DO TROPICAL TYPHOONS SMASH COMMUNITY TIES? THEORY AND EVIDENCE FROM VIETNAM*

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Abstract

Natural disasters trigger large inequalities between affected and spared households in a same village. The extent to which communities compensate for these shocks allegedly depends on the balance of power between needy households and households unwilling to implement redistribution. Matching objective and precise data on a wave of tropical typhoons with a panel household survey in Vietnam, I find less redistribution in villages where the median household is less affected than the average villager. Whereas 15 cents on average are covered through informal transfers for an income loss of $1 relatively to the average village loss, access to liquidity falls around 8 cents when the distribution of losses is highly skewed in favor of spared families and reaches 25 cents in the opposite case. Finally, repeated exposure leaves a community with a greater capacity to compensate losses.

JEL: Q54, D64, H84, D71, H23

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Natural disasters, such as earthquakes or typhoons, pose a threat to social cohesion by creating inequalities among members of the same community. In 2005, tropical storms swept across regions of Vietnam, bringing torrential rains and destroying crops. Entire villages were divided into groups of unemployed farmers,

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affected landowners, and less affected households. This paper investigates theoretically and empirically how spared members of the community compensated the needy families in the aftermath of these episodes.

This paper builds on the theoretical intuition that, in the wake of a catastrophe, the skewness of the distribution of losses might influence the degree of informal risk-sharing (or charity) in a community. In the absence of commitment, redistribution is influenced by the ex-post balance of power between those who gain and those who lose from it. I develop an illustrative model where the level of compensation is determined by (i) the contemporaneous willingness of the median voter to redistribute and (ii) his future vulnerability to shocks. In this centralized setting, the community leader will not ensure redistribution if the median voter is not among the needy agents unless the vulnerability of the latter induces him to accept redistribution now in exchange for future insurance.

I find support for this intuition using a representative panel household survey in Vietnam between 2004 and 2006 matched with typhoon trails at a very disaggregated level. My findings indicate that the redistribution of resources across households is limited. On average, individual losses of $1 relatively to village losses are covered by a net positive transfer of 15 cents in rural areas. In villages where the needy families are in the minority, insured losses are close to 5% of actual losses relatively to the rest of the village. When the distribution of losses is highly skewed in favor of affected families, access to liquidity reaches 25% of income losses due to the catastrophe. As negative skewness is generally not considered as desirable, this study establishes that redistribution is low precisely when it would be a priori the most welfare-improving.

Overall, however, the average insurance rate in Vietnam following this wave of typhoons is far from being negligible. An explanation is that repeated exposure, as is the case with periodic typhoons, leaves a community with a better capacity to implement redistribution. I find support for this idea in the fact that villages having suffered big trauma in the recent past show greater signs of resilience in 2005: the average compensation reaches 30 cents there.

Vietnam is plagued by tropical typhoons forming in the warm waters of the West-Pacific basin. More than once every 5 years, the equivalent of a category 4 typhoon with maximum sustained winds between 210 and 249 km/h hits the Vietnamese coasts, and milder tropical storms occur every season on a regular basis between June and October. Only the southern part - too close to the equator - and the mountainous zones are usually spared. As Vietnam is still an agrarian economy, income fluctuations due to the passage of typhoons and associated disasters (mudslides or floods) are significant. Despite this predictable vulnerability, there are no formal institutions designed to smooth large and correlated shocks such as natural catastrophes. The devolution of tasks to people's committees illustrated by the decree of 29 May 1998 on "Grassroots Democracy" has led to much less responses from the central government. Interventions of regional authorities, NGOs, firms or public organizations do not reflect real losses in terms of amplitude and come with a penalizing delay. Lastly, credit constraints rule out the possibility for households to smooth consumption by contacting institutional lenders.

As a substitute for these failing institutional or macroeconomic responses, households reallocate resources within villages through informal transfers (see the riveting article by Townsend (1994) and the seminal papers of Rosenzweig (1988) and Coate and Ravallion (1989)). Nonetheless, imperfect commitment substantially constrains the extent of these risk-sharing networks: partners are supposed to be relatives, friends, neighbors or colleagues (Foster and Rosenzweig (2001), Fafchamps and Lund (2003), Fafchamps and Gubert (2007a)). Untimely, occupational activity of friends and relatives are often close to the household's. It is thus difficult for households to fall back completely on these small insurance networks in the aftermaths of a typhoon.

Informal insurance at the village level is not the only mechanism for reducing the exposure to income shocks. Off-farm employment and precautionary savings[1] allow farmers to untangle consumption dynamics from agricultural revenues. Finally, migrants have been identified as risk-sharing partners in many studies (see Yang and Choi (2007) in the context of rainfall shocks in the Philippines). Foreign and urban migrations are very limited in Vietnam; only a very small fraction of rural families receive remittances.

The evidence presented in this paper supports two seemingly contradictory observations. On the one hand, as highlighted by the psychological literature, sentiments toward the rest of the community can deteriorate in the aftermath of disasters. People can not commit to give as much as they should: "the victims' expectations (usually inflated) for support may clash with postdisaster reality" (Kaniasty et al. 1990). This observation illustrates the importance of imperfect commitment and the discrepancy between ex-ante and ex-post willingness to redistribute. On the other hand, communities ties may be reinforced by a disaster and decisions may be more coordinated. This observation was referred to as the "democracy of distress" (Kutak 1938), the "post-disaster utopia" (Wolfenstein 1957) or the "altruistic community" (Barton 1969). In the economic literature, the early work of Douty (1972) remarks that residents affected by a natural disaster are inclined to be more charitable toward other members of the community. More indirectly, the variability of climate over centuries seems to be a determinant of trust in European regions through the consolidation of community links (Durante 2009). Agents revise their beliefs about the social contract after having experienced a situation where inequalities arise mainly because of circumstances and not efforts or merits.

To my knowledge, this paper is the first one focusing on informal arrangements at the village level after large natural disasters. A major stumbling block is usually the absence of micro-economic datasets combining both information of links between households and a sufficient number of observed villages. The present paper uses

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

particular features of a representative household panel survey conducted between 2004 and 2006 in more than 1000 villages of rural Vietnam. The estimation strategy rests upon the construction of a virtual network composed of a random subsample of villagers for each village. Another stumbling block is the endogeneity of self-reported losses. In this study, accurate and objective data on cyclones are used to construct the local impact of the 2004-2005 seasons on each village and the propensity of being hit. The empirical identification of income losses relies then on two treatments: (i) a treatment constructed at village level - typhoons - and (ii) different vulnerabilities of villagers to this common treatment. The individual vulnerability to the passing of a typhoon is captured by the risk embedded in the occupations and assets of each household before the catastrophe. Intuitively, I compare the evolution of the gap between protected villagers and vulnerable families in affected villages compared to unaffected villages with the same average exposure to typhoons. This strategy allows me to capture indirect losses due to unemployment and business disruption in addition to capital losses and alleviate the bias due to the use of self-reported losses.

Section I. develops an illustrative model and derives simple testable predictions on the role of the asymmetry in the distribution of losses. Section II. details the strategies to construct a consistent dataset and documents the magnitude of tropical typhoons. In section III., I present the empirical strategies to predict income losses due to the passage of typhoons and the preliminary results on the average insurance rate. Section IV. provides insights into the importance of skewness of losses as a determinant of ex-post redistribution and section V. highlights the role of past traumas as catalysts for implementing redistribution.

I. The model

The model largely departs from classical models of informal insurance and imperfect commitment *à la* Ligon et al. (2002). The idea is to highlight in an illustrative median voter framework the intuitions behind the role of the distribution of losses on the level of insurance observed in a closed village.[2] The model generates simple predictions depending on the current incentives of the median voter, but also his future interest in having redistribution. Redistribution will partly pass from one period to the next and both actual losses and vulnerability will matter. Intuitively, turnover in the population at risk will foster redistribution as current winners may be future losers. They accept to participate in the redistribution in exchange for future insurance.

Consider a simple two periods model where agents are either vulnerable in proportion α or non-vulnerable – *à la* Besley and Burgess (2002). Agents have utility u non-decreasing and concave. In both periods, with probability $1-p$, the state of nature is *normal* and agents earn 1 irrespectively of their type (transfers will be nil in this state of nature as no ex-ante premiums will be paid by vulnerable agents in this framework). With probability p, the state of nature is *catastrophic*. Non-vulnerable agents earn 1 in the catastrophic state and the income of vulnerable agents is a random variable X_1 (resp. X_2) following the distribution F_1 in first period (resp. F_2 in second period), defined over $[0,1]$. Vulnerable agents share the same ex-ante vulnerability at both periods. For simplicity, let me denote $\bar{x} = 1-\alpha+\alpha\mathbb{E}(X_1)$ and $x_{1/2} = F_1^{-1}(\frac{1}{2\alpha})$ the mean and the median of community income[3] in first period and

[2]The interaction between the capacity to enforce an insurance contract and the influence of the needy group members can also be modelled in a pure informal contract framework. In a decentralized risk-sharing setting, this intuition would correspond to the threat represented by the formation of a coalition of agents willing to break away jointly from the implicit contract and shy away from their obligations. Among others, Genicot and Ray (2003), Bloch et al. (2007), and Bold (2009) present models with an endogenous pressure on the contract arising from unambiguous externalities on others' cost of defaulting. The larger the group of spared agents the lower the punishment from defaulting on the contract.

[3]Recall that X_1 is the random variable standing for the income of vulnerable agents only in

in the catastrophic state. Finally, consider $\lambda = x_{1/2}/\bar{x}$, which captures the position of the median agent relatively to his companions, vulnerable or not, and stands for the skewness of the distribution of losses in first period. When $\lambda < 1$, the median agent will be *needy*.

The only smoothing instrument in period t is a constant tax rate (or degree of covered losses) T_t homogeneously enforced at the community level. Savings and other smoothing instruments are not available. In short, any kind of legally-enforced contingent assets is excluded.[4] Once the value of T_t is chosen, agents having earned x should give or receive $T_t\,(x - \bar{x}) + \bar{x}$ depending on their position as winners or losers relatively to the rest of the village. T_t can be understood as the part of losses covered by insurance or a taxation rate on the relative surplus generated by the shock. For simplicity, I assume that agents can not shy away from their obligations once the level of insurance has been chosen. Here, imperfect commitment only arises from the fact that agents may influence how T_t is determined through an election but the *individual* punishment is so high that they comply to the community effort afterwards.[5] In both periods, this level of insurance is chosen by the community leader.

The timing is the following: the state of nature in period 1 is revealed and agents observe their income x and the community income $\bar{x}$. Then, a majority election between two candidates takes place to choose the community leader who will stay in office during both periods. Importantly, the candidates commit on this first period redistribution but can not commit on the second period redistribution. Candidates are thus elected on their platforms which only consist in the first-period

the catastrophic state of nature, the median household in the community is not the median of the distribution F_1.

[4]Naturally, agents smooth shocks through the use of precautionary savings in rural economies. Note however that losses in the aftermath of typhoons are sufficiently large for agents not to be able to rely on liquid savings alone. They are obliged to sell means of production or make a dent in their pledgeable capital and even so this might not be sufficient. The model will rely on these considerations and consider that savings are infinitely costly.

