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

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Abstract

In rural economies, risk-sharing arrangements in small groups of relatives and friends are common. Imperfect commitment seems to impede the development of informal insurance mechanisms in larger networks. I model two major threats - (i) the endogenous formation of subgroups willing to break away and (ii) the initial fractionalization of the community - and predict the sustainability of an insurance contract at the village level. I test two specifications derived from the theory on a panel survey in Vietnam, using tropical typhoons wind structures. A first estimation exhibits limited risk-sharing in the aftermath of natural disasters at the village level. Yet, ex-post redistribution is not completely failing, as 17 cents are covered through informal transfers for a relative income loss of $ 1. The influence of social norms and identities of contractors on the degree of participation in the ex-post redistribution gives support to the theoretical predictions. Finally, communities having already suffered important trauma show greater signs of resilience, explained partly by a higher degree of cohesiveness and a resurgence of altruistic behaviors.

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

JEL classification: D85, O12, O17, Z13

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I. Introduction

The recent earthquake in Haïti has highlighted the risk of double penalty in the wake of a severe shock: the disruption of the classical allocative mechanisms can be accompanied by a rise of certain anti-social behaviors, pointing out a potential destruction of social links. In certain situations of despair, individual motives and uncertainty on the attitudes of others might overwhelm the belief in social coordination. A breakpoint may exist above which it is difficult to restore the initial social environment and revivify the pre-existing community ties. The Haïti earthquake or the cyclone Nargis in Myanmar are good illustrations of both market and social failures to ensure efficient ex-post access to resources.

Relying on a model of imperfect commitment à la Ligon *et al.* [2002], I derive predictions on the evolution of informal transfers in fractionalized communities after the realizations of large income losses. The core of the argument for risk-sharing being limited at the village level relies here on two critical assumptions: first, defaulting costs as felt by agents depend on the attitudes of others toward the social contract. Agents forming a lobby can lower the burden imposed on them by the rest of the community. Second, the incentives for a household to participate in the redistribution process depends on its social identity and those of affected households. In the aftermath of natural disasters, the endogenous division of the community into affected and unaffected agents coincides with the pre-disaster fragmentation into castes. As such, the pressure on an unaffected guild will be principally exerted by villagers from other guilds, the unaffected guild will be tempted not to cooperate and the compensation will mirror the threat represented by potential exiters. Using a representative panel household survey in Vietnam between 2004 and 2006 matched with typhoon trails, I find that the ex-post redistribution of resources across households in a community affected by a cyclone is indeed limited. Individual losses of $ 1 relatively to communal losses are covered by a net positive transfer of 15 cents, reaching 20 cents in rural areas. In line with the theory, the social identity of the contractor and the pre-disaster structure of the community influence the ex-post access to liquidity. Nonetheless, this average amplitude of risk-sharing is far from being negligible, showing that risk-sharing arrangements are not utterly inefficient at covering those shocks. More importantly, communities seem to build social capital after a disaster as villages having suffered important trauma in the recent past show greater signs of resilience. The average compensation reaches there 40 cents, a feature explained by a greater capacity to secure interactions independently of the social identities of contractors. While anecdotal evidence seems to suggest that the creation of a centralized structure is at the heart of the learning process, the empirical results tend to favor an evolution of altruistic behaviors.

In rural Vietnam, formal institutions designed to smoothen income fluctuations are missing. Decentralization has led to much less coordinated responses from regional authorities. The interventions of NGOs, firms or public organizations do not always echo real losses and come with a penalizing delay. At last, credit constraints rule out the possibility for households to use formal loans for short-term purposes such as consumption smoothing.

Households in rural economies use other instruments to cover income fluctuations. The riveting article of Townsend [1994] pointed out that consumption smoothing within village was offsetting partly idiosyncratic fluctuations. Without any attempt at a comprehensive bibliographical list, the following papers investigate some leads which could explain the strong comovement of consumption relative to income within rural villages. Kochar [1999] shows some evidence in favor of an additional family labour supply in response to crop shocks and unemployment during the harvest season. Off-farm employment seems to allow the household to insure a part of the losses incurred by crop shocks. Precautionary savings, as Paxson [1992] highlights, is also a way to disentangle consumption dynamics from income dynamics. The lack of work opportunities and the use of savings for special purposes with a strong cultural connotation (dowries, bequests...) tend to limit in practice the use of those two instruments for insurance purposes. Accordingly, households in agrarian economies rely on informal transfers. Firstly, migrants have been identified as outstanding partners in many studies. Yang & Choi [2007], using rainfall shocks in the Phillipines, demonstrates that income shocks are partially covered by foreign remittances. Households with migrant members present a flat consumption path while consumption and income are strongly correlated for households without migrants. Secondly, an extensive literature has documented the existence of risk-sharing networks in villages. The present paper fits into this class of articles. Rosenzweig [1988] and Coate & Ravallion [1989] are the seminal papers raising the importance of implicit contracts and informal risk-sharing arrangements in rural areas. On the one hand, households make an extensive use of these instruments. On the other hand, imperfect commitment substantially constrains the extent of these networks. The statuses of contractors reported in the Philippino villages studied by Fafchamps & Lund [2003] confirm that proximity is a main determinant of links between villagers and limit link formation to a small number of potential partners. Along the same lines, Foster & Rosenzweig [2001] point out the fact that commitment is more credible in networks of relatives as monitoring should be tighter than in networks of friends or neighbors. Another interpretation is that care for the contracting parties' welfare plays an important role in ameliorating commitment constraints. In short, whether due to altruism or easier monitoring, the privileged networks are prominently networks of relatives, friends and neighbors (Fafchamps & Gubert [2007a]). Inopportunely, occupational activity of friends and relatives are often close to the household's. The arbitrage between efficiency (diversification) and proximity (monitoring issues/altruism) during link formation leans strongly toward the latter. The scope of classical informal insurance networks relying on relatives and friends makes then agents particularly vulnerable to geographically and occupationally co-moving shocks, which is why households should not be able to fall back on these insurance networks in the midst of co-varying shocks. The present project questions the possibility of risk-sharing mechanisms at the village level to alleviate this issue.

While the literature on risk-sharing rejects the existence of credible commitment at village level, another strand of literature provides some hints in favor of stronger community ties in the wake of important traumas. Douty [1972] describes the use of informal social networks in the wake of severe environmental shocks as an unexpected pattern of behavior. The confusion and uncertainty in the aftermath of the shock should lead any agent to go into her shell. Surprisingly enough, Douty remarks that residents affected by a natural disaster are inclined to be more charitable toward other members of the community. Douty's seminal work on natural disasters and resilience of community feeling has recently found a counterpart in the economic literature. Bellows & Miguel [2009] show that individuals whose households have been directly affected by the 1991-2002 Sierra Leone civil war were more likely to show a community feeling, being more likely to participate in community meetings, join political groups. Durante [2009] identifies the variability of climate over centuries as determinants of trust in European regions. The present paper brings some evidence in line with those long-term observations. Agents seem to revise their beliefs about the social contract after having experienced a situation where inequalities arise mainly because of circumstances and not efforts or merits. This feature relates the present work to the literature on the foundations of the welfare state and the interaction of fairness ideals and optimal level of taxation.

