Analyses of topical policy issues

Impact of devolved forest tenure reform on formal credit access for households: Evidence from Fujian, China☆

Jiayun Dong [a,b,d], Wenyuan Liang [c,*], Yimin Fu [d], Liu Weiping [d], Shunsuke Managi [e,*]

[a] College of Economics and Management, Nanjing Forestry University, Nanjing, 210037, China
[b] Institute of Geographic Sciences and Natural Resources Research, CAS, Beijing, 100101, China
[c] Wageningen School of Social Sciences, Wageningen University and Research, Wageningen, 6708 PB, The Netherlands
[d] School of Economics, Fujian Agriculture and Forestry University, Fuzhou, 350002, China
[e] Urban Institute & Departments of Urban and Environmental Engineering, Kyushu University, Fukuoka, Japan

ARTICLE INFO

ABSTRACT

The Collective Forest Tenure Reform, as a devolved forest tenure reform, was first launched in Fujian, China, in 2003, issuing forestland-use certificates to and increasing forestland access for rural households, allowing households to collateralize forestland for formal credit. This study aims to identify the impact of forestland-use certificates and household forestland and further explain their channels of impact on formal credit access. The conceptual framework in the literature includes two potential channels of impact: household's willingness to formal credit access and the institutional constraint in formal credit access. An econometric analysis was conducted using panel data of household level in Fujian province from 2012 to 2016. The econometric results demonstrated that: (1) forestland-use certificates had a significantly positive impact on the households' formal credit access when it is measured only as formal credit by collateralizing forestland; (2) household forestland had significantly positive impact on households' formal credit access when it is measured as total formal credit and formal credit by collateralizing forestland; (3) households' willingness to access credit was significantly and positively affected by forestland-use certificates and household forestland, although the impact of household forestland is more certain and (4) institutional constraint in formal credit access was significantly and positively impacted by forestland use certificates but not by household forestland. Our study contains implications on the appropriate use of formal credit as a financial instrument in devolved forest tenure reform.

1. Introduction

Forest tenure reforms have been a critical issue in devolved forest tenure and agricultural land reforms in the developing world since the 1980s. Many governments have devolved fractions of forests from government-controlled

* Corresponding authors.
E-mail addresses: dsz.djy@163.com (J. Dong), wenyuan.liang@wur.nl (W. Liang), yiminfafu@163.com (Y. Fu), lwp789326@126.com (W. Liu), managi@doc.kyushu-u.ac.jp (S. Managi).

agencies to local people in various ways (Fao, 2016). Policymakers and researchers expect that devolved forest tenure would benefit local people and improve forest management because local people are expected to be more capable of effectively regulating forest management issues than far-away, top-down, centralized institutions (Phelps et al., 2010; Sikor and Nguyen, 2007). In addition, liberal perspectives propose to secure property rights and increase land access for poor people (Boucher et al., 2005). By so doing, poor people could strengthen investment on land with entitled land and credit access by using land as collateral (K. Petracco and Pender, 2009; Piza et al., 2015). Despite of this, allowing forestland as collateral for formal credit access is rarely an element in any policy package proposing devolved forest tenure reform.

China's Collective Forest Tenure Reform (CFTR) is a unique case of devolved forest tenure reform which allows to collateralize forestland for formal credit. Before CFTR, the government controlled forestry production by regulating committees of rural communities and requiring forestland in a community collectively owned by the community. The central government initiated CFTR in 2003 (Yin et al., 2013) . While the government confirmed the ownership of rural community's forestland remained unchanged, the government reallocated plots of forestland from rural communities to rural households. Rural households have been granted with 30–50 years of use rights over forestland, including selling, leasing, and inheriting the use rights during the valid period. To confirm the security of household's use rights, rural households were issued with forestland-use certificate by government, with the possibility of renewal upon expiry. However, a critical problem after CFTR was that rural households lacked sufficient funds for forestry investment. To improve forestry investment, the government approved households to collateralize their forestland for credit in formal financial institutions in 2009 (Central Committee of the Communist Party of China and State Council, 2008; People 's Bank of China et al., 2009). By so doing, formal financial institutions could accept forestland within valid period of use rights as legal collateral for loans. The amount of loans is determined by bilateral bargains between formal institutions and rural households.

Research on devolved forest tenure reform rarely discusses formal credit access. As one trend of devolved forest tenure reform, community-based forest management (CBFM) emphasizes forest management involving community members (Arts and de Koning, 2017; Nygren, 2005). Thus, households credit access is not a focus in CBFM. CFTR in China represents another trend of devolved forest tenure reform by transferring forests from state to households, which is similar to securing property rights in agricultural land reforms (Xu and Hyde, 2018). Besley (1995) hypothesized a positive connection between securing property rights of land and investment through collateralizing land. However, returns of forestry investment are less profitable compared to investment in agricultural land (Xu and Hyde, 2018).

