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

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March 26, 2010

Abstract

In rural economies, risk-sharing arrangements through networks of relatives and friends are common. Monitoring issues seem to impede the development of informal insurance mechanisms at higher level. As such, after a large and covariate shock, the prerequisites under which informal arrangements are feasible might refrain the community to redistribute efficiently resources between sub-groups. I rely on a model of imperfect commitment to derive predictions on the sustainability of risk-sharing arrangements in the aftermath of extreme events at a higher level than usually considered by the literature. I then test these predictions on a representative panel data in Vietnam, using tropical typhoons trails and wind structures. The estimation of a structural equation derived by the theory is compatible with a model of imperfect commitment where the aftermath of natural disasters is associated with stronger enforcement mechanisms at commune level. As such, between 15 and 20 cents are covered through informal transfers at hamlet level for income losses of $ 1 relatively to its neighbors. The influence of pre-disaster social norms and existing ties to prevent disruption of integrative mechanisms in the community gives support to this interpretation. Finally, communities having already suffered important trauma show greater signs of resilience.

Keywords: Natural disasters, informal insurance, coordination, imperfect commitment.

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 seems to 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. Observers in Haïti even fear difficulties in restoring the initial social environment and revivify the pre-existing community ties. Fortunately, international assistance was granted on a large scale. Furthermore, Haïti has benefited from the impact of a large number of migrants in the United States, and from being a former French colony. As put forward by Eisensee & Strömberg [2007], international assistance are driven by other parameters than immediate needs. The tropical cyclone that struck Myanmar during the spring 2008 left thousands of people killed without an equivalent media mobilisation. Local communities might thus be abandoned and obliged to rely on autarkic responses.

Relying on an extended model of imperfect commitment developed by Ligon *et al.* [2002] with restrictive hypotheses on the punishment threats, I derive classical predictions on the evolution of informal transfers in risk-sharing groups after the realizations of large income losses. I then study small deviations from the base model allowing for blurred contingencies, sub-group deviations, new entrants and an endogenous determination of the level of punishment decided by the community. Using a representative panel data in Vietnam between 2004 and 2006 matched with typhoon trails and wind matrices, I find that risk-arrangements across households in a same community affected by a cyclone is unexpectedly efficient. Income losses of $ 1 relatively to communal losses is covered by a net positive transfer of 15 cents, reaching 20 cents in rural areas. The estimation of a structural equation derived by the theory is compatible with a model of imperfect commitment with higher punishment threats at commune level in the aftermath of disasters. This increase in monitoring capacities can be explained by a resurgence of cooperation, laying the foundations for risk-sharing at a level where *normal* events are not insured. Results tend to highlight that the larger the shock the larger the coalition willing to enforce risk-sharing arrangements. This increased pressure on deviating households induces efficient risk-pooling and even counteracts pre-disaster fractionalization in heavily affected communities. However, pre-disaster social norms still affect the level of coordination and thus the capacity for a community to design efficiently redistribution across households in *normal times*. More importantly, communities seem to build social capital after a disaster as communes having suffered important trauma in the recent past show greater signs of resilience.

In rural Vietnam, formal institutions designed to insure against income fluctuations are failing. For large shocks, decentralization has led to much less coordinated responses from regional authorities. The interventions of NGOs, firms or public organizations (external assistance in general) are not always correlated to the real losses and come often with a penalizing delay. Responding to market incentives, development of long-term crops and specialization have not been accompanied by the creation of formal insurance schemes or institutions designed to facilitate the recovery. Credit constraints and the absence of private insurance penetration coupled with the weak prevention schemes rule out the possibility of any external response. Jacoby [1993] and Kochar [1999] show some evidence in favor of individual response to crop shocks and additional family labour supply in particular. Off-farm employment seems to allow the household to insure a part of the losses incurred by crop shocks, explaining partly the flat consumption curve compared to farm income. Savings, as Paxson [1992] highlights, is also a way to disentangle consumption from transitory income. Nonetheless, these instruments suppose the existence of off-farm flexible employment, positive net wealth and liquid assets or unconstrained credit markets. As a consequence, households in rural economies often deprived of those tend to rely on informal networks and non-market instruments. The role of migrants has been highlighted in many studies. Yang & Choi [2007], using rainfall shocks in the Phillipines, show that income shocks are partially covered by foreign remittances. Households with migrant members show a flat consumption path while consumption and income are strongly correlated in households without migrants. Overseas remittances appeal usually to the generosity of household members (or considered as such). Non-market insurance for idiosyncratic shocks is often provided by sub-groups (friends, relatives, colleagues, neighbors...). Whether this insurance is motivated by charity or simply as a part of a community implicit contract, a lot of anecdotal evidence has been built upon this response as a complement to intertemporal instruments of risk-sharing.

Rosenzweig [1988] and Coate & Ravallion [1989] are the seminal papers raising the importance of implicit contracts and informal risk-sharing arrangements in rural areas. Imperfect commitment substantially constrains informal transfer arrangements. Along the same lines, Foster & Rosenzweig [2001] points out the fact that commitment is more credible in networks of relatives as monitoring should be even tighter than in networks of friends or neighbours. The main insurance mechanisms (zero-interest informal loans combined with pure transfers) and the status of the contractor reported in the Philippino villages studied by Fafchamps & Lund [2003] confirm that tighter monitoring weakens considerably commitment issues in risk-sharing networks. Care for the contracting parties' welfare also plays an important role in ameliorating commitment constraints. Interdependent preferences might indeed reduce the incentives to default on the implicit contract as a default hurts both the future fluctuations of the household and the current income of the other party. As a consequence, the privileged network is the network of relatives, but friends and neighbors are also potential contractors. As family links are the inherited part of the social networks a household might belong to, the cost for creating these links are supposedly lower. The larger the sphere the higher the costs[1]. As occupational activity of friends and relatives are often close to the household's, there might exist an arbitrage between diversification and monitoring capacities. Fafchamps & Gubert [2007a] establish that, leaving aside first-best (kinship links) and second-best (friendship links) contractors, geographic and social proximity are the major determinants of mutual insurance links among villagers. In the arbitrage, monitoring issues seem to prevail. Such agreements should then be useless for covariate shocks since all members might be equally affected while the possibility of risk-sharing mechanisms at village level (between the different subgroups) may be questioned as they require a certain amount of trust, coordination or altruism to be enforceable.

After severe shocks, risk-pooling could improve total welfare even more efficiently than after small fluctuations of income. However, the scope of classical informal insurance networks relying on relatives and friends makes them 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 large shocks. Furthermore, implicit contracts at a higher level (the village) might not cover for large fluctuations as they suppose

[1] the expected gains are also detailed in the 'social capital' literature (Glaeser *et al.* [2002]).

coordination from the community to commit credibly and punish deviations from the informal agreement. 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's seminal work on natural disasters' aftermath showing the resilience of community feeling after a large and unexpected shock has recently found a counterpart in the economic literature. Bellows & Miguel [2006] and 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. The indicators used in this study differ certainly from altruism or trust presented as the prerequisites for implementing risk-sharing arrangements within a network. However, correlations might exist if we think of these indicators as reflecting a more global feeling of trust or social coordination. 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 - or the sphere where actions are directly controlled by herself. Surprisingly enough, Douty remarks that residents affected by a natural disaster are inclined to be more charitable toward other members of the community. The reason advanced in Douty's article is the following: a natural disaster destroys the classical allocative mechanisms (in rural Vietnam, no real allocative mechanisms are contingent to the occurrence of a catastrophe), market coordination can then not be assured. As a consequence, primary units coordinate themselves ignoring market allocative mechanisms. Douty points out the fact that disasters of a sufficient magnitude often creates a super-organization headed by pre-disaster civic leaders at community level. An issue not tackled in the literature is how coordination is made easier during bad times.

To my knowledge, this paper is the first paper of this literature focusing on informal arrangements after large and covariate income fluctuations. I identify the presence of redistribution within a large group of households compensating for the lack of diversification in classical networks. This paper also makes interesting methodological contributions by estimating two specifications directly derived from a self-enforcement model. 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 effect of these large natural disasters and match it with a household representative panel.

I present in section II. theoretical predictions on the enforceability of informal contracts. Then, I discuss the strategies to construct a consistent dataset and document the magnitude of tropical typhoons as well as usual reliance on informal transfers for rural households in section III.. In section IV., I present two specifications induced by the theory, the empirical strategies to construct income losses due to the passage of typhoons and the first results. Extended results using these specifications are discussed in sections V. and VI., focusing on the influence of pre-disaster community background and the importance of past traumas.

II. Theoretical model of contract enforcement, monitoring issues and natural disasters

A. A benchmark

In this model, there are a fixed number of households $i = 1, ..., n$ receiving an income $y_i(s)$ depending on the state of nature s at period t. The shocks are memoryless and follow then a Markov process. Both assumptions (finite number of state of nature and history-independent shocks) are essential. Tropical typhoons are i.i.d., the Markov assumption encompasses my natural shocks. The utility function is strictly increasing, concave and similar for the n households. These households are infinitely lived and maximizes their expected utility:

$$\max \sum_{\tau=t}^{\infty} \beta^{\tau-t} u(c_\tau^i)$$

Savings and other smoothing instruments are not available for households. Any kind of legally-enforced contingent assets is excluded. Sharing of resources is unconstrained in this group of households and any reallocation of resources is theoretically possible. In the following section, a reallocation will be referred to as an anti-symmetric transfer matrix $T_{(n,n)}$ with the coefficient on the i-th row, j-th column being the net transfer received by the household i from the household j. Allocation of resources can be represented by an anti-symmetric transfer matrix[2], this representation will allow us to rely as closely as possible on the initial model of imperfect commitment.

Since legal contracts are not feasible, we impose the presence of a punishment to ensure that implicit contract will not be systematically violated. This punishment $P^i(s)$ depends on the type of the individual and the state of nature and might derive from reputation mechanisms, exclusion from other activities (marriage market...), guilt. In addition to this external cost, households who deviate will be excluded from the risk-sharing arrangements from then on. The exclusion threat is supposed credible. I discuss this hypothesis in the extensions. The transfers can be made contingent to the realization of the state s (considered verifiable). Contracts (antisymmetric transfer matrices T depending on the state s) are enforceable if the punishment for deviating is higher than the instantaneous gain. In other words, at a period t and for the state s_t, the agent i has no interest in deviating in period t as long as:

$$U_{t,i}(s_t, T) \geq U_{t,i}^a(s_t) - P_i(s_t)$$

where:

$$\begin{cases} U_{t,i}(s_t, T) = u\left(c_t^i + \sum_k T_{i,k}(s_t)\right) + E_t\left[V_t^i(s_{t+1}, T)|s_t\right] & \text{utility derived from the contract} \\ U_{t,i}^a(s_t) = \sum_{\tau=t}^{\infty} \beta^{\tau-t} E_t\left[u(c_\tau^i)|s_t\right] & \text{utility derived from autarchy} \end{cases}$$

The concavity of the utility function ensures that the set of enforceable contracts will be convex. Any combination of enforceable contracts will also satisfy the sustainability constraints. This assumption guarantees that the Slater conditions are verified as the no-transfer contract does not bind any of the enforcement constraint. The solution of the method of Lagrange multipliers generalized to inequality constraints is thus optimal following Karush-Kuhn-Tucker.

[2]not unique, though.

Over the set of enforceable contracts, the optimal contracts maximizes the expected utility of agent i keeping the utilities of the other households above the surplus expected from violating the contract $\left\{\bar{U}_j(s_t) = U^a_{t,i}(s_t) - P_j(s_t)\right\}_{j\neq i}$. The program can be written as follows for the household i:

$$
\begin{aligned}
&V^i_t(s_t) = \max_T U^i_t(s_t, T)\\
&u.c. \begin{cases} U^j_t(s_t, T) \geq \bar{U}_j(s_t) \quad \forall j & (\lambda_{j,i}) \\ \\ V^j_t(s_{t+1}, T) \geq \bar{V}_j(s_{t+1}) \quad \forall j, s_{t+1} & (\beta\mu_{j,i}(s_{t+1})P(s_{t+1}|s_t)) \end{cases}
\end{aligned}
\tag{MC}
$$

Let us define $\Lambda_{j,i}$ as the matrix composed of the columns of shadow prices $\lambda_{j,i}$ related to the maximization of household i under the enforcement constraint induced by the household j at the contracting period. Let us define $\Theta_{j,i,s_{t+1}}$ as the matrix composed of the columns of shadow prices $\mu_{j,i}(s_{t+1})$ related to the maximization of household i under the enforcement constraint induced by the household j at the following period contingent to the state s_{t+1}. Intuitively, these shadow prices are the marginal variations of utility of household i for the optimal solution of this optimization problem when relaxing the constraint on household j and decreasing the transfer from j to i by one unit.

