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RESEARCH ARTICLE

Natural catastrophes and insurance in a developing economy: new theoretical and empirical evidence

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Abstract
We analyse the effect of natural catastrophes on insurance demand in a developing economy and the role of insurance regulation in this relationship. The analysis is based on a theoretical model and a panel regression using data for Vietnam. What makes Vietnam especially interesting is the fact that it is strongly affected by natural catastrophes and experienced a change in insurance regulation in recent years. The theoretical results indicate that a loss experience likely has a less positive effect on demand in developing economies than in developed economies. A higher insurance penetration and a tighter insurance regulation, however, can make the impact of a loss event more positive. These findings are mirrored by our empirical analysis: overall natural catastrophes decrease insurance demand of affected households in Vietnam. The enhancement of regulation was not only accompanied by increased insurance demand but it also reverses the effect of natural catastrophes on demand.

Key words: insurance demand; insurance regulation; natural catastrophes

JEL classification: G22; G52; Q54

1. Introduction

In this paper we assess the impact of a natural catastrophe on the demand for loss-based insurance in a developing economy and evaluate if this impact is changed by an enhancement of insurance regulation. Loss experiences from natural catastrophes affect insurance demand via several factors. Some of these factors increase demand and others dampen it. Hence, whether the net effect is positive or negative in an economy depends on which of the factors dominate.

On the one hand, the experience of a natural catastrophe might increase the subjective probability assessment of individuals and might therefore increase their willingness to pay for insurance. Botzen and van den Bergh (2012) argue that individuals follow a Bayesian updating when assessing flood probabilities in the Netherlands. As a result, if households have a prior probability distribution regarding flood risk, the experience

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of a flood event is expected to result in an elevated posterior probability distribution. According to Seifert *et al.* (2013), a higher frequency of natural catastrophes – whether due to residing in high-risk areas or as a consequence of climate change – leads to increased demand for corresponding insurance products, as individuals become more likely to experience such events. Moreover, following a natural catastrophe, if the insurer provides a payout, households may form a positive perception of insurance. Nshakira-Rukundo *et al.* (2021) suggest that such positive experiences with insurance payouts can further enhance demand for insurance products.

On the other hand, loss experiences from natural catastrophes might dampen the demand for insurance as losses can tighten households' budgets and therefore their ability to pay (Nshakira-Rukundo *et al.*, 2021; Seifert *et al.*, 2013). Losses might tighten budgets because they were not insured (i.e., the household is not insured against the specific risk or there is a high deductible) or because an insured loss is not compensated due to the insurer's unwillingness or inability to pay. Especially these uncompensated insured losses result in a negative experience with insurance and can damage the reputation of insurance providers. This creates an additional dampening effect on insurance demand. The net effect of a natural catastrophe on insurance demand might therefore be negative if uncovered losses are high.

Many developing economies are heavily exposed to natural catastrophes (Winsemius *et al.*, 2018). However, losses from natural catastrophes are often not insured in developing countries. This is reflected in a low insurance penetration. According to AXCO data, while people in high-income countries spend 0.6 per cent of their income on property insurance, people in low-income countries spend less than 0.3 per cent of their income on it.[1] Hence, the wealth effect of natural catastrophes is likely to be much stronger in developing than in developed countries and, therefore, the impact of natural catastrophes on insurance demand more negative.

Another important impact factor in the relationship between natural catastrophes and insurance demand could be institutional framework conditions like the tightness of insurance regulation which influence the non-performance risk of an insurance. This is also highlighted by Bah and Abila (2024). When households face the risk that their insurance company may not pay in the event of a loss, their trust in and demand for insurance products will significantly decrease (Clarke, 2016). This seems to have an impact especially on the demand for property insurance in developing countries (Kelikume and Otonne, 2022). A sub-pillar of the WEF's Global Competitive Index, which rates the institutions of each country, shows higher scores in high-income countries than in low-income ones. The higher non-performance risk in developing economies may reduce the impact of natural catastrophes on insurance demand, as more households face uncompensated losses and tighter budgets. In addition, if an insurer does not pay in a loss event, affected households will likely adjust their subjective assessment of the non-performance risk. Hence, we could also expect that an enhancement of insurance regulation increases the impact of natural catastrophes on insurance demand.

Our paper adds to the literature by analysing the effect of natural catastrophes on insurance demand in a typical developing economy and the specific role of insurance regulation in this relationship. To the best of our knowledge, this role of insurance regulation has not been analysed before. Furthermore, we base our analysis on a theoretical model as well as an empirical model.

[1] We assume a threshold between high- and low-income economies of a GNI per capita of US\$12, 736.

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The theoretical part models insurance demand of risk averse, expected utility maximizing households (e.g., Rothschild and Stiglitz, 1976). In a three-period model (similar to Gollier, 2003), households are subject to the risk of suffering a loss. They can buy insurance protection against this risk. However, the probability that the insurer pays in a loss event is below 100 per cent (like Doherty and Schlesinger, 1990 non-performance risk). This kind of non-performance risk can have different causes depending on the nature of the insurance product. The performance of index-based insurance products depends on the correlation between the used index and losses (e.g., Clarke, 2016; Hott and Regner, 2023). As a result, a household can suffer a loss but the index used in the insurance product does not trigger a corresponding payment. In this paper, however, we look at traditional loss-based insurance products (dominantly used in our focus country of Vietnam). Here the performance of the insurance depends on the willingness and the ability of the insurance provider to pay in a loss event (Nshakira-Rukundo *et al.*, 2021). Hence, the non-performance risk is influenced by the rule of law in a country and the default risk of insurance companies.

Furthermore, we assume that, depending on their loss experience, households adjust their subjective probability assessment regarding the loss event and the non-performance risk. This setting allows us to evaluate the impact of typical developing economy framework conditions on the relationship between loss events and insurance demand.

The results indicate that a loss event should have a different impact on insurance demand in a developed economy than in a developing economy. While in a developed economy the impact should be positive, in a developing economy with low insurance penetration and weaker consumer protection, a loss event is likely to have a negative impact on insurance demand. Our model also indicates that an enhancement of insurance regulation would make the impact of a loss event on insurance demand more positive.

Our empirical analysis focuses on Vietnam, a developing economy with low insurance penetration, heavily impacted by natural catastrophes, and subject to a change in insurance regulation in 2011. We conducted a robustness test using the difference-in-difference-in-differences method with Vietnam as the treatment group and Thailand as the control.

We use the Thailand Vietnam Socioeconomic Panel (TVSEP) for our empirical analysis. To the best of our knowledge, this household survey panel data has not yet been used to answer insurance questions. The dataset includes information on insurance consumption at the household level. This enables us to evaluate the impact of natural catastrophes on the property insurance demand of affected households and how this effect is influenced by the change in regulation. In Vietnam, property insurance is a traditional multi-peril policy with manual claims assessment, which covers natural catastrophes such as storms, floods and earthquakes. Therefore, in the analysis, we focus only on property insurance demand of households. We use both the total losses from natural disasters reported by households in the TVSEP survey and household-level natural disaster indicators constructed from spatial data on storms and tropical depressions.

