Do climate disasters make farmers more willing to cooperate? Evidence from rural communities in southern China

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Abstract

Purpose – This article aims to explore the impact of climate disasters on small-scale farmers’ willingness to cooperate and explore the mediating effect of social capital.

Design/methodology/approach – The study investigates farmers’ willingness to cooperate through a framed field approach and surveys the information of individuals and villages, including climate disasters and social capital, using a structured questionnaire from rural communities in Jiangxi and Sichuan, China.

Findings – The results show that climate disasters and social capital are significant and positive determinants of farmers’ willingness to cooperate. In specific types of climate disasters, drought is positively associated with farmers’ cooperation willingness. Moreover, the mediation effect of drought on farmers’ willingness to cooperate through social capital has been demonstrated to be significant although negative, whereas the mediation effect of flood on farmers’ willingness to cooperate through social capital is significant and positive.

Originality/value – First, given the limited studies focusing on the impact of climate disasters on small-scale farmers’ willingness to cooperate, the authors complement the existing literature through a framed field experiment approach by designing a scenario that every farmer may encounter in their production activities. Second, the study figures out the roles of drought and flood as different kinds of climate disasters in farmers’ decision-making of cooperation and sheds light on the positive impact of climate disasters on small-scale

We would like to express our gratitude to the anonymous reviewers and editor. Any remaining errors are solely our own.

Funding: This research was funded by National Key R&D Program of China (No: 2021YFC3200500) and Chinese Scholarship Council (No: 201806360261). The order of authorship is alphabetical with shared first authorship.
farmers. Finally, this paper provides empirical evidence of social capital as a potential channel through which climate disasters could possibly affect farmers’ willingness to cooperate.

Keywords Climate disaster, Cooperation, Social capital, Collective risk

Paper type Research paper

1. Introduction

Small-scale farmers in developing countries with limited access to markets (Ortmann and King, 2007) are vulnerable to climate change (Bissonnette et al., 2017). They have restricted capability to cope with climate-related disasters such as droughts and floods, which are closely related to water resources that are fundamental for agricultural production (Dinar et al., 2010), due to their lack of financial and technical resources (Mugiya and Hofisi, 2017).

Nevertheless, existing literature has shown that farmers’ cooperation through their sharing of information, production tools, capital and knowledge in the processes of production, processing and sales of agricultural products (Baillet and van Lange, 2013; Carpenter et al., 2004; Kittredge, 2005) may help them to reduce transition costs, gain access to markets (Metzlar, 2017; Ortmann and King, 2007), and cope with climate disasters more effectively (Dinar et al., 2010). As a result, cooperation has become an effective solution to the above-mentioned problems caused by small-scale farmland management, stimulating investment intensity. In China, for instance, irrigation cooperatives (ICs), also known as Water User Associations, work as effective village organizations to concentrate resources from members in the construction, management, and maintenance of irrigation systems, which are fundamental for agricultural activities (Plunkett et al., 2010; Sahasranaman et al., 2018).

Farmers from the same rural community have social ties with one another and share similar customs and traditions. Hence, they are more likely to cooperate with farmers from the same community. As a result, rural communities serve as the fundamental building blocks of farmer cooperation (Yang et al., 2020). It has been shown that farmers with high social capital are more likely to participate in cooperative affairs, including production activities, decision-making meetings and training courses (Torfi et al., 2011). It is also shown that social capital facilitates farmers’ participation in ICs (Cai et al., 2016; Miao et al., 2015).

According to Woolcock (1998), social capital involves three dimensions including social relation, norms and trust. Social capital is important for cooperation in its potential to affect these dimensions of social capital: First, social relation lays the groundwork for improved communication and understanding among people (Spagnolo, 1999) and is significantly related to cooperation decisions made in public goods games (Apicella et al., 2012; Carpenter et al., 2004; Wang et al., 2017). Second, norms shape a standard of cooperation (Fehr and Fischbacher, 2004) and motivate cooperation in common pool resource conservation and public good provision (Song et al., 2012; Lapinski et al., 2017). Third, trust contributes to optimism towards the outcomes of cooperation (Anderson et al., 2004; Chaudhuri, 2011; Fischbacher and Gächter, 2010; Kocher et al., 2015).

However, cooperation is affected by collective risks caused by climate change. And the impacts of these collective risks on cooperation are complex. On the one hand, collective risks may directly decrease the farmers’ willingness to cooperate. For example, existing literature has shown that farmers’ cooperation is hindered when they are faced with collective risks such as those arising from natural disasters (e.g. Barrett and Dannenberg, 2014; Cárdenas et al., 2017; Shi et al., 2021). On the other hand, collective risks may indirectly enhance cooperation willingness by strengthening social capital among farmers. For instance, it is found that collective risks have increased cooperative social norms and further raised cooperation levels (e.g. Szekely et al., 2021). The majority of studies focus on cooperation under hypothetical climate risks, yet inadequate attention is paid to the impact of the
experiences of climate disasters on cooperation, specifically in the context of cooperatives related to forestry operations of small-scale forest farmers in China.

