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

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Abstract

In rural economies, risk-sharing arrangements through networks of relatives and friends are common. Indeed, contract enforcement issues impede the development of formal insurance mechanisms. However, after a disruption of the allocative instruments of the market, the prerequisites under which informal arrangements are feasible might evolve. I rely on a model of imperfect commitment to derive predictions on the sustainability of risk-sharing arrangements in the aftermath of extreme events. 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. Allowing for altruistic sentiments or coordination among the members of a community, I find that a resurgence of charity or a higher level of cooperation explain this unexpected result. 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.

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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.

In rural Vietnam, formal institutions designed to insure against income fluctuations are failing. For large shocks, the 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. Development of long-term crops and specialization[1] 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 additional family labour supply in response to crop shocks. 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 (60%) 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), donations or informal loans involve contracting parties outside of the primary or secondary family circles. Non-market insurance for idiosyncratic shocks is often provided by subgroups (friends, relatives, colleagues, neighbors...) of the entire community. 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 community 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. As a consequence, the privileged network is the network of relatives. Family links are the inherited part of the social networks a household might belong to. In other words, the cost for creating these links are supposedly lower in the family sphere. The larger the sphere the

[1] responding to market incentives.

higher the costs[2]. Along the same lines, Foster & Rosenzweig [2001] points out the fact that commitment is more credible in networks of relatives as monitoring should be tighter than in networks of friends or neighbours. Care for the contracting parties' welfare plays an important role in ameliorating commitment constraints. Interdependent preferences (Pollak [1976]) might indeed weaken 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. 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. Trust and monitoring issues seem to prevail. 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 [2007] establish that, leaving aside friendship or kinship, geographic and social proximity are the major determinants of mutual insurance links among villagers. Such agreements should be useless since all members might be affected while the possibility of risk-sharing mechanisms at village level 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 make 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 when hit by a natural disaster. Furthermore, implicit contracts at a higher level (the village) might not be robust to large fluctuations as they suppose coordination from the community to commit credibly and punish deviations from the informal agreements. The failure of market allocative mechanism might then also be accompanied by a failure of implicit contracts. 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 (households) 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. Informal allocative instruments seem less used in normal times as market institutions might be more efficient. An issue not tackled

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

in the literature is how coordination is made easier during bad times. The non-market coordination evoked by Douty is what I will consider as informal interactions. In other words, this paper will focus on every allocative mechanism between or within households that does not rely on market coordination. Domestic and overseas remittances from migrants, donations or low-interest loans, relief funds, public labor are the main observable components of the community response.

Relying on an extended model of imperfect commitment developed by Ligon *et al.* [2002], 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 coordination mechanisms. 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 communities affected by a cyclone are unexpectedly more efficient than for idiosyncratic shocks. 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. I show that this increase in monitoring capacities is associated with a resurgence of charity or cooperation, laying the foundations for risk-sharing at a level where *normal* events are not assured. Pre-disaster social norms and coordination affect more the level of informal transfers following a typhoon than after some idiosyncratic shocks. More importantly, communities seem to build social capital after a disaster as communes having suffered important trauma in the past show greater signs of resilience.

To our knowledge, this paper is the first paper of this literature focusing on large and correlated income fluctuations risks and identify a learning-pattern in the enforcement of implicit contract within a group. This paper also makes interesting methodological contributions by estimating directly the self-enforcement model and, at a different level, by matching cyclone trails with microeconomic data.

We present in section II. theoretical predictions on the enforceability of informal contracts. Then, we discuss the strategies to construct a consistent dataset and describe the magnitude of tropical typhoons as well as reliance on informal transfers for rural households in section III.. The section IV. presents the empirical strategies to test the theoretical implications. Extended results are discussed in sections V. and VI., focusing on cooperation and the importance of past traumas.

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

A. A benchmark

In this section, we assume that 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[3]. The utility function is strictly increasing, concave and similar for the n households. We suppose that households are infinitely lived and

[3]both assumptions (finite number of state of nature and history-independent shocks) are essential.

maximizes their expected utility:

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

We suppose that saving and borrowing are impossible. We rule out the existence of smoothing instruments. We assume that sharing of resources is unconstrained in this group of households. Any reallocation of resources is theoretically possible. In the following section, we will refer to a reallocation 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. An allocation of resources can be represented by an anti-symmetric transfer matrix, this representation will allow us to rely as closely as possible on the initial model of imperfect commitment.

Nevertheless, legal contracts are not feasible, which imposes the presence of a punishment to ensure that implicit contract will not be systematically violated. I will consider a punishment $P^i(s)$ without specifying if this punishment derives from reputation mechanisms, exclusion from other activities (marriage market...). 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. We 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:

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

Let us remark that 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.

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 $\left\{\bar{U}_j(s_t) = U_{t,i}^a(s_t) - P_j(s_t)\right\}_{j \neq i}$. The program can be written as follows for the household i:

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

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 change of utility of household i for the optimal solution of this optimization problem when relaxing the constraint on the 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:

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

- the envelope and the first-order conditions:

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

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

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 implies first that current payment will be lower than what an unconstrained contract would specify to keep the incentives intact. Second, this readjustment is permanent[4], the ratio adjust to the

[4]before the next violation.

new target[5]. 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. Let us suppose that 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. We assume that 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, we assume that there is a private cost c of being in the losing group. For tractability, let us suppose that there is a continuum of 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, we will focus on the enforceability of the full-insurance contract T_{fi}. Suppose that with a community punishment cost 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, we 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 for 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 where 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 ourselves to monotonic equilibria, there always exists 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

[5]Incidentally, the only unaffected by an infectious disease in a village will pay less than what the first-best contract would predict. 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 initial contracting conditions.

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, a 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 a smaller community sanction 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:

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

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. This remark holds equally for individuals.

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 (Fafchamps & Gubert [2007] show that the groups are principally composed of acquaintances with the same occupation and geographic location), the networks in rural economies are not designed to share efficiently risk (especially large risks). As a consequence, 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^*:

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

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.