The second-best contract is the optimal contract in the set of enforceable contracts. This contract can be represented by the following equations:

- the enforcement constraints at period t and at period $t = 1$ for all households:

$$
\begin{cases} V^j_t(s_{t+1}, T) \geq \bar{V}_j(s_{t+1}) \quad \forall j, s_{t+1} \\ \\ U^j_t(s_t, T) \geq \bar{U}_j(s_t) \quad \forall j, s_t \end{cases}
$$

- the envelope and the first-order conditions:

$$
\Lambda_{j,i}(s_t) = \frac{u\left(y^i_t + \sum_k T_{i,k}(s_t)\right)}{u\left(y^j_t + \sum_k T_{j,k}(s_t)\right)} \quad \forall j
$$

$$
\frac{\Lambda_{j,i}(s_t) + \Theta_{i,i}(s_{t+1})}{1 + \Theta_{j,i}(s_{t+1})} = \frac{u'\left(y^i_t + T_{i,j}(s_t) + \sum_{k\neq j} T_{i,k}\right)}{u'\left(y^j_t - T_{i,j}(s_t) + \sum_{k\neq i} T_{i,k}\right)} \quad \forall j, s_{t+1}
$$

The third and fourth set of equations corresponds to the first-order conditions. The first and second set replicates the enforcement constraint at the following and initial periods. I can define a matrix of bounds for the marginal ratios (as the ratio of marginal utilities between i and j is strictly increasing in $T_{i,j}$). The first set of equations specifies then that marginal ratios between j and i can not fall below a certain threshold $\underline{\Lambda}_{j,i}(s_{t+1})$. This set of equations can be interpreted as a convex set $\Omega(s_{t+1})$ in which the transfers between the members of the risk-sharing group are enclosed. As long as the constraints for i and j does not bind at period $t+1$, the shadow prices $\Theta_{j,i}(s_{t+1})$ will be equal to 0 and the marginal ratios of utilities in $t+1$ will be equal to the marginal ratios at t. If the constraint binds for the household j in the state s_{t+1}, the ratio $\lambda_{j,i}$ at period t for i will be adjusted upward in period $t+1$ so as to satisfy the enforcement constraint for the household j.

$$\Lambda_{j,i}(s_{t+1}) = \begin{cases} \Lambda_{j,i}(s_t) & \text{if } \Lambda_{j,i}(s_t) > \underline{\Lambda}_{j,i}(s_{t+1}) \\ \\ \underline{\Lambda}_{j,i}(s_{t+1}) & \text{otherwise} \end{cases}$$

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. This contract ensures then perfect insurance among the contractors when the punishment costs are high enough. Once a marginal ratio is too low, the household unaffected by the catastrophe might be tempted to violate the terms of the implicit contract as the payment might be too important. The optimal contract readjusts the targeted ratio downward to the limit where the contract remains enforceable. This adjustment implies first that current payment will be lower than what an unconstrained contract would specify to keep the incentives intact. Second, the targeted ratio adjusts to the new ratio of utilities for next periods. Incidentally, the only villager unaffected by an infectious disease will pay less than what the contract would have predicted had the enforcement constraints been infinite following this state of nature. Furthermore, to ensure sustainability, once she has paid her tribute to the community, her targeted relative well-being will rise. The distribution will be in her favor from then on, relatively to the pre-disease contracting conditions. An example of how ratios might evolve with potential incentives to deviate is shown in figure F1 in the appendix.

B. Extensions

Cooperation

In the previous section, we have considered a general punishment function encompassing exclusion from informal markets, reputation issues... Tighter monitoring, contempt from the community for disregarding the terms of the contract or contingent punishment (exclusion from other activities) both alter and relax the enforcement constraints, leading to contracts closer to the first-best contract. In this extension, there exists a fixed (independent of the state of nature) cost P_{ind} for a household and a global cost $P(s_t) \in \{0,1\}$ resulting from a cooperative game of the risk-sharing group. Intuitively, the former can be interpreted as guilt while the latter would be related to reputation issues and community punishment. The game fixes at each period the level of punishment that will prevail if a default occurs. The negotiation is memoryless: the level of punishment at period t does not influence the level at period $t+1$. The level of punishment depends on a vote, for which there is a private cost c of being in the losing group. For tractability, a continuum of households will stand up for our initial n households. The level of punishment is determined by the number of households voting for a community sanction ($p : [0,1] \mapsto [0,1]$ the probability to have a sanction depending on the proportion of households who vote for the sanction). This extension weighed down considerably the base model as the decision to vote depends on the contract, whose enforceability itself is influenced by the punishment level. In order to simplify the analysis, I will focus on the enforceability of the full-insurance contract T_{fi}. With community punishment equal to 1, the full-insurance contract would be sustainable, in other words:

$$\Lambda(s_t, T_{fi}) \in \Omega(s_t), \quad \forall s_t$$

For each state of nature, I sort the households by the private gains expected from the sustainability of the current contract. $m = 0$ corresponds to the most enthusiastic household in favor of a sanction. The vote from the point of view of a single household has an interest (except from the cost of not cooperating with the rest of the group) in the situation in which the least enthusiastic household could default or respect the agreement depending on the level chosen by the community:

$$-P_{ind} - 1 \leq V_{t,1}(s_t, T_{fi}) - V^a_{t,1}(s_t) \leq -P_{ind}$$

Let us denote $P^*(s_t)$ the level for which the least enthusiastic household is indifferent between the two options. Even when restricting to monotonic equilibria, there always exist two Nash equilibria -the full sanction (FS) equilibrium and the full forgiving (FF) equilibrium. However, both equilibria are not simultaneously robust to the addition of uncertainty on the set of information used by households to derive their best response. Taking into account the scenario where households vote without any priors on others' behaviors, the only robust equilibrium will be determined by the type of the 'pivotal' household, $m = p^{-1}(P^*(s_t))$. A vote for the sanction would generate the surplus $V_{t,m}(s_t, T_{fi}) - (1 - p(m))c$ while a vote against would trigger $-cp(m) + V^a_{t,m}(s_t)$. As a consequence,

$$\begin{cases} V_{t,m}(s_t, T_{fi}) - (1 - p(m))\, c \geq -cp(m) + V^a_{t,m}(s_t) & \Rightarrow \text{ coordination on the punishment} \\ \\ V_{t,m}(s_t, T_{fi}) - (1 - p(m))\, c < -cp(m) + V^a_{t,m}(s_t) & \Rightarrow \text{ coordination on the non-punishment} \end{cases}$$

As remarked above, coordination on 'no sanction' would provoke a default. The full-insurance contract is thus enforceable as long as:

$$\begin{cases} V_{t,m}(s_t, T_{fi}) - (1 - p(m))\, c \geq -cp(m) + V^a_{t,m}(s_t) \\ \\ m = p^{-1}(-\min_i \left[V_{t,i}(s_t, T_{fi}) - V^a_{t,i}(s_t)\right] - P_{ind}) \end{cases}$$

In this framework, an increase in the individual reputation costs would imply milder community sanctions to ensure sustainability. The pivotal household will consequently be more in favor of a sanction than before. Nevertheless, the cost of voting for a sanction might be higher as the threat represented by the proportion of households disagreeing should be higher. This latter effect depends critically on the value of c and the influence of the pivotal household on the result of the vote $p'(m)$. Lower c would make the reputation effect negligible compared to the loosened enforcement constraint. Similarly, an increase in the coordination mechanisms might have mitigated effects. The pivotal household will remain the same (for a given state of nature), and the pressure on the household from the community depends on the position of this household in the community. When a large part of the community backs up the household in the decision to respect the contract, an increase in the coordination mechanism will reinforce the sustainability. On the opposite, if a large group is inclined to deviate, the increase in cooperation will induce easier contract terminations.

Presence of sub-groups and piled layers of risk-sharing

In the previous contracting model, we adopt a dynamic framework without considering the possibility that contracts might be renegotiated. Without any renegotiating costs, the contract would be renegotiated at each period and the dynamic game would switch to a simple repeated static game. Assuming that renegotiation costs are equivalent to violation costs, any attempt to renegotiate is punished by the community as a violation of the initial contract. This model supposes that commitment is possible, the community commits not to renegotiate a contract with households reluctant to give some transfers during a period. Nevertheless, since the punishment is a sunk cost, ex-post renegotiation is always optimal when the network links are threatened. Commitment is thus necessary to ensure that the economy does not revert to repeated static Nash equilibrium (which is a non-cooperative equilibrium in the non-altruistic analysis).

Any enforceable contracts T_1 and T_2 within distinct subsets of households N_1 and N_2 can be represented as two contracts within the set $N_1 \cup N_2$ (putting null transfer functions T_1 and T_2 for households in $(N_1 \cup N_2)/N_1$ and $(N_1 \cup N_2)/N_2$) as long as:

$$\forall i, \quad P_i^{N_1 \cup N_2}(s) \geq \begin{array}{ll} P_i^{N_1}(s) & i \in N_1 \\ P_i^{N_2}(s) & i \in N_2 \end{array}$$

Conversely, under certain conditions, any enforceable contract within $N_1 \cup N_2$ ('the optimal contract') can be represented as a contract between the groups N_1 and N_2 and risk-sharing arrangements within each group. As long as punishment within the group $N_1 \cup N_2$, $P_i^{N_1 \cup N_2}(s)$, is lower or equal than the combination punishment within each group and the punishment, the transfers implied by the global contract can be replicated consistently in each group. The intuition is the following: the transfer process follows two steps. First, the total transfer between the sub-groups is decided on the basis of the aggregate transfers $\sum_{i \in N_2, j \in N_1} T_{i,j}$ and $\sum_{i \in N_1, j \in N_2} T_{i,j}$ predicted in the optimal contract. Second, the transfers are divided within the group so as to replicate the optimal contract. As such, the utilities are the same as those which would have prevailed in the optimal contract. Similarly, the utilities expected in autarchy are the same. The only constraint for which the optimal contract is enforceable is then:

$$\forall i, \quad P_i^{N_1 \cup N_2}(s) \leq \begin{array}{ll} P_i^{N_1}(s) + P_{N_1,N_2} & i \in N_1 \\ P_i^{N_2}(s) + P_{N_1,N_2} & i \in N_2 \end{array}$$

where P_{N_1,N_2} is the externality a single default imposes on the other members of a sub-group.

This framework is thus compatible under certain conditions with a decomposition into non-overlapping sub-groups with centralized transfers between sub-groups. Nevertheless, our baseline specification is certainly not robust to specifications where deviations from the entire sub-group do not imply punishment from households in the same sub-group. As highlighted by Genicot & Ray [2003] and in a less direct way in Bloch *et al.* [2007], the sustainability of a contract in a sub-group might endanger the stability of the entire group. While the former derives directly this result using a simple and stylized model, the latter could give an intuition shared by the sociological literature. Social capital and stronger ties among groups of individuals can reinforce the pressure an individual might endure if she deviates from the arrangement. On the other hand, it might also endanger the whole group with joint deviations from a sub-network with strong ties. These results are obtained without considering any competition between contractors, the deviation of a sub-group leads to arrangements within the sub-group (sub-group autarchy). Deviations are not followed by renegotiation with the deviants. To be more explicit, in a society with rich farmers, poor farmers and storekeepers, an arrangement between farmers might break if rich farmers are affected by a shock leaving poor farmers unaffected. The latters could have the incentives to deviate jointly, support the contempt of rich farmers and negotiate a contract with the storekeepers. This possibility prevents any risk-sharing arrangements between sub-groups.

C. Predictions derived from the theoretical discussion

Under the assumption that individual punishments are independent of the state of nature and with i.i.d. realizations of s,

a. the optimal contract is designed such that constraints of individuals are not violated. The proportion of households which would have received positive net transfers had the punishment threats been infinite has no influence. Covariate shocks do not lead to increased risk-pooling.

b. the presence of pre-disaster sub-groups generates correlated incentives to default after the realization of the state of nature. As a consequence, fractionalization in the community does not increase the set of potential enforceable contracts. Uncertainty on the composition of the risk-sharing group plays the same role.

Under the assumption that punishments are endogenously determined after the realization of the state of nature and constant across the households,

c. the proportion of households which would have received positive net transfers had the punishment threats been infinite has an influence on deviation costs. Covariate shocks can then be associated with increased risk-pooling as communities coordinate on tighter monitoring.

d. the presence of pre-disaster sub-groups reduces resources reallocation for small shocks but might be offset by the constitution of a coalition in favor of contract enforcement following large covariate shocks. Uncertainty on the composition of the risk-sharing group discourages risk-pooling similarly than under the exogenous-punishment assumption.