Climate disasters such as storms, drought and flood also have complicated impacts on social capital (Toya and Skidmore, 2014; Albrecht, 2018; Dinar et al., 2010). Farmers’ positive experiences of kindness from others in the aftermath of climate disasters have brought them closer together in social relations (Cassar et al., 2017). Receiving help from others, during the post-disaster recovery phases, forms or reinforces the norms that all members should cooperate for collective welfare. Also, frequent interactions between farmers, because of reconstruction, foster familiarity and thus enhance trust (Alesina and la Ferrara, 2002). However, it is possible as well that individuals suffering from climate disasters, such as storm and flood, prioritize personal interests (i.e. the security of private property) over collective interests, which makes them less socially connected to others (Dinar et al., 2010; Wang and Ganapati, 2018). In this regard, climate disasters could have competing effects on social capital. Yet few studies are conducted to offer more empirical evidence to show the competing impacts of different climate disasters on social capital.

As collective risks are expected to be inevitably increased by more frequent climate disasters due to climate change, there is a need for more empirical research to study how cooperation among small-scale farmers in rural communities may be affected by climate disasters, as well as how social capital may help to mediate the cooperation among farmers who are faced with climate disasters that bring collective risks to small-scale farmers who are vulnerable to climate change. This study aims to investigate the impact of climate disasters on small-scale farmers’ willingness to cooperate using a unique dataset collected from two major rice production regions in China through framed field experiments and surveys. Two typical climate disasters, drought and flood, are chosen since farmers in rural China are mainly affected by these two disasters (Yin et al., 2018; Zhang et al., 2014). In this study, we particularly explore the mediating role of social capital in farmers’ willingness to cooperate by controlling for those community contextual factors such as disputes among farmers, which may weaken social cohesion; and fire, which could be caused by rising temperatures resulting from climate change (Xu et al., 2021) or by human factors.

Our study adds to the literature in three ways. First, given the limited studies focusing on the impact of climate disasters on small-scale farmers’ willingness to cooperate, we complement the existing literature through a framed filed public good game by designing a collective irrigation scenario that every farmer may encounter in their production activities. Second, we figure out the roles of drought and flood as different kinds of climate disasters in farmers’ decision-making of cooperation and shed light on the positive impact of climate disasters on small-scale farmers’ cooperation. Finally, the literature overlooked the role of social capital and its potential impact when it came to the mechanism by which farmers’ willingness to cooperate was affected by climate disasters. In this regard, we provide empirical evidence of social capital as a potential channel through which climate disasters could possibly affect farmers’ willingness to cooperate.

The remainder of this paper is organized as follows: In the next section, we present the theoretical framework. The third section focuses on the data, including the study area, data collection and data measurement. The estimation strategy is explained in the fourth section. The fifth section presents the results, while the sixth discusses the main results of the study, with implications for policymakers.

2. Theoretical framework
The rationale for this study needs to be better understood, which calls for a conceptual model. The model is mainly developed from a linear public good game (Nunn and Watkins, 1978). Farmers’ choices of contributing public good can reflect their willingness to cooperate in real
world mainly for four reasons: First, most cooperative projects, such as ICs, could be regarded as the organizations where individuals collectively provide public goods, like irrigation water in ICs, for collectives. Second, individual farmers voluntarily cooperate in the public good game, just as they do in real world. Third, the benefits farmers receive from cooperation in the public good game are proportional to the total contribution, which is the same as in agricultural cooperatives where the greater scale of the cooperatives will produce greater profits. Fourth, individual farmers have incentives to free ride in public good games as well as in cooperatives (Bonroy et al., 2019). For instance, farmers with croplands around irrigation canals or on the upper stream of the canal can get water without even paying since it is hard to exclude them from draining water from the canal.

We assume there are $N$ farmers in community $j$ who can cooperate to provide public goods for the whole group. For farmer $i$ in community $j$, he/she can choose to allocate $x_{ij}$ from his/her endowment $F$ to the public account. The total contribution from every participant constitutes the public account that is shared among all members regardless of whether he/she contributes. The payoffs farmer $i$ can get include returns from the private account and public account. Since returns from the public account cannot be estimated precisely, farmer $i$’s expected payoff is given by:

$$
\pi_i = k(F - x_{ij}) + h(B_{ij} + x_{ij})
$$

and the payoff for the whole group $j$ is as follows:

$$
\pi_j = k\left(NF - \sum_i x_{ij}\right) + hN \sum_i x_{ij}
$$

where $k$ is the expected rate of return per unit of individually reserved resources, $h$ is the expected rate of return per unit of collective resources, and $B_{ij} = E_i \sum_{n \neq i} x_{nj}$ is farmer $i$’s expected contribution level of the whole group $j$ except himself/herself. Here we assume $h$ is smaller than $k$, and $hN$ is greater than $k$. The optimal choice for every single farmer is derived by the maximization of $\pi_j$ that specifies one should reserve all resources in the private account. However, it will result in social dilemma if everyone contributes zero for individual profit maximization since the socially optimal choice by maximizing $\pi_j$ is that everyone contributes all resources.