C. Predictions derived from the theoretical discussion

a. Informal contracts could exist even in communities without any institutionalized punishment mechanisms. Unconstrained transfers are made so that the marginal ratios of utilities between the members of the group are kept constant. Some ratios might decrease or increase so as to ensure the contract sustainability.

b. When punishments are independent of the state of nature, a uniform increase in the deviation cost extend the 'sustainable' set. Local increase might have mitigated effects depending on the role of the household concerned by the tighter monitoring mechanisms. The presence of sub-groups with correlated incentives to default decreases the expected punishment and the potential enforceability of a contract. Entrants play the same role.

c. With punishment mechanisms independent of state of nature, whether unanticipated or part of a deviation clause, natural disasters should generate smaller instantaneous risk-sharing. They should not imply different transfers than other shocks of similar amplitude if perfectly anticipated and not contingent-specific. When predicted or forgiven, post-disaster risk-sharing should not be smaller than before on longer horizons with the same monitoring facilities. On the opposite, unanticipated deviations should imply exclusions from the risk-sharing groups and lower aggregate risk-sharing on the long term.

d. With cooperation, the effect of higher coordination among the households might have mitigated effects depending on the proportion of households willing to deviate. A higher level of cooperation should trigger a higher level of risk-pooling in communities where the coalition favors contract enforcement in the aftermath of a typhoon.

III. Description of the data

A. Construction of the datasets

Vietnam Household Living Standards Surveys

In this article, we use the Vietnam Household Living Standards Surveys which were carried out in 2002, 2004 and 2006 by the General Statistics Office. These surveys reproduced quite faithfully a first wave of surveys (VLSS 1992/1993 and 1997/1998) organized with a tight monitoring of the World Bank but departs 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 are represented in this study and geographical indicators are sufficiently precise to locate each commune[6] in a district despite changes in enumeration areas between 2002 and 2006. In each commune, 3 households are randomly interviewed. The surveys we use contain a household survey and a commune survey. The former covers household characteristics, education, health, housing conditions, employment, agriculture, 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. 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 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. Furthermore, the study have 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

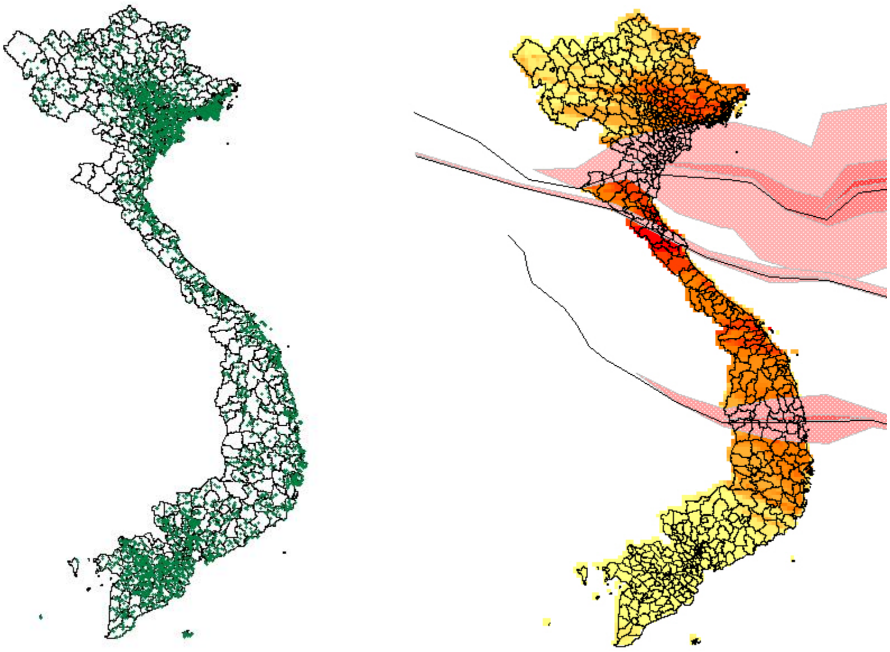
From Joint Typhoon Warning Center, I extract best tracks of tropical typhoons between 1997 and 2006 having landed or generated torrential rains on Vietnamese coasts. Wind intensity, pressure, precise location, form and size of the eye are precisely documented every 6 hours. This allows us to reconstruct the trails and the wind structure. I then

[6] a commune is often composed of several small villages and represents one of the smallest enumeration areas in Vietnam.

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 total wind structure of a selected panel of cyclones (Vicente, Damrey and Chanthu) and an index of the local exposure to tropical typhoons. In order to account for the floods associated to tropical typhoons, I create a band[7] 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[8].

At district level, I compute the precipitation 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)



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 an estimate of the outcome. 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

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

[8] 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.

districts so as to create the total exposure to bombing between 1965 and 1975 for each district. The figure 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. Our surveys covers almost 600 districts, and between 1 and 36 households surveyed by districts. A first random draw determines the communes in the districts which will receive the visit of a surveyor and another draw defines the sub-sample of households to be interviewed in the commune. 75%[9] 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. As we construct the natural disasters exposure not on direct measure of income losses, we compute in this section a rough estimation of the influence of each tropical typhoon considered in this study. Relying on objective measures on exposure, we compute the average exposure per commune for each cyclone. Using the weights provided by VHLSS, this measure can be extended and provide an estimation of direct and indirect damages at country level. We can then compare the results we find with estimations of direct damages recorded in the EM-DAT[10] database. Unsurprisingly, our index differs from EM-DAT estimations. While EM-DAT announced 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[11], our measure predicts USD 580 millions of losses over the surveyed window, approximately 1% of the Gross Domestic Product of Vietnam in 2005. Besides the potential measure error 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. Our index tends to highlight also 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[12] 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 Angsane in the late 2006 underwent similar losses.

Failure of formal institutions

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[13] while health insurance seems to be more frequent[14] but covers extremely small amounts. 47% of rural households are currently reimbursing a loan. The proportion falls

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

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

[11]Xangsane having occurred in September 2006, only few households surveyed in October reported losses.

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

[13]respectively 5,4% and 3,8%.

[14]respectively 39% and 35%.

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.

We 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 the relief aid is often dealt by the commune leader mitigates the reach of intervention of any single household. Using the commune questionnaire of VLSS and the amount and provider of relief aid, we compute the correlations between these ex-post transfers and our measure of income losses. The 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 the reasons behind the relief aid, the amount are extremely small. Allowance for disaster recovery hardly reaches 1% of the household 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 the whole range of instruments but a large proportion of communes (essentially in rural zones) are deprived of the whole panel of risk-sharing mechanisms.