III. Description of the data

A. Construction of the datasets

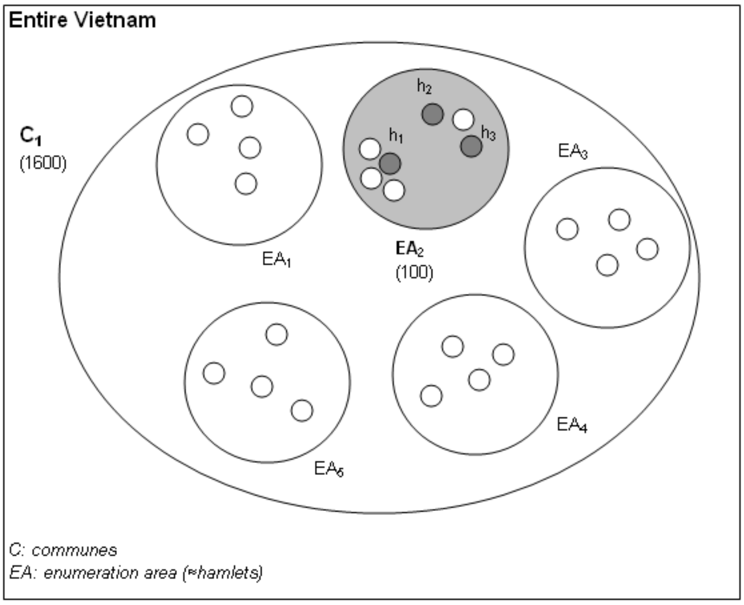
Vietnam Household Living Standards Surveys

In this article, I use the Vietnam Household Living Standards Surveys which were carried out in 2002, 2004 and 2006 by the General Statistics Office. These surveys reproduce quite faithfully a first wave of surveys (VLSS 1992/1993 and 1997/1998) 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 three waves of 2002, 2004 and 2006 and the structure of the questionnaire remains stable. As shown in figure 1, a very large number of districts[3] are represented in this study and geographical indicators are sufficiently precise to locate each commune in a district despite changes in 'nomenclature' between 2002 and 2006. A commune is often composed of several small villages and represents one of the smallest potential sampling units in Vietnam. In each commune, a subsample of enumeration areas composing the commune is chosen and 3 households are randomly interviewed in a single[4] enumeration area. Enumeration areas were determined

[3]This study is designed to be representative of the whole population, and weights are supplied so as to compensate for over-representation of rural areas.

[4]for the expenditure module we use in this article.

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 hamlet. In the rest of the paper, for simplicity, I will refer to the surveyed households as living in the same commune instead of enumeration area/hamlet. To sum up, the dataset is composed of approximately 2500 small and random conglomerates of 3 households living in the same geographic area which we will consider as 2500 potential risk-pooling networks. These households are not necessarily linked by actual informal transactions but provide a statistically unbiased picture of risk-pooling within this hamlet.



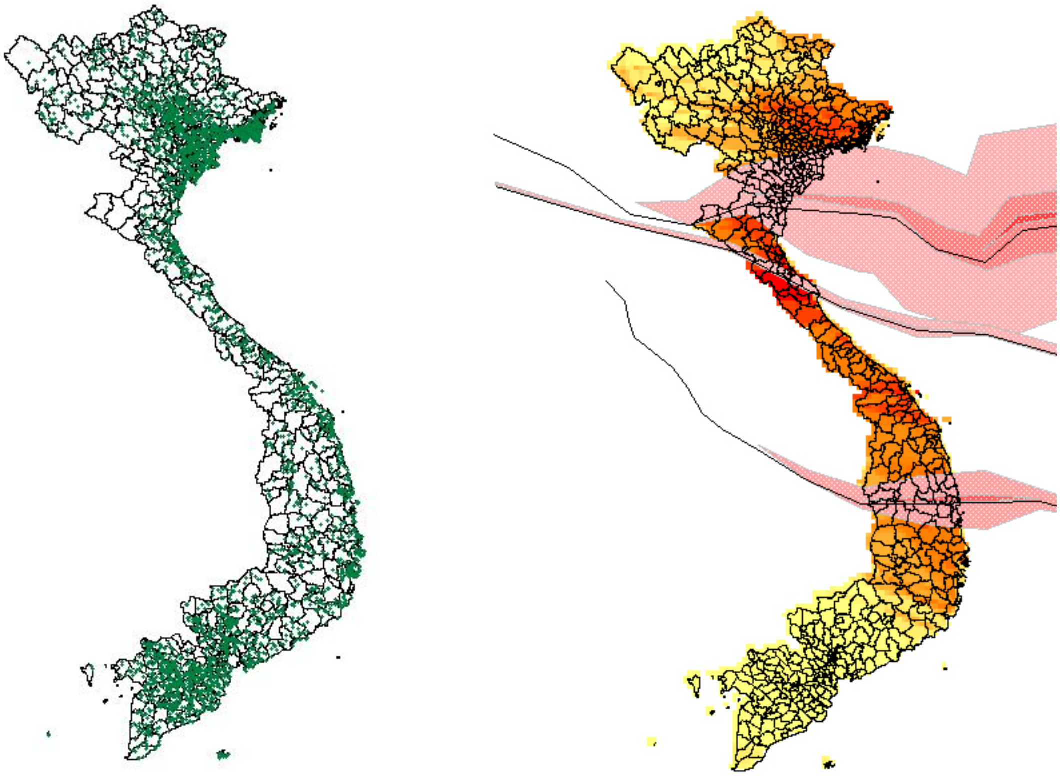
The surveys contain household and commune sections. The former covers household characteristics, education, health, housing conditions, employment, type of self-employed activities and income related to each of these occupations, expenditure, remittances, 'social-oriented' expenditures and credit access for each household while the latter focuses mostly on general living standards and, in particular, eligibility to reforms, natural disasters and potential relief, agriculture and credit barriers at commune level and infrastructures of the hamlet chosen for these waves. This description of hamlet infrastructures might be slightly irrelevant as enumeration areas and hamlet might not perfectly coincide. Investment in social capital as described in the introduction can be precisely controlled with the expenditure module. Gifts, donations, investment in funds or inflows such as domestic remittances are well documented. Controls for potential externalities, financial constraints are present in the database. Unfortunately, the questionnaire is not as detailed as the General Social Surveys concerning membership in social groups, church attendance and indicators of trust. It is impossible to define precisely risk-sharing partners or potential partners and reconstitute the friends and relatives networks. Similarly, the module on migration (urban or foreign) 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.

Cyclone tracks and exposure to natural disasters

From Joint Typhoon Warning Center, I extract best tracks of tropical typhoons between 1997 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 1 shows the wind structure of a selected panel of cyclones (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[5] along the path of the cyclone. As a consequence, I associate a measure of wind intensity and an exposure to torrential rains for each cyclone. To control for the potential exposure to such events, I use the Global Cyclone Hazard Frequency and Distribution data and assess precisely the exposure profile of a district[6].

At district level, I compute precipitations for each month between 1997 and 2002 (extracted from Global Energy and Water Cycle Experiment and the specific Asian Monsoon Experiment which was an international collaborative research project as part of World Climate Research Program). I consider the average monthly precipitation level during these six years and generate indicators of droughts and inundations.

Figure 1: Location of surveyed households in the panel between 2004 and 2006. Potential exposure to the passage of typhoons and 3 occurences: Vicente, Damrey (2005) and Chanthu (late 2004)



[5]whose width depends on the pressure reported by JTWC.

[6]the data associates the exposure profile computed between 1980 and 2000 for 'squares' whose dimensions are roughly 0.25 degree of latitude and 0.25 degree of longitude.

Bombing intensity in Vietnam and Laos between 1965 and 1975

Combat Air Activities (CACTA) and Combat Naval Gunfire (CONGA) files, which are both records of the U.S. Joint Chiefs of Staff, are provided by the Department of Defense and the National Archives. Each entry documents an assault, giving information on the type of ammunitions used, the aircraft, the alleged objective and a guess of the outcome (based on visual signs). I use the total weight of bombs used during the attack as a proxy for the energy dissipated around the impacted zone. I then interpolate these observations with the 600 districts so as to create the total exposure to bombing between 1965 and 1975 for each district. The figure [to be completed] presents the results showing the large spectrum of regions affected by during the 1965-1975 window.

B. Descriptive statistics

Magnitude of natural disasters

The figure 1 shows the geographic dispersion of surveyed households. the surveys covers almost 600 districts, and between 3 and 36 households surveyed by districts. 75%[7] of the surveyed households live in rural areas, 53% of those are located in the Delta, 7% in coastal areas, 7% in hilly lands and 33% in mountainous areas. Relying on objective measures on exposure, I compute the average exposure per commune for each cyclone. As I construct natural disasters exposure not on direct measure of income losses, I compute also in this section a rough estimation of the influence of each tropical typhoon considered in this study. Using the weights provided by VHLSS, this measure can be extended 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[8] database. Unsurprisingly, the measure differs from EM-DAT estimations. While EM-DAT reports approximately USD 900 millions of losses due to the tropical typhoons between 2004 and 2006 and 300 millions for the typhoons that belong entirely to the surveyed window[9], the weighted index predicts USD 580 millions of losses over the surveyed window, approximately 1% of the Gross Domestic Product of Vietnam in 2005. Besides potential measurement errors implied by our estimation process, this difference can be easily explained as EM-DAT provides direct estimations; indirect effects for typhoons in and out of the surveyed window are not taken into account. The computed measure accounts also for indirect and long-term effects. Even though none of the tropical typhoons studied here were considered dreadful, economic damages in the aftermath of the shocks remain significant. Being in the eye of Damrey[10] presumably affected durably a whole region, a dozen of districts present predicted losses over the year above 20% of their usual predicted annual income. Districts of the central regions affected successively by Chanthu in 2004, Kai-tak in 2005 and Xangsane in the late 2006 underwent similar losses.

Failure of formal institutions

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

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

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

[10]which provoked USD 220 millions direct damages according to EM-DAT.

Table 1: Descriptive statistics on formal and informal instruments

	rural	urban
general		
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 proportions of households.

Private insurance is almost absent in our sample. Thus, only 5.6% of the surveyed households in 2004 have a formal non-life and not health-centered insurance contract and less than 4.5% when ruling out urban areas. The figures are similar for life insurance contracts (respectively 5.4% and 3.8%) while health insurance seems to be more frequent (respectively 39% and 35%) but covers extremely small amounts. 47% of rural households are currently reimbursing a loan. The proportion falls respectively to 30% when we only consider loans contracted with a formal credit institution (private or public credit institutions). 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. Long-term loans (above 2 years) are rare. Loans for other reasons than durable investments represent less than 10% of loans provided by formal institutions and 40% of those contracted with friends, relatives. The access to formal loans seems to be restricted and does not respond to consumption needs but to capital investments. However, the access to private insurance and credit institutions do not account for the whole 'formal sector' when it comes to the analysis of non idiosyncratic risk.

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. Putting aside reasons behind relief aid, the amount are extremely small. 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. To conclude, the presence of ex-post transfers organized by regional or national authorities seems to be correlated with the institutional environment more than immediate needs. Finally, credit market access, private insurance penetration and external ex-post transfers (presence of NGOs) are significantly correlated at district-level. Some communes benefit from extended range of instruments while a large proportion of communes (essentially in rural zones) are deprived of the whole panel of risk-sharing formal mechanisms.

Informal risk-sharing arrangements

Informal risk-sharing arrangements are present in the surveys in the forms of gifts, transfers, remittances and loans. In-kind transfers and cash payments are also collected. These data are total inflows and outflows 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). Gifts and donations are largely present in rural and urban areas. Only 10% of households in rural areas and 20% of urban households had zero outflows during the past year. The average annual outflow represents approximately 3.5% of the annual income of each household. To confirm these data on outflows, inflows of domestic remittances and gifts[11] are absent for only a sixth of the total sample. The average and median amounts received during the past year from relatives and friends are respectively 10% and 2.9% of the receiver's income. The average amount is biased upward compared to the outflows data and median amount reflecting that a large number of households have relied on remittances only during the past year, not bnefitting from other sources of income. Unsurprisingly, foreign remittances concern a much smaller part of the population. 11.5% and 4.5% of the urban and rural samples receive positive foreign remittances. In line with the intuition that foreign migrants support financially aging households, the average amount when present is six time higher than the average domestic remittances. It represents approximately a third of the total income perceived by the domestic household. These 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 in line with these results. The loan part of the survey confirm the importance of informal transfers. Thus, 15% have contributed to a revolving group or lent to another household in the past year. This proportion is homogenous between rural and urban areas. The median contribution represents 5.6% of the lending family income.