Previous studies on CFTR mainly investigated the impact of CFTR on households' forestry investment. Evidence of CFTR has revealed that securing forestland positively contributes to households' willingness to pay for forestland and improves households' forestry inputs (Xie et al., 2014, 2013; Yi et al., 2014). In particular, Liu et al. (2017) considered collateralizing forestland for credit as a part of CFTR and observed that collateralizing forestland increases household labor and expenditure in forestry production. Dong et al. (2020) showed that the collateralized forestland impacted positively on the amount of the forestland mortgage loan. However, it is still not clear whether, at household level, forestland mortgage loan increases total amount of formal credit or only crowds out other types of formal credit. Furthermore, current literature has not identified channels through which devolved forest tenure reform could impact on household's formal credit access.

This paper focuses on the following research question: what has been the impact of CFTR on a household's formal credit access? By answering this research question, this study can provide implications on devolved forest tenure reforms. Devolving forests to rural households is only an initial step. Our analysis emphasizes the importance of bringing institutions closer to rural households and motivating rural household to participate in forest management. In particular, market-based financial institution is potentially promising to improve rural household's forest management by providing forestry investment. Our analysis could further reveal factors enabling and constraining formal credit access. In this way, our analysis will inspire future research and policy practices on properly bringing financial services closer to rural households in devolved forest tenure reform.

The remainder of this paper is organized as follows. Section 2 briefly reviews devolved forest tenure reform and formal credit access in China. Section 3 explains our conceptual framework and variable measurements. Section 4 describes the statistical information of the data set. Section 5 introduces the econometric methods for analysis. Section 6 presents the econometric results. Section 7 summarizes and interprets econometric results in line with the conceptual framework and literature. Finally, Section 8 concludes the paper.

2. Overview of devolved forest tenure reform and formal credit access in China

For decades, rural households in China have been irrelevant to formal credit access by collateralizing forestland. Since the late 1950s, China has established a centralized forestry system under which forests were controlled by state. Specifically, the central government restricted households in rural communities from owning forests. Instead, the government-stipulated forests in rural communities are exclusively owned and collectively managed by communities. In 1981, the central government implemented the first round of forest tenure reform by devolving forest management responsibilities from rural communities to households (Central Committee of Communist Party of China and Council, 1981). However, in 1987, the central government had to cease the reform and reemphasized collective forest management by rural communities because of the reported deforestation (Liu et al., 2018). Later, even though China enacted the Guarantee Law in 1995, this law explicitly excluded the possibility of collateralizing forestland for credit.
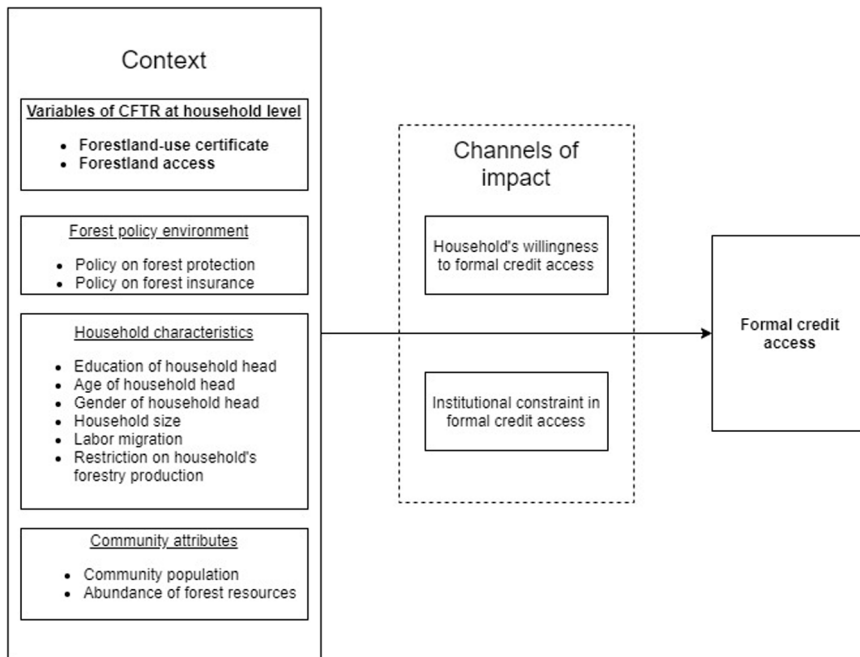
Fig. 1. Conceptual framework.
Source: Adapted by authors.