Informal risk-sharing arrangements

Informal risk-sharing arrangements are present in our surveys in the forms of gifts, transfers, remittances and loans. In-kind transfers and 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 study is extremely low). Gift 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 outflow represents approximately $3,5\%$ of the income of each household. To confirm these data on outflows, inflows of domestic remittances 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. Unsurprisingly, the 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

Table 1: Descriptive statistics on formal and informal instruments

	rural	urban
general		
Income (USD 2004)	1382	2511
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

domestic remittances. 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%[15] 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[16]. 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). 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

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

[16]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.

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 households affected by a typhoon

As shown in the following table, the evolution of some key variables in districts affected by a typhoon confirms the intuition developed above. First, the results confirm that predicted losses at commune level (depending on the exposure of a commune - proportion of assets exposed to typhoons) do find a counterpart at individual level! Affected households have a higher probability of having contracted informal loans and lower probabilities for formal loans. They have received higher domestic remittances but similar levels of foreign remittances, insurance reimbursement or aid from NGOs. The outflows also documents a higher activity for informal mechanisms following a disaster. Contribution to funds (including natural disaster funds) and lending are positively correlated to the predicted income losses incurred by a disaster.

Table 2: Descriptive statistics on households affected by tropical typhoons

Direct consequences on 'social' inflows and outflows in 2006

	Coefficient	(Standard error)
income		
Income	-.218	(.041)**
Income in rural areas	-.172	(.047)**
Commune income (district FE)	-.793	(.195)**
Commune income in rural areas (district FE)	-.912	(.231)**
inflows		
Probability to contract formal loans	-.332	(.162)*
Probability to contract informal loans	.359	(.176)*
Domestic remittances and presents	1.22	(.296)**
Foreign remittances	-.210	(.265)
Aid	.007	(.193)
Insurance	.262	(.218)
outflows		
Donations and support	-.394	(.371)
Contribution to funds	.675	(.261)*
Entertainment	.893	(.450)*
Funeral and death anniversaries	-.562	(.301)†
Lending	.776	(.310)*

These are the elasticities to the average (within a commune) income losses induced by natural disasters. Each regression includes the explained variable in 2004 and controls for the expected exposure to natural disasters. Significances are indicated at 10%†, 5%*, 1%**.

IV. Empirical strategies and first results

The model developed in the previous section predicted 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. Let us suppose that the expected income in a sub-group is homogeneous and that the shocks are small compared to the income level. We then linearize the equations, resulting in a linear expression of transfers as a function of individual shocks and the historical λ_t (conditions under which the contract has been designed). We denote $\bar{y}^i$ the expected component of income, z^i_t the unexpected component, τ^j_t 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

$$\lambda^{i,j}_{s,t} = \frac{u^{'}(\bar{y^i}) + u^{''}(\bar{y^i})(z^i_{s,t} + \tau^i_t)}{u^{'}(\bar{y^j}) + u^{''}(\bar{y^j})(z^j_{s,t} + \tau^j_t)} \quad \forall i, j$$

As a consequence,

$$z^j_{s,t} + \tau^j_t = \frac{1}{u^{''}(\bar{y}^j_t)} \left[\frac{u^{'}(\bar{y}^i_t)}{\lambda^{i,j}_{s,t}} - u^{'}(\bar{y}^j_t) \right] + \frac{u^{''}(\bar{y}^i_t)}{\lambda^{i,j}_{s,t} u^{''}(\bar{y}^j_t)} [z^i_{s,t} + \tau^i_t]$$

$$\sum_{j=1}^{n} [z^j_{s,t} + \tau^j_t] = \sum_{j=1}^{n} \frac{1}{u^{''}(\bar{y}^j_t)} \left[\frac{u^{'}(\bar{y}^i_t)}{\lambda^{i,j}_{s,t}} - u^{'}(\bar{y}^j_t) \right] + \sum_{j=1}^{n} \frac{u^{''}(\bar{y}^i_t)}{\lambda^{i,j}_{s,t} u^{''}(\bar{y}^j_t)} [z^i_{s,t} + \tau^i_t]$$

As the sum of transfers should be zero,

$$\tau^i_t = -z^i_{s,t} + \frac{1}{N^i_t} \sum_{j=1}^{n} z^j_{s,t} - \left(\frac{u^{'}(\bar{y}^i_t)}{\bar{y}^i_t u^{''}(\bar{y}^i_t)} \right) \bar{y}^i_t + \frac{1}{N^i_t} \sum_{j=1}^{n} \left(\frac{u^{'}(\bar{y}^i_t)}{\bar{y}^i_t u^{''}(\bar{y}^j_t)} \right) \bar{y}^i_t$$

where N^i_t is defined as:

$$N^i_t = \sum_{j=1}^{n} \frac{u^{''}(\bar{y}^i_t)}{\lambda^{i,j}_{s,t} u^{''}(\bar{y}^j_t)}$$

Under a **non-binding specification**[17], we can notice that 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 written as a function of the risk aversions and expected incomes of the households::

$$\begin{cases} \tau^i_t = -(1 - \frac{1}{N^i_t}) z^i_{s,t} + \frac{1}{N^i_t} \sum_{j \neq 1}^{n} z^j_{s,t} \\ \\ N^i_t = \sum_{j=1}^{n} \frac{\bar{y}^i_t \sigma^j}{\bar{y}^j_t \sigma^i} \end{cases} \tag{S1}$$

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[18] when linearizing around the

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

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

expected income:

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

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.

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

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

The equation S2 can also 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.

Empirical counterpart - Estimation of the equation S1

$$\begin{cases} \tau^i_t = -\alpha\Delta z^i_t + \gamma\Delta\sum_j z^j_t + \varepsilon^i_t \\ z^j_t = y^j_t - \tilde{y}^j_t, \quad \forall j \\ \tilde{y}^j_t = f(y^j_{t-1}, X^j_{t-1}), \quad \forall j \end{cases}$$

The identification method relies on a three step process: first, we predict the level of income in t, given observables X^j_{t-1} in $t-1$. To perform this analysis, we do not impose any structure on the model 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). The unexpected part is the difference between a household's income and the income of households sharing similar initial characteristics. Nevertheless, this income is 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). As a consequence, we extract this unexpected part of income and decompose it into different kind of shocks. The third step is the estimation of the transfer function using the shocks of the household and the potential contractors.

