On the Sources of Risk Preferences in Rural Vietnam

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Abstract

In this paper, I provide a new empirical evidence that natural environment can shape individual risk preferences. By combining historical data on climate variation and contemporary survey questions on risk aversion, I find that risk aversion is significantly different for people who live in areas that have suffered high frequency of natural disasters. In particular, individuals highly affected by climate volatility show a long term risk aversion. The finding also supports the hypothesis that when people used to live in risky environment, an incremental increase in risk affects their risk preferences less.

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1. Introduction

Risk preferences play an important role in economics. Studies in experimental economics have examined to what degree risk attitudes lead to impacts on economic performance. They found that risk aversion has been inversely linked with economic outcome such as investment in physical and human capital and wage growth (Levhari and Weiss, 1974; Shaw, 1996).

However, most economic analyses assume the preferences of an individual agent are taken as given and those preferences decide the agent's selection (Stigler and Becker, 1977). Later, society's economic behaviour is obtained by aggregating the choices of agents in the society. This way of aggregating decisions leaves little room for investigating how the environment in which agents make decisions affects those decisions (Postlewaite, 2011). Recent studies, however, suggest that individual experiences can have long term effects on preferences such as risk and patience. For example, Malmendier and Nagel (2011) investigate whether differences in individuals' experiences of macro-economic shocks affect long term risk attitudes for generation that experienced the Great Depression. They find that birth-cohorts that have experienced high stock market returns throughout their life show lower risk aversion and tend to participate more into stock market and invest a higher fraction of liquid wealth in stocks. The empirical results also indicate that cohorts that have experience high inflation are less likely to hold bonds.

A few number of studies have looked at natural environment influences on shaping preferences and risk attitudes (for example, van den Berg, Fort and Burger, 2009; Cameron and Shah, 2010; Cassar, Healy and Kessler, 2011)[1]. All of these studies using field experiments consider the short-term impact of extreme events, such as floods and earthquakes on risk preferences of village farmers. They find that individuals affected by disasters are substantially more risk averse. In addition, the effects of extreme disasters are only persistent for several years (Cameron and Shah, 2010). However, those results from one-time shock of natural disasters could be contaminated by historical background of risks. If rural households used to be staying for a long time in regions with frequent natural disasters, the risk attitudes are likely to come from recalling the past memory rather than recent events.

[1] Other papers have investigated the impact of natural disasters on outcomes such as household welfare (Thomas et al, 2010), macroeconomic output (Noy, 2009), income and financial flows (Yang, 2008a), migration decisions (Halliday, 2006; Paxson and Rouse, 2008; Yang, 2008b), fertility and education investments (Baez et al., 2010; Finlay, 2009; Portner, 2006; Yamauchi et al., 2009), and mental health (Frankenberg et al., 2008).

Therefore, we may not disentangle the short term present impacts from long term past experience.

This paper supplements current studies by implementing an empirical examination of living environment in shaping subsequent economic development and individual behaviours. Similar to other studies, my focus is on rural village people who are more vulnerable to unpredictable weather when the availability of insurance instruments is limited, and they are greater dependent on natural resources for survival. I ask whether the living environment can create long term effects on risk perception of rural village households in Vietnam. My hypothesis is people who heavily exposed to hazardous environment with frequency of typhoons, storm and floods tend to more risk averse. In addition, I would like to show that village peasants have different preferences responding to different aspects of the historical climate variation. This study also would like to test the hypothesis that put originally by Kahneman and Tversky (1979) that if the level of risk is high, people may not be particularly concerned about the addition of a small independent risk.

Using several experimental questions from contemporary individual-level survey data on risk aversion and basing on cumulative prospect and expected utility theories, I calculate different measures of risk aversion of rural households. At the same time, the use of different question asking people about their willingness to take allows us to estimate whether consistent pattern of risky environments can lead to greater risk aversion.

Combining with historical data on climate variation, the empirical results confirm that rural households suffering more natural disaster show significantly higher levels of risk aversion. The results support the hypothesis that when people used to live in risky environment, an incremental increase in risk does not change their risk attitude. Moreover, the results indicate the importance of historical factors to outcome today that risk perception may have evolved over time in this environment and continue to persist to this day.

The remainder of the paper is structured as follows. In the next section, I start with a detailed description of climate diversification and history of natural disasters in different regions in Vietnam. Section 3 illustrates the mechanism that climate volatility, which is measured by temperature and rainfall variation, can affect and frame risk preferences. Section 4 describes data on main variables and the way to calculate different risk aversion parameters. Section 5 presents reduced form model and estimation results. It reports OLS estimates of the relationship between historical climate variation and individual risk attitude today. In section 6, I then turn to find out whether the contemporary risk preferences resulted by current shock or by historical factors. Section 7 offer concluding remarks.

2. Characteristics of climate variation and natural disasters in Vietnam

Vietnam is one of the world's most exposed countries to multiple natural disasters, including tropical cyclones (typhoons), tornados, landslides and droughts (World Bank, 2010). Storms and tropical depressions often occur from June to November but mainly in September and October. The occurrence of typhoons typically affects the north of the country between June and September, the centre from August to October and the south between October and December. However, typhoons are predominantly concentrated on the centre and north of the country, particularly the central provinces between Thanh Hoa to Quang Nam. The south experiences fewer typhoons, about once every five years (Benson, 1997).

There is an average of four to six typhoons annually although in some years there are none and in others considerably more (Viet Nam MWR et al., 1994). According to Viet Nam MWR and UNDP (1992), some 62 percent of the population and 44 percent of the country are frequency affected by typhoons, with 250 persons killed annually. The worst typhoons in last century are reported to have occurred in 1904, killing and injuring 5,000 people; and in 1985, leaving 900 dead (VNCIDNDR, 1994).

Storms and tropical depressions result in heavy rain and flood after that. It is estimated 59 percent of its total land area and 71 percent of its population that are vulnerable to cyclones and floods (World Bank, 2005). Flooding occurs almost every year, particularly in the central provinces, as frequent typhoons typically coincide with the monsoon whilst the country's terrain, which includes steep high mountains and narrow low plains, implies a potentially high risk of flash flooding (Benson, 1997).

The two main delta regions also experience annual flooding. Major floods of the Red River are reported to have occurred in about 100 years between 977 and 1990 - equivalent to one every 10 years. Heavy rainfall combined with poor drainage facilities can also cause urban flooding. Pho and Tuan (1994), who define floods as events where discharges are three or more times the annual mean level, estimate that Viet Nam experiences some 3 to 8 floods every year. The flood season is typically earlier in the north than the south of the country, with flooding most probable in July and August in the Red River Delta and in late September or early October in the Mekong Delta. Since 1900, severe floods inundating of over 300,000 hectares of land have occurred in 1913, 1915 and 1945, 1971 and 1986 (ESCAP, 1990; ADB, 1994).

3. Conceptual framework

The existing theories are inconclusive about the effects of natural environment on risk behaviour. Climate variation and natural disaster could affect individual through many mechanisms. One possible channel would be through a large negative shock in wealth or income, then changing individual preferences (Cassar, Healy and Kessler, 2011; Cameron and Shah, 2010). Thomas et al (2010) in recent study show that natural disasters have profound effect on living condition of people. By combining repeated cross sectional national living standard measurement surveys (2002, 2004, and 2006) from Vietnam with proxy of natural disasters, they show that the immediate losses from floods and hurricanes can be substantial, with floods causing losses of up to 23 percent and hurricanes reducing by up to 52 percent consumption among households close to large urban centres.

A second channel would involve an increase in the perceived likelihood that other negative events would occur. Cameron and Shah (2010) provide experimental and survey estimates that support the idea that people living in villages that have been exposed to earthquakes or floods in the past exhibit more risk aversion than others whose villages did not experience such events. They find that individuals update and increase the probability that another flood will occur in the next year because individuals perceive that they are now facing a greater risk, so they are less inclined to take risks.