Our empirical results indicate that, overall, natural catastrophes decrease insurance demand of affected households. The 2011 enhancement of insurance regulation was accompanied by increased insurance demand of the households within our panel. As predicted by our theoretical model, these developments reversed the effect of natural catastrophes on the property insurance demand of affected households.

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2. Theoretical model

We argue that natural catastrophes have two opposing effects on insurance demand: on the one hand, they increase demand since natural catastrophes become more salient to households and hence increase their subjective natural catastrophe probability. On the other hand, natural catastrophes lower insurance demand since uninsured losses tighten households' budget constraints. In order to capture these effects, our theoretical model has to consider the impact of a natural catastrophe experience on subjective probabilities and the impact of uninsured losses on wealth. Households which experience a loss event should have a higher insurance demand than other households if they receive a relatively high payment by the insurer (i.e., in countries with a high insurance penetration) and, hence, the income effect of the loss event is limited.

In addition, we want to analyse the effect of insurance regulation on the relationship between natural catastrophes and insurance demand. We assume that a tighter insurance regulation leads to a lower non-performance risk which implies that the probability of the insurance paying in a loss event increases. As a result, a higher percentage of households receive a payment after a loss event and have a positive experience with insurance. Hence, tighter insurance regulation should have a positive effect on the impact of a natural catastrophe on insurance demand.

2.1 Basic assumptions

There are many households which live for three periods and receive an income of 1 in each period. Households are exposed to a natural catastrophe risk which leads to the loss l, where $0 < l < 1$. We assume that households do not have the possibility to save but can insure the loss event in the next period, i.e., in the first period they insure potential losses in the intermediate period, and in the intermediate period they insure potential losses in the final period. For simplicity, however, we only analyse insurance demand in the intermediate period in which households' wealth and subjective probabilities are affected by their individual experiences. For the first period, we assume that each household insures the fraction α_0 of the loss in the intermediate period, where $0 < \alpha_0 \leq 1$.

In the intermediate and the last period, a fraction of households equal to the loss probability suffers a loss. However, there is a non-performance risk: households face the risk that their insurance company does not pay in a loss event. Hence, in this intermediate period, there are three groups of households: households with no loss (N), households with an insured loss (I) and households which suffer a loss but do not receive a payment by the insurance (L).

In the intermediate period, households have to decide which fraction α_i ($0 \leq \alpha_i \leq 1$ and $i = N, I, L$) of the potential loss in the next – and final – period they want to insure. Households are assumed to be risk averse (with a standard logarithmic utility function) and rational. However, we assume that they do not know whether the natural catastrophe probability is high or low and whether the non-performance risk is high or low. Since households are assumed to be rational, they use Bayesian updating to process new information and to update their probability assessment (see, e.g., Botzen and van den Bergh, 2012 or Dumm *et al.*, 2017). Hence, the decision about which fraction of the potential loss a household wants to insure depends not only on individual wealth (i.e., whether a household suffers a loss and whether the insurer pays) but also on the household's subjective probabilities.

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2.1.1 Probabilities

The natural catastrophe probability is assumed to be constant over time and the same for each household. However, households do not know whether this probability is high (π_x, where $0 < \pi_x < 0.5$) or low ($x\pi_x$, where $0 < x < 1$). If, for example, the high probability π_x is 0.25 and the parameter x is 0.40, the low probability would be 0.10.

Furthermore, we assume that the number of independent risks (regions in the case of natural catastrophes) is high enough that it is reasonable to assume that the fraction of households which suffers a loss is equal to the loss probability (i.e., π_x if the loss probability is high and $x\pi_x$ if the loss probability is low).

Also the probability that the insurance company pays in a loss event is assumed to be constant over time and the same for each household. However, households also do not know whether this probability is high (π_z, where $0.5 < \pi_z < 1$) or low ($z\pi_z$, where $0 < z < 1$). If, for example, the high probability π_z is 0.80 and the parameter z is 0.75, the low probability would be 0.60.

Furthermore, we assume that the number of independent risks (insurers in the case of non-performance risk) is high enough that it is reasonable to assume that the fraction of households which receive a payment from their insurer in the case of a loss is π_z if the probability of a payment is high and $z\pi_z$ if this probability is low.

2.1.2 Insurance premium

We assume that insurance supply is exogenous and given. For the premium p ($1 > p \geq \pi_x\pi_z$) households can insure as much as they want. Since the different probabilities do not change over time and across households, also the premium is unchanged over time and the same for all households.

The insurance premium equals the fair premium plus a mark-up. Since households can only observe the premium p, however, they do not know whether the premium is the result of a high fair premium and a low mark-up or the result of a low fair premium and a high mark-up. The actual mark-up can be between m_l or m_h, where $p = (1 + m_l)\pi_x\pi_z$ and $p = (1 + m_h)x\pi_x z\pi_z$. Since each of the combinations of mark-up and probabilities has to be equal to the observed p, we can write: $p = \lambda\pi_x\pi_z$, where $1/(\pi_x\pi_z) > \lambda \geq 1$.

Following our example above, if both probabilities are high, the fair premium would be $\pi_x\pi_z = 0.25 * 0.80 = 0.20$. If the probability for a natural catastrophe is high but the pay-out probability is low, it is $\pi_x z\pi_z = 0.25 * 0.60 = 0.15$, and if both probabilities are low, the fair premium is $x\pi_x z\pi_z = 0.10 * 0.60 = 0.06$. Households, however, can only observe the actual premium which is for example $p = 0.202$ (hence, $\lambda = 0.202/0.2 = 1.01$) and do not know whether the mark-up is low ($m_l = p/(\pi_x\pi_z) - 1 = 0.01$), medium ($p/(\pi_x z\pi_z) - 1 \approx 0.35$) or high ($m_h = p/(x\pi_x z\pi_z) - 1 \approx 2.35$).

2.1.3 Individual wealth

In the intermediate period, each household receives an income of 1. However, the available wealth W_i of household i depends on whether it suffers a loss l and on whether this loss leads to the payment $\alpha_0\, l$ by the insurance company:

- The fraction $1 - \pi_x$ (if true loss probability is high) or $1 - x\pi_x$ (if true probability is low), respectively, of all households does not suffer a loss and therefore has $W_N = 1$.
- A fraction equal to the true loss probability (i.e., π_x or $x\pi_x$) multiplied by the true payout probability (i.e., π_z or $z\pi_z$) suffers a loss l and receives the payment $\alpha_0\, l$. The available income of such a household is therefore $W_I = 1 - l(1 - \alpha_0)$. If the

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loss is $l = 0.5$ and the initial insurance of this loss is $\alpha_0 = 0.5$, this available income is $W_I = 0.75$.
- A fraction equal to the true loss probability (i.e., π_x or $x\pi_x$) multiplied by one minus the true payout probability (i.e., $1 - \pi_z$ or $1 - z\pi_z$) suffers a loss l but does not receive payment by the insurance company. The available income of such a household is therefore $W_L = 1 - l$. If the loss is $l = 0.5$, this available income is $W_I = 0.5$.