[5]Relaxing this hypothesis does not change the core of the argument. A fixed and finite punishment for deviating would only limit risk-sharing and add a fixed upper bound for the level of compensation T_t.

level of insurance. In period 2, the state of nature is revealed and incumbents decide on the level of T_2 that they prefer independently of the preferences of the citizens.

Candidates' types – either vulnerable inclined (VI hereafter) or non-vulnerable inclined (NI hereafter) – are not directly observable to villagers. Candidates gain utility Ω from being elected independently of their type but incur a private cost for reneging on their preferences[6] in their platform, $c_v(1 - T_t)$ for the VI candidate with c_v non-decreasing (and $c_n(T_t)$ with c_n non-decreasing for the NI candidate). I impose the participation constraint $\min(c_v(1), c_n(1)) > \Omega$, which implies that candidates prefer to exit rather than defend and apply a platform at the extreme of her preferences. I focus on situations where the two candidates are of different types as other cases are trivial. In the *catastrophic* state of nature, the platforms can be informative on the types of candidates and their future behaviors. In the *normal* state of nature, there is no room for redistribution and candidates are randomly chosen with probability 1/2 as nothing can distinguish them. Note again that in second period, incumbents have no re-election concerns and fully follow their preferences setting $T_2 = 1$ or $T_2 = 0$ depending on their type.

As the behavior of the incumbent in second period is straightforward and her platform binds her in first period, the only non-trivial choice is the choice of platforms when the state of nature in period 1 is catastrophic. I will focus on the Nash equilibrium outcomes. We can distinguish several situations depending on the vulnerability and misfortune of the median voter:

Proposition 1. *When the median voter is* not vulnerable *($\alpha < 1/2$), the covered losses in the catastrophic states of nature are $T_1 = T_2 = 0$.*

When the median voter is vulnerable *($\alpha \geq 1/2$), two cases may be distinguished:*

[6]This cost can also be understood as a monetary cost if candidates are also potentially affected by the redistribution in the village.

- $\lambda \geq 1$, *the median household is* not needy *and*

$$\begin{cases} T_1 = T_2 = 0 & \textit{if } c_v(1-T^*) > \Omega \\ T_1 = \min\left(T^*, 1\right), T_2 = 1 & \textit{if } c_v(1-T^*) \leq \Omega \end{cases}$$

where T^* is defined as:

$$u\left(\lambda\bar{x}\right) - u\left[\left(\left(1-T^*\right)\lambda + T^*\right)\bar{x}\right] = p\left[u\left(\int_0^1 x dF_2(x)\right) - \int_0^1 u\left(x\right)dF_2(x)\right] \tag{T}$$

- $\lambda < 1$, *the median household is* needy *and* $T_1 = T_2 = 1$.

Proof. In the appendix. □

The cases where $\alpha < 1/2$ or $\lambda < 1$ are situations where the preferences of one of the two candidates match the preferences of the median voter. There is no redistribution when the median voter is not vulnerable as he is both unaffected and not at risk, and the NI candidate is fully happy to implement this schedule. There is full insurance in both periods when the median voter is needy during period 1 (since he is also vulnerable in period 2), and the VI candidate is glad to fully redistribute in both periods. However, in the intermediate case, the median agent is temporarily spared but vulnerable and none of the candidates can offer the optimal scheme for the median voter. The median voter ends up either accepting to bear a risk in second period against no redistribution in first period or accepting to give a part of the surplus in first period in order to be fully insured in second period.

Now, let us focus on some comparative statics and consider the impact of changing the position of the median voter (λ) while keeping both $\bar{x}$ and the distribution of losses F_2 fixed. Naturally, in reality, the distributions in both periods should be close one to another as being partly determined by the activities of households in the village. Increasing the skewness in period 1 would then be associated with a more skewed distribution in second period and would impact the gains for future insurance subsequently.[7] Let me shut down this effect for simplicity. Figure I illustrates the redistribution in the catastrophic state as a function of λ. Let me restrict the discussion to the interesting situation where $\alpha > 1/2$ and the median agent favors redistribution in second period.

We can distinguish 3 zones on figure I:

- When $\lambda < 1$, the median agent is willing to redistribute in first period and a redistributive leader can be elected with $T_1 = 1$. As λ goes past 1, the median voter loses from redistribution in first period. However, as long as λ is sufficiently close to 1, the gains from being insured in second period $p\left[u\left(\int_0^1 x dF_2(x)\right) - \int_0^1 u\left(x\right) dF_2(x)\right]$ still exceed the cost of giving away the surplus relatively to the rest of the village $u\left(\lambda \bar{x}\right) - u\left(\bar{x}\right)$. The VI candidate can still offer her preferred platform $T_1 = 1$ without being threatened by the NI candidate.

- As λ goes past the threshold λ^- for which the surplus is equal to the gains from insurance, the threat of the NI candidate becomes binding and the VI candidate has to give in full redistribution in first period. She offers the maximal level of redistribution which would make the median voter indifferent. As λ increases, this level steadily decreases up to the point $T^*\left(\lambda^+\right)$ where the participation constraint of the VI candidate prevents her from credibly compete with the NI candidate ($c_v(1 - T^*\left(\lambda^+\right)) = \Omega$).

- For $\lambda > \lambda^+$, the only competitive platform is the one propsoed by the NI candidate and T is set to 0 in both periods.

In addition to these predictions on the role of the vulnerability and misfortune of

[7] In the parameter space defined by $\lambda > 1$ and $\alpha > 1/2$, the marginal impact of moving the skewness of both F_1 and F_2 is ambiguous as two effects might compete. On the one hand, the more negatively skewed the distribution and the less the median household wants to redistribute - as illustrated by the welfare cost on the left-hand side of equation (T). On the other hand, the more negatively skewed the distribution and the more unhappy the vulnerable median agent might be in second period without insurance (if agents dislike negative skewness).

the median voter, two additional intuitions can be derived from the transmission of redistribution between periods.

Corollary 1. *In the parameter space defined by* $\lambda > 1$, $\alpha > 1/2$, *and* $c_v(1-T^*) \leq \Omega$,

- *the level of transfers* T_1 *increases with the catastrophic risk* p*;*
- *the level of transfers* T_2 *is higher after a catastrophe than after a normal state in period 1 as a catastrophe allows agents to ensure the election of a redistributive leader.*

Here, both the propensity and the recent exposure should increase the observed redistribution. First, catastrophic risk fosters the incentives of vulnerable households to elect a vulnerable-inclined leader. Accordingly, it is possible to extract more from them in the first period. Second, recent catastrophes allow households to recognize redistributive leaders and put them in office for sure.

The following sections mainly propose tests of the median voter effect and the decreasing pattern of redistribution in λ. Unfortunately, the data will not allow me to follow a community through several shocks and directly assess the importance of vulnerability and turnover.

II. Data

A. The household survey

I use the Vietnam Household Living Standards Surveys (VHLSS hereafter) which were carried out in 2004 and 2006 by the General Statistics Office. These surveys reproduce quite faithfully a first wave of surveys organized with a tight monitoring of the World Bank but depart from them by including an expenditure module to the initial questionnaire. A panel is conducted between the two waves of 2004 and 2006 and the structure of the questionnaire remains stable. As shown in figure II, the surveys cover almost the 600 districts of Vietnam. The survey allows me to locate each commune in a district. This study is representative of the whole population and weights are supplied so as to correct for the over-representation of rural and deprived areas. The sampling is part of the empirical strategy: 1200 communes[8] are drawn; in each commune, an enumeration area is drawn and 3 to a dozen households are randomly interviewed. The majority of rural villages only have 3 surveyed households. To sum up, when restricting the sample to rural villages, the dataset is composed of approximately 1000 small conglomerates of few households living in a very restricted geographic area, i.e. 1000 potential risk-pooling networks or small communities in which a social or insurance contract is very likely to exist. These households provide a very partial but unbiased picture of risk-pooling within the hamlet. I discuss later the implications of these features on the identification strategy. Some traits of the datasets compensate for the small number of households interviewed in each village. Firstly, the household section of the survey covers a large spectrum of household characteristics: education, health, housing conditions, employment, type of self-employed activities and income related to each of these occupations, expenditure, remittances, and credit access. Outflows such as gifts, donations, investments in funds or inflows such as incoming gifts and loans are well documented. Secondly, a commune section complements the individual questionnaires and documents living standards, eligibility to reforms, natural disasters and potential relief, activities, credit barriers and infrastructures in the hamlet chosen for these waves. Unfortunately, the questionnaire is not very detailed concerning membership in social groups. It is also impossible to define precisely risk-sharing potential partners and reconstitute the friends and relatives networks. Furthermore, the study has been conducted during several months (mostly during June

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

and September), generating difficulties when determining the relative exposure of villages to a certain event occurring contemporary to the survey.

Table I documents the income decomposition, reliance on informal transfers, formal credit or insurance of households in the sample. The income of rural households can be decomposed into 4 main components, crops and aquaculture, livestock and forestry, non-agricultural wage activities or businesses, and subsidies. Rural households rely a lot on crops and aquaculture (around 90% of them earn some income from one of the two activities), which make them particularly vulnerable to tropical typhoons. Some of them have access to other activities and may potentially mitigate losses. Private insurance is almost absent in the sample. Thus, only 6% of the surveyed households in 2004 have a formal non-life and not health-centered insurance contract and less than 5% when excluding urban areas. The figures are similar for life insurance contracts (respectively 5% and 4%) while health insurance seems to be more frequent (respectively 39% and 35%) but covers extremely small amounts. The access to formal loans seems to be restricted and does not respond to consumption needs but to capital investments and long-term projects. On the other hand, informal risk-sharing arrangements – gifts, transfers and loans – are highly present. The documented variables are aggregate inflows and outflows (in-kind and cash) over the past year, except for the loan section for which each transaction is recorded with the partner type. 90% (resp. 15%) of households have given (resp. lent) to another household in the past year. A concern is that some domestic remittances may appear as gifts (foreign remittances are coded separately) but there is limited urban migration in Vietnam. In the rest of the paper, I will aggregate gifts and informal loans and consider that they both reflect access to liquidity when needed and participation in a social or insurance contract. Finally, note that the presence of ex-post transfers organized by regional or national authorities is not very correlated with the immediate needs and reported amounts are negligible.

B. Catastrophe data

Data are from UNEP/GRID-Geneva - PreView Global Cyclones Asymmetric Windspeed Profile. I consider the wind structure of tropical typhoons having landed or generated torrential rains on Vietnamese coasts between 1980 and 2006. This measure of maximum sustained wind around the trail comes from a modified Holland formula (see Herold et al. (2006) for the derivation of this formula) where wind is calculated at a very disaggregated level from the distance to the eye, the pressure and both the rotating and translating movements of the typhoon (for the Pacific basin, tracks, wind intensity, pressure, precise location, form and size of the eye are precisely documented every 6 hours by the Joint Typhoon Warning Center). In the rest of the paper, I will consider the cube of the local maximum sustained wind speed as a measure of local destruction (see Emanuel (2005)), as it can be interpreted as the total amount of kinetic energy dissipated by the typhoon on potential vertical surfaces. The basic intuition is that the quantity of molecules hitting a vertical surface is proportional to the speed of the molecule cloud and each atom releases its cinetic energy, proportional to the square of this speed.