A third explanation is also possible. The mechanism may not be the result of income losses or perceived future hazards, as in the previous explanations. Instead, it is possible that hazard experience makes people more worried and fearful, and that worry leads to more risk-averse choices (Cassar, Healy and Kessler, 2011). Empirical study by Li et al. (2009) find supporting results in case Chinese people affected by an unprecedented snowstorm and a major earthquake. Particularly, their results, based on data collected one month after the power outages and two months after the earthquake, suggest that people tend to give more weight to low probabilities after a disaster, preferring a sure loss but a probable gain. They also found that participants tend to buy both insurance and lotteries after those events.

Another explanation for the risk attitudes is that they could be rooted from the past memories. It is possible that our results arise not because of existing events but because the shocks caused by historical natural disasters could create an imprint on rural households and have not yet fully dissipated. This explanation is consistent with the dominant presumption that preferences and norms change slowly (e.g., Bisin and Verdier, 2001, 2008; Alesina and Nicola Fuchs-Schundeln, 2007; Nunn and Wantchekon, 2011).

From the different perspective, the hypothesis put forth by Kahneman and Tversky (1979) suggests that people's preferences undergo some form of adaption and if the level of risk is high, people may not be particularly concerned about the addition of a small independent risk. Moreover, repeated exposure to risky environment is likely to build up a high level of reference for risk and patience which makes the agents more willing to make risky and patient choices. For example, fishermen constantly make risky decisions and constantly face a trade-off between limiting fishing efforts today and receiving higher profits in the long run. (Nguyen, 2011)

4. Data description and risk aversion parameters

Risk aversion

Data for calculating risk aversion parameters is taken from the fourth wave of Vietnam Access to Resources Household Survey (VARHS), starting from 2004. The VARHSs are longitudinal datasets conducted biannually by the Institute of Labour Science and Social Affairs of the Ministry of Labour, Invalids and Social Affairs under the technical support from Department of Economics at the University of Copenhagen. They have been carried out in the rural areas of twelve provinces in Vietnam. These twelve provinces are distributed evenly throughout the country with Ha Tay in Red River Delta; Lao Cai and Phu Tho in Northeast; Lai Chau and Dien Bien in Northwest; Nghe An in North Central Coast; Quang Nam and Khanh Hoa in South Central Coast; Dac Lac, Dac Nong and Lam Dong in Central Highland; and Long An in Mekong River Delta. Therefore, even the surveys only cover 12 over 63 provinces, they representatively reflect regional climate and geography throughout the country.

The fourth wave of VARHS in 2010 resurveys all rural households in twelve provinces, which include 1,314 rural households that were interviewed for the 2004 Vietnam Household Living Standards Survey[2]. The survey also collects detailed information on a wide variety of topics, including information on household demographics, such as gender, age, education, labor market status income and expenditure as well as social network and political participation.

The speciality of this survey is that I could assess the robustness of results by using different types of risk measures. I use two questions of individual's risk attitudes to calculate risk parameters.

The first question adapts a simple unpaid lottery experiment. In this experiment, respondents are asked to choose between six lotteries that differ in payoffs and whether they want to accept or reject it. In each lottery the winning money is fixed at 6,000 VND and only the losing price is varied (between 2, 000 VND and 7, 000 VND[3]). The advantage of this unpaid experiment over the real money payments is the second may result in incentive effects and may not reveal the true risk preferences of rural households. However, the drawbacks of the first method are that various factors, including self-serving biases, inattention, and strategic motives could cause respondents to distort their reported risk attitudes (Dohmen et al, 2011)[4].

The exact words of this question are: "You are given the opportunity of playing a game where you have a 50:50 chance of winning or losing (for example, a coin is tossed so that you have an equal chance of it turning up either heads or tails). In each case choose whether you would accept or reject the option of playing:

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[2] The VHLSS is a nationally representative, socio-economic survey, carried out biennially by the General Statistics Office (GSO). In addition to the 1,314 resurveyed VHLSS-2004 households, the survey contains two other main groups of households. First, 820 rural households are resurveyed from the 2002 VHLSS in Ha Tay, Phu Tho, Quang Nam and Long An provinces. Second, the sample includes 945 additional households from the five provinces covered by the Agricultural and Development Program (ARD-SPS), including Lao Cai, Dien Bien, Lai Chau, Dak Lak and Dak Nong. These households were surveyed specifically for the purpose of generating a baseline study for the ARD-SPS program.

[3] These amount is equivalent to U$ 0.10 - 0.30

[4] Some previous studies, such as Rabin (2000), Rabin and Thaler (2001), Schmidt and Zank (2005), Wakker (2005), Köbberling and Wakker (2005) suggested that this lottery may measures loss aversion rather than risk aversion.

Lottery	Accept	Reject
a. You have a 50% chance of losing 2,000 VND and a 50% chance of winning 6,000 VND	O	O
b. You have a 50% chance of losing 3,000 VND and a 50% chance of winning 6,000 VND	O	O
c. You have a 50% chance of losing 4,000 VND and a 50% chance of winning 6,000 VND	O	O
d. You have a 50% chance of losing 5,000 VND and a 50% chance of winning 6,000 VND	O	O
e. You have a 50% chance of losing 6,000 VND and a 50% chance of winning 6,000 VND	O	O
f. You have a 50% chance of losing 7,000 VND and a 50% chance of winning 6,000 VND	O	O

I also consider another hypothetical risk measure to estimate the coefficient of absolute (and relative) risk aversion based on the following question: "Consider an imaginary situation where you are given the chance of entering a state-run lottery where only 10 people can enter and 1 person will win the prize. How much would you be willing to pay for a 1 in 10 chance of winning a prize of 2,000,000 VND?". The answer to this question is regarded as a reservation price above which the household rejects the lottery.

Calculating parameters of risk aversion

For the first question, risk aversion in the risky choice task can be identified by applying cumulative prospect theory (Tversky and Kahneman, 1992). A village household will be indifferent between accepting and rejecting the lottery if $w^{+}(0.5)v(G) = w^{-}(0.5)\lambda^{\text{risk}}\ v(L)$, where L denotes the loss in a given lottery and G the gain; $v(x)$ is the utility of the outcome $x \in \{G, L\}$, λ^{risk} represents the coefficient of risk aversion in the choice task; and $w^{+}(0.5)$ and $w^{-}(0.5)$ denote the probability weights for the chance of gaining G or losing L, respectively.

If I assume that the same weighting function is used for gains and losses, $w^+ = w^-$, the ratio $v(G)/v(L) = \lambda^{risk}$ will define an household's implied risk aversion in the lottery choice task. I assume that $v(x)$ is linearity ($v(x) = x$) for small amounts, which gives us a simple measure of risk aversion: $\lambda^{risk} = G/L$. I will relax some of these assumptions later.

In my lottery choice task $\lambda^{risk} = w^+(0.5)/w^-(0.5)(v(G)/v(L))$. I only consider monotonic acceptance decisions (99 percent of respondents exhibit monotonicity). Table 1 records the results of four different assumptions on probability weights and diminishing sensitivities for gains and losses. The rationale of these four models is to vary assumptions on probability weighting and diminishing sensitivities to see their impact of climate variation on different implied levels of risk aversion. The benchmark case (model (1)) is that both probability weighting and diminishing sensitivity are set to be equal to one. Model (2) assumes that differential probability weighting for gains and losses is unimportant (that is, $w^+(0.5)/w^-(0.5) = 1$) but allows for diminishing sensitivities for gains and losses. Model (3) assumes diminishing sensitivity is unimportant but allows for differences in probability weights for gains and losses. I follow Gächter et al (2010) to take the estimates of Abdellaoui (2000) who reports that $w^+(0.5) = 0.394$ and $w^-(0.5) = 0.456$ for the median individual (implying $w^+(0.5)/w^-(0.5) = 0.86$). It therefore provides an upper bound for the importance of differential probability weightings of gains and losses for the median individual in our context. Model (4) assumes that both probability weighting and diminishing sensitivities matter.

