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Cooperation makes beliefs: Weather variation and social trust in Vietnam

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ABSTRACT

Many studies have found that social trust plays crucial roles in economic development through their facilitation of cooperation and network connections amongst the members of a community. However, there are few studies that examine the relationship between the natural environment and social trust. In this paper, we examine empirically the hypothesis that the development of trust is based on the demand for cooperation to cope with natural weather fluctuations, which are considered as the main risks for agricultural activities. To test our hypothesis, we use data from the 2008 Vietnam Access to Resources Household Survey to investigate the relationship between weather variability in the past and current trust. The result shows that individuals who are heavily threatened by negative weather fluctuation seem to have higher level of trust in neighbours and others within their close group. The evidence shows that the relationship between weather variation on social trust may be transmitted through strengthening the cooperation amongst village peasants and family ties as they cope with risk and uncertainty. There is also evidence that households with a higher proportion of agricultural income tend to trust people more.

1. Introduction

The past two decades has seen a rapidly increasing consensus amongst economists that institutions are one of the most important determinants of economic growth and hold the key to prevailing patterns of prosperity around the world.[1] Along with expanding research on formal institutions, economists also now pay more attention to the role of informal institutions and their interaction with formal institutions as key factors contributing to economic development (Jutting, Drechsler, Bartsch & Soysa, 2007; Levitsky & Helmke, 2004). Substantial studies have found that informal institutions, such as social trust,[2] play crucial roles on economic and institutional development through their facilitation of cooperation, network connections, and mutual monitoring amongst the members of a community.[3]

However, little attention has been paid to ascertaining the relationship between social trust and natural environment. Some studies have attempted to explain the large differences in trust across and within countries and revealed that historical circumstances, particularly experiences of cooperation or conflict such as the city-state experience in medieval Italy, the missionary activities and slave trade in Africa, can have long-lasting effects on the level of trust in a community (Guiso, Sapienza & Zingales, 2008; Nunn, 2010; Nunn & Wantchekon, 2011; Tabellini, 2010). At the same time, Van de Vliert (2007) provided evidence that there is a relationship between the harshness of the climate, measured as the deviations temperature from ideal temperature, and inhabitants' social capital. In particular, they found that compared to people living in higher-income countries with harsher climates, people in lower-income countries with harsher climates are expected to value greater behavioural investments in survival and less trusting.

The primary objective of this paper is to complement studies that try to understand factors leading to social trust. Specifically, we examine empirical relationships between weather variation and social trust in

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[1] See for example Knack and Keefer (1995); Mauro (1995); Alesina et al. (1996); Hall and Jones (1999); Acemoglu, Johnson and Robinson (2001, 2002); Rodrik (2000a, 2000b); Easterly and Levine (2003); La Porta et al. (1999, 2004); Acemoglu and Johnson (2005); Acemoglu (2009).

[2] Social trust can be understood as shared expectation of honest and cooperative behaviour in a community (Fukuyama, 1995). The trust literature also distinguishes between two kinds of trust: generalized trust and particularized trust. Particularized trust refers to the situation in which individuals trust members of a narrow circle of persons. In this paper, we focus on generalized trust, which is trust toward people in general, outside family and kin networks, including strangers (Delhey et al., 2011; Freitag & Traunmüller, 2009).

[3] Some influential studies include Helliwell and Putnam (1995); Knack and Keefer (1995); Guiso, Sapienza and Zingales (2004, 2006); Tabellini (2010).

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Viet Nam. Viet Nam offers an attractive setting to study social trust. Unlike many other developing countries and transitional economies, Viet Nam has experienced exceptional per capita income growth in the last three decades, accompanied by fundamental but gradual social changes without large-scale social or political upheavals. However, the high economic growth cannot be explained by the quality of formal institutions as Viet Nam is ranked at a low level in international ranking tables such as Polity IV and Governance Indicator. One explanation is that weak formal institutions are likely to be supplemented by strong informal institutions. For instance, the World Value Surveys show that the Vietnamese national level of social trust appears higher than some other East Asian nations at the same stage of economic development (Dalton & Ong, 2005).

We examine empirically the hypothesis that development of trust is based on the demand for cooperation between rural people to cope with natural weather fluctuations, which are considered as the main risks for agricultural activities (Durante, 2009; Rambo, 1979; Tran, 1997). Farmers in rural and remote regions, in which well-functioning credit and insurance markets do not exist, have to rely on different strategies to protect themselves from natural shocks. Of these strategies, some are only effective if there is some degree of collective effort and involvement of the broader community (Durante, 2009). They also can improve their insurance capacity against natural risks by expanding their relationship with other members in the same commune, who are likely to be affected by weather fluctuations in the same way. All of these increase trustworthiness amongst them.

To test our hypothesis, we use data from the 2008 Viet Nam Access to Resources Household Survey to investigate whether households living in regions that were heavily affected by weather variability in the past now trust other people more. Through combining historical weather data for the period 1927 - 1995 with contemporary survey data on social capital available from different regions across the country, the analysis provides evidence that regions with greater inter-annual fluctuations in rainfall and extreme rainfall variation have higher levels of interpersonal trust amongst village peasants. This study also indicates that although some can argue that other factors, such as genetics or education, play a much larger role in the development of social capital, the relationship of weather variability and social trust can no longer be ignored. In other words, Vietnam's natural weather variation may play an important role in the development of Vietnamese culture and social values.

We then turn to specific mechanisms and examine some potential explanations for the relationship between weather variation and trust. We found the evidence that people living with more weather variation tend to ask for help from their neighbours in the case of emergency, and this may enhance mutual trust. Besides, we find that households who rely more on agricultural incomes may trust other people more. We also examine the relationship between weather variation and an individual's propensity to rely on the family for insurance purposes. We find that weather variation increases family ties.

The paper has been organized in the following way. Section 2 illustrates the conceptual framework and its predictions. Section 3 describes the data. Section 4 explains the empirical strategy and presents the results obtained using historical weather data. Finally, Section 5 summarizes the key findings and concludes.

2. Conceptual framework

There are several mechanisms by which weather variation is likely to impact on trust. The first mechanism is that the difficult natural environment creates favourable conditions for cooperation. Some authors seek to explain the development of trust based on the demand for cooperation between peasants to cope with natural weather fluctuations, which are considered as the main risks for agricultural activities (Durante, 2009; Rambo, 1979; Tran, 1997). Durante (2009) proposed that peasants in rural and remote regions, in which well-functioning credit and insurance markets do not exist, have to rely on different strategies to protect themselves from natural shocks. Of these, some strategies are only effective if there is some degree of collective effort and involvement by the broader community. For example, as large-scale constructions have to be built to ease the impacts of a hazardous environment, they require cooperative action amongst members of the local community. In addition, as natural shocks happen frequently, there is an increase in peasant's perceived probability that a similar event might occur in the future. They can improve insurance capacity against natural risks by expanding the relationship with other members in the same communes, who are likely to be affected by weather fluctuations in the same ways. This may make people to be more trusting (Cassar, Healy & Kessler, 2017).[4]

Rambo (1979) demonstrated that a peasant society in a high-risk environment has evolved a series of institutions which serve to reduce individual insecurity by spreading risk-taking over a group larger than the nuclear family such as the extended family and the corporate community. As village members choose to cooperate with other members, it increases the trust of other village members. As Ermisch & Gambetta (2010) suggested, interacting more with other people can lead to more "outward exposure", and improve their ability to trust other people by (1) estimating more correctly the probability of trustworthiness; or (2) reading the signs of untrustworthiness more precisely. Therefore, peasants who cooperate and interact less with other people will exhibit a lower level of trust in other village members.