Households spend their wealth on consumption and insurance for the final period $p\alpha_i l$.

In the final period, each household receives an income of 1. Independent of the experience in the intermediate period, in the final period a fraction equal to one minus the true loss probability of the households does not suffer a loss, a fraction equal to the true loss probability multiplied with the true payout probability suffers a loss l and receives the payment $\alpha_i l$ and a fraction equal to the true loss probability multiplied by one minus the true payout probability suffers a loss l but does not receive a payment. The remaining wealth is used for consumption.

2.1.4 Subjective probabilities

The probability for a natural catastrophe and hence the probability for a loss is the same for each household. However, households do not know whether this probability is π_x or only $x\pi_x$. The a priori probability for each loss probability is 50 per cent. Depending on their individual loss experience, households re-estimate their subjective loss probability using Bayesian updating.

In the intermediate period, households which do not suffer a loss (households N) update their subjective loss probability π_{xN} to:

$$\begin{aligned}\pi_{xN} &= \frac{(1-\pi_x)}{(1-\pi_x)+(1-x\pi_x)}\pi_x + \frac{(1-x\pi_x)}{(1-\pi_x)+(1-x\pi_x)}x\pi_x \\ &= \frac{(1-\pi_x)+x(1-x\pi_x)}{(1-\pi_x)+(1-x\pi_x)}\pi_x. \end{aligned} \tag{1}$$

The updated subjective loss probability of households which suffer a loss is given by:

$$\pi_{xI} = \pi_{xL} = \frac{\pi_x}{\pi_x + x\pi_x}\pi_x + \frac{x\pi_x}{\pi_x + x\pi_x}x\pi_x = \frac{1+x^2}{1+x}\pi_x. \tag{2}$$

Hence, $\pi_{xN} < \pi_{xI} = \pi_{xL}$. If we look at our example above with $\pi_x = 0.25$ and $x = 0.4$, the subjective probabilities are $\pi_{xN} \approx 0.168$ and $\pi_{xI} = \pi_{xL} \approx 0.207$.

In addition to the loss probability, households have to assess the probability that the insurer pays in a loss event. Households do not know whether the probability is π_z or only $z\pi_z$. The a priori probability for the high probability π_z is 50 per cent. Again, depending on their individual loss experience, households re-estimate their subjective probabilities using Bayesian updating. However, households which do not suffer a loss (households N) do not have any experience regarding the non-performance risk. Their subjective probability is therefore given by:

$$\pi_{zN} = \frac{1+z}{2}\pi_z. \tag{3}$$

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The subjective probability π_{zI} of households which suffer a loss and receive a payment from the insurer is given by:

$$\pi_{zI} = \frac{1+z^2}{1+z}\pi_z. \tag{4}$$

The subjective probability π_{zL} of households which suffer a loss but do not receive a payment from their insurer is given by:

$$\pi_{zL} = \frac{(1-\pi_z)+z(1-z\pi_x)}{(1-\pi_z)+(1-z\pi_z)}\pi_z. \tag{5}$$

Hence, $\pi_{zL} < \pi_{zN} < \pi_{zI}$. If we look at our example above with $\pi_z = 0.8$ and $z = 0.75$, the subjective probabilities are $\pi_{zL} \approx 0.667$, $\pi_{zN} \approx 0.700$ and $\pi_{zI} \approx 0.714$.

2.2 Optimal insurance demand

We look at the insurance demand of the different households in the intermediate period. We assume that households maximize expected utility from consumption in the present (intermediate) and next (final) period by choosing an optimal degree of insurance α_i. As described above, consumption in the intermediate period is given by the individual wealth W_i minus expenditures for insurance $p\alpha_i l$. Household i assumes that in the final period, with probability $1-\pi_{xi}$ consumption is 1 (no loss), with probability $\pi_{xi}\pi_{zi}$ consumption is $1-l(1-\alpha_i)$ (insured loss) and with probability $\pi_{xi}(1-\pi_{zi})$ it is $1-l$ (loss without payment by insurer).

We further assume that households have a standard logarithmic utility function and, for simplicity, we value utility in the next period equally to utility in the present period (discount factor one). Hence, the expected utilities of households N, I and L are:

$$\begin{aligned} EU_N = {} & \ln\left[1-p\alpha_N l\right] + (1-\pi_{xN})\ln[1] \\ & + \pi_{xN}\pi_{zN}\ln[1-l(1-\alpha_N)] + \pi_{xN}(1-\pi_{zN})\ln[1-l], \end{aligned} \tag{6}$$

$$\begin{aligned} EU_I = {} & \ln\left[1-l(1-\alpha_0)-p\alpha_I l\right] + (1-\pi_{xI})\ln[1] \\ & + \pi_{xI}\pi_{zI}\ln[1-l(1-\alpha_I)] + \pi_{xI}(1-\pi_{zI})\ln[1-l], \end{aligned} \tag{7}$$

and

$$\begin{aligned} EU_L = {} & \ln\left[1-l-p\alpha_L l\right] + (1-\pi_{xI})\ln[1] \\ & + \pi_{xI}\pi_{zI}\ln[1-l(1-\alpha_L)] + \pi_{xI}(1-\pi_{zI})\ln[1-l]. \end{aligned} \tag{8}$$

Households maximize their expected utility. Since they are risk averse and have a decreasing marginal utility from consumption, households not only want a high consumption but also want a consumption which does not differ too much across possible outcomes and across time. In our model, purchasing insurance is the only way to transfer wealth across time: households lower their consumption in the intermediate period by purchasing insurance and thereby increase consumption under specific circumstances in the final period. Following equation (8), however, in the intermediate period the maximum possible consumption of households L (i.e., no insurance demand: $\alpha_L = 0$) is equal to the minimal possible consumption in the final period $(1-l)$. Hence, households L will

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not transfer any wealth from the intermediate period to the final period and therefore they will not purchase any insurance.

Optimization leads to the following insurance demand α_N, α_I and α_L:

$$\alpha_N = \frac{\pi_{xN}\pi_{zN} - p(1-l)}{pl(1+\pi_{xN}\pi_{zN})} = \frac{\frac{(1-\pi_x)+x(1-x\pi_x)}{(1-\pi_x)+(1-x\pi_x)}\frac{1+z}{2} - \lambda(1-l)}{\lambda l(1+\pi_{xN}\pi_{zN})}, \tag{9}$$

$$\alpha_I = \frac{\pi_{xI}\pi_{zI}(1-l(1-\alpha_0)) - p(1-l)}{pl(1+\pi_{xI}\pi_{zI})} = \frac{\frac{1+x^2}{1+x}\frac{1+z^2}{1+z}(1-l(1-\alpha_0)) - \lambda(1-l)}{\lambda l(1+\pi_{xI}\pi_{zI})}, \tag{10}$$

and

$$\alpha_L = \max\left[0; \frac{\pi_{xL}\pi_{zL}(1-l) - p(1-l)}{pl(1+\pi_{xL}\pi_{zL})}\right] = \max\left[0; \frac{\left[\frac{1+x^2}{1+x}\frac{(1-\pi_z)+z(1-z\pi_x)}{(1-\pi_z)+(1-z\pi_z)} - \lambda\right](1-l)}{\lambda l(1+\pi_{xL}\pi_{zL})}\right]. \tag{11}$$

The initial degree of insurance α_0 has a positive effect on the insurance demand of households with an insured loss (I) but no effect on the decision of the other households.