The results from the experiment show that most households are risk averse, as expected given the high levels of poverty and the particularly unpredictable features of agricultural activities. A variation of assumptions on probability weighting and diminishing sensitivity shows a change the values of implied λ^{risk}.

According to Table 1, 1.86 percent acceptes all lotteries with a non-negative expected value and only rejected lottery f according to the benchmark model (1) their implied $\lambda^{risk} = 1$. Only 0.81 percent of our respondents accepts lottery #7 in model (1) with their $\lambda^{risk} < 0.87$. Most participants rejected gambles with a positive expected value. A lot of respondents (68.28 percent) reject all six lotteries; for these people $\lambda^{risk} > 3$..

For the second question, I can rely on Pratt (1964) and Arrow (1965), who used a concave utility function U which is defined over income (or wealth), to construct formal measures of absolute risk aversion.

I assume that households are initially endowed with income of w and having a twice differentiable, state independent utility function U, such that $U^{'}(w) > 0$ and $U^{''}(w) < 0$. The reservation price, z, makes the household indifferent between the risky asset and the initial income; the endowment is therefore the certainty-equivalent of the proposed investment.

Suppose that the household's behaviour can be described by the maximization of expected utility, then we have the relationship:

$$U(w) = 0.1U(w-z) + 0.9U(w-z+2) \quad (1)$$

or equivalently,

$$10U(w) = U(w-z) + 9U(w-z+2) \quad (2)$$

A second order of Taylor series expansion of the right-hand side of Equation 2 around an income of w gives:

$$10U(w) = U(w) - zU^{'}(w) + 0.5z^2U^{''}(w) + 9[U(w) + (2-z)U^{'}(w) + 0.5(2-z)^2U^{''}(w)]$$

After rearranging, we yield the Pratt-Arrow measure of absolute risk aversion as:

$$A(w) = -\frac{U^{''}(w)}{U^{'}(w)} = \frac{18-10z}{5z^2+18-18z}$$

An attractive characteristic of the two calculations of subjective risk variables is that they provide measures of the risk values based on different theories. However, I expect that there is a close link between the objective measures from two approaches. The pairwise correlation between difference risk parameters is represented in Table 2. As is apparent, there is a strong relationship between the risk parameters calculated by prospect and expected utility theories.

Climate and Geographical Variables

Rural households in Vietnam are exposed to many natural risks that could potentially threaten their livelihoods and incomes. For example, since the majority of households in rural areas rely on agricultural activities, they will experience fluctuations in agriculturally derived income from exogenous natural shocks such as drought, floods, pest infestation and livestock disease. (CIEM, 2008)

To investigate these effects of natural environment on living conditions of village people, I employ two kinds of data that cover different time periods. For historical natural condition, I pay attention to temperature and precipitation variation. These two variables are expected to have a considerable impact on household incomes from agriculture and other natural resource-dependent activities. They are also highly associated with other important natural phenomenon such as floods, land slides, typhoons, storms and droughts that could result in negative effects on incomes and increasing risks of harmful pests. For contemporary conditions, I use information from the survey question that asks about whether households have suffered any natural shocks and losses due to extreme events over the past years. This information allows us to observe the severity of recent shocks on risk preferences of rural household. Moreover, by using both historical and recent data, I can examine whether risk aversion correlates with recent events or historical variability can frame risk attitudes and it has been transmitted through generations.

A. Historical Climate Variation

I obtain historical data on climate variability from weather stations in 46 districts produced by the Institute of Meteorology and Hydrology. The data prolongs 35 – 50 years from 1927 to 1985 depending on each station. These stations are allocated to capture the best variation of weather within regions. For each station, I have climate data, such as precipitation and temperature, at station with latitude-longitude degree point p in district i during month m of year t.

To compute the climate variation, I first calculate average of temperature and rainfall in each station for each month (month-specific average). I take average of weather over 35-50 years to reduce the effect of extreme weather condition in specific years. After that, I obtain the standard deviation of temperature and rainfall of each station over twelve months to investigate within year weather fluctuations.

For districts without climate stations, the weather condition is assumed to be similar to other districts with the same latitude. The reason to apply this strategy is that stations are expected to gauge the significant climate variation in different regions. Therefore, climate data from one station can be used to measure neighbouring districts with similar condition.

B. Contemporary Natural Disasters

The data on natural disasters is taken from three rounds of the Vietnam Access to Resources Household Survey (VARHS) for 2006, 2008 and 2010. In 2008 and 2010 waves, households were asked to select from a list of twelve natural and biological and economic shocks that the household suffered a loss from past two years and the time of the survey. The exact words of the question are "Since xxx, did the household suffer from an unexpected loss from any of the following shocks? 1. Floods, land slides, typhoons, storms, droughts; 2. Pest infestation and crop diseases; 3. Avian flu….". Since respondents can give many answers to the question, I construct a measure that assigns any natural disasters that households have suffered from natural disasters within two year as 1 and others as 0. I then accrue the number of natural shocks over two years for each household.

I also consider the second measure of loss intensity from the survey question based on the following question "Please list how much you lost due to this event (000 VND)". The amount of losses for any households has been accumulated over two years.

In 2006 survey, households were instead asked an open ended question: "In which years during the last 5 years did your household suffer an unexpected loss of income? And how much did you lose?". Following the same strategy, I could calculate the number of natural hazards over five years in each respondent and the intensity of losses.

Due to the longitudinal dataset, I can construct a measure of the number of disasters that each rural household suffered in the period 2002-2010. However, since households were asked about the number of natural disasters and losses over the last 5 years in 2006 compared with the last 2 years in both 2008 and 2010 surveys, we would expect the figures to be larger in

2006 as compared with ones in 2008 and 2010. To make them comparable between two periods, I accumulate the number of natural shocks and losses over two waves, 2008 and 2010 to form four year periods. Therefore, two sets of variables measuring the impacts of recent natural disasters would be created: the number of natural disasters and losses in 2002-2006 and 2006-2010.

C. Other geographical variables

Other variables may be important for my analysis. Rainfall, for example, may harm production depending on land type and plot slope. Similarly, a flood will affect only low-lying fields, whereas landslides destroy fields on or below steep or unstable slopes. General climate indicators such as average rainfall and temperature or the passage of a storm and typhoons therefore obscure differences in risk exposure among households. I therefore used household-level questionnaires to gather information on these risk exposures.

Average climate conditions

Average climatic conditions are likely to have considerable impact on agriculture and income. For example, even a region without much climate variation but low (or high) average rainfall or temperature within a year also create risks that caused by drought and flood. To account for these effects, I control for the average level of temperature and rainfall at the district level. These measures are constructed from the same dataset described above, taking their average over twelve months and over the entire period.

Elevation and Land Terrain

Land terrain and elevation can also be expected to be correlated with climate variability. For example, the presence of a mountain can lead to different climatic condition and micro-ecosystems on each side (Durante, 2009). This may decrease or strengthen the risk of negative effects of climate variation on agricultural activities. To control for the relationship between climate variability and topography, I include a plot dummy variable to measure of agricultural land terrain in regressions. The information for land terrain is withdrawn from the question to household heads on topography of household's land plot: "*In general, what is the slope of this plot? Flat, Slight Slope, Moderate Slope and Steep Slope*". The measure of land slope takes the value of 1 if all plots are flat and 0 otherwise. As presented in Table 2, 35 percent of land plots are in slight to steep conditions.

Land area and quality

Land quality and growing conditions could affect the risk of crop failure and household income. To account for this aspect, I include area of land and dummy of land quality in regressions. The area of land is calculated by summing up the area of all the plots for each households. Information on the land quality is taken from the question: "*Do you experience problems with any of following conditions on this plot? Erosion, Dry land, Low-lying land, Sedimentation, Landslide, Stone soils/clay, other or No problem*". I construct a measure of land quality that takes on the value of 1 if households do not have any plots that suffer any above problems and 0 otherwise. Only three percent of households report high quantity of land without any above problems.