To my knowledge, this project is the first paper of this literature focusing on informal arrangements at the village level after large natural disasters. This paper also makes interesting methodological contributions by estimating two specifications derived from a self-enforcement model with endogenous threat. The computation of the second specification allows me to account for the pressure imposed by potential deviations on the level of post-disasters redistribution. Finally, accurate and objective data on cyclone trails are used to construct the local impact of these large natural disasters.

I present in section II. a theoretical model on the enforceability of informal contracts in a village divided into exogenous groups and endogenously-formed 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 first 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 efficient redistribution and redefining the community environment.

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 living for two periods and earning y^k at period 0 and y_s^k at period 1 depending on the state of nature s. Ω describes the finite set of potential outcomes and P the associated probability space. 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[1] S attributing to any villager k a certain income in state s. S can be considered as a representation of the community environment as it depicts the ex-ante set of potential outcomes.

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

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. 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

[1] 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.

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 the redistribution of resources.

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. 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.

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 punishment will represent here indistinguishably the ability to force contract enforcement (reputation mechanisms, exclusion from other activities) or the cost of reneging and disavowing altruism and fairness norms. I do not intend to favor one or the other interpretation in this theoretical framework. This model can be extended relatively easily to a multi-period framework with a dynamic contract. Yet, the core of the model will already be salient in the two-period 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 refuse the redistribution of resources. Namely, when agents deviate simultaneously with other agents, they will 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[2] and let us drop temporarily the subscript s:

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

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,

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

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. One other interpretation is that they feel a strong altruism and moral sentiments toward their peers.

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; their welfare by doing so should be higher than the autarchy welfare. 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) and not only on the conditions under which the strategy [enforcement for all] is a Nash equilibrium (**weak** enforcement). I will consider that weak enforcement is always verified i.e. the punishment felt by deviating alone against the whole village will always be greater than the gain expected from refusing the full-insurance transfers.

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 consumptions following any state of nature, $\left\{c^k, \left\{c^k_s\right\}\right\}$. 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 $U_k(s) = u(c^k_s)$ is the welfare derived from having the contract enforced at period 1 and $A_k(s) = u(y^k_s)$ the autarchy welfare). Sorting the households

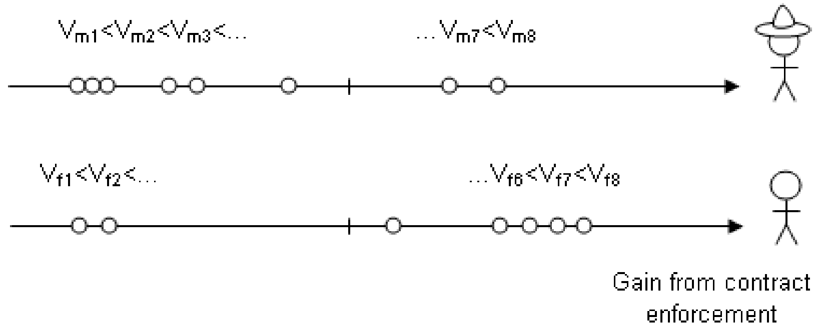


Figure 1: An example of dispersion of gains from contract enforcement in a state where the affected households are mainly farmers (no hat)

by their guilds and their utility from having the contract enforced in state s,

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

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. 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). $\square$

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.

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

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

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 introduces a choice parameter ι for the central planner. It 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:*

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

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 $\Psi^g_{i,j}(V)$ verify the following properties:*

$$
\begin{aligned}
&\forall V, i \in G_f, j \in G_m, k \in G_f,\\
&\forall W' \geq W > V_i,\\
&\forall g, \begin{cases} \Psi^g_{i,j}(V^k(W',V)) \geq \Psi^g_{i,j}(V^k(W,V)) & (i)\\ |\Psi^f_{i,j}(V^k(W',V)) - \Psi^f_{i,j}(V^k(W,V))| \geq |\Psi^m_{i,j}(V^k(W',V)) - \Psi^m_{i,j}(V^k(W,V))| & (ii) \end{cases}\\
&\forall V_i > W' \geq W,\\
&\forall g, \begin{cases} \Psi^g_{i,j}(V^k(W',V)) \leq \Psi^g_{i,j}(V^k(W,V)) & (i)\\ |\Psi^f_{i,j}(V^k(W',V)) - \Psi^f_{i,j}(V^k(W,V))| \geq |\Psi^m_{i,j}(V^k(W',V)) - \Psi^m_{i,j}(V^k(W,V))| & (ii) \end{cases}
\end{aligned}
$$

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 increase the equilibrium burden on the coalited group (i). This effect is larger on the coalited members in the same guild 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,

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

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,

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

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

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

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 to ensure that the Slater conditions are verified. Under the hypothesis (H_c) the ex-post constraints involve quasi-concave functions, they define a convex set of feasible contracts. □

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. These weights can be written as a function of the shadow prices. 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 distribution of welfare extracted from having the contract enforced within each guild and indirectly change the punishment as anticipated by potential exiters. The contract adjusts so as to offset these two effects. Current payment will be lower than what an unconstrained contract would specify to keep the incentives intact.

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

D. Predictions derived from the theoretical discussion

In this section, I focus mainly on two extreme 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 extreme 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. It reflects covarying shocks where the exogenous group formation coincides with the endogenous coalition. 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'' *and linearizing,*

$$\Lambda_{\overline{s}}^{k,k''} = \beta_{k,k',k''} \Lambda_{\overline{s}}^{k,k'} \Lambda^{k',k''} + (1 - \beta_{k,k',k''}) \Lambda^{k,k''} \tag{S2}$$

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

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 pressure exerted by merchants on the transfers received by farmers. Transfers destined to keep the balance between the farmer k and the merchant k'' will be related to other household's k' if and only if some constraints are binding. In that case, the ratios of marginal utilities will covary in the village, depending on the role of each household in the deviation/enforcement sub-game. This specification allows us to infer limits to risk-pooling considering the identity of the contractor and, to my knowledge, has never been tested in the literature.

Let us build upon the previous specification. For environments in the neighborhood $\overline{V}$, consider a farmer f and a merchant m in the potential coalition group ($V_{\overline{s}}^{m} < V_{\overline{s}}^{J}$). The properties of the punishment function implies that $\beta_{f,m,k}$ will be higher when the third household k is a threat to the contract than if she is just a household in the guild of merchants with no intention to deviate. $\beta_{f,m,k}$ will be lower if k is a farmer than a merchant with no intention to deviate. The last effect will be more salient the stronger and more coherent is the potential coalition group. In other words, both the endogenous and exogenous cohesiveness of the defaulting group would contribute to a higher $\beta_{f,m,k}$. Heavily fractionalized societies[3] are expected to present a high degree of covariation within guilds in the attitudes toward redistribution.