The premium parameter λ has a negative effect on α_N and α_I. Since $\lambda \geq 1$ and since α_i is restricted to non-negative values, the optimal insurance demand of a households L is $\alpha_L = 0$. This confirms our reasoning above.

The probability π_z has a negative effect on the insurance demand of a household with no loss and a household with an insured loss. The effects are given by:

$$\frac{\partial\alpha_N}{\partial\pi_z} = -\frac{\left[\frac{(1-\pi_x)+x(1-x\pi_x)}{(1-\pi_x)+(1-x\pi_x)}\frac{1+z}{2} - \lambda(1-l)\right]\pi_{xN}\frac{1+z}{2}}{\lambda l(1+\pi_{xN}\pi_{zN})^2} = -\frac{\alpha_N}{\pi_z}\frac{\pi_{xN}\pi_{zN}}{1+\pi_{xN}\pi_{zN}} \tag{12}$$

and

$$\frac{\partial\alpha_I}{\partial\pi_z} = -\frac{\alpha_I}{\pi_z}\frac{\pi_{xI}\pi_{zI}}{1+\pi_{xI}\pi_{zI}}. \tag{13}$$

Following the example above ($\pi_x = 0.25$, $x = 0.4$, $z = 0.75$, $l = 0.5$, $p = 0.202$ and $\alpha_0 = 0.5$), when $\pi_z = 0.8$ the demand of households N is $\alpha_N = 0.1482$ and the demand of households I is $\alpha_I = 0.0860$. If the probability that the insurer pays in a loss event increases to $\pi_z = 0.95$, the individual insurance demand decreases to $\alpha_N = 0.1453$ and $\alpha_I = 0.0840$. However, since in both cases the demand of households L is $\alpha_L = 0$ and the fraction of households I increases, the overall demand can nevertheless increase. Using the above combination of parameters, the overall demand $(1-\pi_x)\alpha_N + \pi_x\pi_z\alpha_I$ increases from 0.1283 to 0.1289.

2.3 Effect of natural catastrophes on insurance demand

This section evaluates the effect of natural catastrophes on insurance demand. Hence, we are interested in the question: Under which conditions do households which experienced a loss event (natural catastrophe) have a higher insurance demand than households with no loss event? The insurance demand of a household with no loss event is given by α_N. However, the insurance demand of a household which is affected depends on whether the loss event is covered by the insurance or not. If the true payout probability is high, the fraction π_z of the affected household has the insurance demand α_I and the fraction $1-\pi_z$ has no insurance demand $\alpha_L = 0$. Therefore, overall, the experience of a loss event has a positive effect on insurance demand if:

$$\pi_z \alpha_I > \alpha_N. \tag{14}$$

If the true payout probability is low, the fractions would be $z\pi_z$ (α_I) and $1 - z\pi_z$ ($\alpha_L = 0$) and the condition for a positive effect of a natural catastrophe on insurance demand would be:

$$z\pi_z \alpha_I > \alpha_N. \tag{15}$$

Hence, a loss event more likely has a positive effect on insurance demand if the true payout probability is high. As mentioned above, the initial degree of insurance α_0 has a positive effect on α_I but no effect on α_N. Hence, α_0 has a positive effect on the relationship between natural catastrophes and insurance demand and we can expect that the impact of a natural catastrophe on insurance demand is more positive in a country with a higher insurance penetration.

The probability π_z has a positive effect on the impact of a loss event on insurance demand as it increases the fraction of I households. However, π_z also has a negative effect on the individual insurance demand α_I and α_N.[2] Hence, if the true payout probability is high, the overall effect of π_z would be positive if:

$$\alpha_I + \pi_z \frac{\partial \alpha_I}{\partial \pi_z} > \frac{\partial \alpha_N}{\partial \pi_z}. \tag{16}$$

Given equations (12) and (13), condition (16) can be written as:

$$\alpha_I \frac{1}{1 + \pi_{xI}\pi_{zI}} > -\frac{1}{\pi_z}\alpha_N \frac{\pi_{xN}\pi_{zN}}{1 + \pi_{xN}\pi_{zN}}. \tag{17}$$

If the true payout probability is low, this condition would be:

$$z\alpha_I \frac{1}{1 + \pi_{xI}\pi_{zI}} > -\frac{1}{\pi_z}\alpha_N \frac{\pi_{xN}\pi_{zN}}{1 + \pi_{xN}\pi_{zN}}. \tag{18}$$

For both cases (i.e., true payout probability is high or low) the left-hand side is positive and the right-hand side negative. Hence, the conditions are always fulfilled. Therefore, we can expect that the impact of a natural catastrophe on insurance demand is more positive in a country with a low non-performance risk (i.e., a high π_z and therefore high $z\pi_z$). This also implies that a tightening of insurance regulation which lowers non-performance risk would make the impact of a loss event on insurance demand more positive.

As shown in the previous section, if $\pi_z = 0.8$, the example used of parameter values ($\pi_x = 0.25$, $x = 0.4$, $z = 0.75$, $l = 0.5$, $p = 0.202$ and $\alpha_0 = 0.5$) result in $\alpha_N = 0.1482$ and $\alpha_I = 0.0860$. As a result, $\pi_z\alpha_I - \alpha_N = -0.079$. This implies that the experience of a loss event has a negative effect on insurance demand. If the probability that the insurer pays in a loss event increases to $\pi_z = 0.95$, the effect of a loss event would still be negative,

[2] See equations (12) and (13).

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but to a smaller extent ($\pi_z\alpha_I - \alpha_N = -0.066$). A higher α_0 would also have a positive effect on the impact of a loss event on insurance demand. If $\alpha_0 = 0.63$, the impact of a loss event would change from a negative $\pi_z\alpha_I - \alpha_N = -0.013$ (using $\pi_z = 0.8$) to a positive $\pi_z\alpha_I - \alpha_N = 0.011$ (using $\pi_z = 0.95$).

3. Natural catastrophes and insurance in Vietnam

3.1 Natural catastrophes in Vietnam

While Vietnam has not experienced large-scale earthquakes and considerable earthquake damages (Hung *et al.*, 2009), tropical cyclones and floods are the most common natural hazards. Vietnam is ranked as one of the five storm-prone areas of the Asia Pacific region because the country is located in the tropical monsoon area and has a long coastline. On average, Vietnam was hit directly by six to ten storms and tropical depressions annually, which affected up to 90 per cent of the population in Vietnam (Razafindrabe *et al.*, 2014).