The other potential mechanism is from cultural adaptation. Social trust can be arisen by the demand for cooperation by village people in coping with natural disasters and this attitude is transmitted through generations. Several papers show that trust attitudes, like other cultural traits, can persist for surprisingly long periods (for example, Alesina & Fuchs-Schundeln, 2007; Bisin & Verdier, 2001, Guiso et al., 2008, Tabellini, 2008; Nunn, 2010; Nunn & Wantchekon, 2011). A study by Guiso et al. (2008) showed that parents can transmit their prior trustworthiness to their children. In another study, Bjørnskov (2007) found that trust scores are remarkably stable over several decades. Stability of trust is also revealed by the empirical findings on the existence of a strong correlation in the propensity to trust between parents and children (Dohmen, Huffman & Sunde, 2008; Katz & Rotter, 1969) and between second-generation immigrants and current residents of the original country (Guiso, Sapienza & Zingales, 2006; Algan & Cahuc, 2010).

However, there may be another case. It is possible that low-trust individuals may select to stay into areas with more variable weather. For example, Van de Vliert (2007) found that people in lower-income countries with more volatile climates are expected to be less trusting compared to people living in higher-income countries with similar conditions.

[4] Our framework is the simple representation of a coordination game. In which, there are two equilibria: both cooperate and neither cooperate. There may be a case that cooperation among peasants fails as confronting with covariant shocks, leading to risk dominant equilibrium. We assume that the magnitudes of the benefit of cooperation outweigh the risk that results in payoff dominant equilibrium where peasants cooperate. It could be true as peasants live long enough in one place and they can find the mutual benefits of cooperation.

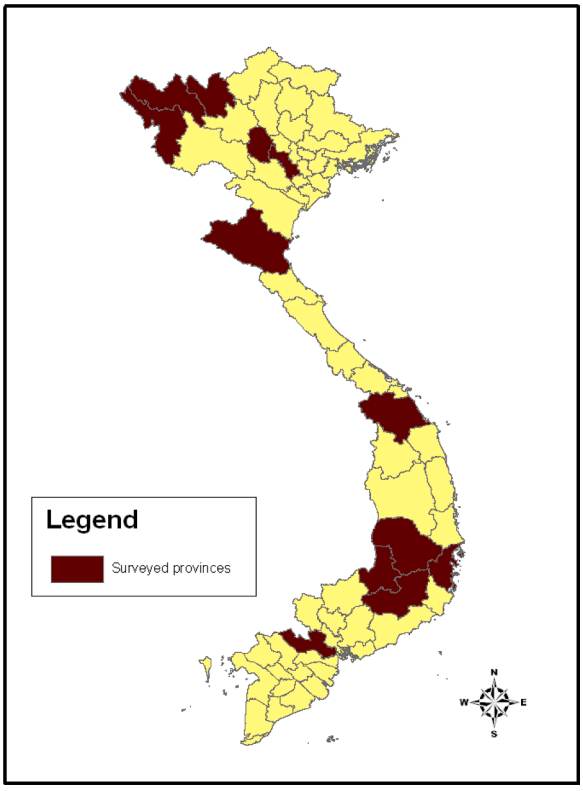

Fig. 1. Map showing the current locations of respondents.

Table 1
Descriptive statistics.

Variables	Obs	Mean	Std. Dev.	Min	Max
Most people can be trusted	2370	0.87	0.33	0	1
Careful in dealing with people	2370	0.53	0.50	0	1
Log highest rainfall variation over 1927 – 1985	2370	4.38	0.52	3.35	5.33
Log rainfall deviation over 1975 – 2006	2370	4.54	0.30	3.97	5.37
Log average monthly rainfall	2370	5.01	0.35	2.96	5.70
Age of head	2370	49.35	14.50	18	107
Year of schooling of head	2370	8.12	3.66	1	13
Gender (Male:=1)	2370	0.84	0.37	0	1
Married	2370	0.85	0.35	0	1
Minority	2370	0.42	0.49	0	1
Log household income	2370	3.18	0.86	−0.12	7.02
Household size	2370	4.88	2.06	1	17
Area of land (1000m2)	2370	8.85	20.72	0.04	830.42
Land terrain (Flat:=1)	2370	0.52	0.50	0	1
Land quality (Good:=1)	2370	0.02	0.12	0	1
Member of social and religious groups	2370	0.78	0.42	0	1
Attend meeting frequently	2370	0.52	0.50	0	1
Hours of watching TV	2370	1.41	1.00	0	5
Borrowing from same village	2084	1.46	0.98	0	3
Borrowing from relatives	2084	1.27	1.01	0	3
Having insurance	2370	0.85	0.36	0	1
Share of minority in communes	2370	0.38	0.46	0	1
Share of villages with roads passable by car	2311	0.73	0.33	0	1
Share of villages with waterway	2311	0.39	0.41	0	1
Share of villages with electricity	2311	0.79	0.35	0	1

Note: The summary statistics are calculated based on VARHS data.

3. Data sources and description

3.1. Social trust

We employ Vietnam Access to Resources Household Survey (VARHS)[5] in 2008 to inspect the impacts of weather volatility on social trust in different parts of the empirical analysis.

The VARHS is uniquely representative surveys which are based on interviews of a random sample of 2370 households in rural regions. In total, the survey covers rural areas of 12 provinces in Vietnam, including: Ha Tay, Lao Cai, Phu Tho, Dien Bien and Lai Chau in the North; Nghe An in the North central Coast; Quang Nam and Khanh Hoa in the South Central Coast; Dak Lak, Dak Nong and Lam Dong in the Central Highland and Long An in the Mekong River Delta. The special feature of this survey is that these provinces are located in different geographical regions that reflect various weather conditions.

The survey provides rich information on a broad range of topics, such as rural employment, on- and off-farm income generating activities, rural enterprises, property rights, savings, investment, insurance and participation in formal and informal social networks. The visual location distribution of current respondents is represented in Fig. 1. The summary statistics of our analysis sample are presented in Table 1. As shown by Table 1, many respondents live in remote and mountainous areas, with 42 per cent belonging to minority groups.

The survey asks two standard questions about self-reported trust. The exact wording of the question is as follows: 'Please tell me whether in general you agree or disagree with the following statements: Most people are generally honest and can be trusted and In this commune one has to be careful, there are people you cannot trust?'[6] Respondents could either agree or disagree.[7]

The two survey questions seem to ask about generalized trust at different levels with the first asking about social trust for a broader community (or broader radius).[8] However, as shown by Delhey, Newton and Welzel (2011), the radius of "most people" is narrower in Confucian countries. Therefore, respondents for this question are likely to extrapolate from their attitudes to trust in their narrow community such as village and commune and both two questions are likely to reflect the interpersonal trust amongst village/commune members.

The distributions of responses for question on social trust are summarized in Table 3.[9] One of the characteristics of the responses is notable. The share of respondents who agree with the statement "most people are generally honest and can be trusted" is above 87 per cent. The results are consistent with those reported in Dalton, Pham, Pham and Ong (2002), which show that the Vietnamese exhibit high levels of trust, compared with other countries surveyed under the World Values Survey project. However, there are more than 50 per cent of people who believe that there are people you cannot trust.

3.2. Family and village ties

The importance of family is a historical aspect of Vietnamese society,

[5] The survey data was conducted in 2008 by the Institute of Labour Science and Social Affairs of the Ministry of Labour, Invalids and Social Affairs (MOLISA) under the technical support from Department of Economics at the University of Copenhagen. All rural households in 12 provinces interviewed for the 2004 Vietnam Household Living Standards Survey has been resurveyed. The data are publicly available and can be downloaded at: http://www.econ.ku.dk/derg/links/vietnam/.

[6] This kind of questions may not fully reflect individual trust attitudes as it is relatively ambiguous and does not explicitly specify the object of the respondent's trust (Durante 2009).

[7] The respondents for this question are mainly head (74.52 per cent) and spouse (21.78 per cent).

[8] Hoorn (2014) showed that trust level and trust radius is measured differently.

[9] The statistical summary is based on the number of rural households for those heads/spouses born in the same place where they are living.

Table 2
Overview of the responses to trust question and asking for help (percent).