D. Migration

The survey provides some useful information based on questions on how long households have lived in the commune and location that people born. I follow a strategy to take only households with head, spouse or both of them where they live are also where they were born. The argument here is the more time those people have been exposed in this environment, the more their risk attitudes adapt to this natural condition. In Table 1, the average age of household heads who were born locally is above 50 years old. It implies that climate has long-lasting and profound effects on their living and behaviour.

5. Empirical strategies

Having constructed historical district-level measures of climate variation and contemporary shocks, I am able to investigate the relationship between climate variability and current parameter of risk aversion. To further test the robustness of the relationship between risk aversion and historical climate variability, I extend the analysis to account for differential geographical and individual characteristic variables.

I estimate the following individual-level equation[5]:

$$Risk\_aversion_{i,d,p} = \alpha_p + \beta Environ\_Var_d + X'_{i,d}\Gamma + Z'_{i,d}\Phi + \gamma X_c + \varepsilon_{i,d,p}$$

where α_p indicates province fixed effects, which are included to capture provinces specific factors, such as effectiveness of local regulations and norms, that may affect risk aversion. The variable $Risk\_aversion_{i,d,p}$ denotes measures of risk aversion, which vary across households. $Environ\_Var_d$ represents the degree of variability for climate (temperature or rainfall) among districts. β is our coefficient of interest which estimates the relationship between the climate variation in a district and the individual's current level of risk aversion.

The potential effects of climate variation on this risk aversion may vary systematically across demographic groups. For example, climate variation is more likely to correlate with income and education levels, then shifting patterns of risk aversion in predictable ways. Many empirical studies indicate that higher levels of risky activities are expected to increase with wealth and income. Wealthier individuals are often found to be more likely to undertake risky activities (Rosenzweig and Binswanger, 1993; Miyata, 2003; Cohen and Einav, 2007). In addition, it is possible that wealthier households choose to stay in regions that do not experience flooding and are more likely to choose the riskier option (Cameron and Shah, 2011).

Many other studies conclude that the willingness to take risk increases with education (e.g., Dohmen *et al.*, 2011; Donkers *et al.*, 2001; Hartog *et al.*, 2002; Miyata, 2003). However, some evidences indicate that the effect of education may be unidentified. Binswanger (1980) finds little effect of education on risk aversion at low game levels, but negative and often, but not always, significant effects at intermediate and high pay-offs. Also, the effect of education may be small. Some people are risk takers on small bets but become more risk averse on bets with larger economic consequences.

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[5] Because the distribution of the rainfall and temperature are highly left skewed, with a small number of observations taking on large values, I report estimates using the natural log of the climate measures

Risk-taking behavior can change as people age. In earlier studies on risk experiments, older people tend to be more risk averse than younger subjects. In a related finding, single individuals were less risk averse than married individuals, though having more children did not seem to increase risk aversion. Women, in general, are more risk averse than men (Byrnes *et al.*, 1999; Cohen and Einav, 2007; Dohmen *et al.*, 2011; Donkers *et al.*, 2001; Hartog *et al.*, 2002). A number of studies have shown that less risk-averse agents are more likely to choose higher risk jobs for better compensation (Viscusi and Hersch, 2001). For instance, King (1974) finds that individuals from wealthier families choose riskier occupations, while Cramer et al (2002) show that less risk-averse agents are attracted to entrepreneurship, a more risky occupation. Cameron and Shah (2010) find that informal insurance partially reduces risk aversion of households in the face of natural disasters.

To capture all above effects, I include information on household head, such as age, age squared/100, years of education, household income, a gender variable indicator, an indicator variable that equals one if the respondent lives in an urban location, a dummy variable for people who are ethnic minorities and occupational fixed effects into $X'_{i,d,p}$. I also control for dummy variables that reflects whether rural household ask for money help in case of emergency from neighbor and relatives.

The vector $Z'_{i,d,p}$ consists of other geographical variables, such as average rainfall and temperature, land terrain, land quality and area of land. X_c is a variable designed to capture the share of the commune's population that is of the same ethnicity as the respondent.

In addition, many of the explanatory variables in above equation do not vary across individuals, rather at the commune level. For example, climate variation will have the similar effects for people living the same commune. Given the potential for within-group correlation of the residuals, I adjust all standard errors for potentially arbitrary correlation between households in the same commune.

Table 4 and 5 report the results using for log of rainfall variation. In baseline models, I find substantial evidence that rainfall variation is correlated with risk averse indicators. In the all cases without provincial fixed effects, the estimated coefficient for rainfall, β, is positive and statistically significant (at the 1% level), indicating that climate variability positively affects average trust score at household level. This is consistent with the hypothesis that the climate variation affects individuals' risk attitude. However, the significant relationships disappear as I control for provincial fixed effects.

The effects of temperature variation are robust with and without provincial fixed effects, as reported in Table 6 and 7. The estimate of β for all four models is positive and highly statistically significant and of similar magnitude. In Table 7, the estimates fall between 0.53 and 0.36. The interpretation is that one standard deviation increase in log of temperature variation causes an increase in risk aversion that range from 23.8 to 23.52 percent of increase in standard deviation of different risk aversion.

To control for the potential problem that climate variation may be contaminated by the effects of other geographical variables, in Table 8 and 9, I include the vector of geographic controls. My controls include average temperature and rainfall, land area, land terrain and quality. When the geographical controls are included, the point estimates of the coefficients of interest increase substantially and become highly statistically significant in rainfall equation. For the magnitude of the coefficient, holding other variables constant, one standard deviation increase in log of rainfall variation corresponds to a 0.2 increase in risk aversion (approximately 20 percent standard deviation increase in risk aversion). Other variables have their signs as expected though they are not statistically significant. People become risk averse when they are older. Women seem more risk averse than men. Richer households and married people show less risk averse.

I also control for the potential effects of social networks, such as relationship with neighbours and relatives, on risk perceptions. The variables of relationship with relatives and neighbours are indicators of whether households ask money help from their relatives or other member in the same village in case of emergency. The estimated impact of historical climate variation remains robust to the inclusion of these additional controls. The coefficient remains positive and statistically significant and its magnitude only change little from the baseline value.

I undertake a number of other robust checks. First, I separately investigate the impacts of climate variation for each gender group of population. The results, which are reported from Table 10 to 13, are more robust to the male subsample. One possible explanation is men have to take more responsibility for their families in case of unexpected natural disasters. I find that temperature variation has higher impacts on female; however, the results are not obvious for rainfall variation. Second, I check for robustness to alternative estimation methods. Using ordered logit models produces estimates that are qualitatively identical to our baseline OLS estimates (Appendix II) and stable over a range of regressions.

Robustness to alternative risk measures

Table 14 and 15 repeat the same exercise with second measure of risk aversion based on the expected utility theory. The other measure of risk preference yields estimates that are qualitatively identical to the estimates using our baseline variables. We see that both temperature and rainfall variation estimates are highly significant and have positive effect on absolute risk aversion of village members, which are also consistent with above results.

Potential Sources of Bias

In the above section, I deal with omitted variables by including provincial fixed effects and other geographical factors in the climate variation equation. This does not, however, completely solve the concern of omitted variables because unobservable time varying components might be correlated with both changes in climate variables and in individual risk aversion in each district. One may think of specific time varying factors, such as infrastructure, correlating with both risk aversion and impacts of climate volatility. By taking historical climate data that creates a lag between climate variable and contemporary outcomes, this makes it less likely that unobservable time varying components could drive changes both in current measure of risk aversion and climate variation and resulting in spurious estimation.

However, another problem that may affect the estimates is selection bias. The first is the measurement error from the proxy of climate variation correlates with error terms and biases downward estimates. Another problem happens as a non-random subgroup of village peasants select to stay in regions even with more natural risks. These groups of village peasants are likely to be more risk-averse and tend to stay at the same place where they were born even those places are not ideal for living. If these factors correlate with climate variability among district, then the estimates are also to be overestimated. With two biases coming from opposite directions, we may not know whether our estimate biases are downward or upward. However, I expect these biases will be small.