Floods in Vietnam are caused mainly by high tides and heavy rain, which come from storms and tropical depressions (Mu *et al.*, 2021; Razafindrabe *et al.*, 2014). The severe floods in most provinces in central Vietnam in the past were caused by torrential rain from tropical cyclones (Ho and Umitsu, 2011).[3] In the upstream area, torrential rainfall caused by tropical cyclones can rapidly accumulate as floodwaters in the steep gorges, which then travel fast downstream, causing severe floods. In low-lying areas, the extreme amount of rainfall during storms converges quickly and eventually exceeds the drainage capacity of the drainage network, which causes downstream flooding (Mu *et al.*, 2021). In the coastal plains, floods are additionally formed by the increase in the sea's surface water level caused by storm surges and powerful winds during storms.

This paper focuses on the effect of storms and tropical depressions on property insurance demand because these events are Vietnam's most dominant natural disasters and floods primarily caused by the heavy rainfall they generate (Ho and Umitsu, 2011; Razafindrabe *et al.*, 2014; Mu *et al.*, 2021). We also examine total losses from natural disasters, including storms, floods, landslides, and droughts, as reported by households. This broader measure captures both frequent and rare events. By including this variable, we test the stability of our findings under a more comprehensive definition of natural disasters, ensuring robustness even when accounting for smaller-scale or infrequent events.

3.2 Property insurance in Vietnam

In Vietnam, property insurance is one of the largest product lines in the non-life insurance sector. This insurance is a traditional multi-peril policy with manual claims assessment. It covers natural disasters such as storms, floods, earthquakes, and other perils such as fire, explosion, and collision.

Although Vietnam has suffered significantly from storms and floods, there has not been a specific catastrophe-related property insurance product on the market, such as flood insurance, which is relatively popular in developed countries. At the end of 2022, the first Weather Index Insurance was launched in Vietnam to protect rice farmers against irregular rainfall distribution.

[3]The rainfall in the rainy season also causes floods in Vietnam. However, this phenomenon has longer lag times than the extreme rain caused by tropical cyclones.

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In the event of property damage, the property insurance claims process in Vietnam is characterized by prolonged duration due to various procedural and administrative factors. The policyholder must notify the insurance company and submit the claim request along with the adjuster's inspection report, a report from the relevant authorities, a list of damages, and supporting evidence. The insurance provider will then investigate the claim and review it to determine the compensation.

When households face the risk that their insurance company may not pay in the event of a loss, their trust in and demand for insurance products will significantly decrease (Clarke, 2016). This non-performance risk can have a significant negative impact on the demand for property insurance in developing countries (Kelikume and Otonne, 2022). However, regulatory quality has a positive effect on non-life insurance demand (Bah and Abila, 2024). In the case of Vietnam, the Policyholder Protection Fund was established to provide financial protection for policyholders in the event of an insurance company's bankruptcy or illiquidity. Moreover, organizations and individuals funding insurance enterprises must demonstrate sufficient financial capacity and provide proof of legal funding sources. Therefore, it is reasonable to assume that tighter insurance regulation leads to lower risk of contract non-performance in Vietnam.

3.3 Insurance regulation in Vietnam

Insurance was officially recognized as a business in Vietnam through Decree No. 100/CP, issued on December 18, 1993. Subsequently, the Insurance Business Law (Law No. 24/2000/QH10) was introduced on December 9, 2000, marking a foundational step in establishing a legal framework for Vietnam's insurance market. On October 24, 2010, the Vietnamese government adopted Law No. 61/2010/QH12, which came into effect on July 1, 2011. This law amended several articles of the Insurance Business Law of 2000, improving insurance regulation and significantly increasing insurance penetration.

According to macro data from Axco, written premiums for property insurance jumped from an average of 0.07 per cent of GDP in the period from 2004 to 2010 to an average of 0.21 per cent in the period from 2011 to 2017. To the best of our knowledge, the change in insurance regulation was the only event in 2011 besides the economic growth that could have explained the development of the Vietnamese insurance market.[4]

This law imposed stricter regulations and enhanced supervision of insurance companies. First, the certification process for agents was significantly tightened. Agencies must now obtain certificates from training institutions approved by the Ministry of Finance, which also supervises the program, content, training format, and certification. Second, insurance companies and brokers must establish a mandatory reserve fund to supplement their charter capital and ensure their solvency in cash. This fund must be deducted annually at 5 per cent of after-tax profits, with a maximum limit set by the government. Third, the government has strengthened oversight of insurance operations to ensure insurance companies meet financial requirements and fulfill their obligations to policyholders. Fourth, a Policyholder Protection Fund was also established to protect policyholders in the event of an insurance company's bankruptcy or illiquidity. Since property insurance in Vietnam is a traditional multi-peril policy with manual claims

[4]We examined carefully other factors that could be possible explanations for the increase in the written premiums, such as cultural factors (Trinh *et al.*, 2020), economic freedom (Trinh *et al.*, 2016), economic growth, and financial development (Cavalcante *et al.*, 2018).

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assessment, these measures are expected to reduce the risk of contract non-performance (i.e., a higher π_z).

4. Data

4.1 Household data

The TVSEP[5] is a repeated household survey for Thailand and Vietnam. The data was collected in three provinces of Thailand (Nakhon Phanom, Ubon Ratchathani, Buriram) and three provinces of Vietnam (Ha Tinh, Thua Thien Hue, Dak Lak). Figure A1 in the online appendix shows the location of these provinces. Three provinces of Thailand are inland, while Ha Tinh and Thua Thien Hue are coastal, and Dak Lak is located near the coast. The survey was conducted in 2007, 2008, 2010, 2013, 2016, 2017, 2019 (only Thailand), and 2022 (three provinces of Thailand and two provinces of Vietnam). In each wave, around 2,200 households in each country were asked about demographics, occupation, income, insurance, shocks, and other issues.

Our empirical analysis investigates the effect of natural disasters on property insurance demand and the impact of the improvement in insurance regulation in 2011 in Vietnam on this effect. Therefore, first, we focus on data from Vietnam and we are interested in the data close to this change. We constructed a two-year panel dataset from the waves in 2010 and 2013. The reference period for the 2010 survey is from May 2009 to April 2010, while the 2013 survey covered April 2012 to March 2013. Using data in waves 2010 and 2013 helps us observe the effect in the short periods before and after the enhancement of insurance regulation. A problem with using many time periods is that important factors might have changed over time, which we cannot control for. Introducing time fixed effects in panel regression could address this but may mask the regulatory change's impact and there is perfect multicollinearity among time fixed effects and insurance regulation. Thus, estimating the model with the two-wave panel dataset is reasonable.

Second, we constructed a five-year panel dataset from the surveys in 2008, 2010, 2013, 2016, and 2017 in Vietnam. We also use data from the first wave (in 2007) to construct a variable indicating whether a household had property insurance in the previous wave. Since there is no prior data point for this variable, the 2007 data is automatically excluded from the regressions. Moreover, in 2022, only 1 200 households in two provinces of Vietnam were surveyed. This change in sample composition may introduce potential biases. Additionally, there is an eleven-year gap between the change in the Insurance Business Law in 2011 and the survey this year, as well as a five-year gap since the previous wave in 2017, which is the longest gap in the survey's history. By excluding data in 2022, we ensure that our analysis is based on a consistent set of provinces.