One can estimate the expected number of the whole contribution based on his/her own perception of social capital with others and the experience of climate disasters. Generally, farmers tend to expect more contribution $B_{ij}$ if he/she perceives higher social capital in the community. More importantly, the experience in climate disasters from which farmers learn the importance of cooperation helps form a more positive expectation about others’ contribution level $B_{ij}$. Hence:

$$
B_{ij} = B_{ij}(S_{ij}, D_j)
$$

In this equation, $S_{ij}$ is farmer $i$’s perceived social capital from the community $j$. $D_j$ denotes the number of climate disasters that happened recently in the community $j$. Meanwhile, climate disasters may affect social capital in competing ways as discussed above: on the one hand, climate disasters could foster social capital through enhanced interactions between farmers facing great trauma together. On the other hand, climate disasters weaken social ties among farmers who are more worried about their own private security than others. Thus, we have:

$$
S_{ij} = S_{ij}(D_j)
$$
Finally, any increase in $\pi_{ij}$ will enhance the utility in a straightforward way. A rational and self-regarding farmer will not cooperate based on the above discussion. However, one has other-regarding motives, which constitute parts of the utility in the real world, and hence he/she also cares about others’ payoffs or choices. We assume that agents are altruistic such that they will get utility if others get profit from the cooperation (Kant and Vertinsky, 2019). In other words, utility is derived not only from one’s own payoff $\pi_{ij}$, but also from the expectation of others’ payoffs $E_i\pi_{j}$, and hence $B_{ij}$ contributes to the utility from two aspects. Further, disaster-related experience may strengthen the utility derived from prosocial behaviors, which is cooperation in this case (Bauer et al., 2016). As such, the utility of $i$ is given by:

$$U_{ij} = U_{ij}(\pi_{ij}, E_i\pi_{j}, D_j)$$  \hspace{1cm} (4)$$

where $U_{ij}$ denotes the utility farmer $i$ can enjoy, $E_i\pi_{j}$ is the expected $\pi_{j}$ that is determined by $B_{ij}$. With equations (1)-(4), the solution to the problem:

$$\max_{x_{ij} \leq F} U_{ij} = U_{ij}(x_{ij}, S_{ij}, D_j, C_{ij})$$

is given by:

$$x^*_{ij} = x^*_{ij}(S_{ij}, D_j, C_{ij})$$  \hspace{1cm} (5)$$

where $C_{ij}$ denotes other explanatory variables that include age, education, land area, residence years in the community, household income, disputes, agricultural insurance and fire. It shows that the optimal choice of $i$ - $x^*_{ij}$ is related to the function of climate disasters, social capital and other control variables. Additionally, it should be noted that social capital is influenced by climate disasters and consequently $x^*_{ij}$ could be indirectly affected by climate disasters.

For simplicity, we assume that the function $x^*_{ij}(S_{ij}, D_j, C_{ij})$ is linear for $S_{ij}$, $D_j$ and $C_{ij}$. Consequently, equation (5) indicates the derivative of $x^*_{ij}$ with respect to $S_{ij}$ and $D_j$ are coefficients that represent how much farmers’ cooperation is related to social capital and climate disasters, respectively.

3. Data
3.1 Study area
A field survey and a public good game were conducted in rural communities in Sichuan and Jiangxi provinces, two main rice-producing areas in the middle and lower reaches of the Yangtze River in southern China. Specifically, Rong County, Renshou County, Santai County in Sichuan Province, located in Dujiangyan Irrigation District in the upper reaches of the Yangtze River and Jinxian County, Poyang County and Leping City in Jiangxi Province, located in the Ganfu Plain Irrigation District in the middle and lower reaches of the Yangtze River, were selected respectively. Furthermore, five villages were selected in each county and city, and a total of 580 households were surveyed and games were carried out with these samples.

3.2 Data collection
Data were collected through a questionnaire survey and a field public good game in the study. The household questionnaire survey was conducted face-to-face with household heads. The content of the household questionnaire included the followings: basic characteristics of
households, economic status, social capital and other relevant information. Moreover, a community-level questionnaire, in this case, village level, was carried out with the head or cadre from the local village. The content of the community questionnaire included: basic characteristics of the village, climate disasters, disputes, and other information. Furthermore, we adopted a public good game which aims to measure the subjects’ willingness to cooperate. Among all 6 counties, 5 villages are selected in each county according to the local agricultural irrigation facilities, terrain features (hills and mountains) and social and economic conditions; in each village, 16 to 20 households are randomly selected for the survey and game. Finally, 580 heads of rural households make up the whole sample, of which 535 are valid (92.24% of the whole sample). The head of each sample household was invited to participate in the survey and another adult family member was surveyed when the head was absent.