I then decompose Vietnam into cells of approximately 5×7 kilometers (each district is divided into a dozen of cells) for which I consider the population density as of 2005 provided by the Center for International Earth Science Information Network (CIESIN). I average the energy dissipated between 1980 and 2004 for each typhoon at the district level weighting for the local population density relatively to the district density. As a consequence, the district measure can be thought as the average energy faced by a randomly-picked individual in each district for any typhoon. Finally, I derive a measure of propensity to be hit by averaging annual energy dissipated weighted by the 2005 population density. I use different annual discount factors (0, 5, 10% per year) to account for how recent the shocks were. Figure II shows the wind structure of a selected panel of cyclones between 2004 and 2005 (Vicente, Damrey and Chanthu) and the undiscounted index of historical exposure to tropical typhoons. The match between the household survey and the geographic data is done at district level.

Using the weights provided by VHLSS, I estimate of the influence of each tropical typhoon considered in this study by regressing the district income in 2006 as a function of the energy dissipated, controlling for the district income in 2004. I then compare the predictions with estimations of direct damages recorded in the EM-DAT[9] database. While EM-DAT reports approximately \$300 millions for the typhoons that belong entirely to the surveyed window, this simple specification predicts \$580 millions of losses over the surveyed window, approximately 1% of the Gross Domestic Product of Vietnam in 2005. Beside measurement errors implied by the estimation or declaration biases from officials, the difference can easily be explained as EM-DAT essentially provides direct capital losses. On the opposite, the computed measure accounts mainly for indirect and long-term effects. Disruption of agricultural activities created severe under-employment in entire regions. A dozen of districts lost up to 20% of their predicted annual income following the passage of Damrey. The amplitude of the shock is thus quite large at regional level, especially since it was not equally distributed over the population and affected mainly farmers growing crops and capital-intensive landowners.

None of the tropical typhoons studied here were considered particularly dreadful. As such, they echoed a similar wave in the early 2000's and, as shown in figure III, affected districts are risky-prone areas. From this viewpoint, such catastrophes landing on Vietnam is not a particularly unlikely event. That being said, the frequency of being hit by a category-2 typhoon for a certain district is quite low even in the central parts of Vietnam.

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

III. Empirical strategies and benchmark results

This section is organized as follows. I first define the empirical counterpart of the measure of redistribution considered in the theoretical model. I then describe the empirical strategy to estimate (i) income losses due to the catastrophe and (ii) the average degree of redistribution. Finally, I discuss potential biases induced by the empirical strategies.

A. A measure of risk-sharing at the village level

The first issue when it comes to capturing insurance is to extract a single measure of redistribution which can ideally be compared across different types of loss distributions. I will naturally follow the theoretical measure. To this purpose, consider that (i) shocks are small and (ii) there is perfect insurance in the village (which is a closed entity of n households). I fix the expected component of income equal to 0 for all households, y^i the unexpected component, τ^i the aggregate informal flows. Inflows are associated with positive τ's and outflows with a negative τ's. Net informal transfers are inflows minus outflows where both quantities aggregate informal loans and gifts at face value without any consideration for the exact purpose of the loan. Perfect insurance ensures that ratios of marginal utilities should remain independent of the shock $\mathbf{y}$, which gives after few computations $\tau_f^i = -y^i + \frac{1}{n}\sum_{j=i}^{n} y^j$. From this full-insurance benchmark, it is tempting to deviate and consider the measure γ, capturing the distance to full-insurance:

$$\tau^i = \gamma \tau_f^i = -\gamma y^i + \frac{\gamma}{n}\sum_{j=i}^{n} y^j \tag{T}$$

The interpretation of γ is straightforward: transfers of amplitude γ offset a relative loss of 1 compared to losses underwent by other households. γ directly echoes the measure T described in the theoretical section, i.e. an insurance rate or a tax rate on the surplus relatively to the average in the village. Note that the informal flows τ^i are directly documented in VHLSS but not the unexpected income component y^i. The empirical strategy needs to indirectly extract those losses.

To obtain the estimates of individual losses y_t^i (resp. commune losses y_t^c) following the passing of a typhoon, I explain the raw income extracted from job activities during the past year and declared in 2006 by the interaction of (i) a **district treatment** T_t^d (the energy dissipated along the typhoons between late 2004 and early 2006) and (ii) a measure of **individual vulnerability** A_{t-1}^i (resp. A_{t-1}^c). The choice of A_{t-1} is discussed in the following lines. It captures the investment of households in risky activities before the passing of the typhoon and its ex-ante ability to cope with it. The inclusion of the district propensity to be hit P^d interacted with the vulnerability as predicted in 2004 ensures that treatment will only capture the actual occurrence of the natural catastrophe and not responses to potential losses had a tropical typhoon affected the district in which the household lives.

The estimated equation of income losses is:

$$\mathbf{y}_t = \beta_T \mathbf{A}_{t-1} \times T_t^d + \left(\beta_A + P^d \times \beta_P\right) \mathbf{A}_{t-1} + \nu^d + \varepsilon_t,$$

with $\mathbf{y}_t = \begin{pmatrix} y_t^i \\ y_t^c \end{pmatrix}$ and $\mathbf{A}_{t-1} = \begin{pmatrix} A_{t-1}^i \\ A_{t-1}^c \end{pmatrix}$, ν^d the district fixed effects and ε_t the bivariate error term. β_T, β_A and β_P are 2×2 matrices.

The regression of the level of individual and village income in 2006, given observables P^d, $\mathbf{A}_{t-1}$ in 2004 and the treatment $T_t^d \times \mathbf{A}_{t-1}$ presented above constitutes the first stage of the empirical strategy. I do not add control variables other than the vulnerability $\mathbf{A}_{t-1}$ as of 2004, and the risk faced by those households $P^d, P^d \times \mathbf{A}_{t-1}$.

The second stage is the estimation of equation (T) presented above and explains how net informal transfers τ_t^i are affected by individual $\widehat{y_t^i}$ and village $\widehat{y_t^c}$ income losses predicted during the first stage.

$$
\left\{
\begin{array}{ll}
\mathbf{y}_t = \beta_T \mathbf{A}_{t-1} \times T_t^d + \left(\beta_A + P^d \times \beta_P\right) \mathbf{A}_{t-1} + \nu^d + \varepsilon_t & (1), \\
\\
\tau_t^i = \gamma \cdot \widehat{\mathbf{y}}_t + \left(\delta_A + P^d \delta_P\right) \cdot \mathbf{A}_{t-1} + \mu^d + \mu_t^i & (2),
\end{array}
\right. \tag{S}
$$

where the coefficient of interest γ as well as δ_A and δ_P are 2-element vectors.

B. Income losses in the wake of a typhoon - a first stage

The identification strategy uses anecdotal observations on the nature of income losses in the aftermath of a disaster. Leaving aside physical injuries and temporary disabilities, a household might be hurt through three channels during and after the passing of a tropical typhoon. First, the destruction of public goods might lead to higher local taxes collected as compulsory public labor for instance. I do not account for these potential losses as the interaction between the use of this required labor and redistribution is unclear. Second, physical assets might be destroyed. Third, few vulnerable activities could be disrupted for a long time, resulting from the destruction of crops and the absence of other job opportunities. Figure III in the appendix shows that the growth of crops and aquaculture income seems to be frozen in affected places relatively to livestock and forestry income. This large effect on crops and aquaculture is the main channel through which farmers were affected during this episode. The next paragraph captures more formally the risk embedded in the portfolio of assets of households before the catastrophe.

Assets in the portfolio will be incomes in 2004 chosen among different sources – subsidies, wages, crops, livestocks, agricultural services, hunting or fishing, forestry, aquaculture and businesses other than those evoked above. I add to these occupations the value of fixed capital (land, houses and capital used for professional activities) and durable appliances so as to capture potential capital losses. The joint estimation of the household and commune income in 2006 as a function of the full decomposition of sources of income and assets in 2004 is shown in table II with three different levels of fixed effects ν. This specification is a reduced form: if farmers in 2004 lose 10% of their income, it does not mean that the returns on farming activities have decreased by 10%. It might well indicate a complete shutdown of the farming activity and a reallocation of labor in another activity. The most affected households were relying essentially on crops and aquaculture in 2004. In the most affected districts (where the energy index T_t^d equals 1), their income loss in 2006 is of the order of magnitude of the income that they extracted from crops and aquaculture in 2004. Comparatively, farmers with livestock and forestry activities in 2004 are better off in 2006, which could indicate (a) a price effect through which the destruction of crops increases the revenue of substitutes, (b) misreported sales of means of production (bullocks for instance). Wage earners and self-employed in other sectors than agriculture are unaffected. Finally, the initial stock and repartition of capital (fixed assets, land, house, durable appliances) seems to influence the amplitude of income losses.[10]

As for now, I restrict the portfolio of vulnerable activities to the most relevant ones. In the case (I_1), A^i_{t-1} include the income extracted from crops and aquaculture, the income extracted from livestock and forestry and the income extracted from wage and non-agricultural businesses. (I_2) is even more straightforward as A^i_{t-1} will be a 1-dimension index composed of the risky component of income, i.e. crops and aquaculture minus the income extracted from livestock and forestry in 2004. The estimation with the first (resp. second) set of instrument is reported in panel A of table III (resp. panel B). The coefficients are stable through the different specifications and that individual and communal equations give very similar estimations.[11] The penalty for growing crops and being involved in aquaculture is always both statistically and economically significant.

[10]Repairs and replacement of capital are included in the measure of income in 2006.

[11]The commune estimation with district fixed effects is not very well identified as there are only few communes per district. The weak identification of communal losses in the presence of district fixed effects will be visible in the rest of the paper.

C. Average redistribution at the village level - a second stage

The second stage evidences that informal arrangements play a role after this wave of typhoons. As shown in panel A of table IV (resp. panel B) using the specification (I_1) (resp. (I_2)) as a first stage, a loss of 1$ relatively to the rest of the community is offset on average by positive net transfers accounting for approximately 15 cents. Note that the estimation of the covered losses is remarkably stable and resists to the addition of district-level fixed effects and additional household controls (age, education and household composition).

As already suggested by the analysis of the first stage, the issue of weak instrument is not extremely strong in the parsimonial specifications, i.e. once the measures of risk are either restricted to (I_1) or (I_2). The partial R-squares are sufficiently large to ensure that the Kleibergen F-statistic is above or around 10 in most of the specifications. Naturally, the inclusion of the whole decomposition of activities and assets in 2004 crossed with the wind as instruments would substantially decrease this statistic by introducing many weak instruments. Doing so does not change the results of the second stage.

Informal transfers are not the only way for households to smooth consumption, savings adjustments (withdrawal of savings, sales of fixed assets, or means of production, gold or jewelry or formal loans) also offset a part of the income losses as shown in table AII in the appendix. When added with the access to liquidity provided by informal transfers, smoothing reaches around $3/4$ of the initial shock.

Finally, this article does not aim at testing if these transfers make everyone better off in the village as the test for reciprocity and time consistency would be far more demanding to the data. Direct OLS regressions of the second stage without a first stage indicate that households with risky activities in risky places do not pay ex-ante premiums. Ex-post transfers might reflect purely altruistic motives or inequality aversion, independently of insurance purposes. Premiums could also be paid afterwards, as reimbursements of the informal loan.