At the heart of the argument, 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). The hypothesis (H1) is tested in section IV.. Things are quite different in the presence of a shock covarying strongly within guilds, as collusion is made between members of the same guild. Agents collude and reduce significantly the burden imposed by the rest of the community. The level of transfers will be interdependent in the village. In particular, the level of transfers will be strongly affected by the guild a household belongs to and its role within this guild. Besides, the structure of the community as a whole influences the compensation from one guild to the other. Those last predictions are tested in sections IV. and V..

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

E. Comments

The critical assumptions of the model that create an endogenous pressure on the contract and the constitution of default groups are (a) the unambiguously positive externalities that each default exerts on others' cost of defaulting and (b) the premium on this spillover for individuals in the same guild. The former 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 other 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 (cash transfers made in order to convince other households to deviate are not possible). Remark that this hypothesis does not impose substantial restrictions on the model as ex-post cash transfers might be offset by the contract itself.

This model can be extended to a multi-period framework with a dynamic contract. Yet, two main issues arise as a consequence of the repeated game structure: what is the outside option and how do the punishment costs evolve through time? When an individual defaults on a risk-sharing contract, the literature has imposed autarchy for the deviating agent from then on. When an endogenously-constituted group decides to default, they might decide to renegotiate a contract among themselves. In addition, if contract enforcement mechanisms can not be distinguished from fairness norms in a static framework, these two patterns might follow different dynamics. Finally, 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, a very large number of districts are represented in this study 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. 2500 communes[4] are drawn; in each commune, an enumeration area is chosen and 3 households are randomly interviewed in this area. To sum up, the dataset is composed of approximately 2500 small and random 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 are not necessarily linked by actual informal transactions but provide a statistically unbiased picture of risk-pooling within the hamlet.

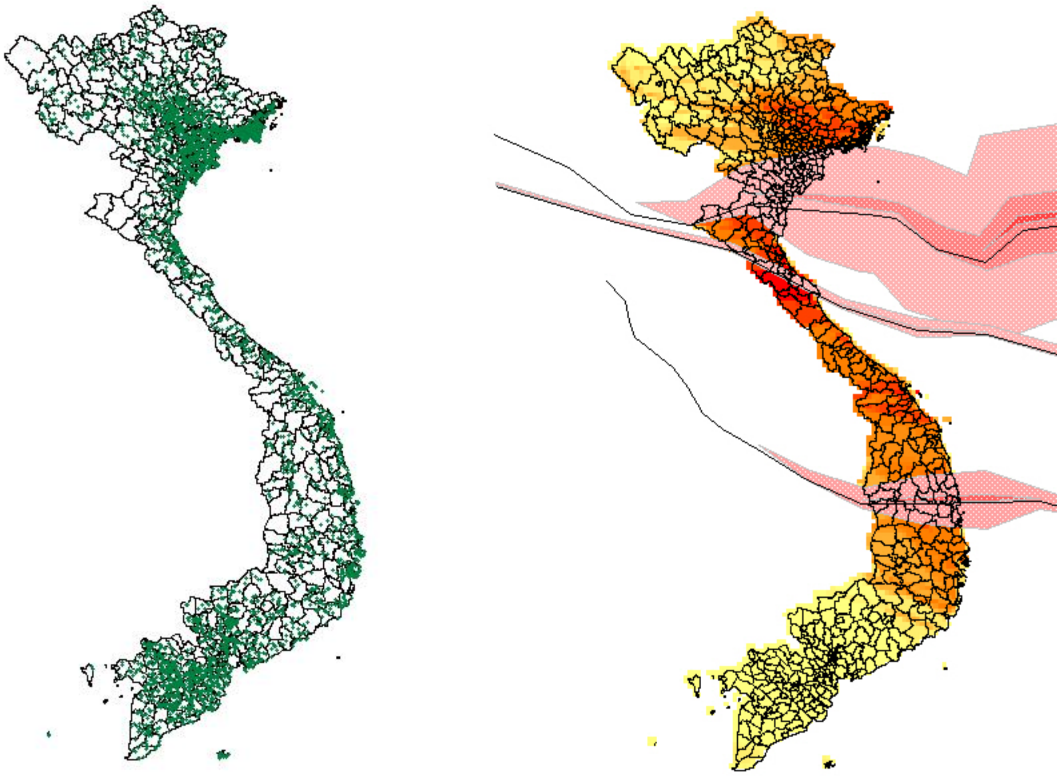
The surveys contain household and commune sections. The former covers house-

[4]A commune is composed of several small villages and represents one of the smallest potential sampling units in Vietnam. Enumeration Areas were determined during the 1999 census so as to divide communes or wards (1600 households on average, from 500 to 5000 for the more important) into units composed of approximately 100 households. Intuitively, enumeration areas are close to hamlets even if households in a same EA do not live necessarily in the same village. In the rest of the paper, for simplicity, I might refer to the surveyed households as living in the same commune instead of enumeration area/hamlet.

hold characteristics, education, health, housing conditions, employment, type of self-employed activities and income related to each of these occupations, expenditure, remittances, social-oriented expenditures and credit access for each household while the latter focuses mostly on general living standards and, in particular, eligibility to reforms, natural disasters and potential relief, importance of agriculture and credit barriers at commune level and infrastructures in the hamlet chosen for these waves. Investment in social capital as described in the introduction can be precisely controlled with the expenditure module. Gifts, donations, investments in funds or inflows such as domestic remittances are well documented. Unfortunately, the questionnaire is not as detailed as the General Social Surveys concerning membership in social groups, social meetings attendance and indicators of trust and charity. It is also impossible to define precisely risk-sharing potential partners and reconstitute the friends and relatives networks or determine exactly the limits of a social contract. Similarly, the module on migration is not available in 2004 and 2006. Furthermore, the study has been conducted during several months (mostly during two periods, June and September), generating difficulties when determining the relative exposure to a certain event occurring contemporary to the survey.

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 the cyclone 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 to tropical typhoons, I create a band whose width depends on the pressure reported by JTWC along the path of the cyclone. To control for the potential exposure to such events, I use the Global Cyclone Hazard Frequency and Distribution data as a complement to the average 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)



The figure 2 shows the geographic dispersion of surveyed households. The surveys covers almost 600 districts, and between 3 and 36 households by districts. 75%[5] of the surveyed households live in rural areas, 60% of those are located in risky-prone areas, 7% in hilly lands and 33% in mountainous areas. Relying on objective measures on exposure, I compute the district exposure for each cyclone. 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[6] 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

[5]The figures in this section are extracted from the 2004 wave. Descriptive statistics do not change dramatically with other waves.

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

millions for the typhoons that belong entirely to the surveyed window[7], the weighted index predicts \$ 580 millions of losses over the surveyed window, approximately 1% of the Gross Domestic Product of Vietnam in 2005. Beside potential 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 for typhoons in and out of the surveyed window are not taken into account. On the opposite, the computed measure accounts mainly for indirect and long-term effects; unreplaced capital losses are very likely to be under-reported. Even though none of the tropical typhoons studied here were considered particularly dreadful, economic damages in the aftermath of the shocks remain significant. Damrey presumably affected durably a whole region, with a dozen of districts having lost 20% of their usual predicted annual income. Districts affected successively by Chanthu in 2004, Kai-tak in 2005 and Xangsane in the late 2006 underwent similar losses. In table T1, I display the correlations of some key district variables with the energy dissipated in the district by the typhoons occurring between 2004 and 2006. First, district income in 2006 is negatively correlated with dissipated wind energy. Affected districts present higher levels of expenditures on repaired assets and new assets. The table also documents a higher activity for informal instruments in regions affected by a disaster. Finally, affected districts were without surprises risky-prone areas.