Using typhoon trails, we identify the unexpected income component lost in the aftermath of a disaster. To derive this measure, we regress the unexpected income on two indicators: the energy dissipated along the typhoon path and the probability of suffering from heavy rains[19]. This process generate a district natural exposure. Individual exposure are determined using the assets owned by the households in 2004. To control for potential bias induced by other regional factors, we control for the risk of being hit by a typhoon as

[19] we construct a belt along the track whose width depends on the pressure at the center of the eye.

Table 3: Gifts and informal loans flows following natural disasters

Specification (S1)				
Specifications	**OLS**		**District FE**	
	Coeff.	(SE)	Coeff.	(SE)
Own shock	-.318	(.08)**	-.286	(.08)**
Average shock on neighbors	-.10	(.09)	-.055	(.10)
Observations	6508		6508	

Significances are indicated at 10%†, 5%*, 1%**.

predicted at the previous period (in 2004). The component of unexpected income predicted by our natural manifestations is what we define as the *natural shocks*. Similarly, we identify compulsory *health expenditure shocks*. We 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, we construct an unexpected shock with a loss profile closer to those generated by natural disasters. 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 our estimation process for natural shocks, we consider communes where community leaders reported heavy losses from the epizooty and create an indicator of commune exposure. 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, we can not control for expectations of households in 2004 for these *epizooty shocks*. 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.

Table 4: Transfers of assets following natural disasters

Specification (S1)				
Specifications	**OLS**		**District FE**	
	Coeff.	(SE)	Coeff.	(SE)
Own shock	-.473	(.28)†	-.511	(.30)†
Average shock on neighbors	.608	(.34)†	.547	(.39)
Observations	6508		6508	

Significances are indicated at 10%†, 5%*, 1%**.

The first estimation concerning natural shocks proves that informal arrangements still play a role after severe shocks. Thus, approximately 30% of income losses incurred by a tropical typhoon is insured through domestic remittances and informal loans. We can decompose this effect into two significant effects: loans contracted with friends account for 18% while gifts represent 13% of these informal flows. The results are robusts to the addition of district-level fixed effects or household control variables (age, ethnicity, education level of the head, number of old parents and young children...). Combined with asset transfers, we can not reject the full-insurance hypothesis. The fact that the coefficient for shocks affecting the rest of the community is not close to being the opposite of the coefficient for the household income fluctuations implies that our model 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. We discuss the importance of risk-pooling across districts at the end of this section.

Table 5: Informal transfers and saving flows following non-natural disasters shocks

Specification (S1)				
Informal transfers	**OLS**		**District FE**	
	Coeff.	(SE)	Coeff.	(SE)
Own shock	-.003	(.057)	-.038	(.056)
Average shock on neighbors	-.024	(.069)	-.089	(.071)
Observations	6771		6771	
Transfers of assets	**OLS**		**District FE**	
	Coeff.	(SE)	Coeff.	(SE)
Own shock	-.693	(.207)**	-.592	(.212)**
Average shock on neighbors	.972	(.249)**	1.16	(.266)**
Observations	6771		6771	

Significances are indicated at 10%†, 5%*, 1%**.

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 and individual levels 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 and predict constant λ's.

- 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

We replicate the previous construction of expected income and unexpected shocks. We aggregate the observations (we restrict the sample to the communes where exactly 3 households are interviewed) for each commune and create series of effective marginal ratios between the surveyed households, using a CARA utility function with a risk aversion of 1.92. We then sort the 3 surveyed households of a certain commune along their predicted effective exposure to different shocks (tropical typhoons, health expenditures and epizooty). We do not know if these households are actually members of a same risk-pooling group or if they can consider themselves as potential partners. Nonetheless, these households (randomly chosen) provide a picture of the distribution of households in a commune. Consequently, under the hypothesis that risk-pooling intervenes at commune level, the supposed partners approach the profiles of real potential partners.

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 should be either equal to the targeted marginal ratio $\lambda_{t-1}^{1,2}$ or to the *transposed* 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 written as:

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

where:

$$\hat{\beta} = P\left(BC=0 | \ln \lambda_{t-1} - \ln \chi_{s,t}\right) = \alpha + \gamma \hat{z}_t + \nu_t$$

where $\hat{z}_t$ is a normalized[20] measure of the amplitude of the shock affecting the commune. 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. In this framework,

- α and ζ are the respective probabilities that the constraint is effectively binding conditional on the fact that the model respectively predicts it should be or not. $\alpha > \beta$ is a test that the model predictions concerning potential default do coincide with tighter constraints.

- 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 of the effective

[20]we use the hyperbolic tangent of the average effective exposure of the commune. Thus, an infinite loss would be associated with a measure of -1.

enforcement constraint on the marginal ratios when the model predicts that the enforcement constraint should be binding.

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%**. We display the results for constrained and unconstrained regressions. We 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 results obtained during the first battery of tests are confirmed by this specification. The weight of the constraint on the level of risk-sharing is significantly higher in the case of large health and epizooty shocks. Additional communal losses of 1% due to the H5N1 epizooty increases the propension of the enforcement constraint binding by 0.0086. As health shocks are less correlated among sub-groups, the importance of the communal effective exposure to health shocks should be less pronounced. 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 without livestocks could represent a deviating sub-group.

On the opposite, additional losses due to tropical typhoons loosen the enforcement constraint. An additional marginal loss of 1% at communal level moves the marginal ratio closer to the targeted ratio (perfect insurance conditional on the history) by 0.0064. The more a commune is exposed to a natural disaster, the more efficient the risk-pooling will be at commune level.