D. Potential biases

To control for potential differences between "treated" districts and the "control" group with the same ex-ante propensity to be hit, I replicate the tests presented above with the pre-disaster informal transfers and savings adjustments. As shown in tables AI and AII in the appendix, the affected districts are not initially different than the control group in terms of informal redistribution or recourse to savings. There are no real and satisfying tests for the exclusion hypothesis but these placebo tests indicate that nature does not discriminated districts by the initial level of informal transfers. This placebo experiment also controls for potential systematic biases created by the estimation method. Placebo tests are replicated for each regression presented in this paper and never display significant differences between affected and non-affected places once controlled for the propensity to be hit by a typhoon, these regressions are available upon request.

The fact that, in certain specifications, the coefficient for the shock affecting the rest of the community is not exactly the opposite of the coefficient for the individual fluctuations implies that this linear specification might not fully fit the real process. Potentially, it could also reflect a classical attenuation bias. Measuring the average level of income losses in a village with only three or so observations should spark off this level of asymmetry.[12] A concern is that this measurement error could not only bias downward the coefficient on the aggregate shock but also the direct elasticity. From this viewpoint, the elasticity might be a lower bound of the true level of redistribution.

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

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

Another issue is the selection bias induced by panel attrition. Households disappearing from the panel might precisely be those affected by a catastrophe and suffering from a lack of coordination. Natural disasters might eliminate households for which our measure of community link is temporary low. Communes losing households between 2004 and 2006 are not particularly affected by typhoons or different from the others along their recourse to informal transfers. Naturally, these communes are more concerned by turnovers, but attrition is independent from the interaction of turnover and natural disasters.

Finally, the effect captured here could be explained by remittances from migrants in the wake of a typhoon having affected their relatives, rather than from the local community. As explained earlier, data do not disentangle local gifts from domestic remittances of urban migrants. The results could then illustrate temporary migration to the cities for unemployed farmers during the harvest season following the passage of typhoons. This issue might be of particular concern and I detail the institutions which hinder migration as a consumption-smoothing instrument in the online appendix.

IV. Influence of the median voter

This section is divided into two parts. I first explain how to account for the shape of the distribution of losses and integrate it in the previous framework. Secondly, I assess its role in the village as a determinant of ex-post transfers and discuss the results.

A. Measures of skewness

The ideal test of the theoretical framework would imply the observation of the full sample of villagers and the computation of the income loss of the median household relatively to the average income loss in the village. Two issues arise here. First, only a small subsample of villagers is interviewed. Second, the income losses are not directly observed but inferred from the empirical strategy.

To alleviate the second issue, I take advantage of the vulnerability index $V_{t-1}^{j} = A(crops)_{t-1}^{j} - A(livestock)_{t-1}^{j}$ which predicts the degree to which household j would actually be affected by the passing of a typhoon. Under the assumption that income losses are proportional to this index in a given village, the shape of the distribution of ex-post losses is approached by the distribution of ex-ante vulnerability. The shape of the former - which is not directly observed – can be captured by the shape of the latter – which can be directly computed.

Figure IV shows the distribution of this vulnerability over all rural regions of Vietnam. This distribution is obviously skewed toward non-vulnerable households. Following the theoretical intuition, the fortune of the median household should influence ex-post redistribution. To capture the weight of this threat at the commune level, I define four indices of skewness. The first three indices capture the degree of potential misfortune of the median voter V_{t-1}^{med} relatively to the subsample of surveyed companions $\frac{1}{n}\sum_{j=i}^{n} V_{t-1}^{j}$. The larger these indices and the better off the median household relatively to the average household. The first index proposes a smooth transformation (similar to the inverse-logit transformation) of the distance $V_{t-1}^{med} - \frac{1}{n}\sum_{j=i}^{n} V_{t-1}^{j}$. The second index normalizes this distance by the standard deviation of the index V_{t-1}. The third index is a dummy equal to 1 if the median household is less needy than the average. Finally, the last index is the third moment of the distribution of the index V_{t-1}, which is another measure of skewness, less directly related to the position of the median household.

The four indices are:

$$\begin{cases} sk_1 = \frac{\frac{1}{n}\sum_{j=i}^{n} V_{t-1}^{j} - V_{t-1}^{med}}{1+|V_{t-1}^{med} - \frac{1}{n}\sum_{j=i}^{n} V_{t-1}^{j}|}, \\ \\ sk_2 = \frac{\frac{1}{n}\sum_{j=i}^{n} V_{t-1}^{j} - V_{t-1}^{med}}{\sqrt{\frac{1}{n}\sum_{j=i}^{n}[V_{t-1}^{j} - \frac{1}{n}\sum_{j=i}^{n} V_{t-1}^{j}]^2}}, \\ \\ sk_3 = \mathbb{1}_{\frac{1}{n}\sum_{j=i}^{n} V_{t-1}^{j} > V_{t-1}^{med}}, \\ \\ sk_4 = \frac{\frac{1}{n}\sum_{j=i}^{n}[(V_{t-1}^{j} - \frac{1}{n}\sum_{j=i}^{n} V_{t-1}^{j})^3]}{[\frac{1}{n}\sum_{j=i}^{n}(V_{t-1}^{j} - \frac{1}{n}\sum_{j=i}^{n} V_{t-1}^{j})^2]^{3/2}}. \end{cases} \qquad ()$$

Figure V shows the dispersion of the indices sk_1, sk_2 and sk_4 in Vietnam. Remark that the lower percentile and the upper percentile of communes in the sample coincide roughly with $sk_1 = -1/2$ and $sk_1 = 1/2$ and that this distribution seems very symmetric with respect to 0. Indices sk_2 and sk_4 are very correlated. The correlation of both with sk_1 is lower (.75) as the definition of sk_1 underweights the right and left tails of the distribution of skewness.

I estimate redistribution as in section III. except that the parameter of interest γ as well as δ_A and δ_P are now 3-element vectors and the β's are 3×3 matrices.

$$\begin{cases} \mathbf{y}_t = \beta_T \mathbf{A}_t \times T_t^d + \left(\beta_A + P^d \times \beta_P\right) \mathbf{A}_t + \nu^d + \varepsilon_t \quad (1), \\ \\ \tau_t^i = \gamma \cdot \widehat{\mathbf{y}}_t + \left(\delta_A + P^d \delta_P\right) \cdot \mathbf{A}_t + \mu^d + \mu_t^i \qquad (2), \end{cases} \qquad \text{(Sk)}$$

$\mathbf{y}_t = \begin{pmatrix} y_t^i \\ y_t^c \\ y_t^i \times sk \end{pmatrix}$ and $\mathbf{A}_t = \begin{pmatrix} A_t^i \\ A_t^c \\ A_t^i \times sk \end{pmatrix}$. This specification allows communities with different distributions to be affected differently.

B. Redistribution as a function of skewness

As shown in panel A of table V, the coefficient γ_s accounting for the skewness of the distribution of vulnerabilities is always positive and significant, independently of the index or the presence of provinces fixed effects. Results with district-fixed effects are reported in table VII. The worse the median household is relatively to the average household, the higher the amplitude of the ex-post redistribution. Going from one extreme to the other creates differences of 20-25 cents in the compensation received by households losing one unit relatively to their peers. Thus, for villages where $sk_1 = -1/2$ (first centile), the covered losses are around 8 cents for a unit lost relatively to the village loss. 18 cents are exchanged when $sk_1 = 0$. For villages where $sk_1 = 1/2$ (last centile), the covered losses reach 28 cents. Note that these estimations are consistent with indices sk_2 and sk_3, also computed using the median household. Finally, when skewness is captured by the third moment of the distribution as with sk_4, the direction and amplitude of the effect are in line with the previous indices. This discrepancy is naturally smaller than what was predicted in the theoretical model (with insurance going from 0 to 1) but accounting that savings smooth part of the shock can reconcile the theory with the empirics.

A concern is that the few observations at the village level might give a very noisy picture of the real distribution of losses and bias the results downward. Nonetheless, specifications give the same results when the indices of skewness are constructed using the subsample of households surveyed at district level rather than at the village level (see panel B of table V). Naturally, the district vulnerability is also a noisy measure of village vulnerability. Still, the average portfolio of activity in villages is quite correlated within districts, reflecting that the degree of reliance on land and crops is spatially correlated. Finally, remark that the addition of the second moment of the distribution of vulnerabilities does not have any influence (column 5 of table VII). Insurance reacts to skewness, not to the variance of vulnerabilities.

Another concern is that villages with different vulnerabilities to tropical typhoons are also different along other characteristics. The differences of redistribution patterns following natural catastrophes might then reflect other intrinsic characteristics of the social environment. For instance, the initial social identity of villagers determines their access to liquidity. Farmers form a united caste compared to others. The higher aggregate access to liquidity could be driven by a higher proportion of agents assimilated in the local culture. I consider a specification including both an individual participation effect – being a farmer/wage earner – and a community effect - the skewness indices. The latter still impedes redistribution with the same amplitude (columns 6 and 7 of table VII). In the same vein, as shown in table VII, the results are the same when the distribution of vulnerabilities is calculated using crops only or using livestock only as measures of potential exposure. In parallel, the skewness indices do not significantly affect redistribution when defined along non-relevant dimensions as regards the passage of tropical typhoons (wages and subsidies for instance). Factors shaping the village composition do not influence the redistribution except if they are directly associated with losses generated by risky activities.

In a nutshell, a body of corroborating evidence hints toward the asymmetry of losses as a major determinant of ex-post redistribution.

That being said, transfers are not the only instrument available for households to smooth their consumption. Families might compensate for the lack of access to liquidity by making a dent to their savings, in particular in communities in which redistribution is low. Data do not seem to strongly support the perfect substitutability of those two instruments (see table AIII in the appendix). Even though the coefficients would point to an additional recourse to savings in communities where needy households are in the minority, they are not statistically significant.[13]

[13]The estimates are approximately the opposite of those found for transfers, but the standard deviations are much higher.

C. Interpretation of the results

The previous results might have social welfare implications. As documented in the literature, agents are quite averse to negative skewness; loss-aversion should be magnified by a left-hand fat tail in the distribution of income. In order to see this pattern, consider the following thought experiment.

A typhoon hits the whole country (Vietnam here). Imagine that households can not smooth their consumption in any other way than by the access to liquidity provided by informal transfers[14]; the distribution of losses can be mapped to the distribution of vulnerabilities.

Two cases are considered: (a) the case where the distribution of vulnerabilities is the observed asymmetric distribution observed in Vietnam as mapped in figure IV, and (b) the counterfactual case with a symmetric normal distribution with the same mean and variance.

A social planner computes the aggregate welfare by summing power utility functions with $\sigma = 1.6$ over the whole population in Vietnam. For the social planner to get the same social welfare for the asymmetric distribution of vulnerabilities as in the symmetric case with transfers of 18 cents, the level of insured transfers should be approximately 25 cents. This computation reflects that agents are quite averse to negative skewness and that transfers should be higher to compensate for that. The fact that the distribution is skewed toward spared families should in principle foster redistribution.