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 (the partner can not be exactly identified and the probability to have a partner in the sample is extremely low). Only 10% of households in rural areas had zero outflows during the past year. To confirm

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

Table 1: 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.

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%[8] 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 (zero 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 to clearly identified long-term investments while the proportion hardly reaches 50% for informal arrangements.

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 exposure in the village as a determinant of ex-post transfers in addition to the individual and average exposure. Before diving into the estimation of specification (S2), I will investigate quickly whether transfers incorporate ex-ante risk or reflects the existence of a social contract (substitute for a welfare state). Although preliminary, this analysis gives some hints for the reader concerned by the exact motives behind redistribution in the village. 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.

Empirical strategy (S1)

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

Using typhoon trails, I identify a treatment explaining income[9] losses by the passage of a disaster in a reduced-form setting. To derive the **individual exposure** T^k, I interact the energy dissipated along the typhoon paths between late 2004 and early 2006 (**district exposure**) and the **potential individual exposure** using the assets owned by the households and the activities of its members in 2004. Intuitively, the identification relies on the idea of double differences. In each district, people differ by their propensity to lose something during the passage of a typhoon. Depicting a country with protected households and endangered families, I compare how much the former group compensates the latter in villages where a natural disaster has occurred compared to unaffected villages with the same initial propensity to be affected. The propensity score 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 P^k_{t-1} 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. In this first stage, I predict the level of income in t, given observables X^k_{t-1}, P^k_{t-1} in $t-1$ and the treatment T^k. Finally, to be exhaustive, I do not impose any structure on the control variables X^k_{t-1} 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 income losses predicted for all villagers during the first stage.

$$\begin{cases} y^k_t = \kappa_t T^k + \zeta f(X^k_{t-1}) + \kappa_p P^k_{t-1} + \nu^k_t, \quad \forall k & \text{(stage 1)} \\ \\ \tau^k_t = -\alpha \hat{y}^k_t + \alpha' \sum_{k'} \hat{y}^{k'}_t + \zeta_2 f(X^k_{t-1}) + \kappa_2 P^k_{t-1} + \varepsilon^k_t & \text{(stage 2)} \end{cases}$$

[9] 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 2: Hypothetical first stage regression for individual income in 2006

First stage		
	Annual income	
Specification	OLS FE	
Activities in 2004 crossed with wind exposure		
Subsidies	-.021	(.354)
Wage from employment	.018	(.036)
Crops	-.253	(.111)*
Livestock	.195	(.175)
Agricultural services	.067	(.420)
Hunting	.903	(8.58)
Forestry	-.581	(.660)
Aquaculture	.178	(.185)
Other business	.005	(.045)
Assets in 2004 crossed with wind exposure		
Renting	-.027	(.009)**
Own house	-.001	(.002)
Own land	.003	(.005)
Controls for propensities	Yes	
District FE	Yes	
Observations	6794	

Significantly different than zero at † 90% confidence, * 95% confidence, ** 99% confidence. The results are shown omitting the coefficients for past level of income, assets owned by the family, initial propensity to be affected by a typhoon and their interactions.

The construction of $T^j_{t-1,t}$ and P^j_{t-1} reflects anecdotal observations on the nature of income losses in the aftermath of a disaster. Leaving aside physical injuries and temporary disabilities, three main channels might affect a household during and after the passage of a tropical typhoon. First, the destruction of public infrastructure 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 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... Indicators on the different sources of income try to capture both fixed assets losses and disruptions related to certain activities. The values of land and houses decomposing between those kept for personal usage and those rent to other households stand up for the physical assets. The prevalence of a specific economic activity is approached by the income brought by this occupation in 2004. As for the different income sources, I consider subsidies, wages, crops, livestocks, agricultural services, hunting or fishing, forestry, aquaculture and businesses other than those evoked above.

The cautious reader can refer to the appendix for more detailed comments on the explanatory power of typhoons in different hypothetical[10] first stages. Let us focus here on the influence of energy dissipated by the wind interacted with the individual exposure[11] on individual income in 2006. Table 2 documents losses mainly for households growing crops and for households renting out houses or land. Table T4 in the appendix displays similar results for slightly different specifications. In particular, it seems possible to construct a one-dimension index capturing part of the individual exposure to natural disasters using 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. This might be a direct consequence of the disruption of lessees' activities. Furthermore, income extracted from renting out captures partly the physical capital owned by a household and thus the physical capital wrecked by the catastrophe. Unfortunately, unreplaced capital losses are unlikely to be reported by households, which could lead to a systematic under-estimation of the amplitude of the economic damages during the first stage.

The second stage evidences that informal arrangements still play a role after severe shocks. As shown in table 3, a loss of 1$ relatively to the rest of the community (the other households in the same enumeration area) will be offset by positive net transfers accounting for approximately 15 cents. The elasticity is slightly higher when restricting the sample to rural areas only, reaching then 18 cents. As highlighted in table T7, this effect can be decomposed into two significant components:

[10] the real first stage is the joint estimation of income losses for each household in the village.
[11] leaving aside flood indicators.

Table 3: Informal transfers flows following natural disasters

Specification (S1)

	Informal net transfers in 2006							
Specifications	2SLS		2SLS FE		2SLS		2SLS FE	
Own shock	-.155	(.041)**	-.154	(.041)**	-.171	(.036)**	-.176	(.037)**
Shock on neighbors	.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.

loans contracted with friends account for 10 cents in the access to liquidity while gifts represent 6 cents of these informal flows. Gifts (direct or indirect via funds) and informal loans are considered both as instantaneous access to liquidity subject to reciprocity. Note that the decomposition is stable when considering rural areas only and the results are also robust to the addition of district-level fixed effects and other controls than those used in X^j_{t-1} (age, education, income of the head...) and P^j_{t-1} (activities and assets owned by the households). As shown in the appendix, the choice of instruments during the first stage does not drive these coefficients which are pretty consistent even when restricting activities to crops and renting out. In those specifications, the first stage is directly a double difference along the dimensions *unexpected natural disasters* and *risky activity*.

Let us depart from the benchmark and add other indicators as determinants of individual participation in the ex-post redistribution. The possibility for households to collude and deviate together should endanger the social contract especially when the average exposure is larger than the median exposure, i.e. when the median household is willing and eager to reduce the social pressure by deviating with the least affected family. Focusing on communes with only 3 surveyed households, I construct an index of distance between the median household and the average household in terms of exposure[12]. Notice first that the position of the median household relatively to its peers matters (table 4). 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 median household from the average position to the extremes has an effect only if this household offers to the least affected villagers the possibility to deviate. As such, diminishing the distance between the median household and spared families -$d = 1/2$- reduce the average compensation by 11 cents while the symmetric move in direction of the affected families does not improve risk-pooling significantly. In a nutshell, the very basic specification (S1) can not provide any definite answer on the reasons behind imperfect insurance but gives a broad picture of risk-pooling at the village level and hints toward the strength of the potential exiters as a major determinant of ex-post redistribution.