3.3 The procedure of the game
A framed public good game was carried out in the study areas, with 16–20 farmers participating for each group from the same community (for the game manual, see Appendix A at the supplementary file). In the experiment, each farmer receives a voucher worth 40 CNY [1], and they have two choices with the voucher - keep it for themselves or give it to the collective. Every respondent is facing a scenario where they were expected to contribute their endowment, namely the voucher, for the irrigation system maintenance project that is used by the collective. Thus, they have two choices: “non-cooperation” by keeping the voucher or “cooperation” by giving it to the collective. The payoff of each farmer in the game consists of two parts: the private return brought by keeping the voucher in the private account and the public return brought by the common profit from the public account (the rate of return is 0.125), which depends on the number of farmers who cooperate. Hence, we can rewrite equation (1) as:

\[ \pi_{i,j} = 40(1-x_{i,j}) + 5 \sum_i x_{i,j} \]  
\[ s.t. x_{i,j} = 1 or x_{i,j} = 0 \]  

It satisfies the social dilemma situation that \( h < k < Nh \) and hence it is consistent with the discussion in the theoretical section. Although \( x_{i,j} \) has been reduced from a continuous value to a binary value between 0 and 1, farmers’ choices in the game can still be regarded as a reflection of their willingness to cooperate.

3.4 Variables and measurements
3.4.1 Dependent and independent variables. The measurements of all variables are presented in Table 1. The decision of whether to contribute to the public good game is used as the dependent variable, which was captured by a dummy variable. As discussed above, this choice represents farmers’ willingness to cooperate. In addition, the main independent variables include climate disasters and social capital that are derived from the field survey (for the questionnaire, see Appendix B at the supplementary file). Climate disasters are measured by the number of climate disasters, specifically drought and flood that happened in the community in the past 5 years. Drought and flood are focused types of disasters that are closely related to climate change.

In existing literature, social relation is defined as the social relationship between members of a community (Qiu et al., 2021; Saukani and Ismail, 2019). Under this definition, various measurements have been used to represent social relation and have been proven to be related to cooperation decisions in public good games from lab experiments in various countries (Apicella et al., 2012; Carpenter et al., 2004; Wang et al., 2017). Social norms are defined as
rules and standards that are understood by members of a group, and/or constrain social
behaviors without the force of laws (Cialdini and Trost, 1998). Moreover, trust can be defined
as a psychological state where an individual has the intention to accept vulnerability based
upon positive expectations of the intention or behavior of another (Rousseau et al., 1998).
Trust can be reflected in two aspects: trusting: “how I trust others” and trustworthiness:
“how others trust me” (Glaeser et al., 2000).

Following the definition in the literature above, we collect information on social capital
that involves social relation, norms and trust. Respondents are asked to rank their agreement
with statements using five-point Likert scales (1 = totally disagree to 5 = totally agree) on the
following four aspects: (1) social relation: “I have contact with all members of the community”; (2)
norms (of the help): “All members in the community are willing to help others”; (3) trusting:
“I trust others in the community in paying back, so I will lend them money”; (4) trustworthiness:
“I am trusted by others in paying back, so I can easily borrow money from them”. A generalized variable of social capital is produced based on all these dimensions. Based on the information collected on the above four dimensions, two alternative approaches are used to construct the aggregate level of social capital. The first approach is to take the average value of the items. The second is to treat the aggregate level of social capital as a latent variable and use a confirmatory factor analysis (CFA) model (Huang et al., 2021; Schneider, 2017). The CFA is a measurement application that assumes the latent variable is a common factor of the observed items. Which measurement is chosen will be determined by a comparison procedure discussed in the result section.

3.4.2 Other control variables. Disputes should be controlled as confounders since they are potential determinants of social capital and cooperation. Some find that disputes, weakening

<table>
<thead>
<tr>
<th>Variables</th>
<th>Definition and measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual-level variables</td>
<td></td>
</tr>
<tr>
<td>Willingness to cooperate</td>
<td>Equal to 1 if the respondent invests his/her token in the game</td>
</tr>
<tr>
<td>Social capital</td>
<td>The scale of the respondents’ perceived social capital in the community (derived from four dimensions by CFA: social relation, norms, trusting and trustworthiness)</td>
</tr>
<tr>
<td>Agricultural insurance</td>
<td>Equal to 1 if the household is currently covered by any agricultural insurance; 0 otherwise</td>
</tr>
<tr>
<td>Land area (ha)</td>
<td>Household land area per capita</td>
</tr>
<tr>
<td>Household income (1,000 RMB)</td>
<td>Household annual income per capita</td>
</tr>
<tr>
<td>Age (years)</td>
<td>Age of family head</td>
</tr>
<tr>
<td>Female family head</td>
<td>Equal to 1 if the head is female; 0 otherwise</td>
</tr>
<tr>
<td>Years of residency</td>
<td>Years of residency of the household in the community</td>
</tr>
<tr>
<td>Community-level variables</td>
<td></td>
</tr>
<tr>
<td>Drought</td>
<td>Number of drought happened in the community in past 5 years</td>
</tr>
<tr>
<td>Flood</td>
<td>Number of flood happened in the community in past 5 years</td>
</tr>
<tr>
<td>Climate disasters</td>
<td>Total number of climate disasters (drought, and flood) happened in the community in past 5 years</td>
</tr>
<tr>
<td>Fire</td>
<td>Number of fire happened in the community in past 5 years</td>
</tr>
<tr>
<td>Disputes</td>
<td>Number of major disputes concerning community affairs in the last 10 years</td>
</tr>
</tbody>
</table>