Provinces	Most people can be trusted	Careful in dealing with people	Share of helpers who are relatives	Share of helpers who are village members
Northern provinces				
Ha Tay	86.50	59.50	80.23	79.98
Lao Cai	96.86	36.08	66.57	88.91
Phu Tho	91.43	82.50	65.38	75.88
Lai Chau	86.12	12.81	66.54	91.92
Dien Bien	70.68	57.83	81.82	81.06
Nghe An	91.50	39.22	69.05	64.85
Southern provinces				
Quang Nam	94.19	53.49	56.46	78.16
Khanh Hoa	90.38	15.38	85.89	71.79
Dac Lac	90	71.25	46.79	73.71
Dac Nong	92	60	60.04	72.06
Lam Dong	92.59	66.67	44.44	74.69
Long An	79.82	77.13	62.40	64.69
Average	87.47	53.21	67.76	78.23

Note: The summary statistics are calculated based on VARHS data.

as with many Confucian societies in East Asia. The family is a basis of economic organization in an agrarian economy, the role of the father and parents, in general, is reinforced by cultural traditions, and family relations provide a general model for authority relations. Through history and changes in political and social regimes, the centrality of the family appears to be an enduring feature of Vietnamese society (Dalton et al., 2002).

To investigate the relationship between weather variation and extended family ties, we use information about households who reported having helpers. The survey asks respondents to provide information about people who are a source of monetary help in case of emergency. People can list the name of up to three people whom they asked for help. The exact question is "If you were in need of money in case of an emergency who outside of your household could you turn to, who would be willing to provide this assistance?" In addition, the survey includes another question about the relationship of these people with the household: (1) Relative; (2) Friend; (3) Neighbour; or (4) Other. The survey also provides information on whether these people are in the same village or not.

We classify whether a household mainly asks for help from relatives rather than a friend or neighbours by counting the number of people in the response lists who are relatives. Relatives can be people who live outside the villages. Table 2 shows that nearly 68 per cent of the helpers mentioned are relatives of the respondents. The number of households who ask for help from other members of the same village is even greater at 78 per cent.

The results on the share of helpers who are relatives are interesting. They show that households in the more developed provinces such as Ha Tay or Long An are at least as likely as households in less developed provinces (for example, Lai Chau and Dien Bien) to mention relatives as their most important helpers. This similarity in level of family ties is the first indication of an important trend: whereas economic development has tended to erode the relative economic importance of family ties in Western countries, this may not necessarily be happening in Viet Nam. Similar conclusions are reached by Dalton et al. (2002), who in a sample that includes both rural and urban dwellers found that the importance of family ties does not decline with socioeconomic status. In the language of social capital theory, Vietnamese families display high levels of "bonding" social capital, and this "traditional" form of social capital does not appear to be worsened by more modern types of social relations (CIEM et al., 2007).

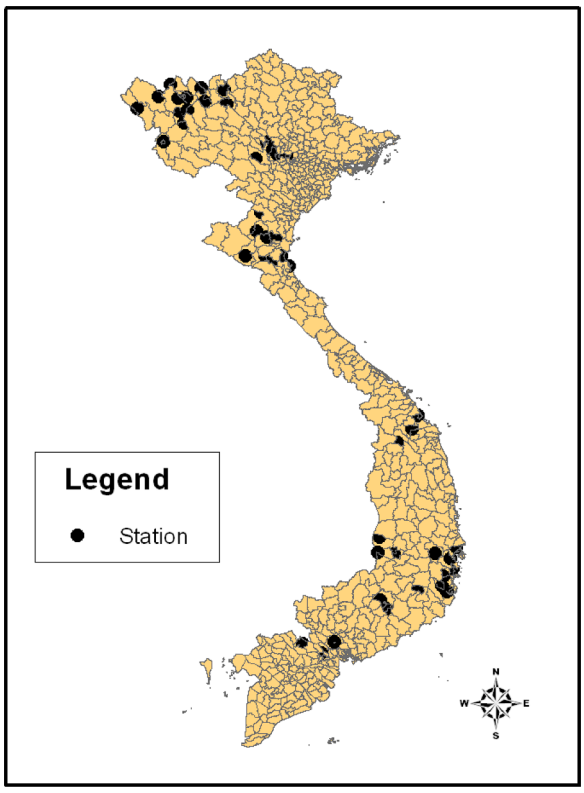

Fig. 2. Map showing the weather station distribution.

3.3. Weather and geographic variables

3.3.1. Rainfall variables

To measure weather variation, we restrict our attention to extreme rainfall variation[10] and year-to-year rainfall deviation. These two variables are expected to have a considerable impact on wet-rice agriculture and other natural resource-dependant activities, and are both highly correlated with other important factors such as storms, typhoon, cyclones, flood and landslides in Vietnam (Benson 1997). Of course, these indicators do not represent a comprehensive catalogue of the physical and biotic components of the Vietnamese habitat. However, they include main factors that have empirically affected the natural adaptation and livelihood strategies of Vietnamese peasants throughout centuries.

The historical data on weather variability was obtained from weather stations in 45 districts produced by the Institute of Meteorology and Hydrology.[11][12] The location of these stations is distributed following the standard of World Meteorological Organization to capture the evolution of weather within regions.[13] To provide the reader with a better sense of station locations, Fig. 2 shows the visual allocation of weather stations across provinces. As it is apparent from the map, the station distribution captures relatively well the effects of weather

[10] Extreme rainfall not only affect crop production but mainly create flood and landslides that destroy accommodation and livestock

[11] On average, there are nearly 12 districts in one province. The area of each district ranges from 27.8 to 3677.4 square kilometres and the mean is 660 square kilometres. For the period 1975–2006, the data is taken from Thomas et al. 'Natural disasters and household welfare: evidence from Vietnam', Policy Research Working Paper, 2010, World Bank.

[12] Weather data at ground stations provide highly accurate measurement of location's climate compared to those composed by gridded or satellite data (Dell et al., 2014).

[13] Law on Meteorology, National Assembly 2015.

variation on our selected group of rural households.

For the remaining 97 districts without stations, the weather conditions were assumed to be similar to districts sharing the same borders with them but have a weather station. The weather in provinces which do not share their borders with any provinces with weather stations is assumed to be similar to that of provinces with the same latitude. The reason for this strategy was that stations were expected to gauge significant weather variations in different regions. Therefore, weather data from one station could be used to measure neighbouring districts with similar conditions.[14]

There were two data series we used to proxy for historical weather variability:

First, monthly rainfall observations (from January to December) were available over 30 years for each station from 1975 to 2006. The rainfall deviation is calculated as following. Consider weather variable x, station i, month m and year y, and define x_{imy} as the value of x in station i in month m in year y. For each month m, we compute the standard deviation of x_{imy} over all years (denoted γ_{im}), which measures the month-specific variability of variable x in station i. To obtain a compound measure of year-to-year variability for station i, we average γ_{im} over the twelve months.[15]

Second, for a longer period, another data series was also available. For each station, we obtained data for the highest rainfall in 58 years for each month during the period from 1907 to 1985. The Institute of Meteorology and Hydrology reported for each station the highest rainfall event for each month over the period from 1927 to 1985. Thus, each station had 12 observations that reported the highest rainfall of that month over 58 years. We calculated the standard deviation over 12 months for that period as a proxy for extreme rainfall variations.

A possible concern regarding these two proxies is whether the measure of rainfall variation can be a good proxy for the riskiness of the natural environment. There are reasons to believe that the construction of year-to-year rainfall and extreme rainfall variations capture the effects of hazardous natural environment such as floods, typhoons and storms in Viet Nam reasonably well. For example, Benson (1997) showed that typhoons are typically associated with heavy rainfall and strong winds. Each typhoon accounts for about 10 to 15 per cent, and sometimes even more, of annual rainfall and causes flash floods and landslides. Besides, heavy rainfall causes rivers to fill and potentially results in flooding.[16] Therefore, we expect the more typhoons and storms one region suffers from, the more rainfall volatility it has.