6. Persistent impacts of natural environment

To this point, I have shown that historical climate variation is associated with more risk aversion of rural household today. These two correlations suggest long-term persistence in the effects of natural environment on shaping people's preferences. To test whether differences in current levels of risk are related to historical rather than to contemporary shock events, I replicate the analysis using both historical climate variation and variables that reflect losses that household have suffered to see the affects of natural disaster on risk aversion.

In Table 16 and 17, I include the variables of number of natural disasters generated from our survey data for both period 2002-2006 and 2006-2010. All regressions have errors clustered at the commune level, including provincial fixed effects and the full set of control variables.

For each of measure of risk aversion, the historical variables are stable and have statistically significant effects. The effects of current natural disasters are small though their signs are consistent with our expectation. The magnitude of the effect is smaller in the period 2002-2006 and larger in period 2006 – 2012 but both of coefficients are found not statistically significant. The qualitative results for temperature are analogous: higher climate variability corresponds to higher risk aversion but contemporary natural disasters do not show significant effects.

I replicate the regression with similar measure of risk aversion but with the other independent variable: share of losses over household incomes. The results of historical climate variation, as reported in Table 18 and 19 are similar to our alternate measure of risk aversion. The severity of damage in households in 2002-2006 correlates negatively with risk aversion parameters but not significant. Experiencing a high share of loss from natural disaster in 2006-2010 increases the probability of being risk-averse.

Thus, the results suggest that natural disasters appears to leaving a deep and lasting imprint on people's risk attitudes and it could be transmitted through generation even current climate variation and natural disasters do not create as much as damage compared to the past.

7. Conclusion

The frequency and damages created by climate variation and natural hazards have increased substantially over the past century and will probably continue to do so in the near future, especially in developing countries. Using historical and contemporary data on climate variation and natural disasters and a survey on rural households in Vietnam, this paper has tested the hypothesis that individuals living in villages that have experienced a natural disaster behave in a more risk adverse manner than individuals in otherwise like. The results strongly support the hypothesis that experiencing natural shocks in the past makes people more risk averse. Experimentally measured risk aversion was substantially higher for rural households who experienced more exposure to natural shocks. Our findings also provide evidence that the recent natural disasters may have moderate impacts on forming risk preferences of rural households.

My focus on the long-term historical determinants of risk perceptions does not disregard the importance of short-run shocks from natural disasters. There is substantial evidence that current experiences from natural shocks are also important in shaping risk attitudes. However, even accounting for these short-term effects, there remains a strong persistent impact of historical climate variation. This indicates that such disasters not only have short-term effects on individual risk attitudes but also shape their long term preferences and survival strategies.

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Appendix I

Table 1. Risk behaviour from different lotteries and implied $\lambda^{risk} = \omega^*(6{,}000^{\alpha}/L^{\beta})$, $\omega \equiv w^+(0.5)/w^-(0.5)$

Risk behavior (lottery choice category)	Perce-nt	Implied Accepta-ble loss (thous. VND)	Implied λ^{risk} under different assumptions of probability weights and diminishing sensitivities for gains and losses (1)	(2)	(3)	(4)
Parameters:			ω=1 α=1 β=1	ω=1 α=0.95 β=0.92	ω=0.86 α=1 β=1	ω=0.86 α=0.95 β=0.92
1. Reject all lotteries	**68.28**	**< 2**	**> 3.00**	**>2.90**	**>2.49**	**>2.58**
2. Accept lottery **a**, reject lotteries **b** to **f**	**4.31**	**2**	**3.00**	**2.90**	**2.49**	**2.58**
3. Accept lotteries **a** and **b**, reject lotteries **c** to **f**	**10.61**	**3**	**2.00**	**2.00**	**1.72**	**1.72**
4. Accept lotteries **a** to **c**, reject lotteries **d** to **f**	**10.39**	**4**	**1.50**	**1.53**	**1.32**	**1.29**
5. Accept lotteries **a** to **d**, reject lotteries **e** to **f**	**3.73**	**5**	**1.20**	**1.25**	**1.07**	**1.03**
6. Accept lotteries **a** to **e**, reject lotteries **f**	**1.86**	**6**	**1.00**	**1.06**	**0.91**	**0.86**
7. Accept al lotteries	**0.81**	**≥ 7**	**≤ 0.87**	**≤0.92**	**≤0.79**	**≤0.73**
Median			**1.50**	**1.53**	**1.32**	**1.29**

Note: I follow the same strategy of Gächter et al (2010) in identifying sensitivity parameter. (1) benchmark parameters: no probability weighting, and no diminishing sensitivity. (2) no probability weighting, but diminishing sensitivity. (3) Probability weighting, but no diminishing sensitivity. (4) Probability weighting and diminishing sensitivity. Parameters on diminishing sensitivity are taken from Booij and van de Kuilen (2009); parameters on ω taken from Abdellaoui (2000).

Table 2. Bivariate correlation

	Risk 1	Risk 2	Risk 3	Risk 4	ARAC	Log Rainfall Variation	Log TempVariation
Risk 1 (ω=1; α=1; β=1)	1						
Risk 2 (ω=1; α=0.95; β=0.92)	1 *	1					
Risk 3 (ω=0.86; α=1; β=1)	1*	1*	1				
Risk 4 (ω=0.86; α=0.95; β=0.92)	1*	1*	0.99*	1			
Absolute Risk Aversion Coeff.	0.57*	0.57*	0.567*	0.57*	1		
Log Rainfall Variation	0.14*	0.14*	0.15*	0.15*	0.14*	1	
Log Temperature Variation	0.16*	0.16*	0.16*	0.16*	0.04	0.3*	1

Note: * Statistically significant at 5 percent.

Table 3. Descriptive Statistics

Variables	Obs	Mean	Std. Dev.	Min	Max
Risk aversion 1	915	3.39	1.09	0.87	4.1
Risk aversion 2	915	3.26	1.00	0.92	3.9
Risk aversion 3	915	2.63	0.75	0.79	3.1
Risk aversion 4	915	2.90	0.93	0.73	3.5
Absolute Risk Aversion Coefficient	921	0.34	0.73	-1.33	1.6
Log Rainfall variation (mm)	920	4.87	0.18	4.57	5.71
Log Temperature variation (oC)	920	0.62	0.49	-0.12	1.61
Average Rainfall 12 months (mm)	920	155.38	38.15	113.24	320.07
Average Temperature 12 months (oC)	920	24.33	2.08	18.31	27.36
Age of head	921	53.74	13.55	24	96
Age of head, squared/100	921	30.71	15.84	5.76	92.16
Year of schooling of head	921	8.11	3.31	0	13
Gender (Male:=1)	921	0.81	0.39	0	1
Married	921	0.85	0.36	0	1
Rural	921	0.97	0.16	0	1
Minority	921	0.22	0.41	0	1
Log Household income (mil VND)	920	4.00	0.85	0.59	7.91
Area of land (1000m2)	921	6.23	11.26	0.04	154.37
Land terrain (Flat:=1)	921	0.65	0.48	0	1
Land Quality (Good:=1)	921	0.03	0.17	0	1

Note: The summary statistics are weighted by household weight and calculated based on VARHS survey data.