Note(s): 1 We chose the period from 2010–2014 because it includes some climate disaster events that may cover the study area, such as the Great Flood in 2010, the Severe Drought in Southwest China in 2010, the Sumner and Autumn Floods in 2011, the Extreme heat in 2013 and the Torrential Rain in Southwest China in 2013. These events were considered significant for the study area and were likely to have an impact on farmers’ behaviors towards cooperative irrigation

Source(s): Created by authors

Table 1. Measurement of all variables

“rules and standards that are understood by members of a group, and/or constrain social behaviors without the force of laws” (Cialdini and Trost, 1998). Moreover, trust can be defined as “a psychological state where an individual has the intention to accept vulnerability based upon positive expectations of the intention or behavior of another” (Rousseau et al., 1998). Trust can be reflected in two aspects: trusting: “how I trust others” and trustworthiness: “how others trust me” (Glaeser et al., 2000).
social ties by creating negative experiences or even trauma regarding getting along with others (Blanton, 2006), have significant and negative impact on cooperation and the creation of social capital (Hasić, 2018). In addition, disputes act as positive moderators of the relationship between trust and cooperation (Balliet and van Lange, 2013). Agricultural insurance should be an important bridge to connect climate disasters and cooperation: On the one hand, buying agricultural insurance is another responsive strategy, besides cooperation, to climate disasters such as drought and flood that are harmful to crops (Zhang et al., 2019). On the other hand, insurance could foster cooperation between farmers, for example, regarding irrigation systems (Denaro et al., 2018).

As a result, we included the number of major disputes concerning community affairs in the last 10 years, agricultural insurance, household land area, income, years of residency for the household as well as age and gender of the head of household as control variables. Fire is also included considering that rising temperatures resulting from climate change are one major cause of fire (Xu et al., 2021) but fire can also be caused by human factors. As such we do not treat fire as climate disasters, which is our variable of interest.

4. Estimation strategy

According to equation (5) from the theoretical model, farmer’s decision of cooperation, which is denoted as \( x_{ij}^* \) in (5), is determined by climate disasters, social capital and other control variables. In addition, we have adopted the public good game mentioned above to collect farmers’ willingness to cooperate, which is a dummy variable. As a result, the Probit model is selected for estimation. The Probit model specifies:

\[
\begin{align*}
W_{ic}^* &= \beta_0 + \beta_1 CD_c + \beta_2 SC_{ic} + \mathbf{C}_{ic} \beta_3 + u_{ic} \\
W_{ic} &= 1 \text{ if } W_{ic}^* > 0, \text{ and } 0 \text{ otherwise}
\end{align*}
\]

where \( c \) denotes villages. \( W_{ic} \) denotes farmers’ willingness to cooperate. \( CD_c \) is the variable indicating climate disasters. \( SC_{ic} \) represents social capital perceived by farmer \( i \) that is constructed based on the four aspects of social relation, norms, trusting and trustworthiness. \( \mathbf{C}_{ic} \) is the vector of covariates including household income, land area, years of residency, age, gender, disputes, agricultural insurance and fire. For further analysis of the mediation effect of social capital on the impact of climate disasters, we also estimate the ordinary least squares (OLS) model describing the correlation between \( SC_{ic} \) and \( CD_c \):

\[
SC_{ic} = \gamma_0 + \gamma_1 CD_c + D_{ic} \gamma_2 + \mu_{ic}
\]

where \( D \) is the vector of covariates including years of residency, age, gender, disputes and fire. Note that \( SC_{ic} \) is a constructed ordinal variable representing the level of social capital, we also estimate the Ordered Probit model for robustness check.

We follow the developed causal steps approach (CSA) from Baron, Kenny and Judd in establishing mediation (Baron and Kenny, 1986; Judd and Kenny, 1981; Kenny et al., 1998):

Step 1: Show that \( \gamma_1 \) is significant.

Step 2: Show that \( \beta_2 \) is significant as well, meaning that there is an indirect effect that mediates the total effect, which is calculated as \( \beta_2 \times \gamma_1 \).

To achieve testification of the mediation effect and provide an alternative of robustness check, we use the Structural Equation Model (SEM) syntax in STATA software to estimate the whole system of equations (7) and (8) (Dai et al., 2022). The nonlinear combinations of coefficients: \( \beta_2 \gamma_1 \) is produced afterward with a t-test assuming that \( \hat{\beta}_2 \hat{\gamma}_1 \) is normally distributed while the direct effect is denoted by the coefficient \( \hat{\beta}_1 \).
5. Results

CFA is preferred over the average value approach since the Cronbach’s alpha for the four items is only 0.29, indicating the poor correlation between the four items and the low reliability of the average value approach. Therefore, a variable representing the aggregate level of social capital is computed using CFA. The loadings for all four items represented by the aggregate variable are positive, indicating that a higher value of the aggregate variable means a higher level of social capital overall.

Table 2 presents the descriptive statistics of the main variables. On average, 73% of participants decided to invest in the public account. In addition, fire, as a control variable, is treated as a discrete variable in the estimation since the value of it only includes 0, 1, 2 and 5. Since the average household income per capita is RMB 17.13, we assume that RMB 40 is great enough for subjects to take the game seriously and hence the choices can elicit their preferences.