3.3.2. *Other geographic variables*

Other factors and geographic conditions may have impacts on the evolution of cooperation and the appearance of trust amongst village members. At the same time, they may correlate with weather variation.

Average climatic conditions are likely to have a considerable impact on patterns of cooperative behaviour. For example, even a region without much weather variation but low average rainfall within a year also can lead villagers to devise different livelihood strategies. To account for these effects, we control for the average level of 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.

Table 3
Summary statistics by local born and immigrant samples.

Variables	Mean		Difference in means	
	Local born sample	Immigrant sample	T-statistics	*P*-value
Most people can be trusted	0.87	0.83	3.15	0.00
Careful in dealing with people	0.53	0.56	1.31	0.12
Log of highest rainfall variation over 1927 – 1985	4.38	3.96	19.62	0.00
Log of rainfall deviation over 1975 – 2006	4.55	4.53	2.16	0.03
Log of average monthly rainfall	5.01	4.81	11.37	0.00
Age of head	49.35	46.94	4.05	0.00
Year of schooling of head	8.12	7.77	2.28	0.02
Gender (Male=1)	0.84	0.84	0.35	0.72
Married	0.85	0.86	0.16	0.87
Minority	0.42	0.30	2.14	0.03
Log of household income (mil VND)	3.18	3.52	9.23	0.00
Area of land (1000m2)	8.85	16.28	8.41	0.00
Land terrain (Flat=1)	0.52	0.44	3.71	0.00
Land quality (Good=1)	0.02	0.08	8.48	0.00
Member of social and religious groups	1.15	1.16	0.43	0.66
Attend meeting frequently	0.67	0.63	1.96	0.05
Hours of watching TV	1.41	1.45	1.02	0.31
Borrowing from same village	1.46	1.21	5.51	0.00
Borrowing from relatives	1.27	0.86	9.40	0.00
Number of observations	2370	738		

Note: The summary statistics are calculated based on VARHS data.

Elevation and land terrain can have both direct and indirect effects on patterns of human interaction and on economic outcomes (Nunn & Puga, 2012). Land terrain and elevation can also be correlated with weather variability. For example, a mountain can have different climatic condition and micro-ecosystems on each side (Durante, 2009). This requires village members on each side to have different cooperative strategies. To control for the relationship between weather variability and topography, we include a plot dummy variable to measure agricultural land terrain in regressions. The response for the survey question on land terrain is drawn 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 plots are flat and 0 otherwise. As presented in Table 1, nearly 50 per cent of land plots are in slight to steep slope conditions.

Diversification in land quality may have significant impacts on productivity and village members' motivation to cooperate in agricultural activities (Durante, 2009). To account for this aspect, we include land areas and a dummy variable to measure land quality in regressions. 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"[17]. We construct a measure of land quality that takes on the value of 1 if households do not have any plots that suffer any of the above problems and 0 otherwise. Only two per cent of households report land without any of the above problems.

[14] We also implement a sensitivity test by taking only rural households in regions with weather stations and dropping observations in districts without stations as discussed later

[15] A possible concern is whether the measure of rainfall in the 1990s is a good proxy for historical weather variation a hundred years ago. The construction of rainfall variation does not give any concerns. In fact, the measure of rainfall variation for each station was very similar when we used the period from 1975 to 2006 instead. Therefore, it is reasonable to assume that the historical variation of rainfall in each region has not changed significantly compared to the past.

[16] The correlation between number of storms and floods in 1961 – 2000 is .84

[17] This subjective answer for land quality and steepness may be not reflected precisely household's land conditions.

3.3.3. Migration

Normally, we would like to know precisely when and where an individual moves. This is because the analysis exploits geographic and environment variation to study their impacts on social trust. Migration is likely to bias the regression coefficient in such a way that respondents appear to have a choice in what region to live in, and those people are thus likely to be more trusting.

The survey provides useful information about migration based on questions on how long households have lived in the commune and where people were born. We use them to restrict the sample to households whose head, spouse or both of them are currently living in the region where they were born. The argument here is that the more time those people have been exposed to this environment, the more their norms adapt to this natural condition (Bjørnskov, 2007). In Table 1, the average age of household heads who are born locally is 50 years old. In addition, if we expect that culture is resistant and transmitted through generations, people who were born in an area also are likely to inherit trust from their ancestors who used to live in those settings.

Table 3 displays the characteristics of the local born and immigrant samples. The two groups are similar in marriage status, gender share and other social activities such as joining groups or watching TV. Immigrants have higher income, education and larger land areas. They also live in areas that suffer less from weather variations. However, local rural households tend to ask for monetary help from their relatives' people in the same village more than immigrants do.

4. Empirical strategy and results

We investigate the relationship between weather variability and trust using historical weather data. Since respondents' answers to the trust questions are binary, we then use a logit model to estimate. Our empirical strategy can be summarized by the following equation :[18]

$$\text{Trust}_{i,d,p} = \alpha_p + \beta \text{Weather}_d + X'_{i,d,p}\Gamma + Z'_{i,d}\Phi + \gamma X_c + \varepsilon_{i,d,p} \quad (1)$$

where i denotes a household, c denotes commune within a district, d denotes a district within a province, and p denotes a province. Province fixed effects, α_p, are included to capture province-specific factors such as the effectiveness of local regulations and cultural norms, which may affect trust. The variable $Trust_{i,d,p}$ denotes measures of self-reported trust, which vary across household heads. Weather_d denotes the degree of variability for weather across stations. Finally, β is our coefficient of interest which estimates the relationship between the weather variation in stations and the individual's current level of trust.

The vector $X'_{i,d,p}$ includes information on the household head, such as age, age squared/100, years of education, household income, a gender variable indicator, a dummy variable for people who are ethnic minorities and occupational fixed effects. The vector $Z'_{i,d}$ consists of geographic and social network variables, such as average rainfall, dummies for land terrain and quality, hours watching TV, an indicator of whether attending groups, an indicator of whether people always attend meeting, an indicator of having insurance. $X_c$is a variable designed to capture commune characteristics such as share of minority in communes, number of household in communes, share of villages with roads passable by car, share of villages with waterway, and share of villages with electricity.

Our main explanatory variable, Weather_d, in the Eq. (1) does not vary across individuals, but varies at the station level. Therefore, weather variation will have similar effects for people living near the same station and thus there is a potential for within-group correlation of the residuals. Given this possibility, we cluster all standard errors for a potentially arbitrary correlation between households in the same station.

Table 4
Baseline estimations. Log of highest rainfall variation over 1927 – 1985.

Variables	(1) Most people can be trusted	(2)	(3) Careful in dealing with people	(4)
	Coef	Odd ratio	Coef	Odd ratio
Log of highest rainfall variation	0.946**	2.574**	−0.467	0.627
	(0.461)	(1.187)	(0.403)	(0.253)
Minority	0.270	1.310	−0.492	0.611
	(0.345)	(0.452)	(0.530)	(0.324)
Age of head	0.006	1.006	0.009	1.009
	(0.028)	(0.028)	(0.019)	(0.019)
Age of head, square/100	0.004	1.004	−0.004	0.996
	(0.028)	(0.028)	(0.017)	(0.017)
Year of schooling of head	−0.002	0.998	0.005	1.005
	(0.017)	(0.016)	(0.021)	(0.021)
Gender (Male=1)	0.129	1.138	−0.101	0.904
	(0.221)	(0.251)	(0.227)	(0.205)
Married	0.157	1.170	−0.000	1.000
	(0.212)	(0.248)	(0.215)	(0.214)
Log of household income	−0.095	0.909	0.021	1.022
	(0.076)	(0.069)	(0.086)	(0.088)
Occupational fixed effects	Yes	Yes	Yes	Yes
Provincial fixed effects	Yes	Yes	Yes	Yes
Number of observations	2370	2370	2370	2370
Nagelkerke's R2	0.106		0.246	
LR chi-squared	11.25		4.48	
P-value	0.00		0.03	

Notes: ***, ** and * indicate significance level of 1%, 5% and 10% respectively against a two-sided alternative. Standard errors, clustered at station level, are in brackets. Log likelihood (LR) test compares the log likelihoods of the two models (with and without weather variation variables) and tests whether this difference is statistically significant.