However, for the level of skewness of the fitted distribution, the empirical analysis predicts insured losses around 14 cents. With the Vietnamese distribution of vulnerability, a large majority of households would lose from redistribution and thus be unwilling to implement it. The observed pattern of redistribution is in the oppo-

[14]As highlighted in the previous subsection, this assumption is not realistic. Households can make a dent in their savings, essentially by selling fixed assets or means of production but this is probably quite costly for them to do so.

site direction of what a benevolent planner would do under this CARA specification and the amplitude does not seem to be negligible. We can think that with the capacity for the community to commit, the pattern of transfers would be closer to the benevolent benchmark. When enforcement is imperfect, the level of insurance in the aftermath of the shock might be influenced by the ex-post balance of power in the community.

V. Influence of past shocks

Both the propensity and the recent exposure should favor redistribution. First, households currently reluctant to redistribute may expect future gains from the existence of insurance. These gains increase with the propensity to experience a catastrophe. In addition, very recent catastrophes should allow the community to ensure that a redistributive leader is in office. This last intuition is in line with anecdotal observations in Vietnam. In communities having overcome recently dreadful natural disasters, natural disasters funds help centralize transfers and ensure redistribution in the village. This process is also explained by Douty (1972): natural disasters provoke the creation of a structure headed by pre-disaster leaders. This structure enforces centralized transfers which would not be sustainable with a decentralized process.

To test these predictions, I estimate the following system:

$$\begin{cases} \mathbf{y}_t = \beta_T \mathbf{A}_t \times T_t^d + \left(\beta_A + P^d \times \beta_P\right) \mathbf{A}_t + \nu^d + \varepsilon_t & (1), \\ \\ \tau_t^i = \gamma \cdot \widehat{\mathbf{y}}_t + \left(\delta_A + P^d \delta_P\right) \cdot \mathbf{A}_{t-1} + \mu^d + \mu_t^i & (2), \end{cases} \qquad \text{(Sp)}$$

where $\mathbf{y}_t = \begin{pmatrix} y_t^i \\ y_t^c \\ y_t^i \times R_d \end{pmatrix}$, $\mathbf{A}_t = \begin{pmatrix} A_t^i \\ A_t^c \\ A_t^i \times R_d \end{pmatrix}$, and R_d captures either the recent or average district exposure to typhoons.

I consider three different measures for R_d. First, I compute the trails of a very similar wave of tropical typhoons (Durian, Lingling and Usagi) having occurred in 2001 and define a dummy district variable equal to 1 when the district has been affected by one of those typhoons. The identification relies here on affected communes which, for a similar exposure in 2005, have been affected recently by eventful typhoons compared to spared communities. Second, I construct undiscounted and discounted propensities, by averaging the energy dissipated over 1980-2004 with yearly discounts (.00, .05 and .10) and normalized such that indices go from 0 to 1. The differences between the undiscounted and discounted indices can be seen in figure VI.

Table VI indicates that recent exposure could influence current responses to catastrophes. Having experienced a large trauma in the early 2000's is associated with a huge premium of 15 cents for the net compensation associated to a \$1 relative loss. In resilient communities, the average compensation reaches 30 cents. This result gives insights to interpret the relatively high level of insurance found in section III. as Vietnam is regularly hit by such catastrophes. The same regression considering assets' transfers and formal instruments does not show additional recourse to precautionary savings in resilient communities. Finally, as illustrated by table VI, the horse race between undiscounted and discounted indices is won by the discounted ones showing a larger print left by recent events, even though both recent and average exposures seem to matter. In line with the previous results, in places very recently affected (with a discounted index close to 1), the redistribution is 15 to 20 cents higher than in places hit a long time ago (with a discounted index close to 0). Accordingly, the analysis gives support for the cleansing effect (or resilience effect) of recent catastrophes, less so for the threat of future shocks on reluctant households. The explanation might be that, even when part of the set of possibilities, the potential passing of typhoons might not have been accompanied by the creation of structures unless recent cyclones have left a mark on a community. It is also reasonable to think that communities do not compute their exact exposure using a long time interval but update their beliefs using recent events.

Another explanation than the one proposed by Douty (1972) involves altruism toward peers and fairness ideals. The community might extricate from a severe shock with different norms regarding these issues. This increased resilience is attractive as it relates the present work to Alesina and Angeletos (2005) or Durante (2009), and points to large exogenous shocks as foundations for the welfare state or the determinants of trust in societies.

VI. Conclusion

This paper has explored the intuition that informal insurance after large shocks might be influenced by the strength of the coalition unwilling to redistribute. This limit to risk-sharing adds to the limits induced by initial partitions (ethnic groups, settled families against newcomers) which have already been highlighted in the literature. Overall, results highlight a more organized redistribution process than usually described.

The nature of the power game between agents unwilling to redistribute and affected households is not discussed here. The theoretical part illustrates the intuition in a very stylized framework. In fact, many different stories might fit. First, reluctant families may be excluded from future informal contracts, from marriage markets, business groups or informal groups of savings. Refusing to give might drastically reduce the interactions that a subgroup maintains with the rest of the village. The size of this group shapes the incentives to maintain contact with the rest of the village. Second, as modeled in this paper, the power game might reflect political issues and the results of a formal election. Third, the threat can be a physical threat. This list is certainly non-exhaustive but the present study can not privilege one explanation over the others. This stumbling block prevents us from deriving direct policy implications. A more experimental framework would give intuitions behind the power game. Unfortunately, it could also alter the core of the argument. The behaviors observed here might be related to the fact that some agents are desperate – a context hardly replicable in an experimental setting.

Another issue related to these findings is their external validity. Much of what is found seems to be related with the absence of any other outside options for affected families in Vietnam. They can only rely on their immediate peers, exacerbating tensions in the village. The reasons behind the absence of efficient redistribution at macroeconomic level, even for supposedly well observed shocks, are not addressed here. Similarly, NGOs interventions are astonishingly unrelated to the gravity of the shock. In fact, those traits should be common to many developing countries. The particular feature of Vietnam might be the limits to migration (at least during the period studied here). These barriers prevent the informal networks of insurance to extend outside of the village. Second, the income losses at the core of this paper are pure shocks. Even though I do not insist on redistribution as being part of a risk-sharing contract, this feature is essential in the understanding of the observed attitudes of agents. Agents should be more disposed to redistribute if the issue of moral hazard is peripheral.

To conclude, one might consider the average level of redistribution found in this paper as reassuring. A couple of remarks may mitigate this impression. First, ideal insurance would imply exchanges across communes, districts or even provinces. This study then hints toward the creation of relatively efficient informal means but only as weak substitutes for failing mechanisms. Second, redistribution is the lowest precisely when it potentially creates the largest welfare gains. In that sense, the welfare implications of the absence of formal instruments go beyond the simple differential between full-insurance and actual average insurance.

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A Appendix - Theory

Proof. Proposition 1.

First, when $\alpha < 1/2$, vulnerable households are in the minority. The median household is not vulnerable and prefers the NI candidate. As the cost for VI candidate to offer $T = 0$ is so large that she prefers not to be elected ($\Omega < c_v(1)$). The only candidate is thus NI and the preferences of the median voter are in line with those of the candidates. She is thus elected with a $T = 0$ platform, which implies $T_1 = T_2 = 0$ at both periods.

Second, in the case where $\alpha > 1/2$ and $\lambda \leq 1$, the median voter is vulnerable and is thus willing to have a VI candidate in second period. In addition, the median voter is also needy in the sense that he gains from redistribution in first period as well. As the cost for the NI candidate to offer $T_1 = 1$ is so large that she prefers not to be elected ($\Omega < c_n(1)$). The only candidate is thus the VI and the preferences of the median voter are perfectly in line with those of the candidates. She is thus elected with a $T_1 = 1$ platform which implies $T_1 = T_2 = 1$ at both periods.

The third case is the interesting case where the median voter theorem does not hold anymore. When $\alpha > 1/2$ and $\lambda > 1$, the median voter is vulnerable but not immediately needy, his preferences clash between the two periods. He would ideally vote for a VI candidate as long as the candidate's platform is 0 in first period. Unfortunately, under the assumption described above, only NI candidates are eager to propose this platform in first period. As a consequence, $T = 0$ is a dominant strategy for the NI candidate and the VI candidate sets T_1 to make the median voter indifferent with the NI's platform:

$$u\left[(1 - T_1)\left(x_{1/2} - \bar{x}\right) + \bar{x}\right] + pu\left(\int_0^1 x dF_2(x)\right) = u\left(x_{1/2}\right) + p\int u\left(x\right) dF(x)$$

Losses incurred in first period by participating to redistribution should then be compensated by the gain of having full redistribution in second period.

$$u\left(x_{1/2}\right)-u\left[(1-T)\left(x_{1/2}-\bar{x}\right)+\bar{x}\right]=p\left[u\left(\int_0^1 xdF_2(x)\right)-\int u\left(x\right)dF(x)\right]$$

This platform can be proposed as long as it does not violate the participation constraint of the VI candidate, $c_v(1-T^*)\leq\Omega$.

If $c_v(1-T^*)>\Omega$, the VI candidate can not offer a better alternative to the median household than the NI candidate without violating her participation constraint, which implies $T_1=T_2=0$. $\square$

B Appendix - Empirics

Table AI: Placebo test

Specification (S) - second stage (I_1)

VARIABLES	**Informal net transfers in 2004**					
Own shock	.027	.023	.042	-.021	-.022	-.021
	(.031)	(.030)	(.040)	(.038)	(.039)	(.042)
Shock on oth.				.062	.076	.226
				(.063)	(.067)	(.148)
FE	-	Provinces	District	-	Provinces	District
Observations	2,726	2,726	2,726	2,726	2,726	2,726

Significantly different than zero at † 90% confidence, * 95% confidence, ** 99% confidence. The standard errors in parentheses are clustered at district level. Only the endogenous variables are displayed here. The results are shown omitting the coefficients for the past level of income, assets owned by the family and neighbors, individual and neighbors' propensity to be affected by a typhoon and district potential exposure. These controls are also included in the first stage. The instruments are the effective exposure to typhoons (energy dissipated by the wind) crossed with income from wage, businesses, crops, subsidies, livestock and fixed assets, durable appliances, value of land and the value of the house in 2004 for the household and its neighbors.

Table AII: Adjustments with savings and placebo tests

Specification (S) - second stage (I_1)

VARIABLES	Savings in 2006			Savings in 2004		
Own shock	-.531	-.534	-.582	-.001	.006	.019
	(.097)**	(.092)**	(.088)**	(.076)	(.069)	(.060)
Controls for income in 2004	Yes	Yes	Yes			
FE	-	Provinces	District	-	Provinces	District
Observations	2,726	2,726	2,726	2,726	2,726	2,726

Significantly different than zero at † 90% confidence, * 95% confidence, ** 99% confidence. The standard errors in parentheses are clustered at district level. Only the endogenous variables are displayed here. The results are shown omitting the coefficients for the past level of income, assets owned by the family and neighbors, individual and neighbors' propensity to be affected by a typhoon and district potential exposure. These controls are also included in the first stage. The instruments are the effective exposure to typhoons (energy dissipated by the wind) crossed with income from wage, businesses, crops, subsidies, livestock and fixed assets, durable appliances, value of land and the value of the house in 2004 for the household and its neighbors.