Third, to identify the causal effect using the difference-in-difference-in-differences approach, we constructed a five-year panel dataset, based on survey data from 2008, 2010, 2013, 2016, and 2017 in Vietnam and Thailand. Since the change in Insurance Business Law occurred in Vietnam, households in Vietnam are in the treatment group and households in Thailand are in the control group.

As our dependent variable, we construct a dummy variable that signals whether a household has property insurance or not. This variable takes the value of one if a household declares that it maintains property insurance at the moment and zero otherwise. We

[5]The TVSEP is a research project financed by the Deutsche Forschungsgemeinschaft. For details, visit https://www.tvsep.de/en/.

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call this variable "Household has property insurance".[6] Table A4 in the online appendix shows that in Vietnam, 367 households had property insurance in 2008. By 2010, this number had dropped to 254, but by 2013, it tripled to 788. The number continued to increase to 1,112 in 2016 before falling to 796 in 2017. In contrast to Vietnam, the number of insured households in Thailand is significantly lower, with only about 10 to 30 insured households.

As right-hand side variables, we have household size, and household head characteristics such as age, gender, education (household head completed high school or not), and farmer (household head is farmer or not). Since most of these variables do not show much variation over time, in the estimations using data in 2010 and 2013, they are already covered by household fixed effects. However, in the estimations using a five-year panel dataset, we control for these variables.

We also control for total income measured in 2005 US$ in PPP-adjusted because after the 2008–2009 global crisis, Vietnam's GDP growth dropped from 6.4 per cent in 2010 to 5.2 per cent in 2012, then steadily recovered from 2013.[7][8] According to our theoretical model, insurance demand should be positively related to household income (Browne and Hoyt, 2000; Trinh *et al.*, 2016; Cavalcante *et al.*, 2018).

We also aim to investigate the role of insurance regulation in the relationship between natural disasters and insurance demand, which to the best of our knowledge, has not been examined yet. Therefore, we add the change in insurance regulation in Vietnam in 2011 as an explanatory variable in the model. The regulation is a dummy variable that takes the value of one if the year is after 2011 and zero otherwise.

Moreover, whether the household had property insurance in the previous wave is also included in the regression. This is a dummy variable that takes the value of one if a household had property insurance in the previous wave and zero otherwise. If a household was insured in the previous period and continues to be insured now, we would expect a positive relationship. However, as we control for household fixed effects in our analysis, this dummy variable captures only the effects of changes over time in insurance status – for instance, the transition from having property insurance to not having property insurance, or vice versa. Therefore, the estimated effect of the variable "Had property insurance in previous wave" on being insured now has to be negative.

4.2 Total losses caused by natural catastrophes

The TVSEP data also provides self-reported losses of income and losses of assets due to shocks, such as natural disasters. This information captures the losses that households experienced from the months following the end of the reference period of the previous

[6]There is information about the insurance premium in the dataset. However, this information cannot be used because the time reference for the premium in wave 2010 is different from wave 2013.

[7]Total income was calculated as revenue minus costs. Some agricultural households show negative income due to high production costs.

[8]We check for outliers with regard to household income as they may distort the estimation results. We exclude two households with total incomes of US$487, 127 and US$342, 184.8 in PPP-adjusted, respectively, because they are clearly outliers. Our analysis is based on a two-year panel dataset with 4,108 observations and a five-year panel dataset with 10,045 observations. Another method to identify outliers is the mean plus or minus three standard deviations approach (Howell, 1998), which indicates that 99.87 per cent of the normal distribution data would appear within this interval. The estimation results based on the dataset excluding outliers based on this method also remain qualitatively and quantitatively unchanged. These results are available on request.

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wave to the end of the reference period of the current survey. For example, the variable in the surveys 2010 indicates the total losses caused by natural disasters from May 2008 to April 2010.

We conducted variable total losses, which is the sum of losses of income and losses of assets due to natural disasters such as storms, floods, landslides, and droughts. This indicator captures not only the losses from extreme events but also those from smaller events that households experienced. According to our theoretical model, since Vietnam is a typical developing economy, the effect of total losses on insurance demand is likely negative. However, this effect should become positive after the change in regulation.

4.3 Tropical cyclone data

According to the World Meteorological Organization, tropical cyclones are characterized by strong wind, torrential rain, and high waves, damaging infrastructure and outside objects. Tropical cyclones are called tropical depressions if their maximum sustained surface wind reaches 33 knots (38 mph or 61 km/h) or less. Whenever their maximum sustained wind is more than 33 knots, they are called tropical storms (Berlemann, 2016).

We apply the International Best Track Archive for Climate Stewardship (IBTrACS version 04) dataset of tropical cyclones, collected by the NOAA National Centers for Environmental Information (Knapp *et al.*, 2010).[9] It provides information on the tropical cyclones' geographic coordinates, time, and maximal wind speed at six-hourly intervals.

This paper combines the IBTrACS data from 2007 to 2017 with TVSEP survey data from 2008 to 2017. We track tropical depressions and storms during the reference periods of the surveys. We construct the event's trajectory and create a 50 km distance buffer around the trajectory.[10] We merge the TVSEP data with the storm data using a shapefile containing the commune borders of Vietnam.[11] As a result, we can identify the households that were located within the 50 km distance from the tropical cyclones' eyes. These households are more likely to be heavily affected by the storm.

We then construct each household's natural disaster indicators following Berlemann and Tran (2021). The first one is the frequency of tropical cyclones, denoted by "Frequency". This variable counts the number of events that occurred in the commune where the household resides during the reference period. The second variable is the severity of the events, denoted by "Severity". This severity indicator is created by summing the average maximum wind speeds of six-hourly intervals of each storm or tropical depression, which affected the commune of residence during the reference period. According to our theoretical model, since Vietnam is a typical developing economy, the effect of these natural disasters on insurance demand is likely negative. However, the impact should become more positive after the change in regulation.

The descriptive statistics for all variables for each wave in Vietnam are in table A1. The descriptive statistics for Vietnam and Thailand in each wave, using a balanced panel, are in table A2. Both these tables are presented in the online appendix.

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[9] For details, visit https://www.ncei.noaa.gov/products/international-best-track-archive.

[10] According to Hsu and Yan (1998), from data of 59 hurricanes from 1983 to 1979 that hit the US coastline, 90 per cent of them fall into categories 2 and 4 and their radius of maximum wind mean is around 48 km with a standard deviation of 3 km.

[11] The shapefiles were downloaded from https://gadm.org on 06.05.2018.

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5. Empirical estimation

5.1 Panel regression approach

We are interested in the impact of natural disasters on property insurance demand and the role of the change in the insurance regulation in this relationship in Vietnam. The left-hand side variable ($B_{i,t}$) is a dummy variable that takes the value one if household i has property insurance in year t and zero otherwise. As $B_{i,t}$ is binary, we can estimate logistic regression or a linear probability model. Usually the signs of the coefficients will be the same across the two estimators and marginal effects are likely to be quantitatively similar. According to Hellevik (2009), a linear regression is preferable in social science because it is easier to interpret and communicate the estimation results. Therefore, we apply a linear probability model in panel data as the main estimation.