4.1. Empirical results

Table 4 reports the results using log of extreme rainfall variation. Along with the main weather variable, we also control for individual characteristics to examine whether the effects vary systematically across demographic groups. For example, higher levels of income are expected to increase involvement in social networks. Van de Vliert (2007) who showed that with increasing harshness of the climate, people in richer countries are expected to have greater cooperative behaviour compared to lower-income countries. Family activities are expected to be higher amongst the better educated. We also might hypothesize that younger Vietnamese might place less reliance on family ties, and be more integrated to work and friendship networks, all of these could affect social trust. Occupation may be an important determinant of social trust in the sense that people who work in more competitive sectors may have different levels of trust (Francois & van Ypersele, 2008). Time-invariant omitted variables at provincial levels that may correlate with both log of extreme rainfall variation and social trust. We include a set of dummy variables that capture provincial fixed effects.

In Column (1), we find evidence that log of extreme weather variation over 1927 – 1985 is correlated with the first self-reported trust indicator. The estimated coefficients for log of extreme weather variation statistically significant and positively affect trust. This is consistent with the hypothesis that weather variation positively affects individuals' trust of those around them.[19]Other variables in the regression do not show significant effects on social trust.

[18] Because the distribution of the extreme rainfall and rainfall variation are highly right skewed, with a small number of observations taking on large values, we report estimates using the natural log of the weather measures.

[19] Because the variation of extreme rainfall covers the period from 1927 to 1985, the findings may partly reflect the effects of the transmission of social trust from generations to generations.

Table 5
Baseline estimations. Log of rainfall variation over 1975 – 2006.

Variables	(1) Most people can be trusted	(2)	(3) Careful in dealing with people	(4)
	Coef	Odd ratio	Coef	Odd ratio
Log of rainfall variation	3.785***	44.021***	−0.208	0.812
	(0.831)	(36.570)	(0.643)	(0.522)
Minority	0.138	1.148	−0.378	0.685
	(0.364)	(0.418)	(0.536)	(0.367)
Age of head	0.009	1.010	0.009	1.009
	(0.029)	(0.029)	(0.019)	(0.019)
Age of head, square/100	0.000	1.000	−0.004	0.996
	(0.029)	(0.029)	(0.017)	(0.017)
Year of schooling of head	−0.005	0.995	0.005	1.005
	(0.018)	(0.018)	(0.021)	(0.021)
Gender (Male=1)	0.104	1.109	−0.079	0.924
	(0.220)	(0.244)	(0.230)	(0.213)
Married	0.190	1.209	−0.018	0.982
	(0.216)	(0.261)	(0.219)	(0.215)
Log of household income	−0.088	0.916	0.023	1.024
	(0.075)	(0.068)	(0.085)	(0.087)
Occupational fixed effects	Yes	Yes	Yes	Yes
Provincial fixed effects	Yes	Yes	Yes	Yes
Number of observations	2370	2370	2370	2370
Nagelkerke's R2	0.115		0.244	
LR chi-squared	23.38		0.23	
P-value	0.00		0.63	

Notes: ***, ** and * indicate significance level of 1%, 5% and 10% respectively against a two-sided alternative. Standard errors, clustered at station level, are in brackets. Log likelihood (LR) test compares the log likelihoods of the two models (with and without weather variation variables) and tests whether this difference is statistically significant.

We also carried out the Log-likelihood (LR) test to compare the log-likelihoods of the two models (with and without weather variation variables) and test whether this difference is statistically significant. The results show that the difference is statistically significant, and then the model with weather variation variables fits the data significantly better than the more restrictive model. In other words, adding the rainfall variation variables significantly increases the explanative power of the regression model.

The log of extreme rainfall variation coefficients negatively correlated with the second measure of social trust. This means that rural households who live in the areas which frequently suffered from natural disasters tend to less careful in dealing with people, which is also consistent with the above hypothesis. However, the coefficients are not statistically significant.

Table 5 replicates the estimation with the same specification. However, the main explanatory variable is replaced with log of rainfall variation over 1975 - 2006. The results also indicate that the year-to-year rainfall variation has a statistically significant relationship with the trustworthiness of rural people. Moreover, the results from different proxies of weather variation confirm that the natural environment has effects on trust preferences.

Recognizing the potential problem that weather variation may pick up the effects of other geographic variables, in Table 6, we incorporate the vector of geographic controls, which includes log of average rainfall, land area, dummies for land terrain and land quality. The estimates of the coefficients of interest still have significant effects on social trust.

Some authors argued that religion can affect trust (for example, Iannaccone, 1998; Tan & Vogel, 2008; Berggren & Bjørnskov, 2011). Participation in associations is also important because it can affect social trust through repeated interactions. In addition, participation in social groups can enhance trust because social networks created by social

Table 6
Weather variation and social trust. Adding geographic variables.

Variables	(1) Trust people	(2)	(3) Careful dealing with people	(4)	(5) Trust people	(6)	(7) Careful dealing with people	(8)
	Log of highest rainfall variation over 1927 - 1985				Log of rainfall variation over 1975 - 2006			
	Coef	Odd ratio	Coef	Odd ratio	Coef	Odd ratio	Coef	Odd ratio
Weather variation	0.801*	2.229*	−0.546	0.579	2.886***	17.916***	−1.338	0.262
	(0.449)	(1.001)	(0.408)	(0.236)	(0.918)	(16.449)	(0.985)	(0.258)
Minority	0.157	1.171	−0.467	0.627	0.060	1.061	−0.354	0.702
	(0.381)	(0.446)	(0.515)	(0.323)	(0.403)	(0.428)	(0.513)	(0.360)
Age of head	0.005	1.005	0.007	1.008	0.007	1.007	0.006	1.006
	(0.029)	(0.029)	(0.019)	(0.019)	(0.030)	(0.030)	(0.019)	(0.019)
Age of head, square/100	0.004	1.004	−0.003	0.997	0.003	1.003	−0.002	0.998
	(0.029)	(0.029)	(0.017)	(0.017)	(0.029)	(0.029)	(0.017)	(0.017)
Year of schooling of head	−0.002	0.998	0.005	1.005	−0.003	0.997	0.006	1.006
	(0.016)	(0.016)	(0.021)	(0.021)	(0.017)	(0.017)	(0.021)	(0.021)
Gender (Male=1)	0.108	1.113	−0.118	0.889	0.079	1.083	−0.104	0.901
	(0.219)	(0.244)	(0.229)	(0.204)	(0.222)	(0.241)	(0.233)	(0.210)
Married	0.152	1.165	0.005	1.005	0.184	1.201	−0.011	0.989
	(0.215)	(0.250)	(0.210)	(0.211)	(0.217)	(0.260)	(0.216)	(0.213)
Log of household income	−0.105	0.900	0.023	1.023	−0.101	0.904	0.024	1.024
	(0.069)	(0.062)	(0.087)	(0.089)	(0.069)	(0.062)	(0.086)	(0.088)
Log of average rainfall (mm)	1.228***	3.413***	0.290	1.337	0.564	1.757	0.591	1.805
	(0.398)	(1.357)	(0.252)	(0.336)	(0.446)	(0.783)	(0.359)	(0.649)
Area of land (1000m2)	0.008	1.008	−0.001	0.999	0.007	1.007	−0.000	1.000
	(0.012)	(0.012)	(0.002)	(0.002)	(0.011)	(0.011)	(0.002)	(0.002)
Land terrain (Flat=1)	0.103	1.109	0.324*	1.383*	0.114	1.121	0.330**	1.391**
	(0.159)	(0.177)	(0.168)	(0.233)	(0.154)	(0.173)	(0.168)	(0.234)
Land quality	0.152	1.164	0.020	1.020	0.122	1.130	0.028	1.029
	(0.454)	(0.528)	(0.437)	(0.445)	(0.460)	(0.520)	(0.413)	(0.425)
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	2370	2370	2370	2370	2370	2370	2370	2370
Nagelkerke's R2	0.118		0.249		0.118		0.249	
LR chi-squared	7.71		6.38		7.12		4.30	
P-value	0.01		0.01		0.01		0.04	

Notes: ***, ** and * indicate significance level of 1%, 5% and 10% respectively against a two-sided alternative. Standard errors, clustered at station level, are in brackets. Log likelihood (LR) test compares the log likelihoods of the two models (with and without weather variation variables) and tests whether this difference is statistically significant.