Confirming these results, 10%[12] of the surveyed households have borrowed the past year from friends and relatives. An additional 4% are contracted between individuals not declared as friends or relatives. The status of this individual is unknown. In practice, she could be a retailer or a colleague but also a usurer offering extremely high interest rates. The median ongoing informal loan represents 20% of the borrowing family income (15% for the informal loans outside of the friends network, which is comparable to the share represented by the formal loan face value compared to the income of the borrowing family).

[11] As discussed during the empirical tests, we can not distinguish gifts from neighbors from remittances by urban migrants.

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

Table 2: 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)**

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%**.

Informal loans interest rate show explicitly more altruistic behaviors or easier enforcement/monitoring mechanisms when the relationship between the contractors is tighter. Thus, interest rate required by relatives or friends is zero for 82% of the rural household. This proportion falls to 12% when the contractor is an individual out of the primary sphere and less than 2% when the contractor is a formal institution. Surprisingly, informal loans do not appear to be more present in poor communities and the proportion of zero interest loans are not higher in these poor communities. Similarly, 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 their friends (94% of zero interest loans against 83% for non-eligible households, reflecting the better outside option). Recent movers seem to rely a bit less on friends. This statistics is confirmed at commune-level: large turnover is associated with smaller importance of informal borrowing (friends, relatives or individuals of the community). The purposes of the loans differ significantly had it been contracted with formal institutions or individuals. 80% of formal loans respond to long-term investments (durable goods, capital, housing issues...) while the proportion hardly reaches 50% for informal arrangements (mainly driven by housing issues). These arrangements are privileged for consumption, medical issues, the maturity of these loans is thus slightly lower than the average maturity.

Descriptive statistics on districts affected by a typhoon

In table 2, 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 degree of insurance, aid and foreign remittances is not associated with the presence of catastrophes. Table 2 also documents a higher activity for informal mechanisms in regions affected by a disaster. Contributions to funds (including natural disaster funds) and informal loans are positively correlated to the passage of a typhoon. I illustrate this effect in the maps F5 and F6 at the end of the appendix. Central parts of Vietnam display a high level of informal transfer intensity (district-level standard deviation for net informal transfers) in 2006 and not in 2004. The map seems to relate this higher activity to the passages of Damrey, Vicente (2005) and Xangsane (2006).

IV. Empirical strategies and first results

The model developed in the previous section predicts a relationship between the level of informal transfers, the history of transfers (establishing the conditions of the ongoing contract), the revenue of the individual and the revenue of the rest of the group. Considering that the shocks are small compared to the income level, I linearize the functions around the expected level of annual income (resulting in a linear expression of transfers as a function of individual shocks and the pre-disaster conditions under which the contract has been designed). I denote $\bar{y}^i$ the expected component of income, z_t^i the unexpected component, τ_t^j the aggregate net transfers received by the household. Inflows are associated with positive τ's and outflows with a negative τ's. The expression of the transfer function can be derived from

$$\lambda_{s,t}^{i,j} = \frac{u^{'}(\bar{y^i}) + u^{''}(\bar{y^i})(z_{s,t}^i + \tau_t^i)}{u^{'}(\bar{y^j}) + u^{''}(\bar{y^j})(z_{s,t}^j + \tau_t^j)} \quad \forall i, j$$

As a consequence,

$$z_{s,t}^j + \tau_t^j = \frac{1}{u^{''}(\bar{y}_t^j)} \left[\frac{u^{'}(\bar{y}_t^i)}{\lambda_{s,t}^{i,j}} - u^{'}(\bar{y}_t^j) \right] + \frac{u^{''}(\bar{y}_t^i)}{\lambda_{s,t}^{i,j} u^{''}(\bar{y}_t^j)} [z_{s,t}^i + \tau_t^i]$$

$$\sum_{j=1}^{n} [z_{s,t}^j + \tau_t^j] = \sum_{j=1}^{n} \frac{1}{u^{''}(\bar{y}_t^j)} \left[\frac{u^{'}(\bar{y}_t^i)}{\lambda_{s,t}^{i,j}} - u^{'}(\bar{y}_t^j) \right] + \sum_{j=1}^{n} \frac{u^{''}(\bar{y}_t^i)}{\lambda_{s,t}^{i,j} u^{''}(\bar{y}_t^j)} [z_{s,t}^i + \tau_t^i]$$

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

$$\tau_t^i = -z_{s,t}^i + \frac{1}{N_t^i} \sum_{j=1}^{n} z_{s,t}^j - \left(\frac{u^{'}(\bar{y}_t^i)}{\bar{y}_t^i u^{''}(\bar{y}_t^i)} \right) \bar{y}_t^i + \frac{1}{N_t^i} \sum_{j=1}^{n} \left(\frac{u^{'}(\bar{y}_t^i)}{\bar{y}_t^i u^{''}(\bar{y}_t^j)} \right) \bar{y}_t^i$$

where N_t^i is defined as:

$$N_t^i = \sum_{j=1}^{n} \frac{u^{''}(\bar{y}_t^i)}{\lambda_{s,t}^{i,j} u^{''}(\bar{y}_t^j)}$$

Under a **non-binding specification**[13], the last terms cancel out, leaving a simple and tractable equation; the λ's are independent of the state of nature and N can simply be

[13]suppose that the violation costs are almost infinite.

written as a function of the risk aversions and expected incomes of the households:

$$\begin{cases} \tau_t^i = -(1 - \frac{1}{N_t^i}) z_{s,t}^i + \frac{1}{N_t^i} \sum_{j \neq i}^n z_{s,t}^j \\ \\ N_t^i = \sum_{j=1}^n \frac{\bar{y}_t^i \sigma^j}{\bar{y}_t^j \sigma^i} \end{cases} \tag{S1}$$

This equation will be referred to as specification S1 in the rest of the paper. The interpretation is straightforward: under perfect insurance, transfers offset perfectly the relative losses of the household i compared to losses underwent by other households j. N_t^i can be interpreted as the number of households weighted by their expected marginal gains from insurance. This specification S1 can thus provide a test for the hypothesis of infinite violation costs. Nevertheless, it does not give any intuition about the relation between limits to risk-pooling and the nature of the shocks (amplitude, covariance...). In the literature, similar specifications have been tested. Nevertheless, considering the difference between the household income and the income of households sharing similar initial characteristics is not sufficient to identify consistently this equation. Since the shock might be unexpected only for the statistician using a couple of observables and might reflect the graduation of a young member of the household or the migration of another (which are certainly expected and does not enter into insurance contracts), credible instruments are to be used to alleviate endogeneity biases.

With **finite violation costs**, there exists a threshold of transfers under which the household might be tempted to default and bear the violation costs. This threshold translates into interdependent upper bounds for the marginal ratios[14] when linearizing around the expected income:

$$\begin{cases} \overline{\lambda}_{s,t}^{i,j} \gamma^{i,j} = \overline{\lambda}_{s,t}^{i,k} \gamma^{i,k} \quad \forall j, k \\ \\ \gamma^{i,j} = u'(\bar{y}_t^j) \frac{\bar{y}_t^j \sigma^i}{\bar{y}_t^i \sigma^j} [z_i + \tau_i] \end{cases}$$

The interpretation is straightforward: the closer a household is to the enforcement constraint, the less correlated the transfers will be. The agent with the strongest incentives not to pay a transfer in a state of nature will be asked to pay a lesser amount than what a first-best contract would have prescribed.

$$\begin{cases} \lambda_{s,t}^{i,j} = \min\left(\lambda_{t-1}^{i,j}, \overline{\lambda}_{s,t}^{i,j}\right), \quad \forall i \\ \\ \overline{\lambda}_{s,t}^{i,j} \gamma^{i,j} = \overline{\lambda}_{s,t}^{i,k} \gamma^{i,k}, \quad \forall j, k \end{cases}$$

$$\ln \lambda_{s,t}^{i,j} \leq \min\left(\ln(\lambda_{t-1}^{i,j}), \ln\left[\overline{\lambda}_{s,t}^{i,k} \frac{\gamma^{i,k}}{\gamma^{i,j}}\right]\right), \quad \forall i, j, k \tag{S2}$$

The system of equations S2 can be interpreted as measuring the pressure exerted by external households k on the transfers received by the household i. Thus, transfers destined to keep the balance between incomes of i and j will be influenced by other households if and only if both constraints (internal - between i and j - and external - between i and some household k) are binding. This specification allow us to infer limits to risk-pooling considering the nature of the shocks (amplitude, covariance...).

[14] In other words, binding marginal ratios for a single household i with respect to the other households are proportional.

Empirical counterpart - Estimation of the equation S1

$$\begin{cases} \tilde{y}_t^j = \kappa_t T_{t-1,t}^j + \zeta f(X_{t-1}^j) + \kappa P_{t-1}^j + \nu_t^j, \quad \forall j & \text{(stage 1)} \\ \tau_t^i = -\alpha \tilde{y}_t^i + \gamma \Delta \sum_j \tilde{y}_t^j + \zeta_2 f(X_{t-1}^i) + \kappa_2 P_{t-1}^i + \varepsilon_t^i & \text{(stage 2)} \end{cases}$$

The identification method relies on a two step process. First, I predict the level of income in t, given observables X_{t-1}^j, P_{t-1}^j in $t-1$ and the treatment $T_{t-1,t}^j$ represented by the typhoons between 2004 and 2006 for all members of the same communes. To perform this analysis, I do not impose any structure on certain variables X_{t-1}^j 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). Using typhoon trails, I identify a treatment explaining income losses by the passage of a disaster. To derive this measure, I consider:

- natural indicators at district level: the energy dissipated along the typhoon path and the probability to suffer from heavy rains[15].
- potential individual exposure, using the assets owned by the households and the activities of its members in 2004. The assets are the value of land and houses decomposing between those kept for personal usage and those rent to other households. The importance of activities are approached by the income brought by these different sources of income in 2004. I consider subsidies, wages, crops, livestocks, agricultural services, hunting or fishing, forestry, aquaculture and business other than those evoked above as the different sources of income.

$T_{t-1,t}^j$ is composed of the natural indicators at district level and their interactions with the variables accounting for individual exposure. To control for potential bias induced by different regional expectations, I have computed a propensity score of being hit by a typhoon as predicted in 2004. This propensity score is constructed using an index reflecting 25 seasons of tropical typhoons and normalized such that the worst predicted outcome coincide with the worst realized outcome. P_{t-1}^j is composed of this score at district level and its interactions 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.

The construction of $T_{t-1,t}^j$ and P_{t-1}^j 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 the household during and after the passage of a tropical typhoon. First, the destruction of public infrastructure (roads, power supply, irrigation...) might lead to higher local taxes collected as compulsory public labor or exceptional taxes. 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 (houses or physical capital). Third, activities could be disrupted for a long time, resulting from destruction of physical capital, long-term crops... Indicators on the different sources of income try to capture both fixed assets losses and disruptions related to certain activities. Results for the first stage on aggregated commune losses show higher losses for households relying mostly on crops and agricultural services. Table 3 documents also losses on leased land. The first stage is consistent with the interpretation

[15] a dummy for being in a belt along the track whose width depends on the pressure at the center of the eye.

Table 3: First stage regression for commune income

Specification	OLS FE	
	Coeff.	(SE)
Activities in 2004 crossed with real wind exposure		
Subsidies	-1.01	(.928)
Wage from employment	-.004	(.094)
Crops	-.395	(.170)*
Livestock	.090	(.416)
Agricultural services	-8.98	(1.45)**
Hunting	1.63	(6.70)
Forestry	.252	(.930)
Aquaculture	.216	(.130)
Other business	.019	(.082)
Assets in 2004 crossed with real wind exposure		
Renting	-.116	(.050)*
Own house	.000	(.004)
Own land	.025	(.019)
Controls for propensities	Yes	
District fixed	Yes	
Observations	2439	

Significances are indicated for the important variables at 10%†, 5%*, 1%**. 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.

that precarious households living from crops and agricultural services for richer farmers are more affected than employees and owners of non-agricultural businesses. Lessees are naturally less affected than renters. For the following regressions, first stages will be performed for several endogenous variables but will always present a good explanatory power on endogenous variables at date t.