5.1 The effect of climate disasters on cooperation willingness

Columns (1) and (2) from Table 3 present the effects of the main independent variables on the predicted probabilities of cooperation derived from the Probit model. Column (1) shows the result regarding the total number of climate disasters from the model of equation (7), while column (2) is the result derived from same model, but with a specific classification of climate disasters: drought and flood. Column (1) indicates that the coefficient of the total number of climate disasters is significantly positive, meaning that farmers are more willing to cooperate in communities suffering more climate disasters. Furthermore, column (2) shows similar results that the frequency of droughts is positively related to farmers’ cooperation willingness. Nevertheless, flood is not a significant determinant of farmers’ willingness to cooperate.

Generally, the number of total climate disasters is positively correlated with the willingness to cooperate: one more climate disaster in the community leads to an increase of 0.013 in the probability of cooperation. When it comes to the classified two kinds of climate disasters, column (2) provides evidence that drought rather than flood, could be the most primary type of climate disasters that is effective to enhance farmers’ community cooperation willingness. More specifically, each additional time of drought happened in the community tends to raise the probability that farmers will cooperate by 0.102. Moreover, farmers are more likely to cooperate if they perceive a higher level of social capital regardless of whether

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Mean</th>
<th>Std. Dv</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Willingness to cooperate</td>
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<td>0.73</td>
<td>0.45</td>
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<td>1</td>
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<tr>
<td>Drought</td>
<td>30</td>
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<td>2.03</td>
<td>0</td>
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<tr>
<td>Flood</td>
<td>30</td>
<td>1.96</td>
<td>1.84</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>Climate disasters</td>
<td>30</td>
<td>4.00</td>
<td>3.22</td>
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<td>12</td>
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<tr>
<td>Social capital</td>
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<td>3.70</td>
<td>0.86</td>
<td>0.06</td>
<td>5.25</td>
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<td>1</td>
</tr>
<tr>
<td>Fire</td>
<td>30</td>
<td>0.26</td>
<td>0.97</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>Disputes</td>
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<td>22.87</td>
<td>0</td>
<td>100</td>
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<td>Household income</td>
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<td>17.13</td>
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<td>184.02</td>
</tr>
<tr>
<td>Age</td>
<td>535</td>
<td>54.10</td>
<td>11.90</td>
<td>17</td>
<td>93</td>
</tr>
<tr>
<td>Gender</td>
<td>535</td>
<td>0.23</td>
<td>0.42</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Years of residency</td>
<td>535</td>
<td>48.84</td>
<td>16.95</td>
<td>0</td>
<td>83</td>
</tr>
</tbody>
</table>

Source(s): Created by authors
the variables of climate disasters are total or categorized, which is a necessary condition for the further analysis of mediation effects through social capital. In addition, agricultural insurance is also a significantly positive predictor of farmers’ willingness to cooperate. At last, the findings show that there is no significant relationship between farmers’ willingness to cooperate and the frequency of disputes.

Furthermore, we are interested in finding out if the impacts of climate disasters persist when the numbers of climate disasters vary and what severities of climate disasters have the greatest impact on farmers’ cooperation willingness. As a result, Figure 1 presents the marginal effect of climate disasters on farmers’ willingness to cooperate at different levels of climate disasters. The consistency observed in Figure 1 aligns with findings from Table 3, indicating that floods exhibit an insignificant impact on cooperation willingness, regardless of the severity of the flood. It demonstrates that the marginal effects of climate disasters on cooperation willingness are diminishing with the number of disasters growing. These findings hold true for different types of climate disaster including both the total number of climate disasters and the number of droughts.

5.2 The effect of climate disasters on social capital

Table 4 displays the result of the OLS and Ordered Probit models explaining the aggregate level of social capital derived from the CFA. The total number of climate disasters and social capital are not significantly correlated according to columns (1) and (3). However, as shown in columns (2) and (4), the impacts of different kinds of climate disasters on social capital are more complex: flood has increased the level of social capital, while drought has the opposite effect. The competing results of different kinds of climate disasters are consistent with the mixed findings from literature: Toya and Skidmore (2014) find that climate disasters increase social trust in many developing and developed countries while Albrecht (2018) finds that social trust decreases after climate disasters in Europe. One possible reason is that different levels of climate disasters have different even reverse effects on social capitals. When climate disasters are relatively moderate, more or greater disasters tend to increase social capital, while in an extreme level, climate disasters will harm social capital (Dinar et al., 2010).