An equivalent of regression (S1) using withdrawal of savings, sales of fixed assets, gold or jewelry or formal loans show no counterbalancing from these instruments. Table T8 establishes that savings adjustments 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.

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 that data reject the hypothesis of homothetic invariance relatively to the amplitude of the shock. In other words, risk-sharing might be more efficient for households having been particularly affected, the coefficient before the

[12]For this, I define I^j as the reliance on a risky activity and normalize $d_c = \frac{med(I^j)-mean(I^j)}{A+med(I^j)-mean(I^j))}$ such that a village where the median household is far more (resp. less) exposed than the average household is associated with $d_c = 1$ (resp. $d_c = -1$). A is chosen such that the lower percentile and the upper percentile coincide roughly with $d = -1/2$ and $d = 1/2$.

Table 4: Informal flows depending on the position of the median household in terms of exposure

Specification (S1)

Specification	Informal net transfers in 2006 (i)		(ii)		(iii)	
Own shock × distribution	-.296	(.104)**	-.034	(.053)	-.215	(.088)**
Own shock	-.175	(.035)**	-.131	(.031)**	-.183	(.035)**
Controls for shocks on neighbors	Yes		Yes		Yes	
Dummies for district fixed-effects	Yes		Yes		Yes	
Observations	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.): $-(med - avg)^-/(A + (med - avg)^-)$. The sample is limited to rural areas in which 3 households are surveyed per commune.

aggregate shock being mechanically lower[13]. Second, it could come from a bias linked to 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 the same lines, results are more satisfying from this perspective in rural areas where the probability to be in a migrant-stayer relationship is lower and with informal loans. 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. Third, it could simply come from the fact that observed partners are not necessarily real partner. Measurement error on the real level of income losses in the network might spark off this asymmetry. At last,

[13]this is a convex argument.

households tend to report having borrowed for incoming transfers and given for outflows, which may echo self-esteem concerns.

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 T2 in the appendix documents three specifications in which the level of net[14] 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 T3) 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 T3 without a first stage may be hardly convincing,

[14] inflows minus outflows.

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. This brief analysis questions the interpretation of further results: are informal transfers purely determined by insurance purposes, or do they illustrate altruistic sentiments and fairness ideals? Are everyone intrinsically better off signing the initial contract? 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) detailed in the theoretical section.

Empirical counterpart (S2)

For this part, the estimation will rely heavily on the sampling strategy and the survey design. Thus I restrict the sample to the 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 the degree of dependence on renting activities and crops[15]. I 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 current income corrected by the access to additional liquidity. In line with the theoretical model, the absence of stocking technologies and investment opportunities justify that current reserves approach the level of consumption. In short, the observations are now villages for which we observe two different ratios of marginal utilities (between 1 and 2, and 1 and 3) reflecting the pattern of ex-post redistribution at hamlet level.

Having sorted the households such that binding constraints for the second household should imply monotonically binding constraints for a third household facing the same sanctions, the marginal ratio between the household representing the most affected households in the commune and the least should lie between the *targeted*

[15]households are ranked along the index presented in the alternative specifications - $i = i(crops) + \frac{1}{10} i(renting)$, 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.

marginal ratio $\Lambda^{1,3}$ and the *transposed marginal ratio* imposed by the pressure exerted by the presence of an outside option. Following the theoretical specification (S2),

$$\Lambda_s^{1,3} = \beta \Lambda_s^{1,2} \Lambda^{2,3} + (1-\beta) \Lambda^{1,3}$$

which can be reversed using the previous ratio of marginal utilities $\Lambda^{1,3}$ as the explained variable:

$$\Lambda^{1,3} = \frac{\Lambda_s^{1,3}}{\beta \Lambda_s^{1,2} \Lambda^{1,2} + (1-\beta)}$$

The empirical counterpart can be estimated under the following form:

$$\ln \Lambda^{1,3} = \alpha \widehat{\ln \Lambda_s^{1,3}} + \beta \widehat{\ln \frac{\Lambda^{1,2}}{\Lambda_s^{1,2}}} + \delta \left(f(X_{t-1}), P_{t-1} \right) + \varepsilon_t \qquad \text{(stage 2)}$$

To account for the pressure imposed by potential coalition, I will consider β as a function of I_t, the social identity of households 3 relatively to households 1 and 2.

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

Income losses are predicted by a similar first stage than in specification (S1). Considering that 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_1^j, T_2^j, T_3^j.

$$\begin{pmatrix} \ln \Lambda_s^{1,3} \\ \ln \frac{\Lambda^{1,2}}{\Lambda_s^{1,2}} \end{pmatrix} = T_t \kappa_1 + T_t^{'} T_t \kappa_2 + \left(f(X_{t-1}), P_{t-1} \right) \kappa_p + \nu_t \qquad \text{(stage 1)}$$

This estimation method is rather counterintuitive. Indeed the previous redistribution in the village is explained by the current situation as predicted by a natural experiment. A way to make sense out of what seems to be a pure estimation trick is to interpret the explained variable as the current 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. In a nutshell, 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 activities interacted with district real exposure predict efficiently the ex-post distribution of marginal ratios in the commune. Controlling by the district propensity to be affected allow to create a real counterfactual of marginal ratios in unaffected districts. γ is the additional weight imposed by the social identity of potential exiters on the effective enforcement constraint. If the hypothesis that $\gamma = 0$ can not be rejected, it is not possible to prove that the social structure of the village adds to the pressure imposed by potential deviations and limits the access to liquidity.

The first results using this specification in table 5 confirm the intuition displayed by specification (S1); the average access to liquidity following a catastrophe is far from full-insurance. The coefficients before $\ln \Lambda_s^{1,3}$ and the transposed ratio $\ln \frac{\Lambda^{1,2}}{\Lambda_s^{1,2}}$ indicate that the ratio of marginal utilities between 1 and 3 is influenced by the current ratio of marginal utilities between 1 and 2. There is some reluctance to supply liquidity from the least affected households - 2 and 3. The test $(\alpha = 1, \beta = 0)$ is rejected by the data. Yet insurance is partly ensured in the village.

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[16] 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. To give an abstract of the results shown in table 5, the degree to which the marginal ratio between the potentially least and most affected household departs from the targeted ratio depends on the social identities of these households. When the least and most affected households do not belong to

[16]the other significant activity beside agriculture.

the same social class (2), the weight of the transposed ratio increases significantly ($\beta = .33$). Basically, potential exiters do not disregard households in the same guild but families from the other guild. To push forward this interpretation, I focus on the influence of social identity of the median household (3). As predicted by the model, the closer the median household is to the potential exiter in terms of exposure the larger the influence of having the same identity as the latter. In other words, not only social identity matters to determine compensation between groups but also implies similar attitudes toward redistribution patterns within groups. Putting together these two indicators of social identities (4) could potentially allow us to capture the distribution of identity and exposure in each village. Unfortunately, it might be too demanding for our dataset. The loaded premium for having another identity for the most affected household than a united coalition of least affected households is astonishingly negative and less surprisingly non-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 households 2 and 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. Individuals associate themselves to social representations and behaviors 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. Furthermore, this particular 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. 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. Nonetheless, 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.