In the case of health and tropical typhoons, α is significantly higher than γ which confirms that a χ higher than the targeted ratio is accompanied by a higher weight given on the constrained ratio for a commune affected by the average natural disaster shock (approximately 1% of the consumption). Thus, the difference between the weights attributed to the targeted ratios when the enforcement is binding or not, would not be different[21] from 0 for communities affected by a 10%-typhoon. For communities particularly affected by tropical typhoons, we can not reject that enforcement constraints do not restrict instantaneous risk-sharing. On the other hand, the prediction that the sustainable contract should be further to the targeted ratio with a higher χ is not verified in the case of epizooty shocks for the average level of avian influenza exposure. For a 10%-avian influenza exposure, 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 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 while epizooty or health shocks remain insured at a sub-group level.

Some of our assumptions are not crucial: it is possible to relax the hypothesis of constant relative risk aversion[22] 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. Our 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, 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.

To control for inverse causality or for other cultural phenomena driving together effective exposure to tropical typhoons and informal transfers, we replicate the tests S1 presented above with the initial level of transfers (gifts and informal loans during the year 2003). As shown in table T1, the shocks are not correlated with past transfers. Similarly, the estimation of the system S2 for natural disasters (table T3) proves that:

- 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.

[21] for a 90% confidence interval.

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

- 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 our results.

Another issue is the potential selection bias induced by the panel attrition. Households (and consequently communes when we restrict our analysis to communes with 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. 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. As explained earlier, the datasets do not disentangle presents from friends and urban migrants. Informal gifts here encompass 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 our study: first, considering successively the household as a unit, part of a commune, the commune as a unit, part of a district, the districts and the provinces as units, parts of the entire Vietnam, the only layer for which aggregate net gifts react to natural disaster shocks is the closest to the nucleus. Transfers within district outside the communes and across districts are not correlated with shocks at commune and district levels. Second, the elasticity of net transfers to natural disaster shocks is the same wherever the household lies relatively to the rest of the surveyed households in terms of income fluctuations. If migrants were to insure the households against these shocks, the affected households would receive positive net transfers but not supplied by the less affected households.

Risk-sharing through informal loans is more pronounced following natural disasters than other shocks. The direct estimation of the theoretical model gives an 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. While a shock correlated among sub-groups (epizooty) predicts tighter constraints in accordance with the theoretical model, the amplitude of tropical typhoon reinforces the risk-pooling system at commune level. The next section 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 (to be completed)

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 the limits to resource-pooling in groups with "distant monitoring". 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 the 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 a 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. It is not possible to reject that the correlation between individual shocks and informal transfers is different from 0 for new entrants.

Table 7: Informal flows for recent movers following natural disasters

Specification (S1)				
Specifications	**OLS**		**District FE**	
Own shock × having moved recently	.372	.608	.352	.736
	(.197)†	(.245)*	(.194)†	(.252)**
Own shock	-.387	-.648	-.350	-.693
	(.084)**	(.112)**	(.087)**	(.122)**
Controls for commune shocks	Yes	Yes	Yes	Yes
Sample	Total	Rural only	Total	Rural only
Observations	6508	4814	6508	4814

Significances are indicated at 10%†, 5%*, 1%**.

Building on the previous results, we 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 8, this effect at commune level is not completely supported by surveyed households having moved for the past few years. Having newcomers as neighbors generates also less risk-pooling at commune level. The results seem to be essentially explained by new entrants and not by departing households. 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 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 8: Informal flows following natural disasters depending on having moved or having welcomed recent neighbors

Specification (S1)

Specifications	**OLS**		**District FE**	
Own shock × having moved recently	.634	.651	.761	.773
	(.249)*	(.250)**	(.257)**	(.257)**
Own shock × new entrants	13.08		11.20	
	(5.96)*		(6.52)†	
Own shock × turnover		8.66		6.28
		(4.50)†		(4.63)
Own shock	-.598	-.629	-.654	-.685
	(.118)**	(.115)**	(.128)**	(.125)**
Controls for commune shocks	Yes	Yes	Yes	Yes
Observations	4662	4662	4662	4662

Significances are indicated at 10%†, 5%*, 1%**. Communes for which we have information on turnover are essentially rural.

In the same vein, if we follow Fafchamps & Gubert [2007], geographical distance attenuates the grip one household might have on the rest of the network. The table 9 illustrates this idea since the greater the number of hamlets in a commune controlling for size effects, the lower the level of risk-sharing. Similarly, cultural distance should matter as punishments might be linked to other activities (exclusion form new year celebrations...). In the same table, we 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, we find that households in a local ethnic minority participate significantly less to risk-pooling in the aftermath of a typhoon.

These results replicate at commune level the results found by the literature at subgroup 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 T6). Using the specification S2, we bring support to the interpretation of the benchmark results 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. As soon as shocks represent more than a certain threshold, the difference induced by the degree of fractionalization disappears. The 'double difference' test in table T6 capture the amplitude of this catch-up effect. The results are not completely similar for turnover. Turnover seems to matter 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

Table 9: Informal flows following natural disasters depending on geographic dispersion and being in an ethnic minority at commune level

Specification (S1)				
Specifications	**OLS**		**District FE**	
Own shock × geographic dispersion	3.22		2.83	
	(1.42)*		(1.47)*	
Own shock × ethnic minority		.252		.357
		(.160)		(162)*
Own shock	-.536	-.882	-.540	-.932
	(.102)**	(.179)**	(.111)**	(.185)**
Controls for commune shocks	Yes	Yes	Yes	Yes
Controls for size effects	Yes		Yes	
Controls for the ethnicity		Yes	N	Yes
Observations	4662	6508	4662	6508

Significances are indicated at 10%†, 5%*, 1%**. Communes for which we have information on turnover are essentially rural.

trauma increases rather than on a clear "catch-up effect"[23]. Unsurprisingly, turnover and new entrants remain a stumbling block for establishing commune-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 shocks might simply affect the expectations of the individuals, 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 dissipated energy for the formers and being close to the eye for the latter. The first results indicate that past exposure could influence recent responses to catastrophes. The same regression considering assets' transfers and formal instruments do not display the same learning pattern. The results do not extend to idiosyncratic shock, indicating that this learning-pattern concerns specifically the larger risk-pooling group designed to cover correlated fluctuations[24].

[23]see table T6 for the 'double difference' test and figure F2 for the illustration.
[24]see table T4 in the appendix.