Table AIII: Adjustments with savings as a function of skewness - commune distribution

Specification (Sk) - second stage

VARIABLES	Savings in 2006			
Shock	-.808	-.766	-.698	-.784
	(.129)**	(.137)**	(.095)**	(.138)**
Shock × index sk_1 (i.)	-.175			
	(.183)			
Shock × index sk_2 (ii.)		-.120		
		(.176)		
Shock × index sk_3 (iii.)			-.180	
			(.308)	
Shock × index sk_4 (iv.)				-.127
				(.189)
FE	Provinces	Provinces	Provinces	Provinces
Observations	2,726	2,679	2,726	2,679

Significantly different than zero at † 90% confidence, * 95% confidence, ** 99% confidence. The standard errors in parentheses are clustered at district level. Only the endogenous variables are displayed here. The results are shown omitting the coefficients for past level of income, assets owned by the family and neighbors, individual and neighbors' propensity to be affected by a typhoon and district potential exposure. These controls are also included in the first stage. The instruments are the effective exposure to typhoons (energy dissipated by the wind) crossed with the vulnerability index in 2004 for the household and its neighbors (in addition, I use the previous instrument crossed with the distribution variable). The indices are computed at commune level. The sample is limited to rural areas in which at least 3 households are surveyed per commune.

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Tables

Table I: Descriptive statistics

	Urban	Delta	Non-delta
Number of households	1002	1457	1374
Exposure to typhoons			
Average annual energy dissipated	.19	.22	.20
Annual energy dissipated in 2005	.20	.32	.21
Source of revenues (past year)			
Annual total income (USD)	4214	2883	2229
Annual crops income (USD)	167	689	586
Annual livestock income (USD)	108	322	428
Annual forestry/hunting income (USD)	4	11	69
Annual aquaculture income (USD)	184	132	136
Annual wage/business income (USD)	2300	1073	567
Households growing crops (%)	.29	.82	.89
Households breeding livestock (%)	.25	.68	.79
Households involved in forestry/hunting (%)	.08	.17	.57
Households involved in aquaculture (%)	.09	.37	.35
Households involved in wage/business (%)	.91	.81	.72
Presence of formal instruments (past year)			
Life insurance	.09	.04	.05
Formal loans	.24	.31	.31
Presence of informal instruments (past year)			
Foreign remittances (inflows)	.10	.05	.04
Gifts (outflows)	.84	.88	.83
Gifts (inflows)	.97	.95	.93
Informal loans (outflows)	.16	.19	.19
Informal loans (inflows)	.40	.44	.44

Averages are computed in 2004 on the panel of households present in 2004 and 2006. Wage/business includes all self-employed or wage non-agricultural activities. Employed farmers are counted as being involved in agriculture. The indices of energy dissipated are normalized by the maximum average district exposure.

Table II: Explaining income losses - full decomposition

Specification (S) - first stage

VARIABLES	Income level in 2006					
	ind.	com.	ind.	com.	ind.	com.
Wind × subsidies	0.404	0.027	0.401	0.023	0.402	0.003
(individual)	(0.853)	(0.031)	(0.862)	(0.037)	(0.933)	(0.009)
Wind × wage/bus.	-0.403	-0.009	-0.397	-0.004	-0.401	-0.006
(individual)	(0.247)	(0.011)	(0.249)	(0.009)	(0.270)	(0.011)
Wind × livestock	0.855	-0.013	0.859	-0.009	0.863	-0.004
(individual)	(0.234)**	(0.009)	(0.236)**	(0.007)	(0.255)**	(0.010)
Wind × crops	-1.098	0.002	-1.099	0.002	-1.101	-0.000
(individual)	(0.358)**	(0.005)	(0.363)**	(0.004)	(0.393)**	(0.002)
Wind × fixed assets	-0.025	0.017	-0.032	0.010	-0.037	0.003
(individual)	(0.104)	(0.011)	(0.103)	(0.008)	(0.111)	(0.013)
Wind × durable appliances	-0.180	0.015	-0.185	0.011	-0.191	0.006
(individual)	(0.335)	(0.010)	(0.338)	(0.008)	(0.366)	(0.011)
Wind × value of house	-0.014	-0.000	-0.014	0.000	-0.014	-0.000
(individual)	(0.017)	(0.000)	(0.017)	(0.000)	(0.018)	(0.000)
Wind × subsidies	-2.224	-1.859	-2.277	-1.911	-2.343	-1.935
(commune)	(1.727)	(1.230)	(1.699)	(1.278)	(2.295)	(2.175)
Wind × wage/bus.	0.141	-0.253	0.020	-0.378	0.007	-0.374
(commune)	(0.294)	(0.287)	(0.302)	(0.265)	(0.480)	(0.394)
Wind × livestock	-0.141	0.729	0.469	1.324	-0.529	0.290
(commune)	(0.510)	(0.458)	(0.469)	(0.411)**	(0.609)	(0.525)
Wind × crops	0.209	-0.902	0.197	-0.920	1.445	0.442
(commune)	(0.326)	(0.359)*	(0.317)	(0.353)*	(0.832)†	(0.834)
Wind × fixed assets	-0.161	-0.201	-0.248	-0.283	-0.241	-0.273
(commune)	(0.086)†	(0.085)*	(0.097)*	(0.081)**	(0.194)	(0.151)†
Wind × durable appliances	1.008	0.819	0.972	0.784	0.817	0.602
(commune)	(0.406)*	(0.408)*	(0.396)*	(0.403)†	(0.596)	(0.641)
Wind × value of house	0.020	0.006	0.001	-0.013	0.041	0.028
(commune)	(0.024)	(0.017)	(0.019)	(0.012)	(0.033)	(0.026)
Propensities	Yes	Yes	Yes	Yes	Yes	Yes
FE	-	-	Pro.	Pro.	Dis.	Dis.
Observations	2,726	2,726	2,726	2,726	2,726	2,726
Clusters	448	448	448	448	448	448

Significantly different than zero at † 90% confidence, * 95% confidence, ** 99% confidence. The estimation method is a simple OLS and standard errors in parentheses are clustered at district level. Fixed-effects are at the province (Pro.) or district (Dis.) level. Only the variables of interest are displayed here. The results are shown omitting the coefficients for the level of income in 2004, risky activities and the district propensity to be affected by a typhoon interacted with the risky activities. Risky activities are proxied by the percentage of income earned in 2004 by subsidies, wages and businesses, crops and aquaculture, livestocks, hunting or fishing and forestry, and durable appliances, fixed assets in crop business, in other businesses, values of land and houses.

Table III: Explaining income losses - a first stage

Specification (S) - first stage

PANEL A	Instruments (I_1)					
VARIABLES	**Income level in 2006**					
	ind.	com.	ind.	com.	ind.	com.
Wind × livestock	.959	-.005	.961	-.002	.962	.001
(individual)	(.249)**	(.005)	(.252)**	(.005)	(.276)**	(.006)
Wind × crops	-.991	-.002	-.993	-.004	-1.00	-.004
(individual)	(.350)**	(.009)	(.354)**	(.007)	(.384)**	(.005)
Wind × wage/bus.	-.173	-.023	-.168	-.018	-.162	-.008
(individual)	(.215)	(.022)	(.218)	(.020)	(.237)	(.020)
Wind × livestock	-.144	.820	.357	1.32	-1.82	-.872
(commune)	(.541)	(.463)†	(.506)	(.428)**	(.736)**	(.692)
Wind × crops	.130	-.870	.104	-.902	1.37	.447
(commune)	(.315)	(.354)*	(.309)	(.352)*	(.779)†	(.783)
Wind × wage/bus.	.067	-.098	-.092	-.258	-.341	-.516
(commune)	(.325)	(.306)	(.322)	(.275)	(.653)	(.583)
Propensities	Yes	Yes	Yes	Yes	Yes	Yes
FE	-	-	Pro.	Pro.	Dis.	Dis.
Observations	2,726	2,726	2,726	2,726	2,726	2,726
Clusters	448	448	448	448	448	448
Partial R-squared	.053	.047	.058	.065	.050	.026
Prob > F	.000	.000	.000	.000	.000	.008

PANEL B	Instruments (I_2)					
VARIABLES	**Income level in 2006**					
	ind.	com.	ind.	com.	ind.	com.
Wind × crops-livestock	-1.01	.001	-1.01	-.001	-1.02	-.003
(individual)	(.230)**	(.004)	(.233)**	(.004)	(.252)**	(.003)
Wind × crops-livestock	.021	-.999	-.199	-1.22	.537	-.471
(commune)	(.211)	(.331)**	(.228)	(.348)**	(.368)	(.329)
Propensities	Yes	Yes	Yes	Yes	Yes	Yes
FE	-	-	Pro.	Pro.	Dis.	Dis.
Observations	2,726	2,726	2,726	2,726	2,726	2,726
Clusters	448	448	448	448	448	448
Partial R-squared	.018	.025	.021	.035	.013	.002
Prob > F	.000	.011	.000	.002	.000	.166

Significantly different than zero at † 90% confidence, * 95% confidence, ** 99% confidence. The estimation method is a simple OLS and standard errors in parentheses are clustered at district level. Fixed-effects are at the province (Pro.) or district (Dis.) level. Only the variables of interest are displayed here. The results are shown omitting the coefficients for the level of income in 2004, risky activities and the district propensity to be affected by a typhoon interacted with the risky activities. Risky activities are proxied by the percentage of income earned in 2004 by wages and businesses, crops and aquaculture, livestocks, hunting or fishing and forestry in panel A, the crops income in 2004 deducted of the livestock income in 2004 in panel 2006.

Table IV: Degree of redistribution - a second stage

Specification (S) - second stage

PANEL A	Instruments (I_1)					
VARIABLES	**Informal net transfers in 2006**					
Own shock	-.191	-.179	-.175	-.161	-.160	-.161
	(.065)**	(.058)**	(.051)**	(.039)**	(.038)**	(.039)**
Shock on oth.				.043	.025	-.169
				(.066)	(.073)	(.141)
FE	-	Pro.	Dis.	-	Pro.	Dis.
Observations	2,726	2,726	2,726	2,726	2,726	2,726
Clusters	448	448	448	448	448	448
First stage						
Partial Rsq (own shock)	.032	.036	.035	.038	.039	.037
Partial Rsq (shock on oth.)				.026	.031	.009
Kleibergen-Paap rk LM	5.16	5.16	5.16	9.73	9.73	9.73
Kleibergen-Paap rk Wald F	11.49	10.89	9.31	7.23	7.08	3.03

PANEL B	Instruments (I_2)					
VARIABLES	**Informal net transfers in 2006**					
Own shock	-.128	-.113	-.168	-.165	-.166	-.164
	(.059)*	(.059)†	(.076)*	(.069)*	(.070)*	(.075)*
Shock on oth.				.066	.104	-.267
				(.058)	(.054)†	(.321)
FE	-	Pro.	Dis.	-	Pro.	Dis.
Observations	2,726	2,726	2,726	2,726	2,726	2,726
Clusters	448	448	448	448	448	448
First stage statistics:						
Partial Rsq (own shock)	.021	.023	.014	.018	.021	.013
Partial Rsq (shock on oth.)				.025	.035	.002
Kleibergen-Paap rk LM	5.83	5.83	5.83	4.34	4.34	4.34
Kleibergen-Paap rk Wald F	16.73	16.36	13.96	9.76	9.54	8.14

Significantly different than zero at † 90% confidence, * 95% confidence, ** 99% confidence. The standard errors in parentheses are clustered at district level. Only the endogenous variables are displayed here. The results are shown omitting the coefficients for the past level of income, assets owned by the family and neighbors, individual and neighbors' propensity to be affected by a typhoon and district potential exposure. These controls are also included in the first stage. The instruments are the effective exposure to typhoons (energy dissipated by the wind) crossed with income from crops and aquaculture, livestock and forestry, and income from non-agricultural wage and business in 2004 for the household and its neighbors in panel A, and the difference between crops income and livestock income in 2004 in panel B.