The second step is the estimation of the transfer response using specification S1. Similarly, I identify compulsory *health expenditure shocks* standing for idiosyncratic shocks in our study. I use a government program providing hospital fees reduction as an instrument to avoid a reverse-causality bias: a positive shock on income could give the opportunity for a certain household to benefit from costly health infrastructure, which would have been prohibited without the substantial lift in income. In addition to these health expenditure shocks, I construct a treatment with a commune loss profile closer to those generated by natural disasters but with different level of covariation. At the beginning 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 consider communes where community leaders reported heavy losses from the epizooty and 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 due to the Avian influenza.

Table 4: Informal transfers flows following natural disasters

	Specification (S1)							
Specifications	**2SLS**		**2SLS FE**		**2SLS**		**2SLS FE**	
	Coeff.	(SE)	Coeff.	(SE)	Coeff.	(SE)	Coeff.	(SE)
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	

Significances are indicated at 10%†, 5%*, 1%**. Only the second stage and 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.

Without fixed effects, the identification relies on differences of effective exposure to cyclones in a hamlet; with fixed effects, identification is supported by differences of effective exposure to cyclones in enumeration areas once controlled for district effective exposure. The first estimation concerning natural shocks proves that informal arrangements still play a role after severe shocks. Thus, as shown in table 4, 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, and 18 cents in rural areas. The elasticity is higher in rural areas than in urban wards. This effect can be decomposed into two significant effects: loans contracted with friends account for 9 cents while gifts represent 6 cents of these informal flows as highlighted in table 5. This decomposition is stable when considering rural areas only. The results are 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} (assets owned by the households). The robustness gives support to the exogeneity of constructed shocks. Potential endogeneity and omission biases could emerge from the fact that unobserved variables might be correlated to predicted exposure and the level of net transfers received following the disaster. Nonetheless, pre-disaster level of transfers is not explained by our shocks as shown in table T3, a feature that tends to challenge the existence of a fixed and systematic bias relating informal transfers to predicted losses.

The same regressions using transfers of assets rather than informal loans and gifts show no counterbalancing from withdrawal of savings, sales of fixed assets, gold or jewelry. Table T2 establishes that savings adjustments do not offset income losses, contrary to informal transfers.

As specified earlier, the test of S1 can not provide any definite answer on the reasons behind imperfect insurance. We can only reject full-insurance hypothesis through the use of informal transfers at hamlet level. The fact that, in certain specifications, the coefficient for shocks affecting the rest of the community has not the opposite sign of the coefficient for the household income fluctuations implies that this specification does not fully capture the motives explaining the level of informal transfers. Potentially, it could reflect that data reject the hypothesis of homothetic invariance relatively to the amplitude shock. In other words, risk-sharing might be more efficient in places where the catastrophe has been particularly dreadful. Second, it could come from a bias linked to external interventions. Domestic remittances are included in our measure of informal transfers and a part of the transfers might occur outside of the districts. In particular, the observation that the two coefficients are not opposed as they should be for gifts while they are consistent with the hypotheses for informal loans is in line with potential biases induced by domestic remittances. I discuss the importance of potential risk-pooling across districts at the end of this section.

Table 5: Decomposition between gifts and informal loans flows following natural disasters

Specification (S1)

Specifications	**2SLS**		**2SLS FE**		**2SLS**		**2SLS FE**	
	Coeff.	(SE)	Coeff.	(SE)	Coeff.	(SE)	Coeff.	(SE)
					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	$(.026)^{\dagger}$	.086	$(.025)^{**}$	.091	$(.025)^{**}$
District Fixed-effects			Yes				Yes	
Sample	Total		Total		Rural		Rural	
Observations	6794		6794		5058		5058	

Significances are indicated at $10\%^{\dagger}$, $5\%^{*}$, $1\%^{**}$. Only the second stage and endogenous variables are displayed here. The results are shown omitting the coefficients for the set of dummies grouping age, education, activity of the head, past level of income, assets owned by the family and neighbors, individual and neighbors' propensity to be affected by a typhoon and district potential exposure. These controls are also included in the first stage. The instruments are the effective exposure to typhoons (energy dissipated by the wind and flood) crossed with assets and activities in 2004 for the household and its neighbors.

The correlations between informal flows and epizooty or health shocks are not significantly different from 0. The difference between these latter shocks and natural disasters can be explained by:

- a difference in the profile of income losses incurred by the different shocks, health shocks might be smaller in general. We should compare the degree of insurance of health shocks to the degree of insurance provided by informal flows for the central part of the loss distribution induced by tropical typhoons. With transaction costs, small transactions might be absent and insurance is under-estimated as informal responses to these individual shocks might have been censored. However, the epizooty triggered a similar loss distribution at commune level with a different degree of covariation and results do not differ when considering only shocks related to the Avian influenza episode.
- a bias induced by the specification. Assuming non-binding constraints for the specification S1 and homothetic invariance as described earlier, we can only test if the empirical results are consistent with perfect enforcement.
- a specific feature of natural disasters implying a greater level of risk-pooling through informal transfers despite similar responses for formal transfers.

Empirical counterpart - Estimation of the equation S2

I replicate the previous construction of unexpected treatment. I aggregate the observations (we restrict the sample to the communes where exactly 3 households are interviewed) for each commune/enumeration-area and create series of effective marginal ratios between the surveyed households, using a CARA utility function with a risk aversion of 1.92. I then sort the 3 surveyed households of the enumeration area along their predicted effective exposure to different shocks (tropical typhoons, health expenditures and epizooty). These households are not necessarily actual members of a same risk-pooling group. They might even not consider themselves as potential partners despite living in the same small geographic area. Nonetheless, these households (randomly chosen) provide a picture of the distribution of households in the chosen enumeration area. Consequently, under the hypothesis that risk-pooling intervenes at hamlet level, the supposed partners approach the profiles of effective potential partners. The identification relies then not only on the difference with the average income losses in each commune but on the complete distribution of losses as approached by the three observations in the conglomerates.

Having sorted the households such that binding constraints for the second household imply monotonically binding constraints for the third, the marginal ratio between the household representing the most affected households in the commune and the median should be either equal to the *targeted marginal ratio* $\lambda_{t-1}^{1,2}$ or to the *transposed marginal ratio* imposed by the pressure exerted by the least affected household $\overline{\lambda}_t^{1,3} \frac{\gamma^{1,3}}{\gamma^{1,2}}$. The intuition is just that this ratio between the most affected household and the median household will be influenced by how much the household standing for the least affected households is eager to compensate the resourceless. Indeed, denoting $BC_{i,j}$ the event "the constraint is binding between i and j":

$$(BC_{1,2} = 1) \Rightarrow (BC_{1,3} = 1) \Rightarrow \left(\lambda_t^{1,3} = \overline{\lambda}_t^{1,3}\right)$$

$$\ln \lambda_{s,t}^{1,2} = \begin{cases} \ln \lambda_{t-1}^{1,2} & \text{if } BC_{1,2} = 0 \\ \\ \ln \chi_{s,t}^{1,2} & \text{if } BC_{1,2} = 1 \end{cases}$$

where $\chi_{s,t}^{1,2} = \left[\lambda_{s,t}^{1,3} \frac{\gamma^{1,3}}{\gamma^{1,2}}\right]$ is the *transposed* ratio. The empirical counterpart can be estimated by a maximum likelihood process under the following form:

$$\begin{cases} \ln \lambda_{s,t} = \hat{\beta} \ln \lambda_{t-1} + (1-\hat{\beta}) \ln \chi_{s,t} + \varepsilon_t & \text{if } \ln \lambda_{t-1}^{1,2} > \ln \chi_{s,t}^{1,2}) \\ \ln \lambda_{s,t} = \zeta \ln \lambda_{t-1} + (1-\zeta) \ln \chi_{s,t} + \eta_t & \text{otherwise} \end{cases} \tag{stage 2a}$$

where:

$$\hat{\beta} = P\left(BC = 0 | \ln \lambda_{t-1} - \ln \chi_{s,t}\right) = \alpha + \gamma \hat{y}_t + \kappa_2 P_{t-1} + \zeta_2 f(y_{t-1}, X_{t-1}) + \nu_t \tag{stage 2b}$$

$\hat{y}_t$ is the income losses predicted by the same first stage than in specification S1. To account for potential coalition, I use with the intra-commune variance of income losses predicted by commune reports on activities. It is difficult to use the number of households having suffered above the average income loss or the intra-hamlet variance generated with the three surveyed households. I use the hyperbolic tangent of the average effective exposure of the commune. Thus, an infinite loss would be associated with a measure of -1. As shocks are mainly distributed around 0, normalizing or not leave the results unchanged. The system above is identified as long as $Cov(\nu_t, \ln \lambda_{t-1}^{1,2} - \ln \chi_{s,t}^{1,2}) = 0$, i.e. conditional on the difference between unconstrained and constrained λ's, the unexplained weight given to one or the other λ should not be correlated with this difference. This assumption is similar to identification assumptions discussed for specification 1. The maximum likelihood process allows us to display robust variance-covariance matrices and provide consistent tests regarding the significance of linear combinations of coefficients. In this framework,

- $\hat{\beta}$ and ζ are the respective predicted probabilities that the constraint is effectively binding conditional on the fact that the model respectively predicts it should be or not. $\hat{\beta} = \zeta$ is a test that model predictions concerning potential default for a hamlet associated with a predicted weight $\hat{\beta}$ do not coincide with tighter constraints. In other words, this is equivalent to testing the following hypothesis:

  $$P\left(BC = 0 | \ln \lambda_{t-1} - \ln \chi_{s,t} < 0\right) = P\left(BC = 0 | \ln \lambda_{t-1} - \ln \chi_{s,t} \leq 0\right)$$

  When this hypothesis can not be rejected, it is not possible to reject that the pressure imposed by potential deviations is absent.

- γ is the elasticity to the amplitude of the shock of this propensity to be constrained when predicted. To grasp the intuition, γ is the additional weight imposed by the amplitude of shocks on the effective enforcement constraint on the marginal ratios when the model predicts that the enforcement constraint should be binding. A positive γ would induce improved enforcement for large shocks.

The results obtained during the first battery of tests are completed by this specification. As predicted by the model of endogenous punishment threats, γ is positive and larger shocks due to tropical typhoons loosen the enforcement constraint. An additional marginal loss of 1% at hamlet level moves the marginal ratio closer to the targeted ratio (perfect insurance conditional on the history) by 0.64[16] percentage points. The more a hamlet is exposed to a natural disaster, the more efficient the risk-pooling will be at hamlet level. The fact that α is significantly higher than γ implies that the higher the pressure imposed by the

[16]the results are similar when relaxing the constraint that the sum of weight should be equal to 1.

least affected household the more important the weight given on the constrained ratio relatively to the targeted ratio for a hamlet affected by the median natural disaster shock (approximately 1% of the consumption). However, as larger exposure to the passage of typhoons tend to bridge the gap between weights attributed to the targeted ratios and thus reduce the empirical counterpart of $P\left(BC=0|\ln\lambda_{t-1}-\ln\chi_{s,t}>0\right)$, it is not possible to reject perfect enforcement for hamlets affected by a 10%-typhoon. For communities heavily affected by tropical typhoons, it is not possible to reject that enforcement constraints do not restrict instantaneous risk-sharing. This result is in line with heavier social pressure in favor of redistribution in the wake of a typhoon. Placebo shocks (idiosyncratic and covariate but among a small sub-group) are also in line with theoretical predictions.

The weight of the constraint on the level of risk-sharing is significantly higher for larger epizooty shocks. Additional communal losses of 1% due to the H5N1 epizooty increases the propension of the enforcement constraint binding by 0.86 percentage points. As health shocks are less correlated among sub-groups, the importance of the communal effective exposure to health shocks should be less pronounced, or absent. The results confirm the prediction of the model stating that idiosyncratic shocks are less exposed to potential deviations of sub-groups. The importance of these shocks on the enforcement constraint should be smaller than epizooty events where farmers with livestocks are the only lobby in favor of higher pressure against potential deviating sub-groups. The prediction that the sustainable contract should be further to the targeted ratio with a higher transposed ratio χ is not verified in the case of epizooty shocks for the median level of avian influenza exposure. For a 10%-avian influenza exposure, however, the difference between the weight attributed to the targeted ratio is significant (11% with a standard error of 3.6%).

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 aggregate level. As such, another interpretation of these results is that the group expands during a catastrophe profiting from more efficient enforcement mechanisms while epizooty or health shocks might remain largely insured but at a sub-group level.

Some of the assumptions are not crucial: it is possible to relax the hypothesis of constant relative risk aversion[17] but 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 a particular form of risk aversion and not by an increase in community ties. Nevertheless, as epizooty displays the same loss profile at commune level, the same results should be observed if the effect was driven by an increasing relative loss aversion. Furthermore, the results displayed in table 6 would suppose that relative risk aversion is decreasing in the amplitude of the shocks. In other words, it would imply an increasing profile for the relative risk aversion, a feature not supported by the literature.