Table 10: Informal flows following natural disasters depending on past exposure

Specification (S1)

Specifications	**OLS**		**District FE**	
Own shock × wind intensity (2000)	-2.13		-2.06	
	(1.07)**		(1.24)**	
Own shock × affected by Linda (1997)		-.732		-.761
		(.347)*		(.347)*
Own shock	-.558	-.481	-.566	-.457
	(.101)**	(.102)**	(.110)**	(.112)**
Controls for commune shocks	Yes		Yes	
Observations	6508	6508	6508	6508

Significances are indicated at 10%†, 5%*, 1%**. The wind intensity is normalized such that a 10 points of percentage increase in energy dissipated relatively to the worst outcome is associated with an increase of 21 points of percentage of risk-pooling.

An issue remains unchallenged: is this effect driven by a higher degree of cohesiveness whatever the amplitude of the shock or is this effect driven by institutions especially built-up for coping with large natural disaster risks? As shown in table T5 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. The 'double-difference' test (see table T5 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. 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

VII. Conclusion

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A Intuition behind the model

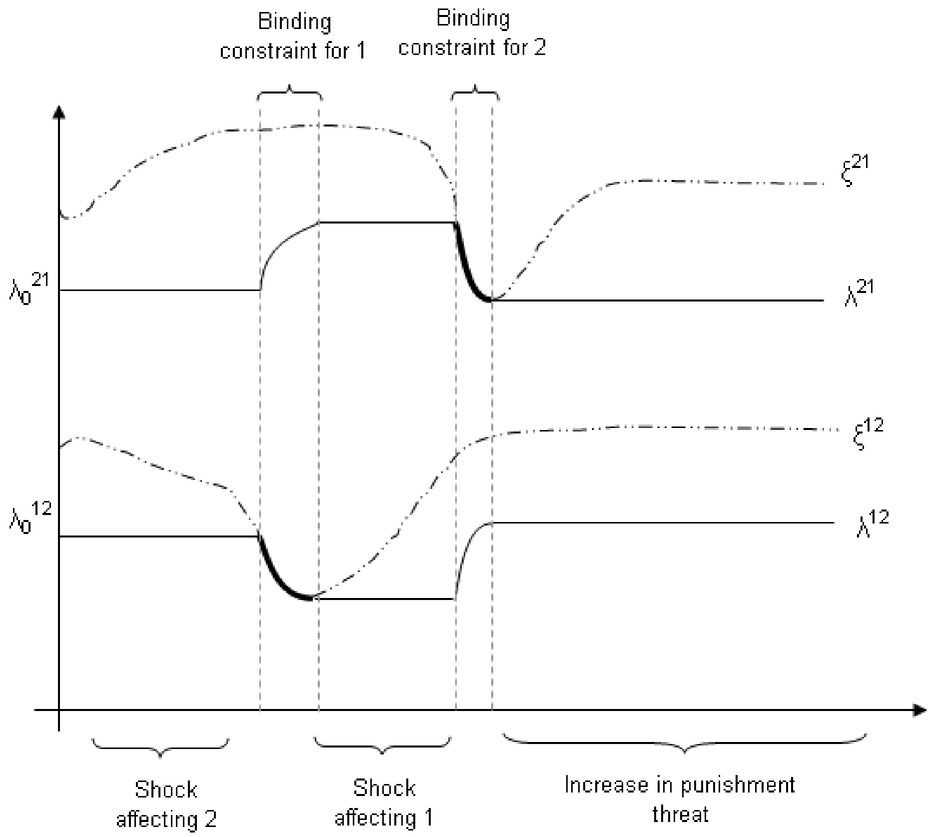

Figure F1: The optimal contract and the evolution of marginal ratios ($\zeta=\bar{\lambda}$)

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.

B Robustness checks

Table T1: Informal flows following natural disasters using past transfers

Specification (S1)				
	Informal loans		Gifts	
	Coeff.	(SE)	Coeff.	(SE)
Own shock	-.036	(.055)	.044	(.058)
Average shock on neighbors	-.019	(.074)	-.013	(.077)
District fixed effects	Yes		Yes	
Observations	4814		4814	

Significances are indicated at 10%†, 5%*, 1%**. The sample is restricted on rural areas. Results are similar with the full sample.

Table T2: Informal flows following epizooty shocks depending on turnover at commune-level

Specification (S1)				
Specifications	**OLS**		**District FE**	
Own shock × having moved recently	.215	.205	.163	.154
	(.143)	(.144)	(.147)	(.148)
Own shock × new entrants	.238		.194	
	(1.05)		(1.06)	
Own shock × turnover		2.15		1.92
		(1.68)		(1.70)
Own shock	-.019	-.013	-.064	-.058
	(0.051)	(.051)	(.053)	(.053)
Controls for commune shocks	Yes	Yes	Yes	Yes
Observations	4870	4870	4870	4870

Significances are indicated at 10%†, 5%*, 1%**. Communes for which we have information on turnover are essentially rural.

Table T3: 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 T4: Robustness checks for past exposure specification

Specification (S1)				
Type of shocks	**Health shocks**		**Natural disasters**	
Type of transfers	**Informal transfers**		**Transfers of assets**	
Own shock × wind intensity (2000)	-.030		-.710	
	(.074)		(5.12)	
Own shock × affected by Linda (1997)		.033		.676
		(.029)		(1.42)
Own shock	-.016	-.018	-.670	-.700
	(.006)*	(.005)**	(.453)	(.460)
Controls for commune shocks	Yes		Yes	
District fixed effects	Yes		Yes	
Observations	6513	6513	6508	6508

Significances are indicated at 10%†, 5%*, 1%**. Coefficients and standard errors for wind intensity are multiplied by 10^5 for readability concerns.

C Additional results using specification (S2)

Table T5: Informal flows following natural disasters depending on past exposure

Specification (S2)		
Type of shocks	**Natural shocks**	
Specifications	ML (FE)	ML
	Results	
Overweight induced (shock × past exposure)	.891	2.68
	(.434)*	(.961)**
Overweight induced (Past exposure)	.001	-.041
	(.019)	(.047)
Controls for overweight	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 T6: 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.