Table 4. Baseline estimations. Log Rainfall variation

	(1)	(2)	(3)	(4)
VARIABLES	Risk aversion 1	Risk aversion 2	Risk aversion 3	Risk aversion 4
Log Rainfall variation (100mm)	0.928***	0.847***	0.646***	0.790***
	(0.273)	(0.249)	(0.187)	(0.232)
Minority	0.109	0.0991	0.0677	0.0921
	(0.107)	(0.0979)	(0.0735)	(0.0914)
Age of head	0.0106	0.00987	0.00734	0.00904
	(0.0196)	(0.0178)	(0.0134)	(0.0166)
Age of head, square/100	-0.00258	-0.00254	-0.00199	-0.00223
	(0.0165)	(0.0151)	(0.0113)	(0.0140)
Rural	0.442*	0.403*	0.295*	0.375*
	(0.227)	(0.207)	(0.156)	(0.193)
Year of schooling of head	0.0106	0.00976	0.00778	0.00909
	(0.0128)	(0.0117)	(0.00871)	(0.0109)
Male	-0.236*	-0.215*	-0.160*	-0.200*
	(0.143)	(0.130)	(0.0965)	(0.121)
Married	-0.133	-0.120	-0.0872	-0.112
	(0.149)	(0.136)	(0.101)	(0.127)
Log Household income	-0.0371	-0.0340	-0.0287	-0.0319
	(0.0535)	(0.0487)	(0.0364)	(0.0455)
Occupational fixed effects	No	No	No	No
Provincial fixed effects	No	No	No	No
Number of observations	913	913	913	913
Number of commune clusters	373	373	373	373
R-squared	0.054	0.054	0.055	0.054

Notes: ***, ** and * indicates significance level of 1%, 5% and 10% respectively against a two sided alternative. Clustered standard errors are in round brackets.

Table 5. Baseline estimations. Log Rainfall variation

VARIABLES	(1) Risk aversion 1	(2) Risk aversion 2	(3) Risk aversion 3	(4) Risk aversion 4
Log Rainfall variation (100mm)	0.559	0.510	0.381	0.475
	(0.368)	(0.335)	(0.250)	(0.313)
Minority	0.123	0.111	0.0735	0.103
	(0.161)	(0.147)	(0.110)	(0.137)
Age of head	0.0124	0.0114	0.00831	0.0105
	(0.0197)	(0.0180)	(0.0135)	(0.0167)
Age of head, square/100	-0.00508	-0.00477	-0.00352	-0.00435
	(0.0164)	(0.0150)	(0.0112)	(0.0140)
Rural	0.516**	0.470**	0.348**	0.438**
	(0.229)	(0.209)	(0.157)	(0.195)
Year of schooling of head	0.0108	0.00989	0.00784	0.00922
	(0.0127)	(0.0116)	(0.00862)	(0.0108)
Male	-0.202	-0.184	-0.138	-0.172
	(0.142)	(0.129)	(0.0959)	(0.121)
Married	-0.169	-0.154	-0.113	-0.143
	(0.146)	(0.133)	(0.0988)	(0.124)
Log Household income	-0.00759	-0.00717	-0.00822	-0.00678
	(0.0522)	(0.0476)	(0.0355)	(0.0444)
Occupational fixed effects	Yes	Yes	Yes	Yes
Provincial fixed effects	Yes	Yes	Yes	Yes
Number of observations	913	913	913	913
Number of commune clusters	373	373	373	373
R-squared	0.124	0.124	0.124	0.124

Notes: ***, ** and * indicates significance level of 1%, 5% and 10% respectively against a two sided alternative. Clustered standard errors are in round brackets.

Table 6. Baseline estimations. Log Temperature variation

VARIABLES	(1) Risk aversion 1	(2) Risk aversion 2	(3) Risk aversion 3	(4) Risk aversion 4
Log Temperature variation (oC)	0.410***	0.374***	0.282***	0.349***
	(0.0973)	(0.0886)	(0.0661)	(0.0827)
Minority	0.143	0.130	0.0910	0.121
	(0.108)	(0.0982)	(0.0737)	(0.0916)
Age of head	0.00332	0.00325	0.00235	0.00285
	(0.0189)	(0.0172)	(0.0130)	(0.0161)
Age of head, square/100	0.00343	0.00293	0.00213	0.00287
	(0.0160)	(0.0146)	(0.0110)	(0.0136)
Rural	0.691***	0.629***	0.467***	0.587***
	(0.254)	(0.232)	(0.175)	(0.216)
Year of schooling of head	0.00727	0.00670	0.00549	0.00623
	(0.0124)	(0.0113)	(0.00843)	(0.0106)
Male	-0.203	-0.185	-0.138	-0.172
	(0.147)	(0.133)	(0.0994)	(0.124)
Married	-0.152	-0.138	-0.100	-0.129
	(0.153)	(0.139)	(0.104)	(0.130)
Household Income (mil.)	-0.0621	-0.0568	-0.0462	-0.0532
	(0.0518)	(0.0472)	(0.0353)	(0.0440)
Occupational fixed effects	No	No	No	No
Provincial fixed effects	No	No	No	No
Number of observations	913	913	913	913
Number of commune clusters	373	373	373	373
R-squared	0.065	0.065	0.065	0.065

Notes: ***, ** and * indicates significance level of 1%, 5% and 10% respectively against a two sided alternative. Clustered standard errors are in round brackets.

Table 7. Baseline estimations. Log Temperature variation

	(1)	(2)	(3)	(4)
VARIABLES	Risk aversion 1	Risk aversion 2	Risk aversion 3	Risk aversion 4
Log Temperature variation (oC)	0.531***	0.483***	0.362***	0.451***
	(0.144)	(0.131)	(0.0976)	(0.122)
Minority	0.298*	0.271*	0.193*	0.252*
	(0.159)	(0.145)	(0.109)	(0.135)
Age of head	0.00381	0.00364	0.00249	0.00326
	(0.0193)	(0.0176)	(0.0132)	(0.0164)
Age of head, square/100	0.00159	0.00130	0.00102	0.00132
	(0.0160)	(0.0146)	(0.0110)	(0.0136)
Rural	0.806***	0.734***	0.546***	0.685***
	(0.254)	(0.231)	(0.174)	(0.216)
Year of schooling of head	0.0101	0.00923	0.00735	0.00861
	(0.0124)	(0.0113)	(0.00843)	(0.0106)
Male	-0.149	-0.136	-0.102	-0.127
	(0.147)	(0.133)	(0.0991)	(0.124)
Married	-0.181	-0.165	-0.121	-0.154
	(0.153)	(0.139)	(0.104)	(0.130)
Household Income (mil.)	-0.0258	-0.0238	-0.0206	-0.0223
	(0.0510)	(0.0464)	(0.0347)	(0.0433)
Occupational fixed effects	Yes	Yes	Yes	Yes
Provincial fixed effects	Yes	Yes	Yes	Yes
Number of observations	913	913	913	913
Number of commune clusters	373	373	373	373
R-squared	0.15	0.15	0.15	0.15

Notes: ***, ** and * indicates significance level of 1%, 5% and 10% respectively against a two sided alternative. Clustered standard errors are in round brackets.

Table 8. Climate variation and social trust. Adding geographic variables

VARIABLES	(1) Risk aversion 1	(2) Risk aversion 2	(3) Risk aversion 3	(4) Risk aversion 4
Log of rainfall variation	1.478**	1.352**	1.026**	1.258**
	(0.730)	(0.664)	(0.495)	(0.620)
Minority	0.159	0.144	0.100	0.134
	(0.168)	(0.153)	(0.115)	(0.143)
Age of head	0.0120	0.0111	0.00803	0.0102
	(0.0197)	(0.0180)	(0.0135)	(0.0167)
Age of head, square/100	-0.00523	-0.00491	-0.00360	-0.00447
	(0.0164)	(0.0150)	(0.0113)	(0.0140)
Rural	0.461**	0.420**	0.312**	0.391**
	(0.218)	(0.198)	(0.149)	(0.185)
Year of schooling of head	0.0119	0.0109	0.00865	0.0102
	(0.0127)	(0.0116)	(0.00866)	(0.0108)
Gender (Male:=1)	-0.192	-0.175	-0.132	-0.163
	(0.138)	(0.126)	(0.0932)	(0.117)
Married	-0.196	-0.179	-0.131	-0.166
	(0.146)	(0.133)	(0.0990)	(0.124)
Log Household income	-0.0167	-0.0156	-0.0152	-0.0146
	(0.0535)	(0.0487)	(0.0363)	(0.0454)
Average Rainfall (mm)	-0.00414	-0.00381	-0.00296	-0.00354
	(0.00406)	(0.00369)	(0.00275)	(0.00345)
Average Temperature (oC)	0.0283	0.0255	0.0179	0.0240
	(0.0484)	(0.0440)	(0.0327)	(0.0411)
Area of Land (1000m2)	0.00108	0.00100	0.000798	0.000926
	(0.00301)	(0.00274)	(0.00205)	(0.00255)
Land terrain (Flat:=1)	-0.0424	-0.0386	-0.0195	-0.0352
	(0.0924)	(0.0842)	(0.0635)	(0.0786)
Land quality	0.133	0.118	0.0829	0.112
	(0.154)	(0.140)	(0.104)	(0.131)
Occupational fixed effects	Yes	Yes	Yes	Yes
Provincial fixed effects	Yes	Yes	Yes	Yes
Number of observations	913	913	913	913
Number of commune clusters	373	373	373	373
R-squared	0.14	0.14	0.14	0.14