To control for inverse causality or for other cultural phenomena driving together effective exposure to tropical typhoons and informal transfers, 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 T3, the shocks are not correlated with past transfers. Similarly, the estimation of the system S2 for natural disasters (table T4) proves that:

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

Table 6: Pressure on the enforcement constraints after a shock

			Specification (S2)			
Type of shocks	**Natural shocks**		**Epizooty shocks**		**Health shocks**	
Specifications	Co.OLS	Un.OLS	Co.OLS	Un.OLS	Co.OLS	Un.OLS
			Binding constraint			
Overweight induced	.642	.938	-.868	-.591	-.090	-.073
	(.334)*	(.335)**	(.199)**	(.200)**	(.043)*	(.043)†
Targeted ratio	.202	-.060	.311	.075	.308	.016
	(.023)	(.025)	(.021)	(.024)	(.021)	(.023)
Constrained ratio	.798	.601	.689	.546	.692	.488
	(.023)	(.024)	(.021)	(.022)	(.021)	(.022)
			Non-binding constraint			
Targeted ratio	.338	.055	.334	.067	.426	.175
	(.022)	(.025)	(.022)	(.025)	(.022)	(.025)
Constrained ratio	.662	.491	.666	.476	.574	.419
	(.022)	(.023)	(.022)	(.024)	(.022)	(.023)
			Tests for equality (average commune shock)			
Targeted ratios	.136	.110	.023	.070	.117	.069
	(.031)**	(.033)**	(.030)	(.032)*	(.029)**	(.031)*
Constrained ratios	-.136	-.116	-.023	.008	-.117	-.159
	(.031)**	(.036)**	(.030)	(.035)	(.029)**	(.033)**
			Tests for equality (10% commune shock)			
Targeted ratios	.072	.016	.126	.076	.110	.129
	(.047)	(.049)	(.029)**	(.031)*	(.036)**	(.038)**
Constrained ratios	-.072	-.022	-.126	-.167	-.110	-.051
	(.047)	(.050)	(.029)**	(.034)**	(.036)**	(.040)
Observations	1756		1724		1855	

Significances are indicated for the important variables at 10%†, 5%*, 1%**. I display the results for constrained and unconstrained regressions. The results are robust to the addition of commune controls (commune composition essentially). The simplest (and closest to the theoretical equations) specifications are displayed here. I perform a maximum likelihood process to account for a general variance-covariance matrix. The tests compare the weight attributed to the targeted and transposed ratios for a commune hitted by an 'average' and 10% shocks.

- the predictions of the model concerning enforcement issues with past transfers have no influence on the weight attributed to the targeted ratio relatively to the placebo ratio taking into account any potential amplitude of shocks. Past transfers are not consistent with the model predictions.
- the amplitude of natural disasters has no effect on the distance between the placebo ratio and the targeted ratio, confirming the absence of a placebo effect driving the results.

This placebo experiment also controls for potential systematic biases created by the sampling method.

Another issue is the selection bias induced by panel attrition. Households (and consequently communes when we restrict our analysis to enumeration areas with exactly 3 households) 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 random draw for example), a household can be temporary excluded from risk-sharing and thus not overcome the catastrophe and disappear from our database. In this case, natural disasters do not strengthen the community links but "eliminate" households for which our measure of community link is temporary low. Attrition issues might be mitigated by a couple of observations derived from the data: communes losing households between 2004 and 2006 are not particularly affected by typhoons or different from the others by the level of initial informal transfers (using Kolmogorov-Smirnov tests, we can not reject the hypothesis that distributions between intact communes and communes where at least one household has disappeared from the survey are equal). Nevertheless, these communes are more concerned by turnovers, but attrition is independent from the combination of turnover and natural disasters.

Finally, the effect captured here could be explained by a greater response from internal migrants in the wake of a typhoon having affected their relatives, rather than from the local community. 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[18]. 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. Furthermore, the picture of the average migrant corresponds to a middle-aged educated man with old parents in rural areas. Remittances are declared for half of the urban migrants but are not specifically designed to compensate for the disruption of activities in departing communes (considering the fact that households with migrants seem less active than the others). As explained earlier, the datasets do not disentangle presents from neighbors from domestic remittances of urban migrants. Informal gifts here encompass also these domestic remittances. As migrants have no direct clue on the real level of income fluctuations of the household in normal times, they might refrain themselves from compensating the household for unverifiable shocks. The worst the disaster, the less uncertain the real level of losses might be. Improved risk-pooling might then be explained by a loosened transparency constraint for migrants. Two facts contribute to mitigate the importance of external assistance in this study: first, 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 T7 in the appendix). Smoothing with neighbors' income is more efficient within communes. Transfers within district outside the communes and across districts are not equally correlated with shocks at commune and district levels. Second, 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 T7 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 less affected households (see table T8 in the appendix). As a consequence, responses to fluctuations from the least affected households should not be correlated to the relative amplitude of the shock in a village had the transfers been uniquely driven by domestic remittances.

[18] registration system in China which denies the right to attend school for rural migrants' children.

Risk-sharing through informal loans is more pronounced following natural disasters than other shocks. The direct estimation of the theoretical model gives empirical support for the importance of enforcement constraints as limits to risk-pooling. The prevalence of enforcement constraints for the group composed of the entire commune disappears following heavy damages provoked by the passage of a typhoon. In accordance with the theoretical model, the amplitude and covariation of tropical typhoon reinforce the risk-pooling system at hamlet level. The next sections propose several tracks to identify precisely the mechanisms through which risk-sharing is achieved at a higher layer than expected and described in the literature.

V. Altruism and monitoring proxies

Risk-sharing at higher layer should certainly be privileged for co-moving shocks and responds to needs from potential participants in a risk-pooling group. That being said, 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 community response to avian influenza confirms the prevalence of monitoring barriers and limits to resource-pooling in groups with "distant monitoring" due to collinear incentives to deviate among sub-groups. In order to derive the reason why natural disasters allow monitoring issues to be side-stepped, I investigate the importance of fertile grounds for coordinated communal response as determinants of risk-pooling. At the same time, I identify time spent in the commune as a factors influencing the individual propensity to belong to the global risk-sharing group.

Recent movers' monitoring capacities 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. The table 7 confirms that households having settled between 2000 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 commune-level. New entrants and households knowing that they will move in the next future represent a danger for an established risk-sharing group. The model predicts a smaller level of risk-sharing for communities where risk-sharing groups face uncertainty on their future composition. Communes for which the turnover is high display lower risk pooling through informal loans or donations. As shown in table 7, this effect at commune level is not completely supported 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. Having additional 1% turnover per year in the commune reduces the compensation by 9 cents[19]. They might be considered as a simple extension of the previous table at commune level: the higher the turnover, the higher the number of persons excluded from the extended group and the smaller the reach of the extended structure. The proportion

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

of temporary residency in the commune does not influence the degree of risk-sharing. The status of temporary resident remains an issue as it does not imply necessarily the presence of uncertainty in the composition of the community.

Table 7: Informal flows following natural disasters depending on having moved or having welcomed recent neighbors

Specification (S1)

Specifications		**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

Significances are indicated at 10%†, 5%*, 1%**. Only the second stage and 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 we have information on turnover 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.

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 8 illustrates this idea since 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 hamlet in the commune or ward. 2 additional hamlets in a commune decrease the compensation by 3 cents for each dollar lost relatively to the rest of the commune. Distance to the closest road illustrates the same idea of geographical dispersion. Each km further from the main road is associated with a lower compensation of 0.1 cents. Similarly, cultural distance should matter as punishments might be linked to other activities (exclusion form new year celebrations...). 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 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.

Table 8: Informal flows following natural disasters depending on geographic dispersion and being in an ethnic minority at commune level

	Specification (S1)					
Specifications	**2SLS**	**2SLSFE**	**2SLS**	**2SLSFE**	**2SLS**	**2SLSFE**
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 neighbors	Yes	Yes	Yes	Yes	Yes	Yes
Dummies for size and district		Yes		Yes		
Dummies for ethnicity						Yes
Observations	4738	4738	4738	4738	6625	6625

Significances are indicated at 10%†, 5%*, 1%**. Only the second stage and 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 we have information on geographic dispersion 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.

These results replicate at commune level features already observed at sub-group level. Nevertheless, it is not possible to conclude from this specification if additional risk-sharing in united communes comes from a permanent higher level of cooperation or from coordination in particularly bad times (table T10). Using the specification S2, the results bring support to the interpretation of the benchmark presenting the constitution of a consistent higher layer of risk-sharing as the main channel through which risk-pooling is more efficient. 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 if decentralized. The effects present for weak shocks in fractionalized communes tend to wash away for larger shocks. The figure F3 illustrates this intuition. Communes with high level of fractionalization tend to catch up with the other communes when the shock is larger. The 'double difference' test in table T10 capture the amplitude of this catch-up effect. The differences of marginal gains induced by higher communal shock of 1% in favor of the targeted ratio between a commune with ethnic majority below 50% and a united commune is 3 percentage points. As soon as the amplitude of the communal shocks is sufficiently high, the difference induced by the degree of fractionalization disappears. The results are different for turnover which seems to impede risk-sharing whatever the amplitude of the trauma. Above a certain threshold, it is not possible to reject the hypothesis that turnover is harmless. Unfortunately, this result relies on exploding variance when the trauma increases rather than on a clear "catch-up effect"[20]. Turnover and new entrants seem to remain a stumbling block for establishing hamlet-level risk-sharing groups.

VI. Influence of past shocks (to be completed)

The creation of a super-structure managing transfers between primary units (households) is backed up by anecdotal evidence: in some communities affected regularly by dreadful natural disasters, natural disaster funds centralize the transfers. Using past traumas, I test for the presence of a learning-pattern in the ability to provide efficient risk-pooling after the passage of a typhoon. First, I rely on recent shocks of the same type to see if these lately affected communities present a higher level of resilience. Second, to depart from the possibility that recent and fresh shocks might simply affect the expectations of the individuals rather than commune coordination, I focus on other type of traumas and construct the exposure of each district to bombing during the late years of the Vietnam war.

A. Past natural disasters

In this section, 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 have been constructed 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 an increase of 19 cents for the net compensation associated to a \$ 1 relative loss. The same regression considering assets' transfers and formal instruments do not display the same learning pattern. The results do not extend to idiosyncratic shock, pointing out that this learning-pattern concerns specifically the larger risk-pooling group designed to cover correlated fluctuations.

An issue remains unchallenged: is this effect driven by a higher degree of cohesiveness whatever the form of the shock in the hamlet or is this effect driven by institutions especially built-up for coping with large natural disaster risks? As shown in table T9 and figure F4, the second specification show an increasing profile for the influence of past shocks. Having experienced the passage of a dreadful typhoons in the late 90's does not increase the community response to small shocks. However, the more a community is affected, the more the experience of similar events matters. Relying on the province fixed-effects specification, the passage of recent typhoons increase the response to a 1% additional communal shock

[20]see table T10 for the 'double difference' test and figure F2 for the illustration.

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

Specification (S1)				
Specifications	**2SLS**	**2SLS FE**	**2SLS**	**2SLS FE**
Own shock × exposed to 99-00 typhoons	-.189	-.190		
	(.093)*	(.096)*		
Own shock × exposed to 97-00 typhoons			-.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	

Significances are indicated at 10%†, 5%*, 1%**. Only the second stage and 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.

by 0.9 percentage points in favor of the targeted ratio against the constrained ratio. The 'double-difference' test (see table T9 in the appendix and figure F4 for the illustration) brings support to a divergence of risk-sharing levels between experienced and unexperienced communes as the amplitude of the shock rises. While responses to small shocks are not different, experienced communities are 17 percentage points closer to the targeted ratio than unexperienced communities for a 20%-shock. 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. The next part of the article builds on these empirical evidence and documents if increased ability to cope with natural disasters is associated with specifically-designed institutions or a more global sentiment of cohesiveness in a community.

B. Bombing intensity between 1965 and 1975 (to be completed)

VII. Conclusion

This paper has explored the intuition that large and covariate shocks are associated with the constitution of a coalition in extended group of informal risk-sharing. Along with this idea, heavy natural disasters are insured efficiently through informal transfers at hamlet level. The recent exposure to the passage of typhoons leaves a community with a greater capacity to implement enforcement mechanisms following covariate fluctuations.