The estimation equation is as follows:

$$B_{i,t} = \alpha_i + \theta \cdot S_{i,t} + \delta \cdot R_t + \gamma S_{i,t} * R_t + \beta \cdot X_{i,t} + \epsilon_{i,t}, \tag{19}$$

where $B_{i,t}$ is the binary variable indicating whether household i in year t has property insurance, $S_{i,t}$ is the tropical cyclone measurement (Frequency/ Severity) or total losses caused by natural disasters, R_t is the regulation change, $X_{i,t}$ is the household characteristics and $\epsilon_{i,t}$ denotes the unexplained residual. The model estimates the parameters including: α_i the household fixed effects, θ the impact of natural disasters on property insurance demand, δ the effect of regulation improvement, γ the impact of the interaction between natural disasters and regulation change on having property insurance, and β the effect of household characteristics.

First, we estimate equation (19) using data in 2010 and 2013 in Vietnam because they are the closest surveys before and after the change in insurance regulation. A problem with using many time periods is that important factors might have changed over time, which we can not control for. Introducing time fixed effects in panel regression could address this; however, they may mask regulatory change impacts and exhibit perfect multicollinearity with insurance regulation. Therefore, it is reasonable to use the two-wave panel dataset. Moreover, we assume that unobserved household heterogeneity is constant and we control for household fixed effects. As the regulation variable takes a value of one in 2013 and zero in 2010 in Vietnam, this variable also captures time fixed effects in the estimations using this two-year panel dataset.

Second, we also estimate equation (19) using a five-year panel dataset as part of the robustness tests. Since there is perfect multicollinearity among time fixed effects and insurance regulation, we control only for household fixed effects.[12] We also control for household head characteristics, because they are likely to change over the ten-year period due to changes in household head. We report robust standard errors for all estimations.

The effect of the regulation on having property insurance is:

$$\frac{\partial B_{i,t}}{\partial R_t} = \delta + \gamma S_{i,t}, \tag{20}$$

where δ provides an estimate for the impact of the regulation change among households who have never experienced a tropical cyclone. The effect of the regulation change on property insurance take-up increases by γ for each additional tropical cyclone event that a household experienced.

[12]The results adding time fixed effects remain consistent and are available upon request.

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We acknowledge that this approach does not allow us to empirically identify the causal effect of the change in regulation in Vietnam. To analyze the impact of insurance regulation on the relationship between natural disasters and insurance demand, the ideal method would be a difference-in-difference-in-differences (DDD) approach. Thus, we apply a DDD method using households in Thailand as the control group. The number of households having property insurance in Thailand and Vietnam before 2011 followed parallel trends and the DDD results are presented in the online appendix. We consider these results as robustness tests because the number of households having property insurance in Thailand is extremely small compared to the number in Vietnam.

The non-causal and causal analyses offer complementary insights into the determinants of property insurance demand in Vietnam. The non-causal estimations highlight the relationship between natural disasters, insurance demand, and regulatory changes without assuming causality, while the DDD approach tests the causal mechanisms. Given that both approaches lead to the same conclusions, our findings are robust. Therefore, we argue that the empirical results combined with the theoretical findings offer strong evidence for our main conclusion.

5.2 Empirical results

In the first step of our analysis, we examine the impact of natural disasters on property insurance demand and explore how the change in insurance law influences this relationship in Vietnam. We apply the linear probability model using data in 2010 and 2013. Table 1 reports the referred estimation results.

Column (1) presents the results of regressing the probability of having property insurance on the frequency of tropical cyclones and other control variables. All control variables have coefficients significantly different from zero. When households increase their income, they are more likely to buy property insurance. This result is in line with expectations. However, households insured in the previous wave are less likely to remain insured in the current wave. This finding also confirms our expectations, as the household fixed effects model captures only changes in insurance status – specifically, transitions from having property insurance in the previous wave to not having it now, or vice versa.

Regarding natural disasters, the estimated coefficient for the frequency of storms and depressions is −0.2589. In the absence of the regulation change, for each additional event experienced by a household, the probability of having property insurance decreases by approximately 25.9 percentage points. However, we find a positive and significant effect of the change in the insurance regulation on the likelihood of being insured. Among households who have never experienced a tropical cyclone, the change in insurance law increases the probability of being insured by 18.77 percentage points. Moreover, the effect of the regulation change on property insurance take-up increases by 21.43 percentage points for each additional tropical cyclone event that a household experienced.

We also regress the probability of being insured on the severity indicator and other control variables. The estimation result is reported in column (2). Before the insurance law was improved, whenever the average maximum wind speed increases by 10 knots, the probability of having property insurance decreases by 6.1 percentage points. However, among households who have never experienced a tropical cyclone, the change in the Insurance Business Law increases the likelihood of having property insurance by 18.77

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Table 1. Factors impact on property insurance demand in Vietnam (data in 2010 and in 2013)

	Dependent variable:		
	Household has property insurance		
	(1)	(2)	(3)
Total income	0.000003 (0.000001)	0.000003 (0.000001)	0.000003 (0.000001)
Had property insurance in previous wave	−0.4090 (0.0261)	−0.4090 (0.0261)	−0.4163 (0.0269)
Regulation	0.1877 (0.0136)	0.1877 (0.0136)	0.2514 (0.0132)
Frequency	−0.2589 (0.0395)		
Frequency * Regulation	0.2143 (0.0297)		
Severity		−0.0061 (0.0009)	
Severity * Regulation		0.0046 (0.0010)	
Total losses			−0.00001 (0.00001)
Total losses * Regulation			0.00005 (0.00002)
Household fixed effects	Yes	Yes	Yes
Adjusted R^2	0.3523	0.3523	0.3253
Observations	4108	4108	4108

Note: Robust standard errors in parentheses.

percentage points. Furthermore, the effect of the regulation change on being insured increases by 4.6 percentage points for each additional episode of wind speed of 10 knots.

Column (3) shows that among households who did not experience losses from natural disasters, the change in the Insurance Business Law increases the probability of purchasing property insurance by 25.14 percentage points. Moreover, the effect of these change on the likelihood of having property insurance increases by 5 percentage points for each additional US$1, 000 in PPP-adjusted losses from natural catastrophes.

In the second step of our analysis, we use a five-year panel dataset spanning 2008 to 2017 to estimate equation (19). The results are presented in table A3 in the online appendix and confirm our findings presented in table 1.

In the final step of our analysis, we apply the DDD approach to identify the causal effect. The DDD estimation approach, parallel trend assumption, and estimation results are presented in the online appendix. Our DDD estimations confirm our earlier findings that the change in the Insurance Business Law in Vietnam has a positive and statistically significant effect on the probability of having property insurance.

Our estimation results support our theoretical findings that in developing economies a loss experience negatively influences insurance demand. Enhancing insurance regulation would make the impact of a shock event on insurance demand more positive. Our results also confirm the critical role of legal factors in encouraging insurance penetration, which is concluded in Esho *et al.* (2004), Zou *et al.* (2003), and Hussels *et al.* (2005).