Notes: ***, ** and * indicates significance level of 1%, 5% and 10% respectively against a two sided alternative. Clustered standard errors are in round brackets.

Table 9. Climate variation and social trust. Adding geographic variables

	(1)	(2)	(3)	(4)
VARIABLES	Risk aversion 1	Risk aversion 2	Risk aversion 3	Risk aversion 4
Log of temperature variation	0.564***	0.514***	0.383***	0.480***
	(0.149)	(0.135)	(0.101)	(0.126)
Minority	0.268	0.243	0.174	0.227
	(0.169)	(0.154)	(0.115)	(0.144)
Age of head	0.00667	0.00625	0.00446	0.00569
	(0.0192)	(0.0176)	(0.0132)	(0.0164)
Age of head, square/100	-0.00111	-0.00117	-0.000838	-0.000978
	(0.0161)	(0.0147)	(0.0110)	(0.0137)
Rural	0.709***	0.646***	0.481***	0.603***
	(0.220)	(0.200)	(0.150)	(0.187)
Year of schooling of head	0.0119	0.0109	0.00866	0.0102
	(0.0125)	(0.0114)	(0.00850)	(0.0106)
Gender (Male:=1)	-0.160	-0.145	-0.110	-0.136
	(0.143)	(0.130)	(0.0964)	(0.121)
Married	-0.193	-0.176	-0.129	-0.164
	(0.151)	(0.138)	(0.102)	(0.128)
Log Household income	-0.0255	-0.0236	-0.0211	-0.0221
	(0.0517)	(0.0471)	(0.0351)	(0.0439)
Average Rainfall (mm)	0.00587**	0.00535**	0.00398**	0.00499**
	(0.00286)	(0.00261)	(0.00196)	(0.00243)
Average Temperature (oC)	0.128**	0.117**	0.0871**	0.109**
	(0.0496)	(0.0452)	(0.0339)	(0.0422)
Area of Land (1000m2)	0.000706	0.000657	0.000531	0.000605
	(0.00298)	(0.00271)	(0.00203)	(0.00253)
Land terrain (Flat:=1)	-0.0800	-0.0729	-0.0450	-0.0672
	(0.0918)	(0.0837)	(0.0631)	(0.0781)
Land quality	0.147	0.131	0.0929	0.123
	(0.160)	(0.146)	(0.108)	(0.136)
Occupational fixed effects	Yes	Yes	Yes	Yes
Provincial fixed effects	Yes	Yes	Yes	Yes
Number of observations	913	913	913	913
Number of commune clusters	373	373	373	373
R-squared	0.14	0.14	0.14	0.14

Notes: ***, ** and * indicates significance level of 1%, 5% and 10% respectively against a two sided alternative. Clustered standard errors are in round brackets.

Table 10. Climate variation and risk aversion by female

	Female			
VARIABLES	Risk aversion 1	Risk aversion 2	Risk aversion 3	Risk aversion 4
Log rainfall variation	1.853	1.694	1.260	1.573
	(1.344)	(1.223)	(0.911)	(1.141)
Individual controls	Yes	Yes	Yes	Yes
Geographical control	Yes	Yes	Yes	Yes
Occupational fixed effects	Yes	Yes	Yes	Yes
Provincial fixed effects	Yes	Yes	Yes	Yes
Number of observations	154	154	154	154
Number of commune clusters	126	126	126	126
R-squared	0.21	0.21	0.21	0.21

Notes: ***, ** and * indicates significance level of 1%, 5% and 10% respectively against a two sided alternative. Clustered standard errors are in round brackets.

Table 11. Climate variation and risk aversion by female

	Female			
VARIABLES	Risk aversion 1	Risk aversion 2	Risk aversion 3	Risk aversion 4
Log temperature variation	0.0733	0.0672	0.0591	0.0633
	(0.334)	(0.304)	(0.226)	(0.283)
Individual controls	Yes	Yes	Yes	Yes
Geographical control	Yes	Yes	Yes	Yes
Occupational fixed effects	Yes	Yes	Yes	Yes
Provincial fixed effects	Yes	Yes	Yes	Yes
Number of observations	154	154	154	154
Number of commune clusters	126	126	126	126
R-squared	0.2	0.2	0.2	0.2

Notes: ***, ** and * indicates significance level of 1%, 5% and 10% respectively against a two sided alternative. Clustered standard errors are in round brackets.

Table 12. Climate variation and risk aversion by Male

	Male			
VARIABLES	Risk aversion 1	Risk aversion 2	Risk aversion 3	Risk aversion 4
Log rainfall variation	1.415*	1.295*	0.988*	1.205*
	(0.795)	(0.723)	(0.540)	(0.675)
Individual controls	Yes	Yes	Yes	Yes
Geographical control	Yes	Yes	Yes	Yes
Occupational fixed effects	Yes	Yes	Yes	Yes
Provincial fixed effects	Yes	Yes	Yes	Yes
Number of observations	759	759	759	759
Number of commune clusters	350	350	350	350
R-squared	0.17	0.17	0.17	0.17

Notes: ***, ** and * indicates significance level of 1%, 5% and 10% respectively against a two sided alternative. Clustered standard errors are in round brackets.

Table 13. Climate variation and risk aversion by Male

	Male			
VARIABLES	Risk aversion 1	Risk aversion 2	Risk aversion 3	Risk aversion 4
Log temperature variation	0.675***	0.615***	0.457***	0.574***
	(0.154)	(0.140)	(0.105)	(0.131)
Individual controls	Yes	Yes	Yes	Yes
Geographical control	Yes	Yes	Yes	Yes
Occupational fixed effects	Yes	Yes	Yes	Yes
Provincial fixed effects	Yes	Yes	Yes	Yes
Number of observations	759	759	759	759
Number of commune clusters	350	350	350	350
R-squared	0.17	0.17	0.17	0.17

Notes: ***, ** and * indicates significance level of 1%, 5% and 10% respectively against a two sided alternative. Clustered standard errors are in round brackets.

Table 14. Climate variation and absolute risk aversion

VARIABLES	Absolute risk aversion coefficient			
	Log Rainfall variation (100mm)		Log Temperature variation (oC)	
Climate variation	0.607***	0.890***	0.101	0.190
	(0.165)	(0.257)	(0.0681)	(0.116)
Individual controls	Yes	Yes	Yes	Yes
Geographical control	No	No	No	No
Occupational fixed effects	Yes	Yes	Yes	Yes
Provincial fixed effects	No	Yes	No	Yes
Number of observations	919	919	919	919
Number of clusters	373	373	373	373
R-squared	0.057	0.107	0.04	0.09

Notes: ***, ** and * indicates significance level of 1%, 5% and 10% respectively against a two sided alternative. Clustered standard errors are in round brackets.