While this article tends to give optimistic insights, 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 and degrees of expectations. Thus, leaving aside over-confidence, no conclusions can be drawn on the ability of rural villages to overcome any sort of disasters. Besides, the efficiency of risk-sharing is associated with the bounds of the group in which we consider the terms of exchange. Conspicuously, ideal insurance would imply exchanges between communes, districts or even provinces. The reasons behind the absence of efficient transfers beyond the scope of a village are not addressed here. This study displays optimistic views as long as we restrain our expectations to relatively small spheres of risk-sharing.

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A Intuition behind the model

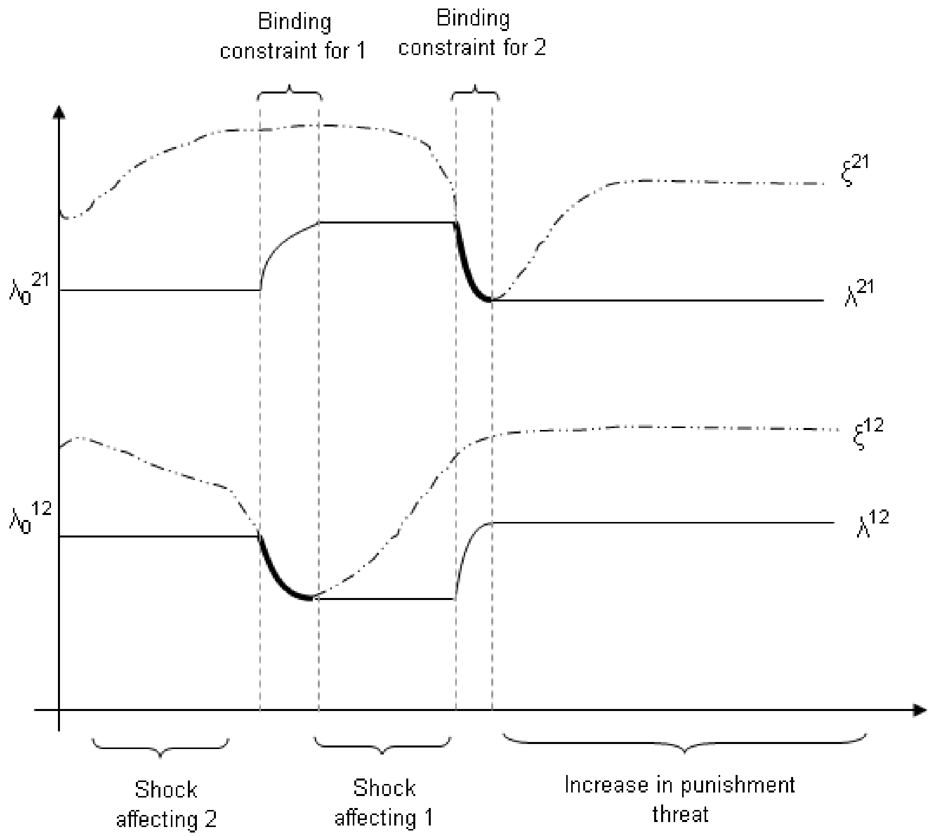

Figure F1: The optimal contract and the evolution of marginal ratios (ζ=$\bar{\lambda}$)

1. A shock affects the individual 2, without binding the constraint for the individual 1.
2. Transfers from 1 to 2 are refrained so that deviation is not preferable for 1.
3. A shock affects the individual 1, without binding the constraint for the individual 2.
4. Transfers from 2 to 1 are refrained so that deviation is not preferable for 2.
5. An increase in punishment threat allows the households to keep the ratio constant.

Influence of natural disasters - breaking the constraints

Another exciting feature of the model developed in Bloch *et al.* [2007] is the concept of fragility. Stressful circumstances might tighten some enforcement constraints and a group "obtains the opportunity to break away". As income exposure to large shocks are certainly correlated in risk-sharing networks, the networks in rural economies are not designed to share efficiently covariate risks. Joint deviation from a sub-group following a natural disaster is to be expected. This event can be observed in the dynamic framework described above with two additional hypotheses. First, no contingency exists in the contract for rare events, the states of nature covered by the contract are not exhaustive. If no contingencies exist, the violation of a constraint is not anticipated and two different outcomes are possible: some households deviate from the contract and a the initial contract become void leading to renegotiation among remaining members of the risk-sharing group. The renegotiation can also incorporate the sub-group, so as to avoid a sunk cost P_i.

Second, a contract might allow deviations of a certain sub-group contingent to certain events or might accept the entire group dissolution. Technically, the group dissolution is easy to implement as it does not change critically the enforcement constraint. Let us consider a subset of states of nature $S_c \subset S$. The expected utility becomes then:

$$U_t^i(s_t, T) = u\left(c_t^i + \sum_k T_{i,k}(s_t)\right) + E_t\left[V_t^i(s_{t+1}, T)|s_t, s_{t+1} \notin S_c\right] + E_t\left[V_t^i(s_{t+1}, T^*)|s_t, s_{t+1} \in S_c\right]$$

The maximization program is similar, given the renegotiated contract T^*:

$$\begin{array}{l} V_t^i(s_t, T^*) = \max_T U_t^i(s_t, T) \\ u.c. \left\{ \begin{array}{lll} U_t^j(s_t, T) \geq \bar{U}_j(s_t) & \forall j & (\lambda_{j,i}) \\ \\ V_t^j(s_{t+1}, T) \geq \bar{V}_j(s_{t+1}) & \forall j, s_{t+1} & \left(\mu_{j,i,s_{t+1}} P(s_{t+1}|s_t)\right) \end{array} \right. \end{array} \tag{MSC}$$

Naturally, denoting $\tilde{T}(.)$ the solution of the previous program, the following condition should hold:

$$T^*(.) = \tilde{T}(.)$$

The results are similar to the results of the base model. With independent realizations of s, the only difference would come from a modified discounted value. However, in the general case, this discounted value depends on the current state s_t.

The two hypotheses generating an effective breach of enforcement constraints predict dissimilar post-disaster risk-sharing. When unexpected, a shock could lead to voluntary departure of a sub-group of individuals. The remaining individuals decide on a forcible eviction of this sub-group. Depending on the model assumption, risk-sharing might still be possible and a contract may be renegotiated among 'traitors'. The first set of hypotheses predicts a breach in the community. Both sets induce lower level of immediate transfers between contracting parties than what would have been designed by a non-enforceable contract. The renegotiating parties consider the post-disaster income path without taking into consideration the pre-disaster income path.

B Robustness checks

Table T1: Informal transfers following health and epizooty shocks

Specification (S1)

Health shocks	**2SLS**		**2SLS FE**	
	Coeff.	(SE)	Coeff.	(SE)
Own shock	-.026	(.363)	.027	(.420)
District Fixed-effects			Yes	
Observations	4615		4615	

Avian influenza	**2SLS**		**2SLS FE**	
	Coeff.	(SE)	Coeff.	(SE)
Own shock	-.022	(.259)	-.010	(.203)
Shock on neighbors	.249	(.545)	.073	(.346)
District Fixed-effects			Yes	
Observations	6794		6794	

Significances are indicated at 10%†, 5%*, 1%**. Only the second stage and 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 and previous health expenditures for health 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 stock of poultries and other livestocks owned in 2004. The instrument for the health shock is health expenditure in 2004 crossed with the evolution of eligibility to a government program of health subsidies in the commune. This information is given on the subsample of rural communes. This feature explains the weaker number of observed households.

Table T2: Transfers of assets following natural disasters

Specification (S1)

Specifications	**2SLS**		**2SLS FE**		**2SLS**		**2SLS FE**	
	Coeff.	(SE)	Coeff.	(SE)	Coeff.	(SE)	Coeff.	(SE)
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	

Significances are indicated at 10%†, 5%*, 1%**. Only the second stage and endogenous variables are displayed here. Transfers of assets include withdrawal from savings, selling means of production, assets, 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.

Table T3: Placebo regressions using pre-disaster informal transfers

Specification (S1)

	Informal transfers				**Loans**		**Gifts**	
Specifications	**2SLS**		**2SLS**		**2SLS**		**2SLS**	
	Coeff.	(SE)	Coeff.	(SE)	Coeff.	(SE)	Coeff.	(SE)
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	

Significances are indicated at 10%†, 5%*, 1%**. Only the second stage and 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. The simplest (and closest to the theoretical equations) specifications are displayed here.

Table T4: Informal flows following natural disasters using past transfers

Specification (S2)		
Type of shocks	**Natural shocks**	
Specifications	Co. OLS	Un. OLS
	Binding constraint	
Overweight induced	.154	.402
	(.336)	(.334)
Targeted ratio	.347	.121
	(.023)	(.025)
Constrained ratio	.655	.471
	(.020)	(.024)
	Non-binding constraint	
Targeted ratio	.348	.079
	(.022)	(.023)
Constrained ratio	.652	.446
	(.022)	(.023)
	Tests for equality	
Targeted ratios	-.001	.024
	(.030)	(.033)
Constrained ratios	.001	.042
	(.030)	(.034)
Observations	1766	1665

Significances are indicated for the important variables at 10%†, 5%*, 1%**.

Table T5: Placebo regressions using pre-disaster informal flows and commune characteristics

	Specification (S1)		
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

Significances are indicated at 10%†, 5%*, 1%**. Only the second stage and 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 we have information on geographic dispersion 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 T6: Placebo regressions using pre-disaster informal flows and past exposure

	Specification (S1)			
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

Significances are indicated at 10%†, 5%*, 1%**. Only the second stage and 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.

C The issue of extra-commune transfers

Table T7: Tackling the issue of urban migrants - transfers between districts

	Specification (S1)							
Units	**households** within **communes**		**communes** within **districts**		**districts**		**provinces**	
2SLS	Coeff.	(SE)	Coeff.	(SE)	Coeff.	(SE)	Coeff.	(SE)
				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	

Significances are indicated at 10%†, 5%*, 1%**. Only the second stage and 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. As a consequence, own and average shocks represent respectively the shock for the unit considered and the average shock for other units in the same group.

Table T8: Tackling the issue of urban migrants - position in the commune

	Specification (S1)					
	Informal transfers		Loans		Gifts	
Specifications	**2SLS**		**2SLS**		**2SLS**	
	Coeff.	(SE)	Coeff.	(SE)	Coeff.	(SE)
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	

Significances are indicated at 10%†, 5%*, 1%**. Only the second stage and 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.

D Additional results using specification (S2)

Table T9: Informal flows following natural disasters depending on past exposure

Specification (S2)		
Type of shocks	**Natural shocks**	
Specifications	ML (FE)	ML (FE)
	Results	
Overweight induced (shock × past exposure)	.891	2.68
	(.434)*	(.961)**
Overweight induced (Past exposure)	.001	-.041
	(.019)	(.047)
Controls for overweight (shock)	Yes	Yes
	Overweight - 2% shock	
For an experienced commune	.032	.151
	(.045)	(.107)
For a unexperienced commune	.004	-.027
	(.009)	(.019)
	Overweight - 10% shock	
For an experienced commune	.177	.428
	(.097)†	(.239)†
For a unexperienced commune	.020	-.129
	(.047)	(.100)
	Double-difference tests	
Difference exp/unexp. & 10/2%	.142	.430
	(.069)*	(.153)**
Provinces-fixed effects	Yes	
District-fixed effects		Yes
Observations	1756	1756

Significances are indicated for the important variables at 10%†, 5%*, 1%**.
An experienced commune has been hit by at least one of the dreadful typhoons at the end of the 90's.

Table T10: Informal flows following natural disasters depending on geographic dispersion and being in an ethnic minority at commune level

Specification (S2)

Type of shocks	**Natural shocks**	
Specifications	ML (FE)	ML (FE)
	Results	
Overweight induced (shock × ethnic minority)	6.63	
	(3.38)*	
Overweight induced (shock × turnover)		-.889
		(13.3)
Controls for overweights (shock, turnover, minority)	Yes	Yes
	Overweight - 2% *shock*	
Fractionalized commune	-.003	
	(.065)	
United commune	.058	
	(.023)**	
High turnover		-.632
		(.311)*
No turnover		.012
		(.015)
	Overweight - 10% *shock*	
Fractionalized commune	.497	
	(.258)*	
United commune	.293	
	(.119)*	
High turnover		-.616
		(.799)
No turnover		.063
		(.078)
	Double-difference tests	
Difference high/low frac. & 10/2%	.265	
	(.135)*	
Difference high/low turn. & 10/2%		.035
		(.534)
Controls for ethnicity	Yes	
Provinces-fixed effects		Yes
Observations	1766	1665

Significances are indicated for the important variables at 10%†, 5%*, 1%**. Controls for ethnicity include individual and commune dummies. High turnover correspond to a 50% renewal of the commune in 5 years. A fractionalized commune is here composed of a main ethnic group representing half of the surveyed households. A united commune is composed of a main ethnic group representing all the surveyed households.