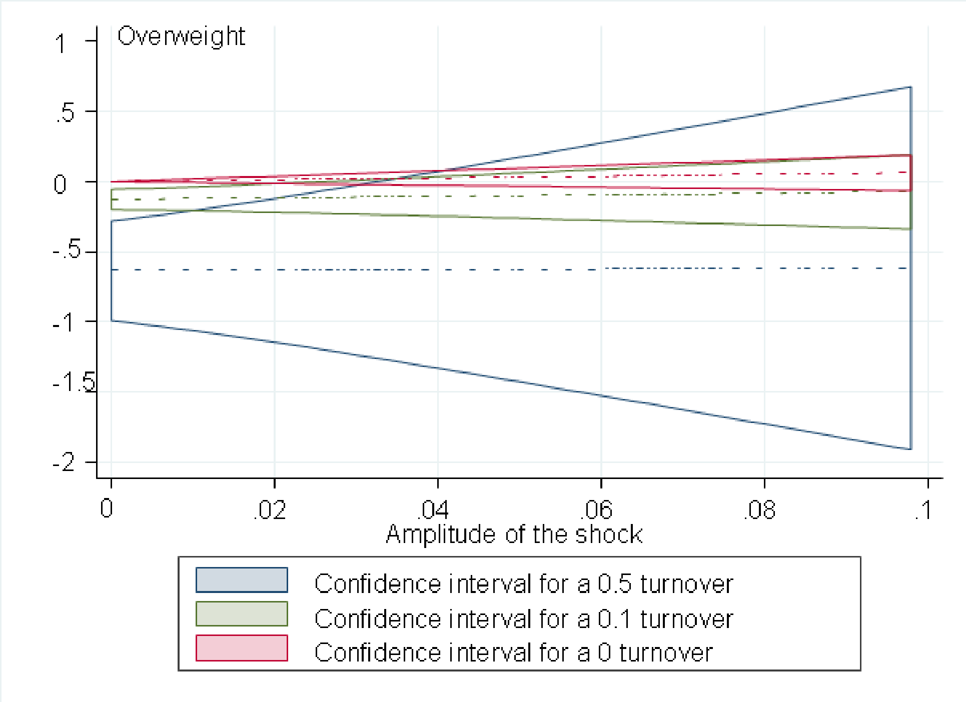

Figure F2: Overweight as a function of the amplitude of the shock and turnover at commune level

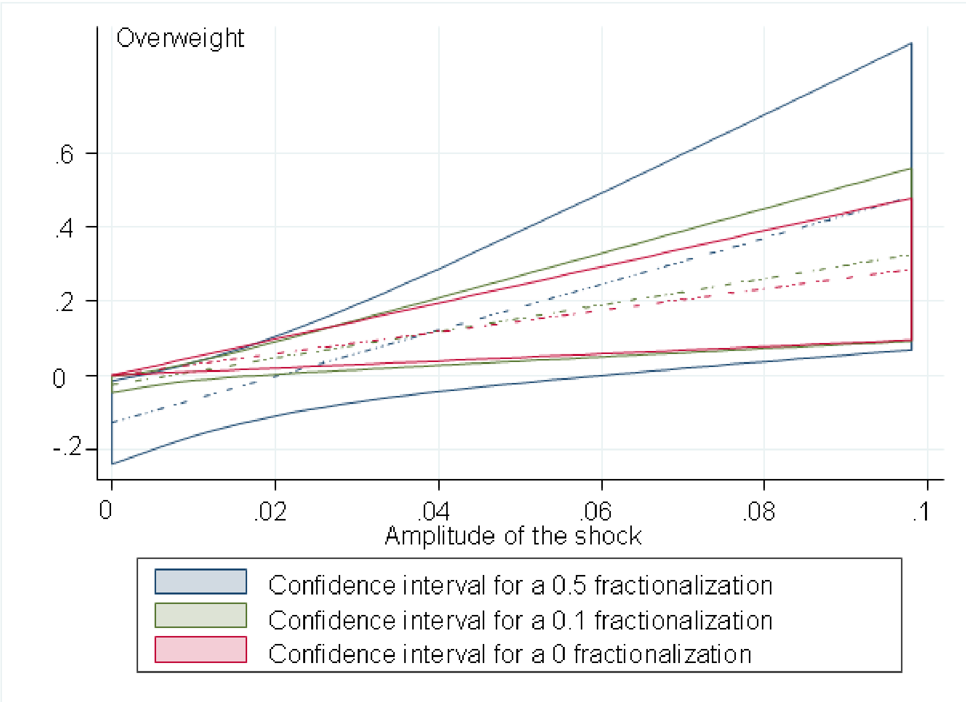

Figure F3: Overweight as a function of the amplitude of the shock and fractionalization at commune level