Table 7
Weather variation and social trust. Adding other social network variables and commune characteristics.

Variables	(1) Trust people	(2)	(3) Careful dealing with people	(4)	(5) Trust people	(6)	(7) Careful dealing with people	(8)
	Log of highest rainfall variation over 1927 - 1985				Log of rainfall variation over 1975 - 2006			
	Coef	Odd ratio	Coef	Odd ratio	Coef	Odd ratio	Coef	Odd ratio
Weather variation	0.817*	2.263*	−0.654*	0.520*	2.922**	18.571**	−1.685*	0.186*
	(0.458)	(1.036)	(0.367)	(0.191)	(1.189)	(22.090)	(1.006)	(0.187)
Minority	−0.272	0.762	0.701	2.016	−0.237	0.789	0.698	2.010
	(0.684)	(0.521)	(0.661)	(1.333)	(0.664)	(0.524)	(0.655)	(1.316)
Age of head	−0.003	0.997	0.008	1.008	−0.002	0.998	0.008	1.008
	(0.029)	(0.029)	(0.017)	(0.017)	(0.029)	(0.029)	(0.017)	(0.017)
Age of head, square/100	0.012	1.012	−0.004	0.996	0.011	1.011	−0.004	0.996
	(0.028)	(0.029)	(0.015)	(0.015)	(0.029)	(0.029)	(0.015)	(0.015)
Year of schooling of head	−0.002	0.998	0.011	1.011	−0.003	0.997	0.011	1.012
	(0.015)	(0.015)	(0.017)	(0.018)	(0.016)	(0.015)	(0.018)	(0.018)
Gender (Male=1)	0.020	1.020	−0.068	0.934	−0.012	0.988	−0.051	0.950
	(0.194)	(0.198)	(0.232)	(0.217)	(0.186)	(0.184)	(0.235)	(0.224)
Married	0.242	1.274	−0.022	0.979	0.283	1.327	−0.046	0.955
	(0.202)	(0.258)	(0.215)	(0.210)	(0.202)	(0.268)	(0.220)	(0.210)
Log of household income	−0.056	0.945	0.014	1.015	−0.062	0.940	0.021	1.021
	(0.071)	(0.067)	(0.094)	(0.095)	(0.068)	(0.064)	(0.092)	(0.094)
Log of average rainfall (mm)	1.202***	3.327***	0.377	1.459	0.549	1.731	0.753*	2.123*
	(0.368)	(1.225)	(0.272)	(0.397)	(0.474)	(0.820)	(0.390)	(0.828)
Area of land (1000m2)	0.006	1.006	−0.000	1.000	0.005	1.005	−0.000	1.000
	(0.012)	(0.012)	(0.002)	(0.002)	(0.011)	(0.011)	(0.002)	(0.002)
Land terrain (Flat=1)	0.115	1.122	0.280	1.323	0.123	1.131	0.283	1.327
	(0.166)	(0.186)	(0.173)	(0.229)	(0.160)	(0.181)	(0.175)	(0.232)
Land quality	0.096	1.101	0.018	1.018	0.083	1.087	0.029	1.030
	(0.502)	(0.552)	(0.416)	(0.423)	(0.513)	(0.557)	(0.388)	(0.399)
Hours watching TV	−0.186	0.831	−0.069	0.933	−0.176	0.839	−0.075	0.928
	(0.127)	(0.105)	(0.068)	(0.064)	(0.126)	(0.106)	(0.068)	(0.063)
Always attending meeting	0.480**	1.617**	0.290	1.337	0.463**	1.589**	0.299	1.349
	(0.214)	(0.346)	(0.237)	(0.317)	(0.214)	(0.341)	(0.236)	(0.318)
Share of minority in communes	0.607	1.835	−1.759**	0.172**	0.449	1.567	−1.587**	0.204**
	(0.812)	(1.490)	(0.732)	(0.126)	(0.734)	(1.150)	(0.723)	(0.148)
Member of any groups	0.033	1.034	0.184	1.202	0.075	1.078	0.163	1.177
	(0.216)	(0.223)	(0.259)	(0.311)	(0.214)	(0.231)	(0.252)	(0.296)
Have insurance	−0.452*	0.636*	0.001	1.001	−0.450*	0.638*	0.008	1.008
	(0.245)	(0.156)	(0.162)	(0.162)	(0.239)	(0.153)	(0.163)	(0.164)
Household size	0.001	1.001	−0.007	0.993	0.002	1.002	−0.007	0.993
	(0.043)	(0.044)	(0.039)	(0.038)	(0.043)	(0.043)	(0.039)	(0.039)
Number of households in communes	0.003	1.003	0.005	1.005	0.000	1.000	0.007**	1.007**
	(0.006)	(0.006)	(0.004)	(0.004)	(0.007)	(0.007)	(0.003)	(0.003)
Share of villages with roads passable by car	0.002	1.002	−0.007***	0.993***	0.001	1.001	−0.006***	0.994***
	(0.003)	(0.003)	(0.002)	(0.002)	(0.003)	(0.003)	(0.002)	(0.002)
Share of villages with waterway	−0.006*	0.994*	−0.000	1.000	−0.007*	0.993*	0.000	1.000
	(0.004)	(0.004)	(0.003)	(0.003)	(0.004)	(0.004)	(0.003)	(0.003)
Share of villages with electricity	0.001	1.001	0.004	1.004	0.000	1.000	0.004	1.004
	(0.006)	(0.006)	(0.005)	(0.005)	(0.006)	(0.006)	(0.005)	(0.005)
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	2299	2299	2299	2299	2299	2299	2299	2299
Nagelkerke's R2	0.135		0.270		0.135		0.269	
LR chi-squared	7.12		8.17		6.79		5.64	
P-value	0.01		0.00		0.01		0.02	

Notes: ***, ** and * indicate significance level of 1%, 5% and 10% respectively against a two-sided alternative. Standard errors, clustered at station level, are in brackets. Log likelihood (LR) test compares the log likelihoods of the two models (with and without weather variation variables) and tests whether this difference is statistically significant.

groups provide a mechanism to enforce agreements amongst network members (Kandori, 1992). Putnam (2000) showed how changes in work, family structure, television and computers have contributed to the decline in stock of social capital. Olken (2009) also found that the more village members spend on watching television and listening to the radio, the less they participate in social organizations and lower they self-report trust. To take into account these factors, we control for hours of watching TV, the number of social and religious groups that people belong to and a dummy variable to indicate how frequently they attend meetings.

The interpersonal trust may be explained by the lack of reliable institutions. Therefore, we add a dummy variable that takes into account whether households have insurance. Trust may also be affected by commune characteristics. To take into account those effects, we incorporate commune characteristics such as number of households per village, average size of household, average length of time residents have lived in the village/commune, share of minority in communes, share of villages with roads passable by car, share of villages with waterway, share of villages with electricity, share of immigrants in communes into the regression.