Table 5: 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.

Robustness checks

The identification method supposes that the surveyed households are part of the same risk-pooling group. The estimation process will consequently underestimate systematically the level of risk-sharing in non-representative sub-groups by focusing only on the existence of the aggregate contract. That said, the objective of our paper is precisely to identify risk-sharing between those sub-groups in which participation constraints are loose.

Some of the assumptions are not crucial: it is possible to relax the hypothesis of constant relative risk aversion[17] but only in a framework where households have similar expected income. With heterogeneous households and large shocks, the hypothesis of constant relative risk aversion (and thus the form of the utility function) is crucial. The results could then be driven by different forms of risk aversion across social classes, which raises the question of the endogenous formation of those social identities.

To control for potential differences between districts effectively affected by the typhoons and their control group with the same ex-ante propensity to be hit, I replicate the tests (S1) presented above with the pre-disaster level of transfers (gifts and informal loans during the year 2003). As shown in table T9, the affected districts are not initially different than their control group in terms of informal redistribution. Similarly, the estimation of the system (S2) (table T10) indicates that the natural disasters have no effect on the distance between a placebo ratio computed with ex-ante transfers and the targeted ratio, 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[18] which disappear from the panel might precisely be those affected by a catastrophe and excluded from informal risk-pooling groups. In a world where instantaneous risk-sharing is decided on frivolous parameters, a household can be temporary excluded from risk-sharing and decide to move out accordingly. In this case, 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

[17] with the logarithm specification, the exact value of this relative risk aversion does not influence the estimations.

[18] and consequently communes when we restrict our analysis to enumeration areas with exactly 3 households.

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 transfers from internal 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. 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[19]. 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 (see table T13 in the appendix). 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

[19]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.

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 (see table T15 in the appendix). 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 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 (see table T14 in the appendix).

The direct estimation of the theoretical model gives empirical support for the importance of enforcement constraints as limits to risk-pooling following natural disasters. Risk-sharing is constrained but not negligible. The prevalence of enforcement constraints is larger when the social identities of the least and the most affected households differ. The results point out similar attitudes for the least affected households toward affected households from another guild, especially when their group is sufficiently large in the village. This can be considered as a weak test of the theoretical model. 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

Severe impediments related to the very nature of informal transfers are supposed to remain and refrain agents from creating links between sub-groups of relatives, immediate neighbours and friends. The theoretical model predicts limits to resource-pooling in village due to collinear incentives to deviate among sub-groups. In order to confirm this intuition or determine if imperfect commitment can be side-stepped, I investigate the fertile grounds allowing for a coordinated communal response.

Table 6: Informal flows following natural disasters depending on having moved or having welcomed recent neighbors

Specification (S1)

	Informal net transfers in 2006		
Specifications	2SLS FE	2SLS FE	2SLS FE
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 neighbors	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.

Accordingly, I identify time spent in the commune as a factor influencing the individual propensity to belong to the global risk-sharing group. Recent movers' monitoring capacities and care for neighbors should be lower than those of settled families. Similarly, 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 6 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. Building on the previous results, I extend 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 6, 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[20]. The higher the turnover, the higher the number of persons excluded from the extended group and the smaller the reach of the extended structure.

In the same vein, if I follow Fafchamps & Gubert [2007a] and the theoretical predictions derived earlier, geographical distance attenuates the grip one household might have on the rest of the network. The table 7 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

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

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.

Table 7: 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. dispersion	.019	.017				
	(.007)*	(.008)*				
Own shock × road to hamlet			.009	.010		
			(.003)**	(.003)**		
Own shock × ethnic minority					.085	.083
					(.045)†	(.046)†
Own shock	-.279	-.259	-.174	-.170	-.166	-.168
	(.060)**	(.064)**	(.036)**	(.039)**	(.038)**	(.038)**
Controls for shocks on others	Yes	Yes	Yes	Yes	Yes	Yes
Dummies for size and district		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.

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 which belong to the local dominant ethnicity from the others. 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 the main local ethnic group. On average, independently of the amplitude and covariation of the shock, turnover and fractionalization discourage redistribution after the realization of the state of nature.

Based upon specification (S2), table 8 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 the full-insurance ratio 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 both households 2 and 3 belong 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 moves the marginal ratio away from the full-insurance ratio.

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.

Table 8: 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.

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. Two competing interpretations could explain these findings. First, in line with anecdotal evidence, natural disasters funds might centralize transfers. Formalizing informal instruments after having experienced large shocks can be the best way to alleviate monitoring issues. A prevailing 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 [September 2005] or Durante [2009], and the foundations of the welfare state or the determinants of trust in societies. Using past traumas and focusing on a population potentially affected by the infrastructures but unfamiliar with the implicit environment, I estimate the amplitude of this learning-pattern in the ability to provide efficient risk-pooling after the passage of a typhoon and try to untangle the two potential mechanisms.

Table 9: Informal flows following natural disasters depending on past exposure

Specification (S1)

	Informal net transfers in 2006			
	1999-2000		**1997-2000**	
Specifications	2SLS	2SLS FE	2SLS	2SLS FE
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 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.

For this purpose, I have computed the energy dissipated by 3 tropical typhoons (Eve, Wukong and Kaemi) of the late 90's at district-level. 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 lies on 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 (voluntarily or not) 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 10 brings to the fore the first explanation. The effect of social identity tends to disappear in recently affected communes. The effect of 1 and 3 being of different identities (i.) and the effect of 2 and 3 being similar both in social identity and exposure (ii.) is 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 super-structure headed by pre-disaster leaders, enforcing centralized transfers which would not be sustainable with a decentralized process. The social effects tend to vanish for resilient communities.

Table 10: Pressure on the enforcement constraints depending on recent exposure

Specification (S2)

	Targeted marginal ratio			
	activity			**entrants**
	(i.)	(ii.)	(iii.)	(iv.)
Recent exposure × social overweight	-.543	-.970	-.264	-.066
	(.332)†	(.499)*	(.430)	(.292)
Social overweight	.462	.540	.011	-.038
	(.266)†	(.337)	(.280)	(.186)
Actual ratio (α)	.198	.178	.150	.109
	(.075)**	(.078)**	(.066)**	(.65)**
Constrained ratio (ζ)	.207	.196	.189	.194
	(.124)†	(.118)†	(.094)*	(.134)
Partial interactions	Yes	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 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.): the interaction of (i.) and (ii.), (iv.): 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).

As in the benchmark case, the more complicated specification including the interaction of these two signals on identity (iii.) does not provide significant results. The weight on constraints imposed by the formation of a coalition against an affected household of another guild is not significantly lower in recently exposed districts. 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 (iv.). Newcomers in the commune are a particular group as they are potentially affected equally than others to enhanced infrastructures. Following a trauma, the community may set a higher norm for altruism and reinforce bonds. New entrants should be partly excluded while they could potentially benefit from an improvement of the legal environment. As a consequence, this last result tends to give support to the evolution of the social contract as the main reason behind the weaker importance of social barriers.