Table V: Redistribution as a function of skewness

Specification (Sk) - second stage (I_2)

PANEL A	Indices computed at the commune level							
VARIABLES	**Informal net transfers in 2006**							
Shock	-.198	-.182	-.181	-.173	-.267	-.267	-.182	-.174
	(.058)**	(.051)**	(.066)**	(.063)**	(.050)**	(.046)**	(.063)**	(.061)**
Shock × index sk_1 (i.)	.171	.201						
	(.091)†	(.080)*						
Shock × index sk_2 (ii.)			.228	.245				
			(.111)*	(.097)*				
Shock × index sk_3 (iii.)					.175	.201		
					(.135)	(.119)†		
Shock × index sk_4 (iv.)							.202	.218
							(.094)*	(.082)**
Shocks on others	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
FE	-	Pro.	-	Pro.	-	Pro.	-	Pro.
Observations	2,726	2,726	2,679	2,679	2,726	2,726	2,679	2,679
Clusters	448	448	445	445	448	448	445	445
PANEL B	Indices computed at the district level							
VARIABLES	**Informal net transfers in 2006**							
Shock	-.288	-.267	-.245	-.242	-.357	-.361	-.185	-.170
	(.092)**	(.073)**	(.064)**	(.058)**	(.102)**	(.097)**	(.084)*	(.078)*
Shock × index sk_1 (i.)	.300	.333						
	(.151)*	(.127)**						
Shock × index sk_2 (ii.)			.278	.341				
			(.176)	(.160)*				
Shock × index sk_3 (iii.)					.290	.316		
					(.133)*	(.119)**		
Shock × index sk_4 (iv.)							.177	.211
							(.113)	(.104)*
Shocks on others	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
FE	-	Pro.	-	Pro.	-	Pro.	-	Pro.
Observations	2,726	2,726	2,679	2,679	2,726	2,726	2,679	2,679
Clusters	448	448	445	445	448	448	445	445

Significantly different than zero at † 90% confidence, * 95% confidence, ** 99% confidence. The standard errors in parentheses are clustered at district level. Only the endogenous variables are displayed here. The results are shown omitting the coefficients for past level of income, assets owned by the family and neighbors, individual and neighbors' propensity to be affected by a typhoon and district potential exposure. These controls are also included in the first stage. The instruments are the effective exposure to typhoons (energy dissipated by the wind) crossed with the vulnerability index in 2004 for the household and its neighbors (in addition, I use the previous instrument crossed with the distribution variable). The indices are computed at commune level in panel A, at the district level in panel B. The sample is limited to rural areas in which at least 3 households are surveyed per commune.

Table VI: Covered losses as a function of recent exposure

Specification (Sp) - second stage (I_1)

VARIABLES	**Informal net transfers in 2006**					
Shock γ_c	-.148	-.150	.007	.181	.134	.125
	(.045)**	(.045)**	(.098)	(.099)†	(.114)	(.078)
Shock × 2001-wave	-.166	-.140				
	(.072)*	(.081)†				
Shock × recent (5%)			-.282	-.196		
			(.121)*	(.103)†		
Shock × recent (10%)					-.420	-.165
					(.146)**	(.088)†
Shock × propensity				-.288		-.290
				(.277)		(.252)
FE	-	Pro.	Pro.	Pro.	Pro.	Pro.
Observations	2,726	2,726	2,726	2,726	2,726	2,726
Clusters	448	448	448	448	448	448
First stage						
Partial Rsq (own shock)	.037	.039	.038	.013	.040	.014
Partial Rsq (shock × recent)	.066	.068	.030	.111	.035	.110
Partial Rsq (shock × propensity)				.025		.025
Kleibergen-Paap rk LM	7.92	7.92	5.37	7.10	5.91	8.26
Kleibergen-Paap rk Wald F	8.48	8.28	9.73	2.88	8.00	3.15

Significantly different than zero at † 90% confidence, * 95% confidence, ** 99% confidence. The standard errors in parentheses are clustered at district level. Only the endogenous variables are displayed here. The results are shown omitting the coefficients for past level of income, assets owned by the family and neighbors, individual and neighbors' propensity to be affected by a typhoon and district potential exposure. These controls are also included in the first stage. The instruments are the effective exposure to typhoons (energy dissipated by the wind) crossed with the difference between crops income and livestock income in 2004 for the household and its neighbors (in addition, I use the previous instruments crossed with past exposure). 2001-wave is a dummies equal to 1 if the district has been exposed to a dreadful cyclone during the 2001 wave. Recent exposure 5% (resp. 10%) is the difference between the average annual energy dissipated between 1980 and 2003 and the same mean computed with an annual discount of 5% (resp. 10%).

Table VII: Redistribution as a function of skewness - robustness checks

Specification (Sk) - second stage (I_1)

VARIABLES	**Informal net transfers in 2006**								
Shock γ_c	-.186	-.169	-.283	-.170	-.198	-.187	-.094	-.271	0.024
	(.066)**	(.072)*	(.058)**	(.068)*	(.055)**	(.066)**	(.039)*	(.067)**	(.073)
Shock × index sk_1 (i.)	.180								
	(.099)†								
Shock × index sk_2 (ii.)		.190			.229	.195	.257		
		(.128)			(.081)**	(.090)*	(.061)**		
Shock × index sk_3 (iii.)			.224						
			(.172)						
Shock × index sk_4 (iv.)				.172					
				(.108)					
Shock × standard dev.					.000				
					(.001)				
Shock × wage earner						.131			
						(.088)			
Shock × crops grower							-.065		
							(.081)		
Shock × index sk_2 (crops)								.257	
								(.140)†	
Shock × index sk_2 (livestock)									.687
									(.209)**
Shocks on others	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
FE	Pro.	Pro.	Pro.	Pro.	Pro.	Pro.	Pro.	Pro.	Pro.
Observations	2,726	2,679	2,726	2,679	2,679	2,679	2,679	2,726	2,726

Significantly different than zero at † 90% confidence, * 95% confidence, ** 99% confidence. The standard errors in parentheses are clustered at district level. Only the endogenous variables are displayed here. The results are shown omitting the coefficients for past level of income, assets owned by the family and neighbors, individual and neighbors' propensity to be affected by a typhoon and district potential exposure. These controls are also included in the first stage. The instruments are the effective exposure to typhoons (energy dissipated by the wind) crossed with the vulnerability index in 2004 for the household and its neighbors (in addition, I use the previous instrument crossed with the distribution variable). The indices are computed at commune level. Standard deviation is the standard deviation of the vulnerability distribution, wage earner (resp. crops grower) is a dummy equal to 1 if wage (resp. crops) income is non-nil. Indices sk_2 (crops, livestock) are computed with only crops income or only livestock income. The sample is limited to rural areas in which at least 3 households are surveyed per commune.

Figures

Figure I: Redistribution as a function of the relative position of the median household in first period λ.

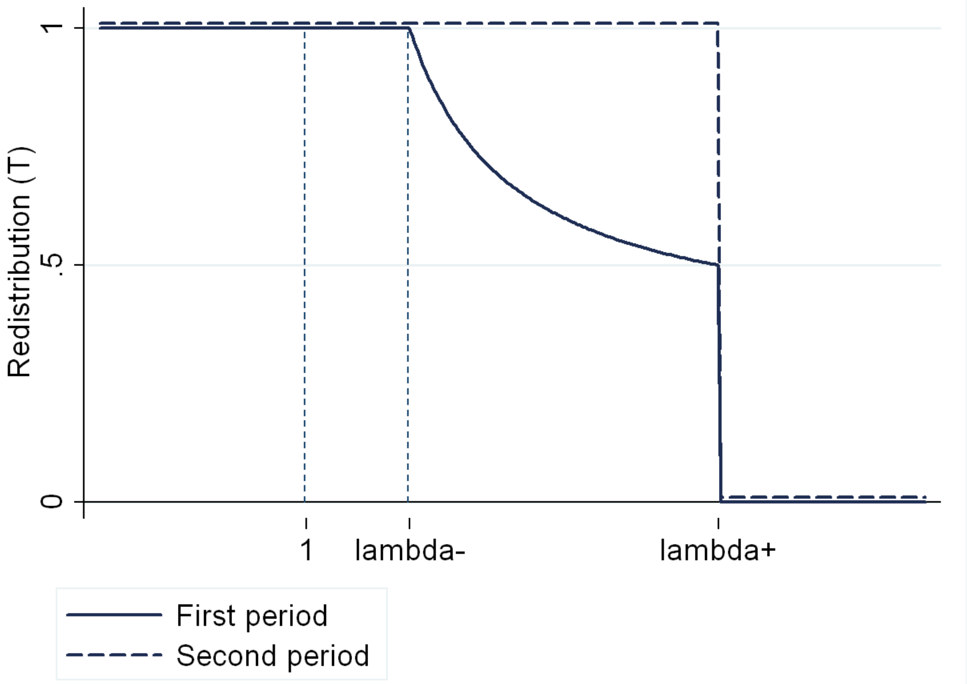

Figure II: Left panel: location of surveyed households. Right panel: potential exposure to the passage of typhoons (white: no category-1 typhoon between 1980 and 2004, red: at least 3 category-2 typhoons between 1980 and 2004) and 3 occurrences: Vicente (september 2005), Damrey (category 2, september 2005) and Chanthu (july 2004). Lines represent level sets for the wind.