Table 15. Climate variation and absolute risk aversion

VARIABLES	Absolute risk aversion coefficient			
	Log Rainfall variation (100mm)		Log Temperature variation (oC)	
Climate variation	0.815***	1.530***	0.185**	0.237**
	(0.271)	(0.520)	(0.0724)	(0.116)
Individual controls	Yes	Yes	Yes	Yes
Geographical control	Yes	Yes	Yes	Yes
Occupational fixed effects	Yes	Yes	Yes	Yes
Provincial fixed effects	No	Yes	No	Yes
Number of observations	919	919	919	919
Number of clusters	373	373	373	373
R-squared	0.08	0.124	0.08	0.12

Notes: ***, ** and * indicates significance level of 1%, 5% and 10% respectively against a two sided alternative. Clustered standard errors are in round brackets.

Table 16. Rainfall variation and risk aversion

VARIABLES	Risk aversion 1	Risk aversion 2	Risk aversion 3	Risk aversion 4	Absolute risk aversion
Log rainfall variation	1.279*	1.228*	0.928*	1.143*	1.435***
	(0.738)	(0.671)	(0.503)	(0.626)	(0.549)
Number of natural disaster 2002-2006	0.0369	0.0318	0.0219	0.0294	0.0160
	(0.0705)	(0.0650)	(0.0487)	(0.0607)	(0.0556)
Number of natural disaster 2006-2010	0.0628	0.0606	0.0466	0.0566	0.0364
	(0.0544)	(0.0509)	(0.0382)	(0.0474)	(0.0396)
Individual controls	Yes	Yes	Yes	Yes	Yes
Geographical control	Yes	Yes	Yes	Yes	Yes
Occupational fixed effects	Yes	Yes	Yes	Yes	Yes
Provincial fixed effects	Yes	Yes	Yes	Yes	Yes
Number of observations	606	583	583	583	610
Number of commune clusters	242	242	242	242	244
R-squared	0.251	0.257	0.258	0.257	0.169

Notes: ***, ** and * indicates significance level of 1%, 5% and 10% respectively against a two sided alternative. Clustered standard errors are in round brackets.

Table 17. Temperature variation and risk aversion

VARIABLES	Risk aversion 1	Risk aversion 2	Risk aversion 3	Risk aversion 4	Absolute risk aversion
Log temperature variation	0.511***	0.494***	0.378***	0.461***	0.282**
	(0.184)	(0.174)	(0.130)	(0.162)	(0.141)
Number of natural disaster 2002-2006	0.0506	0.0448	0.0319	0.0416	0.0215
	(0.0678)	(0.0621)	(0.0465)	(0.0580)	(0.0557)
Number of natural disaster 2006-2010	0.0615	0.0588	0.0452	0.0549	0.0391
	(0.0531)	(0.0498)	(0.0373)	(0.0464)	(0.0392)
Individual controls	Yes	Yes	Yes	Yes	Yes
Geographical control	Yes	Yes	Yes	Yes	Yes
Occupational fixed effects	Yes	Yes	Yes	Yes	Yes
Provincial fixed effects	Yes	Yes	Yes	Yes	Yes
Number of observations	606	583	583	583	610
Number of commune clusters	242	242	242	242	244
R-squared	0.269	0.276	0.277	0.276	0.167

Notes: ***, ** and * indicates significance level of 1%, 5% and 10% respectively against a two sided alternative. Clustered standard errors are in round brackets.

Table 18. Rainfall variation and risk aversion

VARIABLES	Risk aversion 1	Risk aversion 2	Risk aversion 3	Risk aversion 4	Absolute risk aversion
Log rainfall variation	1.262*	1.221*	0.921*	1.136*	1.458***
	(0.747)	(0.680)	(0.510)	(0.635)	(0.554)
Share of losses over income 2002-2006	-0.125	-0.116	-0.0925	-0.107	0.0112
	(0.112)	(0.102)	(0.0801)	(0.0952)	(0.0597)
Share of losses over income 2006-2010	0.136	0.224	0.156	0.209	0.0693
	(0.100)	(0.179)	(0.136)	(0.167)	(0.114)
Individual controls	Yes	Yes	Yes	Yes	Yes
Geographical control	Yes	Yes	Yes	Yes	Yes
Occupational fixed effects	Yes	Yes	Yes	Yes	Yes
Provincial fixed effects	Yes	Yes	Yes	Yes	Yes
Number of observations	606	582	582	582	609
Number of commune clusters	242	242	242	242	244
R-squared	0.252	0.258	0.258	0.258	0.169

Notes: ***, ** and * indicates significance level of 1%, 5% and 10% respectively against a two sided alternative. Clustered standard errors are in round brackets.

Table 19. Temperature variation and risk aversion

VARIABLES	Risk aversion 1	Risk aversion 2	Risk aversion 3	Risk aversion 4	Absolute risk aversion
Log temperature variation	0.500***	0.492***	0.376***	0.459***	0.285**
	(0.185)	(0.174)	(0.130)	(0.163)	(0.142)
Share of loss over income 2002-2006	-0.112	-0.104	-0.0834	-0.0963	0.0109
	(0.118)	(0.107)	(0.0842)	(0.0998)	(0.0611)
Share of loss over income 2006-2010	0.0987	0.240	0.168	0.224	0.0459
	(0.113)	(0.169)	(0.128)	(0.157)	(0.128)
Individual controls	Yes	Yes	Yes	Yes	Yes
Geographical control	Yes	Yes	Yes	Yes	Yes
Occupational fixed effects	Yes	Yes	Yes	Yes	Yes
Provincial fixed effects	Yes	Yes	Yes	Yes	Yes
Number of observations	605	582	582	582	609
Number of commune clusters	242	242	242	242	244
R-squared	0.268	0.276	0.278	0.276	0.167

Notes: ***, ** and * indicates significance level of 1%, 5% and 10% respectively against a two sided alternative. Clustered standard errors are in round brackets.

Appendix II

1. Risk aversion and Climate variation. Rainfall and Temperature regression

VARIABLES	(1) Risk aversion 1	(2) Risk aversion 2	(3) Risk aversion 3	(4) Risk aversion 4	(1) Risk aversion 1	(2) Risk aversion 2	(3) Risk aversion 3	(4) Risk aversion 4
	Log Rainfall variation				Log temperature variation			
Climate variation	0.00803*	0.00735*	0.00556*	0.00684*	0.240***	0.218***	0.163***	0.204***
	(0.00433)	(0.00394)	(0.00293)	(0.00368)	(0.0575)	(0.0523)	(0.0391)	(0.0489)
Individual controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Geographic controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Occupational fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Provincial fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of Observations	913	913	913	913	913	913	913	913
Number of clusters	373	373	373	373	373	373	373	373
R-squared	0.14	0.14	0.14	0.14	0.17	0.17	0.17	0.17

Notes: ***, ** and * indicates significance level of 1%, 5% and 10% respectively against a two sided alternative. Clustered standard errors are in round brackets.

2. Risk aversion and Climate variation. Logistic regression

VARIABLES	(1) Risk aversion 1	(2) Risk aversion 2	(3) Risk aversion 3	(4) Risk aversion 4	(1) Risk aversion 1	(2) Risk aversion 2	(3) Risk aversion 3	(4) Risk aversion 4
	Log Rainfall variation				Log temperature variation			
Climate variation	2.6*	2.6*	2.6*	2.6*	1.46***	1.46***	1.46***	1.46***
	(1.41)	(1.41)	(1.41)	(1.41)	(0.37)	(0.37)	(0.37)	(0.37)
Individual controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Geographic controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Occupational fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Provincial fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of Observations	913	913	913	913	913	913	913	913
Number of clusters	373	373	373	373	373	373	373	373
Pseudo R-squared	0.07	0.07	0.07	0.07	0.09	0.09	0.09	0.09

Notes: ***, ** and * indicates significance level of 1%, 5% and 10% respectively against a two sided alternative. Clustered standard errors are in round brackets.