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. The initial exogenous partition of the society amplifies this mechanism. Accordingly, heavy natural disasters are not completely insured through informal transfers at hamlet level and the fractionalization of the village into sub-groups weakens the incentives to enforce the contract. Both the social position of the contractor and the global structure of the village influence the participation of this agent in the ex-post redistribution.

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 reinforces its capacity to monitor contract enforcement following covariate fluctuations. This view is, however, contradicted as newcomers remain excluded from redistribution. The evolution of altruistic sentiments or a shift of ideals would be consistent with this observation. The present work might illustrate on a small scale some mechanisms already discussed in the literature. The gradient in favor of more redistribution following shocks due to circumstances is locally the same than the one exhibited in studies devoted to the foundations of the welfare state.

To conclude, one might consider the findings as reassuring. Few remarks may mitigate this impression. First, there is still a major difference between the typhoons at the focal point of this study and dreadful catastrophes such as the 2010 earthquake in Haïti. Natural disasters encompass extremely diverse forms of loss distributions. Thus, leaving aside over-confidence, 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. Scenes of pillaging in the aftermath of monstrous catastrophes are not likely to create an auspicious environment for binding members of a same community. In addition, the expectation of plundering might induce affected agents to anticipate and participate in the sacking.

Besides, the efficiency of risk-sharing has to be defined using a certain set of partners. Ideal insurance would imply exchanges between communes, districts or even provinces. The reasons behind the absence of efficient redistribution at macro 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 hints toward the creation of relatively efficient informal means but only as substitutes for failing mechanisms. These instruments are not too bad once scaled at the village level but the scope of these informal risk-sharing arrangements remains limited.

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A Complements - Theoretical model

A.1 Technical appendix

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. □

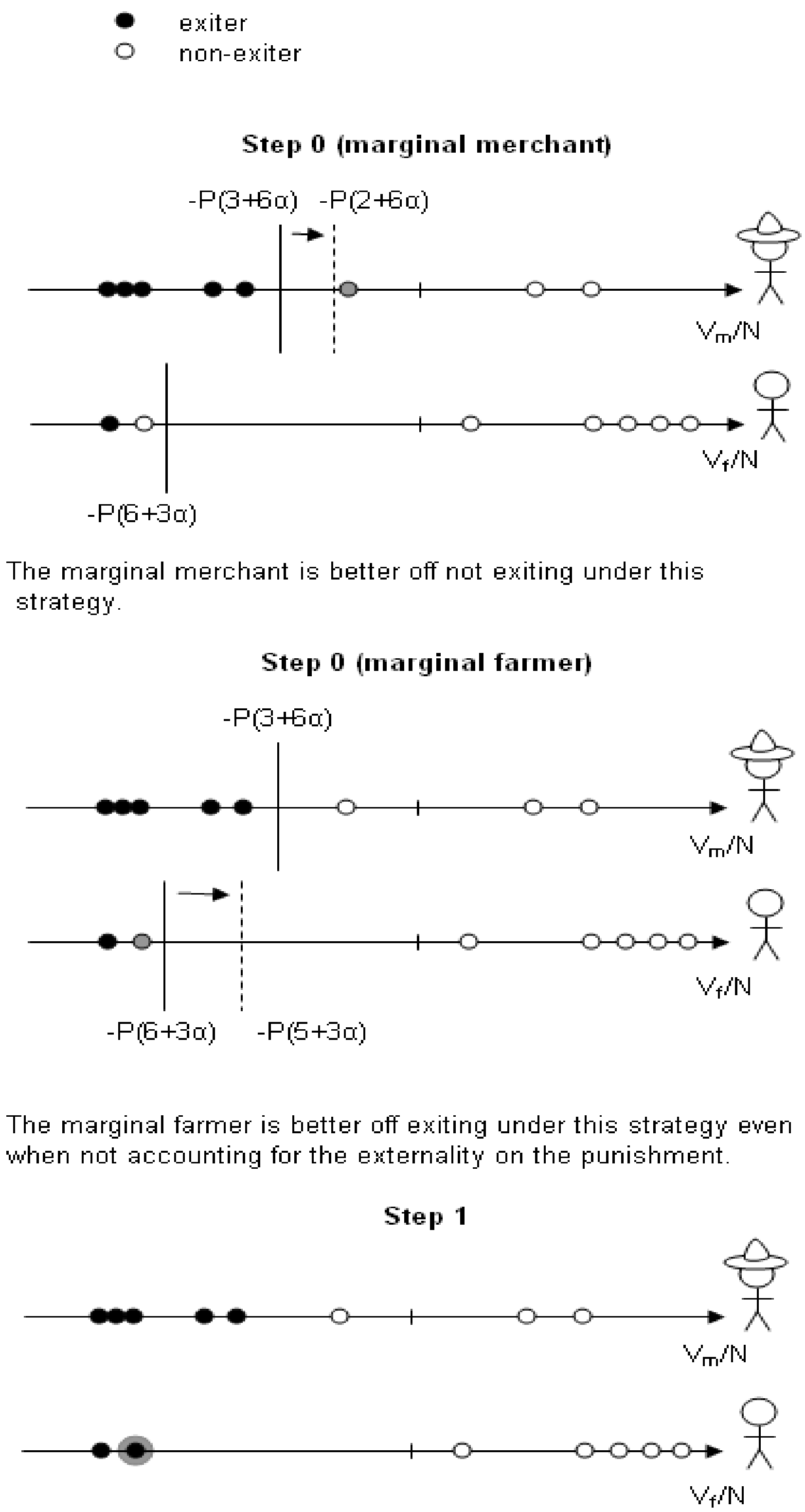

Figure F1: From step 0 to step 1 in the example exposed above where 6 exiters (5 merchants and 1 farmer) have initially the incentives to do so

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 is that the only constraints susceptible to bind concern deviations of merchants:

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

As such,

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

Introducing another household k'',

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

Linearizing these two equations ($\Psi_{J,0}^m$ small enough compared to the λ's) and eliminating $\Psi_{J,0}^m$,

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

After some computations,

$$\Lambda_{\bar{s}}^{k,k''} = \beta_{k,k',k''} \Lambda_{\bar{s}}^{k,k'} \Lambda^{k',k''} + (1 - \beta_{k,k',k''}) \Lambda^{k,k''}$$

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

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[21].

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:

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

[21] 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.

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 $F(0) = f(0) = f^{'}(0) = 0$. $\square$

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 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. $\square$

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: 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%**.

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.

C Charity or insurance?