As reported in Table 7, the interested coefficients are significant when we include all control variables. For the magnitude of the coefficients, holding other variables constant, the result in Column (6)

Table 8
Weather variation and social trust by group of age.

Variables	(1) Trust people	(2) Careful dealing with people	(3) Trust people	(4) Careful dealing with people
	Log of highest rainfall variation over 1927 - 1985		Log of rainfall variation over 1975 - 2006	
Weather variation × Age below 30	−0.303	0.250	−1.851	0.199
	(0.935)	(0.511)	(1.520)	(0.664)
Weather variation	0.836*	−0.657*	3.074**	−1.651*
	(0.462)	(0.370)	(1.205)	(1.001)
Age below 30	1.219	−1.533	8.068	−1.377
	(3.893)	(2.249)	(6.701)	(3.036)
Individual controls	Yes	Yes	Yes	Yes
Geographic controls	Yes	Yes	Yes	Yes
Other controls	Yes	Yes	Yes	Yes
Provincial fixed effects	Yes	Yes	Yes	Yes
Number of observations	2299	2299	2299	2299
Nagelkerke's R2	0.135	0.272	0.137	0.270

Notes: ***, ** and * indicate significance level of 1%, 5% and 10% respectively against a two-sided alternative. Standard errors, clustered at station level, are in brackets. The individual controls include age, age squared/100, years of schooling, log of household income, a gender variable indicator, a dummy variable for people who are ethnic minorities and occupational fixed effects. The geographic and other control variables are log of average rainfall, an indicator for land terrain and a dummy variable for land quality, hours watching TV, an indicator of whether attending groups, an indicator of whether people always attend meeting, an indicator of having insurance, share of minority in communes, number of household in communes, share of villages with roads passable by car, share of villages with waterway, share of villages with electricity.

shows that one per cent increase in rainfall variation[20] corresponds to a 0.18 increase in the odds of trust other people, which is equivalent to 24 per cent of the mean of trust variable.[21] In addition, the results which indicate that historical weather variations significantly associate with current trust are consistent with the findings in the other existing empirical study such as Cassar, Healy & Kessler (2017) or Toya and Skidmore (2014) .[22] As shown in Table 7, the results suggest that people have a higher level of connection (always attend meetings) have higher trust. People who have insurance seem to have lower trust in others. This also indicates that the effects of weather variation on trust could be less profound in case agricultural insurance has been applied in Viet Nam.

We undertake heterogeneity analysis. First, exposure to weather variation may depend on respondents' age. We examine whether the younger generation who exposes less to weather variation may have a different level of trust compared to older ones. The results in Table 8 show that there is no significant difference in trust between two groups in facing weather variation. One potential explanation is that social trust could be transmitted through generations.

Second, we separately investigate the impacts of weather variation for each gender group of the population. The results are mixed. We find that Log of highest rainfall variation (in A.1) has a higher association with female trust but Log of rainfall variation has a higher relationship with male trust.[23]

We also carry out an implementation of a robustness check by taking only rural households in regions with weather stations and dropping observations in districts without stations. The results presented in A.2 show that weather variations have statistically significant effects on trust.

Table 9
Identifying impact channels: Village relationship.

Variables	(1)	(2)	(3)	(4)
	Borrowing from village members			
Log of highest rainfall variation over 1927 - 1985	0.53**	0.033		
	(0.295)	(0.514)		
Log of rainfall variation over 1975 - 2006			−0.342	−0.982
			(0.291)	(0.753)
Individual controls	Yes	Yes	Yes	Yes
Geographic controls	Yes	Yes	Yes	Yes
Provincial fixed effects	No	Yes	No	Yes
Number of observations	2370	2370	2370	2370
Nagelkerke's R2	0.1	0.13	0.07	0.13

Notes: ***, ** and * indicate significance level of 1%, 5% and 10% respectively against a two-sided alternative. Standard errors, clustered at station level, are in brackets. The individual controls include age, age squared/100, years of schooling, log of household income, a gender variable indicator, a dummy variable for people who are ethnic minorities and occupational fixed effects. The geographic variables are log of average rainfall, an indicator for land terrain, land areas and a dummy variable for land quality.

4.2. Possible problems

The use of a rich set of individual characteristics and commune variables reduce concerns about omitted variable bias. However, it is important to admit that we cannot definitively exclude the possibility that some omitted factors such as changes in local regulation or other geographic characteristics, affects both weather variation and social trust, leading to spurious results. In addition, measurement errors may bias the coefficient estimates (Meyer & Mittag, 2017).

Another possible problem is selection bias. It is possible that only a selected group of people stay in regions where there are more natural hazards. It is possible that some groups of village peasants are likely to be more risk-averse or less motivated and tend to stay at the same place where they were born even when this place is not favourable for living. Suppose that these risk-averse people trust others less and these factors correlate with weather variability across stations, then the estimates are also to be underestimated.[24] Conversely, if the selected group is more risk-loving and suppose that these people trust other people more, then the results may be to be overestimated. To check this possibility, we include immigrants into the sample. The coefficients of estimates are still significant and indicate that selection bias may not be our concern (as presented in A.3).

4.3. Exploration of mechanisms

We now turn to mechanisms through which the weather variation may affect social trust. The first potential mechanism is that villagers can improve insurance capacity against natural risks by expanding the relationship with other members in the same communes, who are likely to be affected by weather fluctuations in the same ways. Weather variations may reinforce contacts, co-operation and solidarity between neighbours through manual help for reconstruction, accommodation or money lending. This promotes social networks and trust amongst members in the village. Social trust in return also strengthens social

[20] Given low variation of the first measure of social trust over time, we rely on the second measure of trust to evaluate the impacts of weather variation on trust

[21] The effect is calculated as .18 / .87 =.24 or 24 per cent.

[22] The results are also robust when we run a specification with both 1927-1985 and 1975-2006 rainfall variations in one regression and found that these two variables have a jointly significant effect.

[23] To save space, we do not report the coefficient estimates of the control variables throughout the paper.

[24] However, if these risk-averse people interact frequently with other people in the same village that may improve their ability to trust other people (Ermisch & Gambetta 2010).

Table 10
Identifying impact channels: Extended family ties.

Variables	(1) Borrowing from relatives	(2) Borrowing from relatives	(3) Borrowing from relatives	(4) Borrowing from relatives
	Log of highest rainfall variation over 1927 - 1985		Log of rainfall variation over 1975 - 2006	
Weather variation	1.15*	0.42	−0.874	−1.014
	(0.62)	(0.99)	(0.825)	(2.584)
Individual controls	Yes	Yes	Yes	Yes
Geographic controls	Yes	Yes	Yes	Yes
Provincial fixed effects	No	Yes	No	Yes
Number of observations	338	338	338	338
Nagelkerke's R2	0.25	0.35	0.19	0.35

Notes: ***, ** and * indicate significance level of 1%, 5% and 10% respectively against a two-sided alternative. Standard errors, clustered at station level, are in brackets. The individual controls include age, age squared/100, years of schooling, log of household income, a gender variable indicator, a dummy variable for people who are ethnic minorities and occupational fixed effects. The geographic variables are log of average rainfall, an indicator for land terrain, land areas and a dummy variable for land quality.

networks because they allow their members to get more information about each other through repeated interaction.

To test the empirical validity of our channel, we examine the effects of the frequency of weather variability on village ties, where the village ties are proxied by the whether rural households ask monetary help from village members in case of emergency. We expect that, on the one hand, people living in regions with a high level of weather variation are more willing to provide monetary help to other members of the community. On the other hand, people also are likely to ask for more help from neighbours, regardless of whether they are close family members. All of which increase trustworthiness amongst them.[25]

In Table 9, we start regressing the village ties on log of extreme rainfall variation over 1927–1985. All regressions include both occupational effects and geographic controls.[26]The coefficient on extreme rainfall variation in Column (1) is positive and statistically significant. The estimate in Column (2) with provincial fixed effects has the same sign although it is not statistically significant. The results are also less robust in the case of log of rainfall variation over 1975 - 1995.