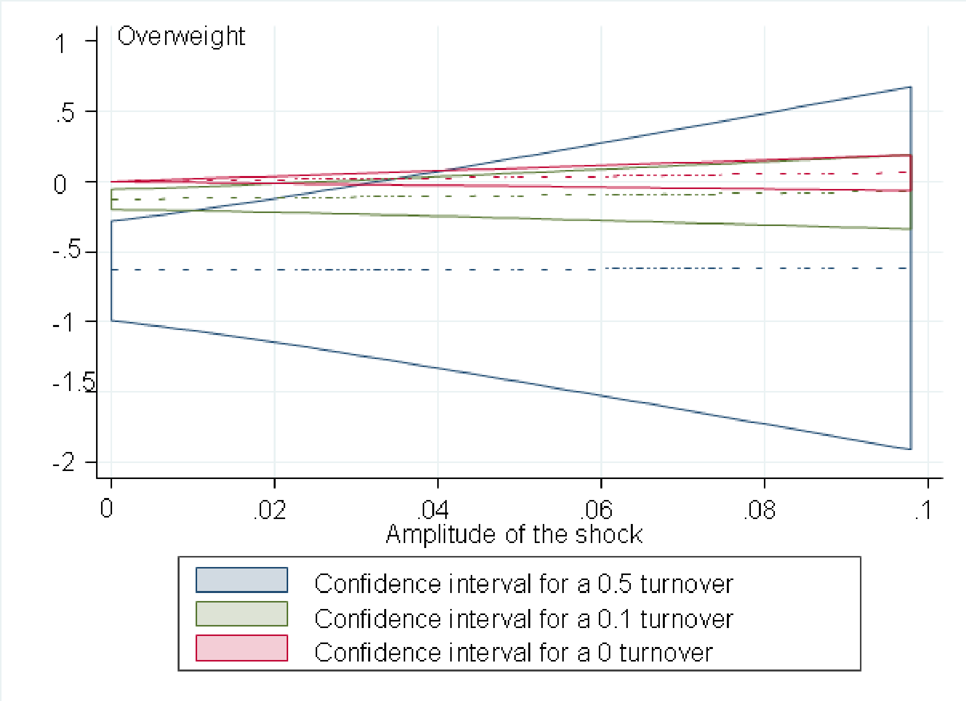

Figure F2: Overweight as a function of the amplitude of the shock and turnover at commune level

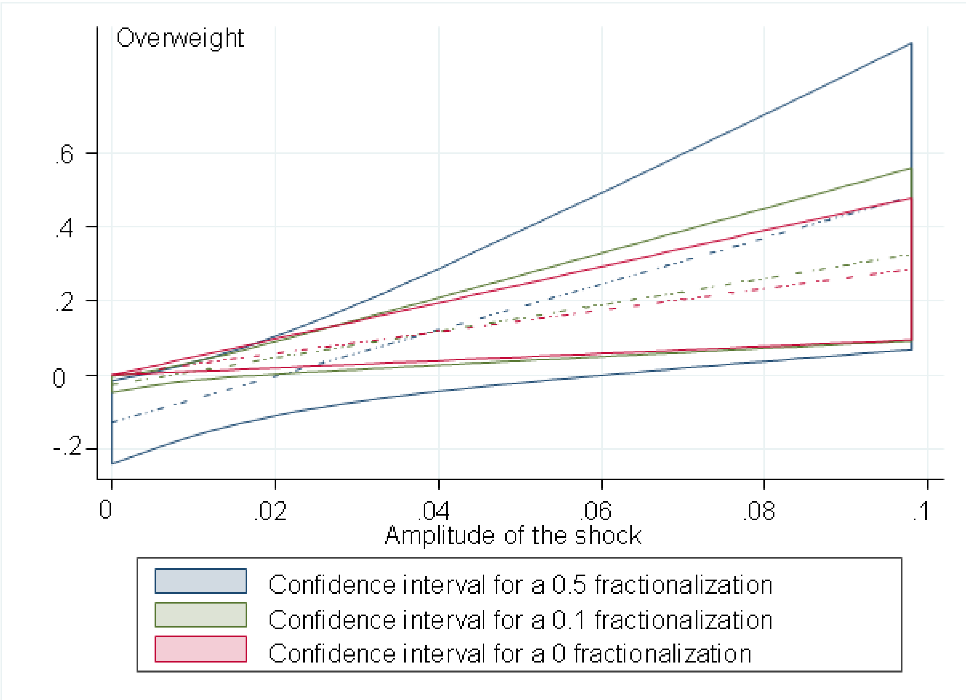

Figure F3: Overweight as a function of the amplitude of the shock and fractionalization at commune level

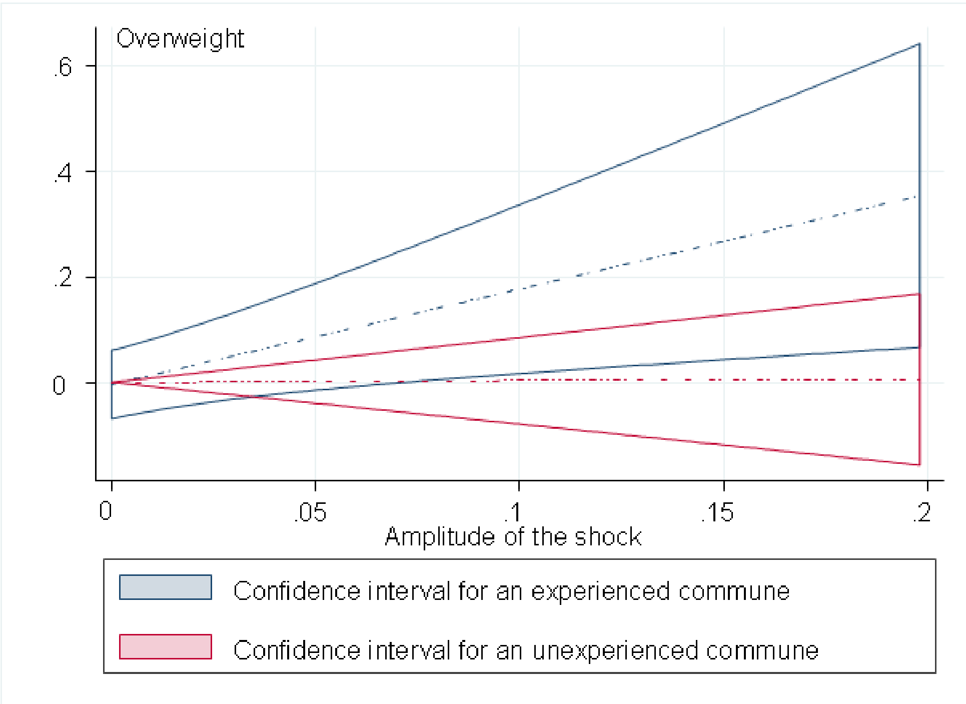

Figure F4: Overweight as a function of the amplitude of the shock and experience

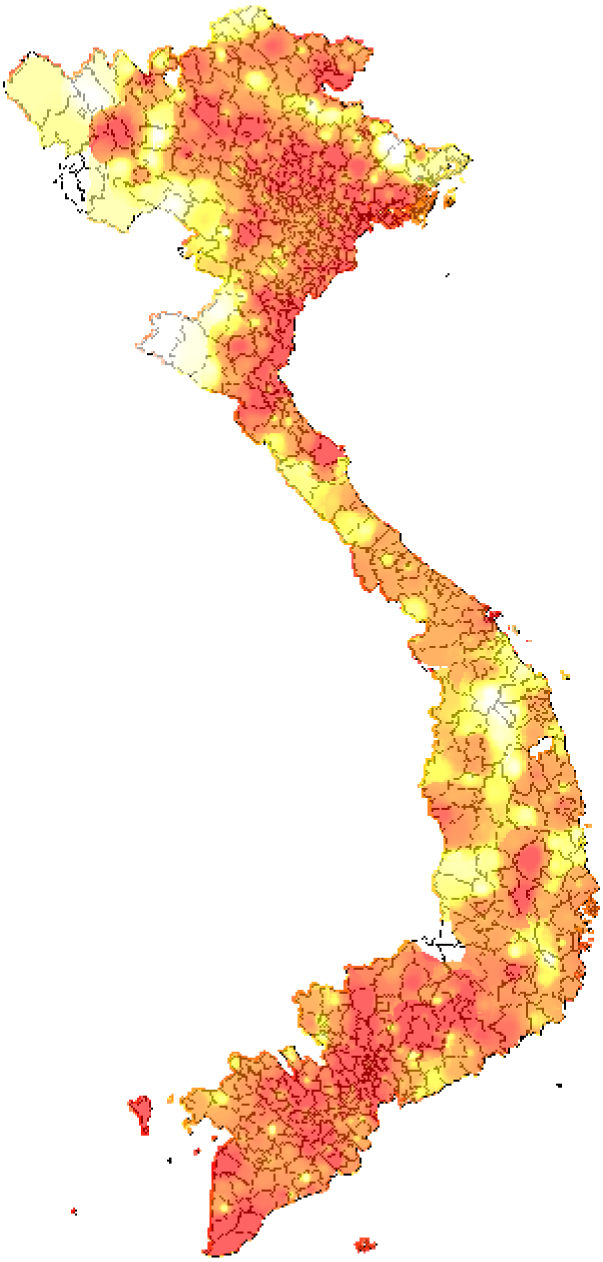

Figure F5: Informal transfer intensity in each district using the household survey in 2004

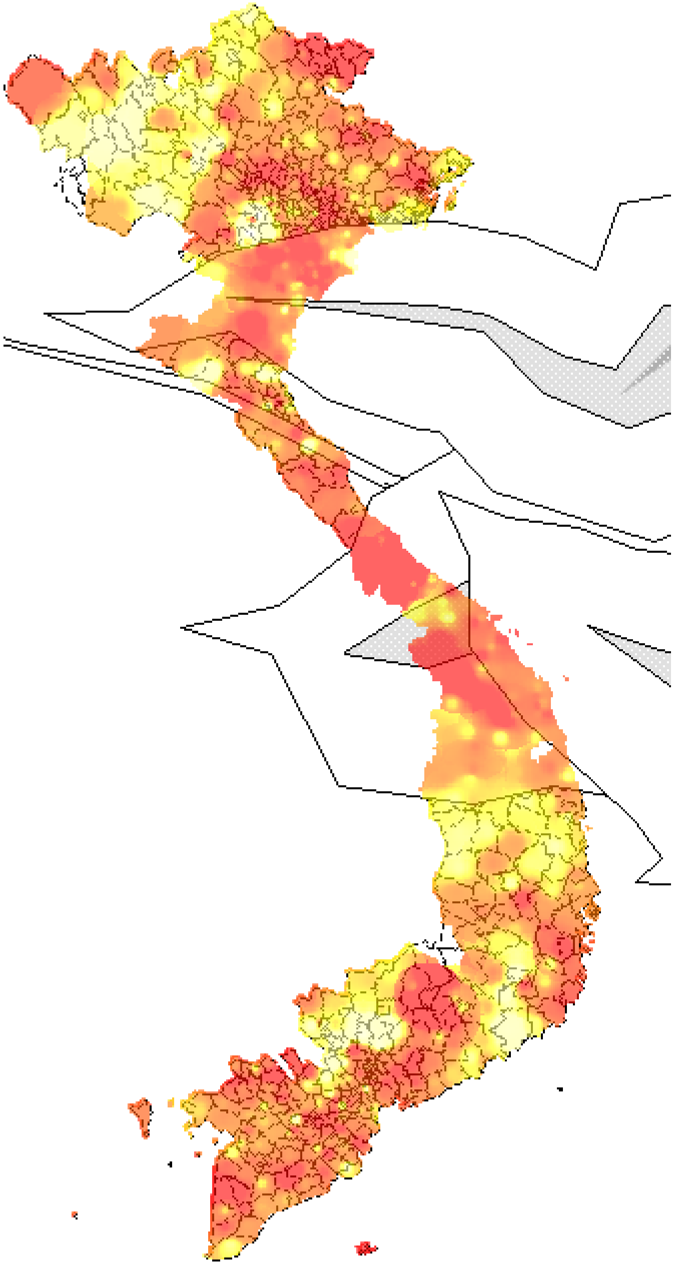

Figure F6: Informal transfer intensity in each district using the household survey in 2006