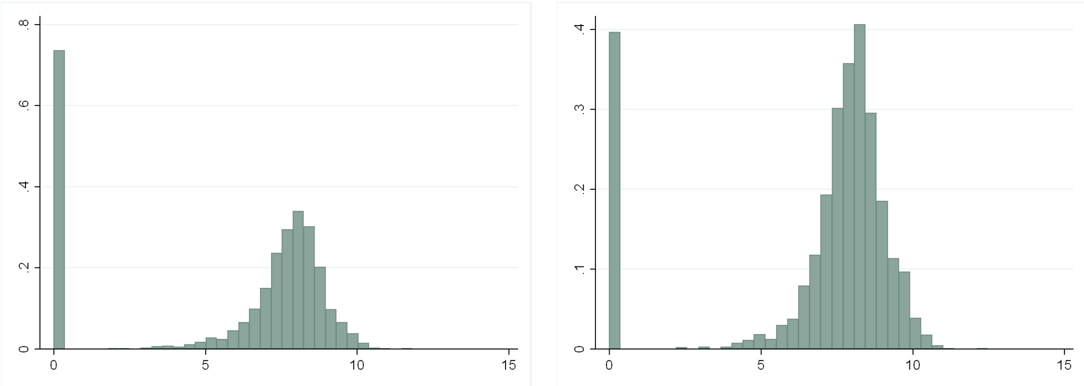


Figure F5: Distribution of the logarithm of vulnerabilities for movers (left panel) and stayers (right panel).

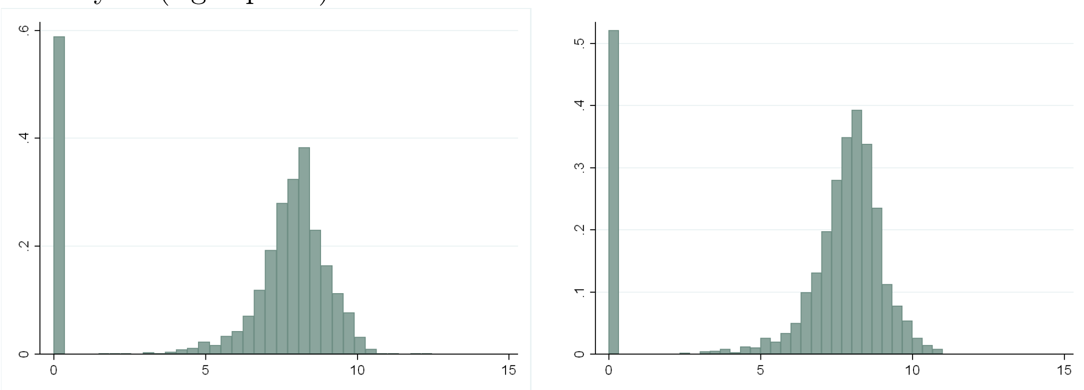
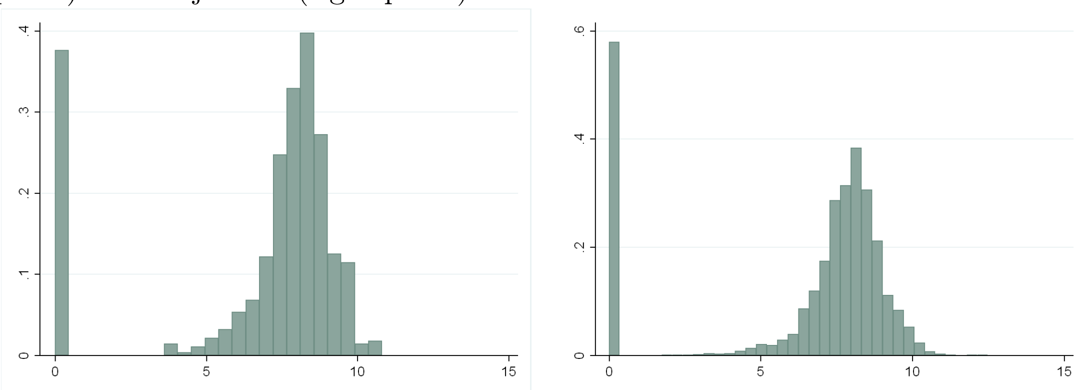


Figure F6: Distribution of the logarithm of vulnerabilities for ethnic minorities (left panel) and majorities (right panel).