We also test the possibility that weather variation increases farmers' reliance on their family. Table 10 reports regression results for the effects of the frequency of weather variation on extended family ties. Extended family ties are defined as a share of the number of relatives that village members ask for monetary help in case of emergency. In Columns (1) to (2), we start by estimating the extended family ties with log of extreme rainfall variation. The coefficient on log of extreme rainfall variation is positive and statistically significant, showing that weather variation enhances family relationships as measured by the willingness to ask relatives for money. The estimate with provincial fixed effects in Column (2) has the same sign although it is not statistically significant. For log of rainfall variation, the results are statistically insignificant.

We continue the investigation of the mechanisms by decomposing the total income of households into farming and non-farming sources.

[25] We cannot rule out the possibility that higher trust people may help other more.

[26] Because social network variables have almost no effects on social trust and in order to increase sample size, we do not control for social network variables into the equation.

Table 11
Identifying impact channels: Agricultural incomes.

Variables	(1) Trust people	(2) Careful dealing with people	(3) Trust people	(4) Careful dealing with people
	Log of highest rainfall variation over 1927 - 1985		Log of rainfall variation over 1975 - 2006	
Weather variation	0.81*	−0.55	2.91***	−1.34
	(0.44)	(0.41)	(0.91)	(0.99)
Share of agricultural income	0.47**	0.11	0.47**	0.11
	(0.217)	(0.23)	(0.22)	(0.23)
Individual controls	Yes	Yes	Yes	Yes
Geographic controls	Yes	Yes	Yes	Yes
Provincial fixed effects	Yes	Yes	Yes	Yes
Number of observations	2370	2370	2370	2370
Nagelkerke's R2	0.12	0.25	0.12	0.25

Notes: ***, ** and * indicate significance level of 1%, 5% and 10% respectively against a two-sided alternative. Standard errors, clustered at station level, are in brackets. The individual controls include age, age squared/100, years of schooling, log of household income, a gender variable indicator, a dummy variable for people who are ethnic minorities and occupational fixed effects. The geographic variables are log of average rainfall, an indicator for land terrain, land areas and a dummy variable for land quality.

We expect that people in households with a higher share of income from farming activities will reveal higher social trust to other people.[27] Table 11 reports regressions for the impact of the share of household income from farming activities. In Columns (1) and (3), the coefficients of the share of income from agricultural activities are positive and show significant effects on social trust. In other words, as household incomes rely more on agricultural activities, people tend to be more cooperative and trust other people more.

5. Conclusion

This study adds to a new and growing literature in economics that seeks to better understand the role of the natural environment on the social trust of individuals. We have shown that the levels of trust amongst village peasants can be associated with historical weather variation. Individuals' trust in their neighbours is higher if their livings are heavily affected by weather variations. To check the robustness of this relationship, we pursue several different strategies. First, we control for potential observable characteristics, including geographic and social network variables, which may correlate with the natural environment and affect social trust. Second, we control for commune characteristic and provincial fixed effects that are expected to wipe out confounding effects caused by invariant unobserved variables. In general, the estimates show a positive relationship between weather variations and social trust within village members.

We then turn to specific mechanisms and examine several explanations for the relationship between weather variation and trust. We find that people living in regions with more variable weathers tend to ask for help from their neighbours in the case of an emergency, which enhances mutual trust. Besides, we find that households who rely more on agricultural incomes tend to trust other people more. We further examine the relationship between weather variability and individuals' behaviour to their family. We find that higher variability in weather appears to increase family ties.

[27] There is a possibility that agricultural activities are more likely to flourish in high-trust regions

A1

Weather variation and social trust by gender.

Variables	Male				Female			
	Trust people	Careful dealing with people	Trust people	Careful dealing with people	Trust people	Careful dealing with people	Trust people	Careful dealing with people
	Log of highest rainfall variation over 1927 - 1985		Log of rainfall variation over 1975 - 2006		Log of highest rainfall variation over 1927 - 1985		Log of rainfall variation over 1975 - 2006	
Weather variation	0.688	−0.569	3.163**	−1.627	1.534*	−1.373**	−2.430	−1.593
	(0.477)	(0.364)	(1.242)	(1.070)	(0.817)	(0.685)	(5.472)	(1.803)
Individual controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Geographic controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Other controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Provincial fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	1928	1928	1928	1928	344	371	344	371
Nagelkerke's R2	0.151	0.281	0.153	0.280	0.197	0.289	0.186	0.279

Notes: ***, ** and * indicate significance level of 1%, 5% and 10% respectively against a two-sided alternative. Standard errors, clustered at station level, are in brackets. The individual controls include age, age squared/100, years of schooling, log of household income, a gender variable indicator, a dummy variable for people who are ethnic minorities and occupational fixed effects. The geographic and other control variables are log of average rainfall, an indicator for land terrain and a dummy variable for land quality, hours watching TV, an indicator of whether attending groups, an indicator of whether people always attend meeting, an indicator of having insurance, household size, share of minority in communes, number of household in communes, share of villages with roads passable by car, share of villages with waterway, share of villages with electricity.

A.2

Weather variation and social trust
(excluding rural households in districts without weather stations).

Variables	(1) Trust people	(2) Careful dealing with people	(3) Trust people	(4) Careful dealing with people
	Log of highest rainfall variation over 1927 - 1985		Log of rainfall variation over 1975 - 2006	
Weather variations	0.452	−1.690**	5.154**	−4.200
	(0.598)	(0.857)	(2.212)	(2.710)
Individual controls	Yes	Yes	Yes	Yes
Geographic controls	Yes	Yes	Yes	Yes
Provincial fixed effects	Yes	Yes	Yes	Yes
Number of observations	829	829	863	863
Nagelkerke R2	0.158	0.418	0.172	0.393

Notes: ***, ** and * indicate significance level of 1%, 5% and 10% respectively against a two-sided alternative. Standard errors, clustered at station level, are in brackets. The individual controls include age, age squared/100, years of schooling, log of household income, a gender variable indicator, a dummy variable for people who are ethnic minorities and occupational fixed effects. The geographic and other control variables are log of average rainfall, an indicator for land terrain and a dummy variable for land quality, hours watching TV, an indicator of whether attending groups, an indicator of whether people always attend meeting, an indicator of having insurance, share of minority in communes, number of household in communes, share of villages with roads passable by car, share of villages with waterway, share of villages with electricity.

A.3

Weather variation and social trust
(full sample with immigrants).

Variables	(1) Trust people	(2) Careful dealing with people	(3) Trust people	(4) Careful dealing with people
	Log highest rainfall variation over 1927 - 1985		Log rainfall variation over 1975 - 2006	
Weather variations	0.886**	−0.448	1.799	−1.907*
	(0.394)	(0.400)	(1.366)	(1.152)
Individual controls	Yes	Yes	Yes	Yes
Geographic controls	Yes	Yes	Yes	Yes
Other controls	Yes	Yes	Yes	Yes
Provincial fixed effects	Yes	Yes	Yes	Yes
Number of observations	2965	2965	2965	2965
Nagelkerke R2	0.129	0.249	0.125	0.251

Notes: ***, ** and * indicate significance level of 1%, 5% and 10% respectively against a two-sided alternative. Standard errors, clustered at station level, are in brackets. The individual controls include age, age squared/100, years of schooling, log of household income, a gender variable indicator, a dummy variable for people who are ethnic minorities and occupational fixed effects. The geographic and other control variables are log of average rainfall, an indicator for land terrain and a dummy variable for land quality, years living in communes, hours watching TV, an indicator of whether attending groups, an indicator of whether people always attend meeting, an indicator of having insurance, household size, share of minority in communes, number of household in communes, share of villages with roads passable by car, share of villages with waterway, share of villages with electricity, share of immigrants in communes.

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Appendices

A.1, A. 2, A. 3

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