<table>
<thead>
<tr>
<th>Variables</th>
<th>(1) Willingness to cooperate</th>
<th>(2) Willingness to cooperate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Climate disasters</td>
<td>0.013**</td>
<td>0.102**</td>
</tr>
<tr>
<td></td>
<td>(0.006)</td>
<td>(0.041)</td>
</tr>
<tr>
<td>Drought</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.044**</td>
<td>0.165**</td>
</tr>
<tr>
<td></td>
<td>(0.021)</td>
<td>(0.072)</td>
</tr>
<tr>
<td>Flood</td>
<td>0.140*</td>
<td>0.457*</td>
</tr>
<tr>
<td></td>
<td>(0.079)</td>
<td>(0.262)</td>
</tr>
<tr>
<td>Social capital</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agricultural insurance</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.160*</td>
<td>0.575*</td>
</tr>
<tr>
<td></td>
<td>(0.090)</td>
<td>(0.262)</td>
</tr>
<tr>
<td>Disputes</td>
<td>0.000</td>
<td>0.005</td>
</tr>
<tr>
<td></td>
<td>(0.001)</td>
<td>(0.005)</td>
</tr>
<tr>
<td>Other control variables</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Observations</td>
<td>535</td>
<td>535</td>
</tr>
</tbody>
</table>

Note(s): Delta-method Standard errors in parentheses. ***, ** and * denote significance at the 1, 5 and 10% levels, respectively. All coefficients represent the effects of corresponding independent variables on the predicted probabilities of cooperation.

Source(s): Created by authors
Based on the developed CSA, drought has been proven to be negatively mediated by social capital regarding its impact on farmers’ willingness to cooperate. Specifically, the overall effects of drought on farmers’ willingness to cooperate remain positive because the positive direct effects of drought exceed its negative indirect effects on farmers’ community cooperation willingness through social capital. In other words, the impact of drought on farmers’ willingness to cooperate could have been enhanced if the mediation effect through social capital had been eliminated. In addition, social capital is also positively mediating the positive impact of flood on farmers’ willingness to cooperate, which means the impact of flood on farmers’ willingness to cooperate could have been positive if the mediation effect through social capital had been promoted.

<table>
<thead>
<tr>
<th>Variables</th>
<th>OLS</th>
<th>Ordered probit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1) Social capital</td>
<td>(2) Social capital</td>
</tr>
<tr>
<td>Climate disasters</td>
<td>−0.002 (0.027)</td>
<td>−0.009 (0.032)</td>
</tr>
<tr>
<td>Drought</td>
<td>−0.081* (0.036)</td>
<td>0.068** (0.026)</td>
</tr>
<tr>
<td>Flood</td>
<td>0.068** (0.026)</td>
<td>0.076*** (0.028)</td>
</tr>
<tr>
<td>Control variables</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Constant</td>
<td>4.251*** (0.301)</td>
<td>4.125*** (0.227)</td>
</tr>
<tr>
<td>Number of respondents</td>
<td>535</td>
<td>535</td>
</tr>
</tbody>
</table>

**Note(s):** This table only presents the primary independent variables of climate disasters. Standard errors in parentheses are clustered at the county level. ***, ** and * denote significance at the 1, 5, and 10% levels, respectively. All coefficients represent the average marginal effects of corresponding independent variables. **Source(s):** Created by authors
5.3 SEM for mediation effect testification

Finally, the mediation effect and direct effect from the SEM syntax in STATA are presented in Table 5. Column (1) indicates that the indirect effects calculated by $\beta_2\gamma_1$ is significant for drought and flood as shown above. Although it demonstrates the significance of social capital as a positive mediator in the channel through which flood affects cooperation willingness due to their positive impacts on social capitals, the direct impact of flood on cooperation willingness is insignificant. Furthermore, column (2) shows consistent results with those from Table 3, which provide a robustness check with the former results that the total number of climate disasters and drought have a positive impact on the community cooperation willingness for farmers.

6. Discussion and conclusion

We conclude from the results that climate disasters, taken as a whole, enhance farmers’ willingness to cooperate. As for specific kinds of climate disasters, drought serves as a facilitator of community cooperation between farmers. It is also indicated that the marginal effects of climate disasters shrink when their frequencies go up, which applies to not only total numbers, but also drought. Moreover, the findings support previous studies showing a positive relationship between social capital and cooperation (Carpenter et al., 2004; Gächter et al., 2004; Schuch et al., 2021). Specifically, one time increase in the number of total climate disasters during the last 5 years will increase the probability of cooperation by 0.013 on average, and one unit increase in the aggregate level of social capital will increase the probability of cooperation by 0.044 based on column (1) from Table 3. Contrary to some studies’ findings (Balliet and van Lange, 2013), farmers’ willingness to cooperate is not significantly influenced by the number of disputes. While agricultural insurance is positive related to farmers’ willing to cooperate.

According to the developed CSA, we further discover that social capital plays the role of negative mediator in the relationship between drought and cooperation willingness. Additionally, there is a positive mediation effect between flood and farmers’ willingness to cooperate through social capital. One possible reason for the conflicting impacts of drought and flood on social capital is derived from the distinctions between drought and flood: On the one hand, drought leads to personal properties loss, mainly through enhancing water resource scarcity. However, farmers can cope with the loss caused by drought if they have access to limited water resource. In most cases, drought triggers competition over water among farmers and hence reduces social capital linking people together. On the other hand, flood damages properties, but not necessarily related to competition among farmers. The

<table>
<thead>
<tr>
<th>Variables</th>
<th>(1) Mediation effect</th>
<th>(2) Direct effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Climate disasters</td>
<td>$-0.000$ (0.004)</td>
<td>$0.047^*$ (0.024)</td>
</tr>
<tr>
<td>Drought</td>
<td>$-0.014^{***}$ (0.004)</td>
<td>$0.103^*$ (0.058)</td>
</tr>
<tr>
<td>Flood</td>
<td>$0.012^{**}$ (0.006)</td>
<td>$-0.007$ (0.048)</td>
</tr>
</tbody>
</table>

Table 5. Mediation effect of climate disasters on cooperation willingness through social capital

Note(s): Standard errors in parentheses are clustered at the county level. $^{***}$, $^{**}$ and $^*$ denote significance at the 1, 5 and 10% levels, respectively. All coefficients represent the average marginal effects of corresponding independent variables.