K Migration

Data from VHLSS 1997/98 gave a broad picture of the average urban migrant in Vietnam and their preferred destination (mainly Ho-Chi-Minh City). Migration is not as developed as expected since Vietnam has a household registration system similar to Hukou[23]. This system is specifically designed to slow rural to urban migration, 80% of urban migrants are registered as non-permanent residents and do not benefit from social advantages. The picture of the average migrant corresponds to a middle-aged educated man with old parents, escaping under-employment in rural areas. Remittances are declared for half of the urban migrants and migration can respond specifically to consumption-smoothing purposes. Recourse to remittances might not be restricted to households having sent one of its member to cities before the disaster. Urban migration might also be a temporary strategy for affected households to prevent its members from staying under-employed during the harvest season.

Four facts contribute to mitigate the importance of external assistance in this study: In a first attempt, I test if the evolution of the number of persons in the household in 2006 is influenced by the passage of typhoons and replicate the baseline specification on a subsample of households with non-decreasing number of members between 2004 and 2006. The results are not consistent with strategic migration responding to typhoons and lasting after 2006. On the one hand, household size does not vary following a typhoon. On the other hand, the results are robust when restricted to households having experienced a positive growth of size during the period. Yet this estimation does not tackle the issue of very short-term migration occurring between the two waves. Assuming that activities for farmers should be disrupted during one season only, the optimal strategy could be consistent with return migration before the second wave. As such, the following tests will be more indirect and focus on the relationship between household's compensation and village losses rather than on households independently of their neighbors.

First, not only the household is compensated following an individual shock but the household is affected significantly by its neigbor's losses at the village level. Second and in the same vein, the elasticity of net transfers to natural disaster shocks is significantly different from zero wherever the household lies relatively to the rest of the surveyed households in terms of income fluctuations. If migrants were to insure the households against these shocks, the affected households would receive positive net transfers but not supplied by the unaffected households. As a consequence, responses to fluctuations from the least affected households should not be correlated to the amplitude of the shock in a village had the transfers been uniquely driven by domestic remittances. Third, considering successively the household as a unit, part of the enumeration area, the commune as a unit, part of a

[23] registration system in China which denied the right to benefit from social benefits such as public schools. The system is still in vigor but not strictly applied. Vietnamese government seemed to be less flexible during the surveyed period.

district, the districts and the provinces as units, parts of the entire Vietnam, the layer for which aggregate net gifts and informal loans react to natural disaster shocks compared to other units in the group is the closest to the nucleus.

Table T17: Tackling the issue of urban migrants - position in the commune

Specification (S1)

	Informal net transfers in 2006					
	Informal transfers		Loans		Gifts	
Specifications	2SLS		2SLS		2SLS	
Own shock - below average	-.153	(.042)**	-.087	(.021)**	-.066	(.031)*
Own shock - above average	-.282	(.134)*	-.160	(.068)**	-.121	(.098)
Shock on others	.082	(.058)	.071	(.029)*	.010	(.042)
Observations	6794		6794		6794	

Significantly different than zero at † 90% confidence, * 95% confidence, ** 99% confidence. Only the endogenous variables are displayed here. The results are shown omitting the coefficients for the past level of income, assets, propensity to be affected by a typhoon for individuals and neighbors and district potential exposure. These controls are also included in the first stage. The instruments are the effective exposure to typhoons (energy dissipated by the wind and flood) crossed with assets and activities in 2004 for the household and its neighbors. Households below average are households particularly affected compared to predicted income losses for the commune.