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6. Conclusions

Natural catastrophes can significantly harm the living standards of affected households and can have long-lasting economic effects. Insurance can help to protect households from the financial consequences of these events. Yet risks are uninsured to a large extent, especially in developing economies. While it seems to be an established assumption that the experience of a loss event influences insurance demand, it is not clear whether this influence should increase or decrease demand. On the positive side, the experience of a natural catastrophe might lead to a subjective reevaluation of risks and therefore to a higher attractiveness of insurance. On the negative side, however, losses from a natural catastrophe limit households' budgets and, hence, the ability to buy insurance.

Our main contribution to the existing literature is that we analyze the role of insurance regulation in the effect of natural catastrophes on the probability of being insured, using a theoretical model and household panel regressions. Our theoretical results indicate that a loss experience should have a more positive effect on insurance demand in developed economies than in developing economies. An enhancement of insurance regulation should make the impact of a loss event on insurance demand more positive.

The empirical analysis shows a substantial increase in insurance demand after the insurance regulation in Vietnam was enhanced. We find that before the change in insurance regulation, households affected by a tropical cyclone were less likely to buy insurance than others. However, after the changes, the affected households are more likely to purchase insurance. These results are confirmed by the DDD method. In combination with the theoretical findings, the empirical results provide strong evidence for our main conclusions: in contrast to developed economies, in developing economies, loss events likely have a negative effect on insurance demand but an enhancement of insurance regulation can make this effect more positive.

Supplementary material. The supplementary material for this article can be found at https://doi.org/10.1017/S1355770X25000130

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Competing interest. The authors declare none.

References

Bah M and Abila N (2024) Institutional determinants of insurance penetration in Africa. *The Geneva Papers on Risk and Insurance-Issues and Practice* **49**, 138–179.

Berlemann M (2016) Does hurricane risk affect individual well-being? Empirical evidence on the indirect effects of natural disasters. *Ecological Economics* **124**, 99–113.

Berlemann M and Tran TX (2021) Tropical storms and temporary migration in Vietnam. *Population and Development Review* **47**, 1107–1142.

Botzen W and van den Bergh J (2012) Risk attitudes to low-probability climate change risks: WTP for flood insurance. *Journal of Economic Behavior and Organization* **82**, 151–166.

Browne M and Hoyt R (2000) The demand for flood insurance: empirical evidence. *Journal of Risk and Uncertainty* **20**, 291–306.

Cavalcante R, Sobreiro V and Kimura H (2018) Determinants of the non-life insurance market in Brazil. *Review of Development Finance* **8**, 89–95.

Clarke D (2016) A theory of rational demand for index insurance. *American Economic Journal: Microeconomics* **8**, 283–306.

Doherty N and Schlesinger H (1990) Rational insurance purchasing: consideration of contract nonperformance. *The Quarterly Journal of Economics* **105**, 243–253.

https://doi.org/10.1017/S1355770X25000130 Published online by Cambridge University Press

Dumm R, Eckles D, Nyce C and Volkman-Wise J (2017) Demand for windstorm insurance coverage and the representative heuristic. *The Geneva Risk and Insurance Review* **42**, 117–139.
Esho N, Kirievsky A, Ward D and Zurbruegg R (2004) Law and the determinants of property-casualty insurance. *The Journal of Risk and Insurance* **71**, 265–283.
Gollier C (2003) To insure or not to insure? An insurance puzzle. *The Geneva Papers on Risk and Insurance Theory* **28**, 5–24.
Hellevik O (2009) Linear versus logistic regression when the dependent variable is a dichotomy. *Quality & Quantity* **43**, 59–74.
Ho L and Umitsu M (2011) Micro-landform classification and flood hazard assessmentof the Thu Bon Alluvial Plain, Central Vietnam via an integrated method utilizing remotely sensed data. *Applied Geography* **31**, 1082–1093.
Hott C and Regner J (2023) Weather extremes, agriculture and the value of weather index insurance. *The Geneva Risk and Insurance Review* **48**, 230–259.
Howell D (1998) *Statistical Methods in Human Sciences*. New York: Wadsworth.
Hsu S and Yan Z (1998) A note on the radius of maximum wind for hurricanes. *Journal of Coastal Research* **14**, 667–668.
Hung T, Kiyomiya O and An T (2009) Evaluation of seismic resistance for a multi-spans bridge in vietnam by investigation of earthquake activity and dynamic response analysis. *Journal of Structural Engineering A* **55**, 537–549.
Hussels S, Ward D and Zurbruegg R (2005) Stimulating the demand for insurance. *Risk Management and Insurance Review* **8**, 257–278.
Kelikume I and Otonne A (2022) The demand for Home and Property Insurance in Nigeria. *Nigerian Journal of Accounting and Finance* **14**, 1–28.
Knapp K, Kruk M, Levinson D, Diamond H and Neumann C (2010) The International Best Track Archive for Climate Stewardship (IBTrACS): unifying tropical cyclone Best Track data. *Bulletin of the American Meteorological Society* **91**, 363–376.
Mu D, Luo P, Lyu J, Zhou M, Huo A, Duan W, Nover D, He B and Zhao X (2021) Impact of temporal rainfall patterns on flash floods in Hue City, Vietnam. *Journal of Flood Risk Management* **14**, e12668.
Nshakira-Rukundo E, Kamau J and Baumüller H (2021) Determinants of uptake and strategies to improve agricultural insurance in Africa: a review. *Environment and Development Economics* **26**, 605–631.
Razafindrabe B, Kada R, Arima M and Inoue S (2014) Analyzing flood risk and related impacts to urban communities in Central Vietnam. *Mitigation and Adaptation Strategies for Global Change* **19**, 177–198.
Rothschild M and Stiglitz J (1976) Equilibrium iin competitive insurance markets: an essay on the economics of imperfect information. *The Quarterly Journal of Economics* **90**, 629–649.
Seifert I, Botzen W, Kreibich H and Aerts J (2013) Influence of flood risk characteristics on flood insurance demand: a comparison between Germany and the Netherlands. *Natural Hazards and Earth System Sciences* **13**, 1691–1705.
Trinh T, Nguyen X and Sgro P (2016) Determinants of non-life insurance expenditure in developed and developing countries: an empirical investigation. *Applied Economics* **48**, 5639–5653.
Trinh T, Nguyen X, Sgro P and Pham C (2020) Culture, Financial Crisis and the Demand for Property, Accident and Health Insurance in the OECD countries. *Economic Modelling* **93**, 480–498.
Winsemius H, Jongman B, Veldkamp T, Hallegatte S, Bangalore M and Ward P (2018) Disaster risk, climate change, and poverty: assessing the global exposure of poor people to floods and droughts. *Environment and Development Economics* **23**, 328–348.
Zou H, Adams M and Buckle M (2003) Corporate risks and property iInsurance: evidence from the People's Republic of China. *Journal of Risk and Insurance* **70**, 289–314.

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