Source(s): Created by authors.
recovery from flood usually requires more frequent interactions and communications among farmers for information, support and resources, leading to an increase in social capital. However, the explanation above assumes that the impact of climate disasters on social capital should always be positive or negative. Another explanation, which relaxes this assumption, is the guess that different levels of climate disasters have different, even opposite, effects on social capital [2]. When climate disasters are relatively moderate, more or greater disasters tend to increase social capital, while at an extreme level, climate disasters will harm social capital (Dinar et al., 2010).

Of great importance is to stimulate the willingness to cooperate among small-scale farmers not only for agricultural productivity, but also for public goods provision and risk-taking resistance. In conclusion, this study has policy implications for facilitating cooperation, especially in the context of irrigation cooperatives, between small-scale farmers not only in China but also in other developing countries. These policy implications are presented as follows:

First, we recommend implementing policies of varying intensities to facilitate cooperation among farmers based on the frequency of climate disasters, particularly droughts, experienced in the community. While climate disasters can have negative consequences on society, such as economic losses and social disruption, they can also create opportunities for boosting social capital among individual farmers, as evidenced in this study, which, in turn, can foster cooperation in addressing not only these disasters but also other unforeseen hazards. Therefore, it is essential to factor in more comprehensive effects of climate disasters in policy design. For instance, in communities with a higher frequency of drought and flood, policies could be tailored to support and enhance the spontaneous emergence of cooperation among community members in providing irrigation water. On the other hand, communities with fewer instances of drought and flood may require more external support and incentives (primarily from governments) to promote cooperation among their members.

Second, under the financial support from governments regarding establishment of most collective infrastructure projects in rural China, individuals’ efforts to invest in subsequent project maintenance should also be valued. Hence, it is crucial to design tailored policy tools that correspond to different types of climate risks, considering their varying impact on social capital and cooperation. For instance, the study shows that drought should be given more attention as it is significantly related to the willingness to cooperate directly and indirectly. On the other hand, even though the flood cannot affect farmers’ community cooperation willingness directly, its total impact on cooperation willingness, constituted by the direct and indirect impacts, could be significantly positive since social capital works as a significantly positive mediator. Since the mediation effect of drought on cooperation willingness through social capital is negative while the mediation effect of flood on cooperation willingness through social capital is positive, policy tools like communication can be adopted to weaken the negative impact of drought on social capital and to strengthen the positive impact of flood on social capital. This can involve a range of communication methods, including face-to-face meetings, workshops, information campaigns and social media outreach.

Finally, considering the enhancement effect of drought on cooperation as one favorable effect of drought, such a favorable effect regarding Irrigation Cooperatives tends to decrease as drought happens more frequently, according to Figure 1. In addition, the high frequency of drought damages social capital based on Table 4. In this regard, policymakers should adopt techniques such as artificial rainfall and hydraulic engineering, especially in areas frequently stricken by drought, to control the occurrence of drought at an acceptable frequency.

We acknowledge that there could be other factors that may influence the impact of climate disasters on social capital and cooperation, such as the severity and duration of the disaster, and the level of preparedness and response of the affected community, which should be included in future research to provide a more comprehensive analysis of the relationship.
between climate disasters and cooperation. In addition, the mechanism of climate disasters on social capital remains further discussed, and we look forward to collecting more comprehensive data.

Notes

1. According to the “China Statistical Yearbook”, the average daily disposable income of rural farmers is RMB 25.61 and 27.72 in Sichuan and Jiangxi, respectively in 2014. And according to our survey data, the average daily total income of rural farmers is RMB 32.69 and 39.84 in samples from Sichuan and Jiangxi, respectively in 2014. All these average incomes are lower than the monetary incentive we provide to them in the game. In addition, the average payoff that the subjects received from the game is RMB 83.07 and 83.28 in samples from Sichuan and Jiangxi, respectively. In this regard, we assume that RMB 40 is great enough for subjects to take the game seriously and hence the choices can elicit their preferences. Moreover, we observed a high level of engagement and seriousness among the participants during the game, indicating that the voucher amount was sufficient to motivate them to participate in the program.

2. We add a supplementary regression in Appendix C, which treats the number of drought and flood as discrete variables in the OLS model explaining social capital. The result verified the guess that, in an extreme level, the same change in the number of drought or flood will result in a more significant decrease in social capital.

References


**Appendix**
The supplementary material for this article can be found online.

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