Table T2: Informal transfers in non-affected zones for risky-prone agents

Specification (S1)

	Informal net transfers in 2006					
Specifications	OLS FE		OLS FE		OLS FE	
			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	Unaffected regions		Unaffected regions		Unaffected 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 T3: 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

Table T4: Robustness over the choice of activities

First stage

	Income level in 2006					
	individual			**communal**		
Specifications	OLS	OLS/FE	OLS/FE	OLS	OLS/FE	OLS/FE
Wind × crops	-.226	-.241		-.307	-.564	
	(.090)*	(.121)*		(.141)*	(.244)*	
Wind × renting	-.025	-.025		-.052	-.058	
	(.009)**	(.009)**		(.019)**	(.023)*	
Wind × index			-.246			-.572
			(.074)**			(.170)**
Propensity × crops	-.170	-.185	-.181	-.099	.073	.078
	(.075)*	(.103)†	(.77)*	(.113)	(.205)	(.172)
Propensity × renting	.039	.047	.047	.050	.079	.079
	(.021)†	(.023)*	(.022)*	(.040)	(.051)	(.048)
Extended controls	Yes	Yes	Yes	Yes	Yes	Yes
District FE		Yes	Yes		Yes	Yes
Observations	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 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, and an index $i = i(crops) + \frac{1}{10} i(renting)$. The results are robust to the addition of district fixed effects.

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

E Additional results with fewer instruments

Table T5: Robustness over the choice of instruments

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 $i = i(crops) + \frac{1}{10} i(renting)$, and both together in the last specifications. The results are robust to the addition of district fixed effects.

F Another large shock: the epizooty H5N1

I construct a treatment with a commune loss profile closer to those generated by natural disasters but with different level of covariation. In the first months of 2004, the Avian influenza epizooty (H5N1) has generated heavy income losses for the households owning livestock (especially poultries). The relief provided by regional and national authorities has been far from fully covering for the total income loss. Copying the estimation process for natural shocks, I create an indicator of commune exposure (a dummy equal to 1 when epizooty is considered as one of the main natural disasters having affected the commune). Individual exposure are determined using the livestocks owned by the households in 2004, distinguishing poultries from other types of livestocks. Contrary to the typhoon exposure, it is not possible to control for expectations of households in 2004 on district propensity to be affected by *epizooty shocks* but I control for potential individual losses had epizooty affected the district in which the household lives. It seems reasonable to think that the expansion of H5N1 through South-east Asia was not predictable. Nevertheless, being affected by the epizooty could reflect bad coordination at commune level, relating endogenously the amplitude of the shock to the intensity of transfers in a certain hamlet. Furthermore, individual losses can be associated with unobserved variables, such as the capacity of farmers to conceal the state of their poultries or livestocks in general and limit the depreciation of their assets. These unobserved capacities might be positively correlated with the ability to benefit from transfers, leading to systematic under-estimation of the elasticity of transfers to income losses.

Table T6: Informal transfers following epizooty shocks

Specification (S1)

	Informal net transfers in 2006			
	2SLS		2SLS FE	
Own shock	-.022	(.259)	-.010	(.203)
Shock on neighbors	.249	(.545)	.073	(.346)
District Fixed-effects			Yes	
Observations	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, livestocks owned by the family and neighbors, individual and neighbors' propensity to be affected for the epizooty shocks. These controls are also included in the first stage. The instrument for the epizooty shock is the effective exposure to epizooty (as reported by the commune leader) crossed with the individual stock of poultries and other livestocks in 2004.

G Decomposition gifts/loans

Table T7: Decomposition between gifts and informal loans flows following natural disasters

Specification (S1)

	Informal net transfers in 2006							
Specifications	2SLS		2SLS FE		2SLS		2SLS FE	
				Gifts				
Own shock	-.065	(.032)*	-.066	(.032)*	-.068	(.029)*	-.071	(.028)*
Shock on neighbors	.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 neighbors	.075	(.027)**	.055	(.026)†	.086	(.025)**	.091	(.025)**
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. 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.

H Transfers of assets and savings

Table T8: Transfers of assets following natural disasters

Specification (S1)

	Transfers of assets in 2006							
Specifications	2SLS		2SLS FE		2SLS		2SLS FE	
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		Total		Total	
Observations	6794		6794		6794		6794	

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.

I Placebo regressions

Table T9: Placebo regressions using pre-disaster informal transfers

Specification (S1)

	Informal net transfers in 2004							
Specifications	2SLS		2SLS FE		2SLS		2SLS FE	
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 T10: 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 T11: Placebo regressions using pre-disaster informal flows and commune characteristics

Specification (S1)

	Informal net transfers in 2004		
	turnover	**distance**	**ethnicity**
Specifications	2SLS FE	2SLS FE	2SLS FE
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 T12: Placebo regressions using pre-disaster informal flows and past exposure

Specification (S1)

	Informal net transfers in 2004			
	1999-2000		**1997-2000**	
Specifications	2SLS	2SLS FE	2SLS	2SLS FE
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.

J Migration

Table T13: Temporary migration between 2004 and 2006

Specification (S1)

	Evolution of household size			
	raw		**corrected**	
Specifications	2SLS FE		2SLS FE	
Own shock	-.119	(.611)	-.625	(.623)
Extended controls	Yes		Yes	
District FE	Yes		Yes	
Sample	Total		Total	
Observations	6794		6794	
	Net informal transfers in 2006			
Specifications	2SLS FE		2SLS FE	
Own shock	-.165	(.054)**	-.178	(.047)**
Extended controls	Yes		Yes	
District FE	Yes		Yes	
Sample	No evolution		Non-negative evolution	
Observations	2444		4781	

Significantly different than zero at † 90% confidence, * 95% confidence, ** 99% confidence. Only the endogenous variable is 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, individual propensity to be affected by a typhoon and district potential exposure. The first panel displays the evolution in the number of members of the household as a linear function of the predicted losses following the passage of a typhoon. The second panel is the classical specification using transfers in 2006 on selected sub-samples. The underlying first stage here explains income in 2006 by the controls displayed above and the treatment composed of the interaction of activities and dissipated energy. For readibility purposes, the coefficients are multiplied by 10^5 in the first panel.

Table T14: Tackling the issue of urban migrants - transfers between districts

	Specification (S1)							
	Average informal net transfers in 2006							
Units	**households** within **communes**		**communes** within **districts**		**districts**		**provinces**	
Specifications	2SLS		2SLS		2SLS		2SLS	
	Informal loans							
Own shock	-.081	(.017)**	-.018	(.013)	-.050	(.021)*	-.041	(.028)
Shock on all units	.058	(.023)*	.003	(.029)				
Sample	Rural		Rural		Rural		Rural	
Observations	4895		1796		418		61	
	Gifts							
Own shock	-.078	(.032)*	-.072	(.029)*	-.078	(.041)†	-.042	(.032)
Shock on all units	.026	(.043)	.043	(.064)		*		
Sample	Rural		Rural		Rural		Rural	
Observations	4895		1796		418		61	

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 pre-disaster income, assets, propensity to be affected by a typhoon for each unit and its neighbors in the same group. 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 each unit and its neighbors in the same group. Own and average shocks represent respectively the shock for the unit considered and the average shock for other units in the same group.

Table T15: 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 for hhold below average	-.153	(.042)**	-.087	(.021)**	-.066	(.031)*
Own shock for hhold above average	-.282	(.134)*	-.160	(.068)**	-.121	(.098)
Shock on neighbors	.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.