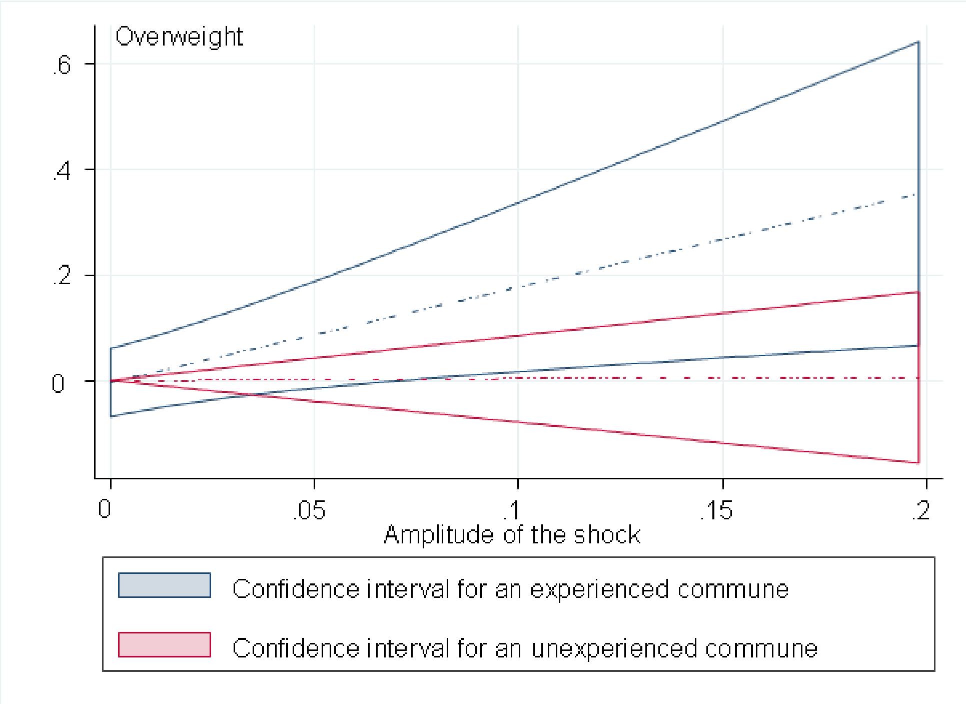

Figure F4: Overweight as a function of the amplitude of the shock and experience

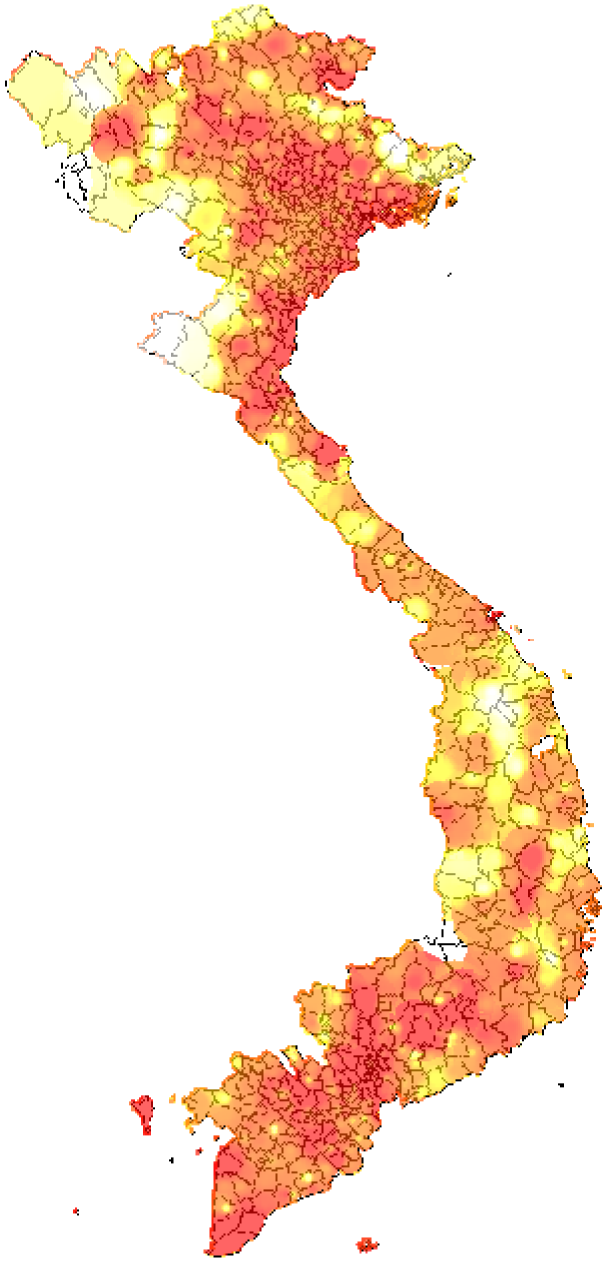

Figure F5: Informal transfer intensity in each district using the household survey in 2004

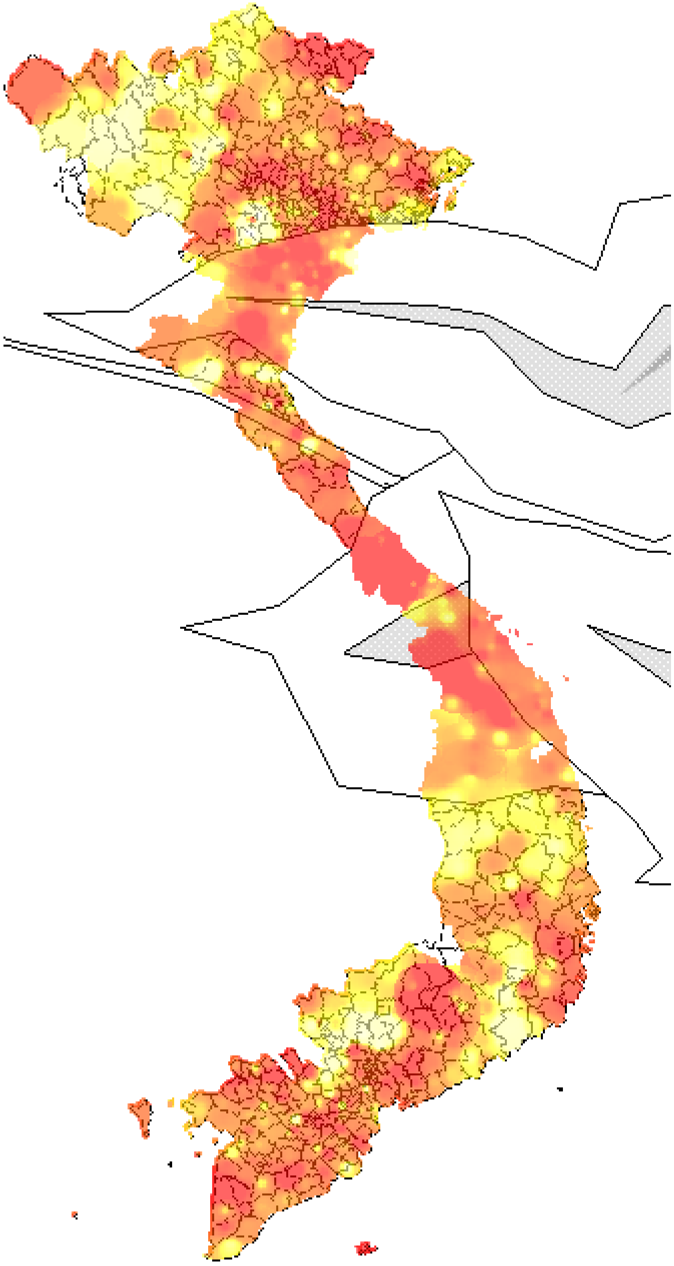

Figure F6: Informal transfer intensity in each district using the household survey in 2006