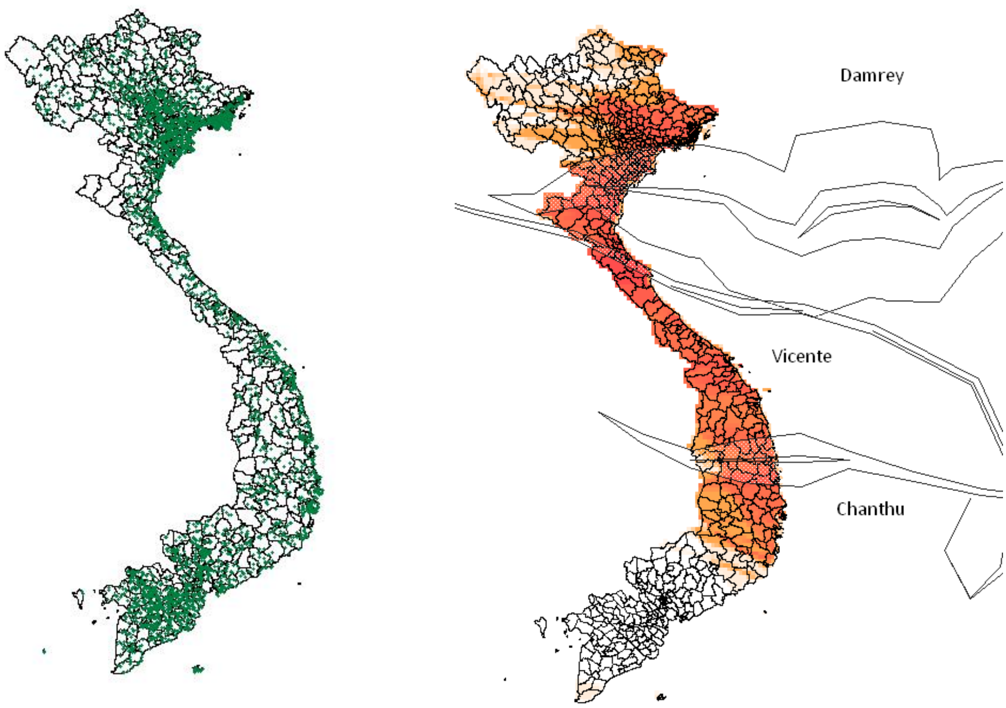

Figure III: Top: Energy dissipated by the 2005-wave and average dissipated energy as a function of latitude, bottom: growth of crops and aquaculture income relative to livestock and forestry between 2004 and 2006 as a function of latitude.

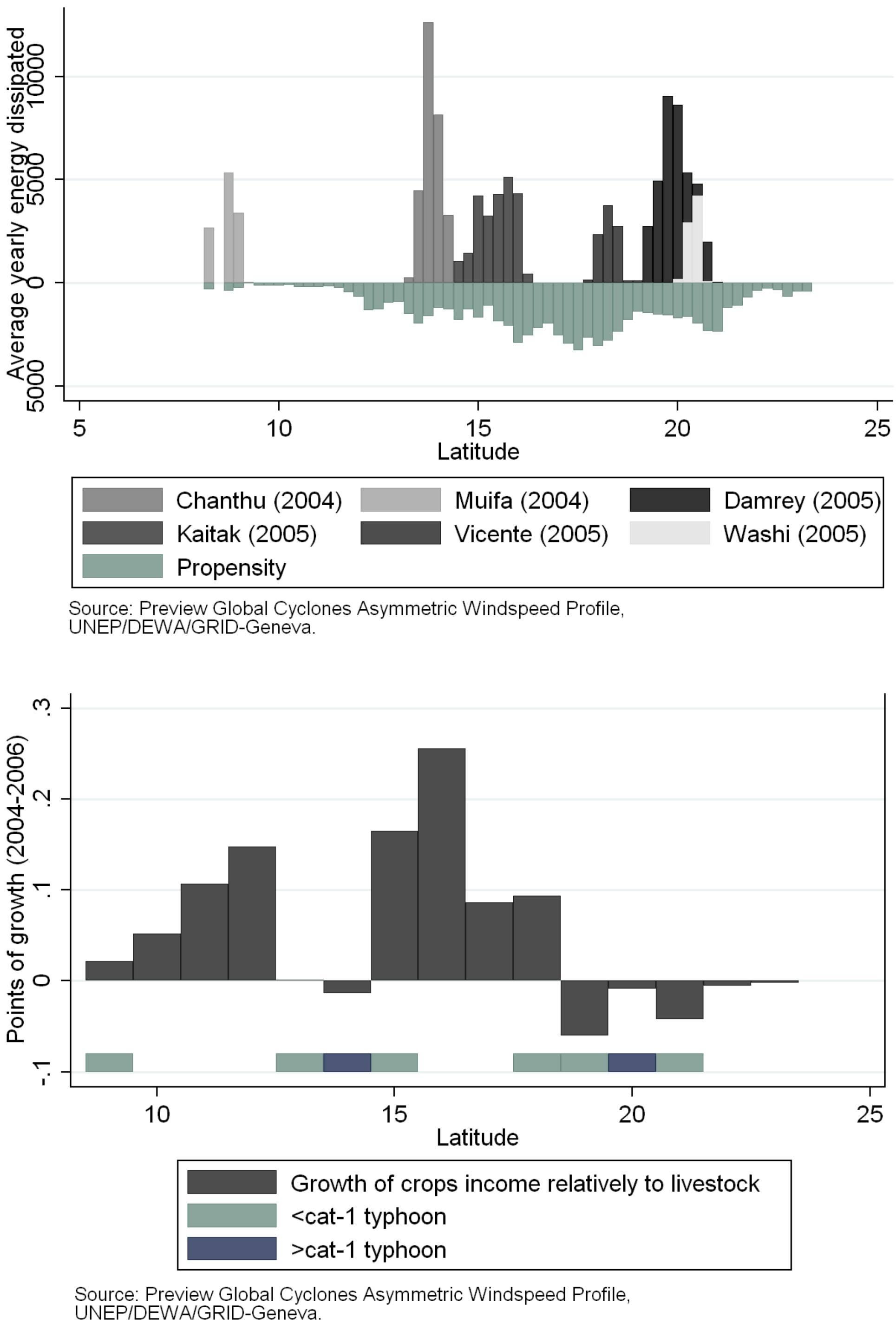

Figure IV: Distribution of vulnerability (defined as crops and aquaculture income deducted of forestry and livestock income in 2004) computed with the whole rural sample of households.

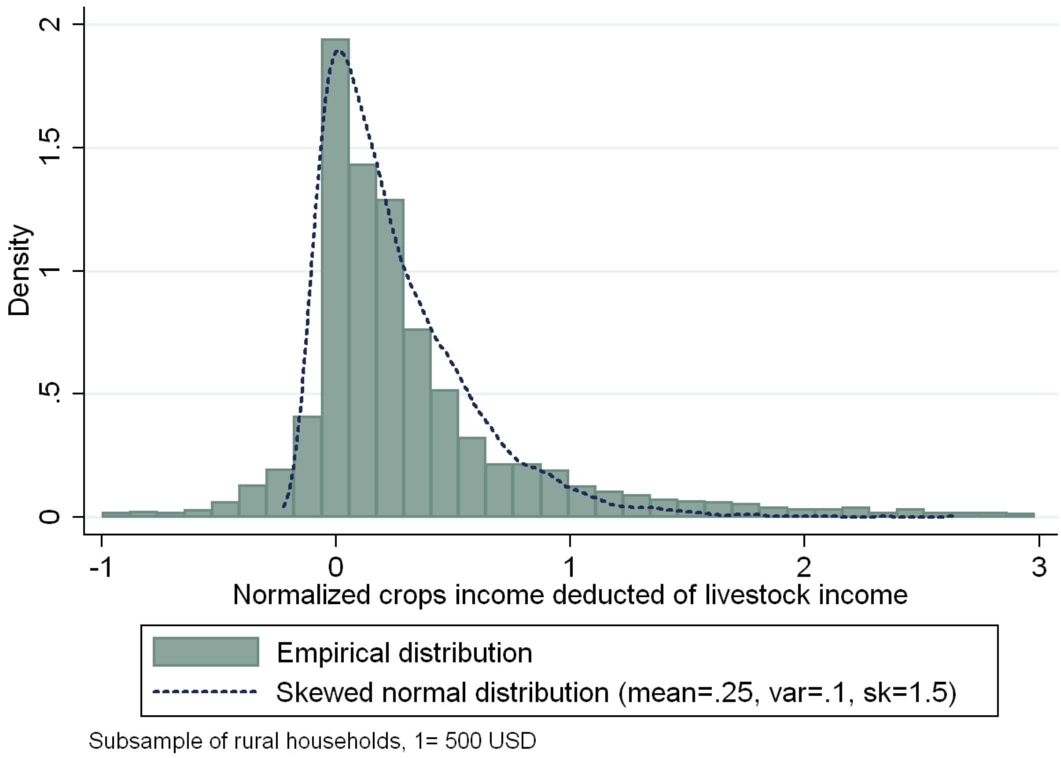

Figure V: Distribution of sk_1, sk_2, sk_4 computed at commune level in rural Vietnam.

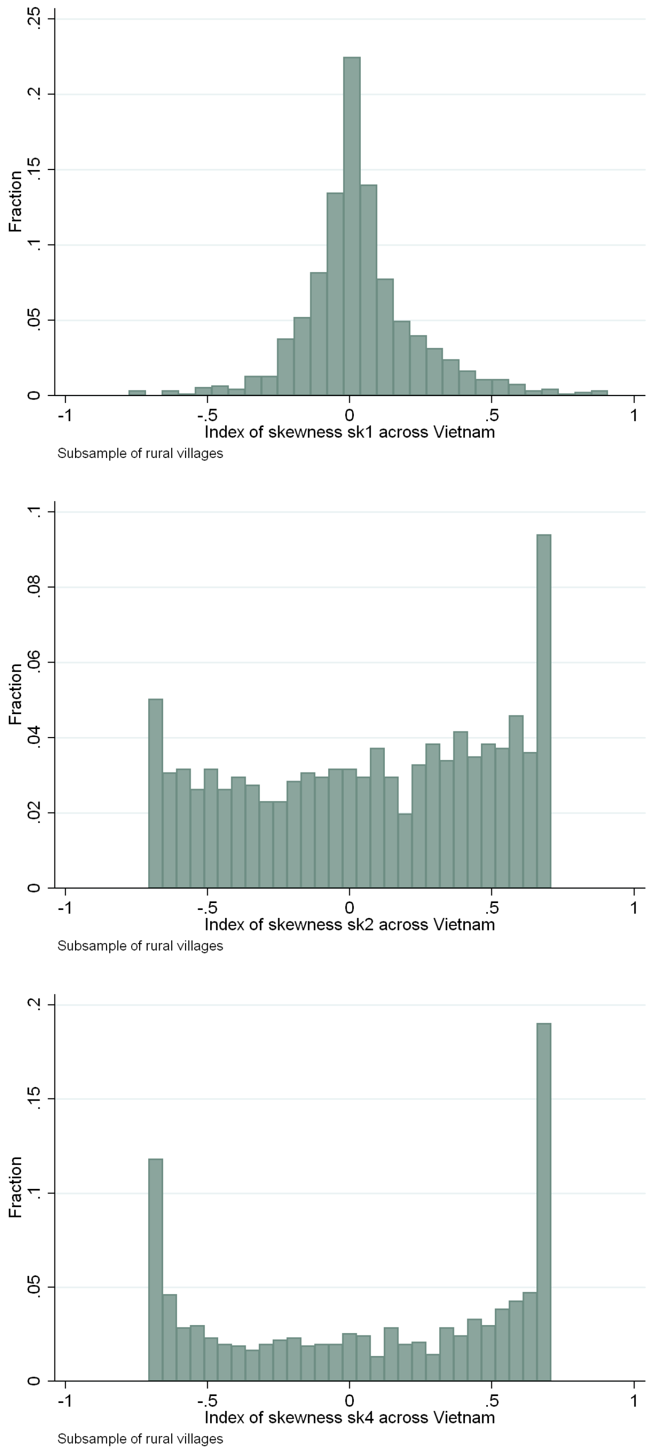

Figure VI: Differences between average exposure and exposure discounted with 5% and 10% annual discounts