Only after CFTR can rural households collateralize forestland to access formal credit. While confirming that forests in rural communities remain community owned, CFTR comprised allocating parts of forestland from communities to households and issuing forestland-use certificates of allocated forestland for households. In 2009, the government allowed households to collateralize forestland for credit in formal financial institutions. In addition, the government urged formal financial institutions to lend based on the quality of forestland collateral when use rights over forestland is within valid period (People 's Bank of China et al., 2009).

Compared to the first round of forest tenure reform, the government has made distinguished achievements in CFTR, which contributes to market activities of collateralizing forestland for credit. First, the government implemented a gradual CFRT reform as it learned from the failures partly caused by haste in 1981. After conducting pilot reform in several counties of Fujian province in 2003 and Jiangxi province in 2004, the government became adequately prepared to implement CFTR nationwide in 2008, cautiously took 5 years to complete CFTR, and remedied problems after 2013. Second, unlike the uncertain expiry date of forestland use in the first round of forest tenure reform, the government in the second round of reform explicitly stated that a forestland-use certificates is valid for 70 years and can be prolonged at expiry date, stabilizing the expectation of both households and formal financial institutions. Third, forestland-use certificates are allowed for buying, selling, leasing, and collateralizing formal credit, which strengthens the value of forestland for households and formal financial institutions (Yin et al., 2013).

3. Conceptual framework and variable measurements

We establish our conceptual framework from a rapidly growing body of literature related to land reforms and households' formal credit access. Based on the literature review, we synthesize concepts and operationalize concepts into measurable variables in a coherent and cohesive way. In this way, we will begin by explaining the concepts and measurement of formal credit access and CFTR at the household level. Next, we illustrate theoretically how CFTR can impact a household's formal credit access through channels of impact and how channels of impact can be measured empirically.

Note that we introduce some variables of forest policy environment, community attributes, and household characteristics into the conceptual framework. As suggested in the literature, these variables could influence the functioning of land tenure reform and credit market (Deinlnger and Binswanger, 1999; Feder and Nishio, 1998). By introducing these variables, we attempt to minimize the estimation bias in the later section of the econometric analysis. Finally, we summarize the conceptual framework in Fig. 1, the definitions of the variables in Table 1, and the expected signs of impact in Table 2.

Table 1
Definition of variables.

Variable	Explanation	Unit
Formal credit access		
FCCF	Amount of household's formal credit by collateralizing forestland	Yuan
FC	Total amount of household's formal credit	Yuan
Channels of impact		
WILLINGNESS	Household's willingness to formal credit access: no willingness = 0; uncertain willingness = 1; certain willingness = 2	Multinomial
DIFFICULTY	To what extent institutional constraint of formal credit access is difficult, responded by households: easy = 0; a little difficult = 1; difficult = 2; extremely difficult = 3	Multinomial
Variables of CFTR		
FUC	Proportion of certificated forestland to total household forestland	0–1 decimal
FORESTLAND	Household forestland	Ha
Forest policy environment		
EFOREST	Proportion of ecological forests to total forestland within a county	Percentage
FINSURANCE	Proportion of forestland with forest insurance to total forestland within a county	Percentage
Household characteristics		
EDU	Education of household head: primary school and below = 0; middle school = 1; high school = 2; college and above = 3	Multinomial
AGE	Age of household head	Unit: years
GENDER	Gender of household head: male = 1; female = 0	Binary
HSIZE	The number of household member	Person
LMIGRATION	Proportion of out-migration labor to total household labors. A labor is a healthy household member ranging from 16 to 60 years old	0–1 decimal
HEFOREST	Proportion of ecological forests to total household forestland	0–1 decimal
Community attributes		
CPOP	Community population	Person
FORPC	Forestland per capita in community	Ha per capita

3.1. Formal credit access and CFTR at the household level

Two types of land tenure reform have been observed in the developing world since the 1980s: certification programs and land access for local people (Boucher et al., 2005; Deinlnger and Binswanger, 1999). Theoretically, certification enhances land security, and land access directly increases the amount of household land. Both can impact a household's formal credit access (Besley et al., 2012; Feder and Nishio, 1998). In China, CFTR comprises both the forestland certification program and the scale-up of forestland access for households (Yin et al., 2013).

In this study, the formal credit access of households is measured in two ways. First, we measure the amount of households' formal credit by collateralizing forestland (FCCF). FCCF can confirm whether CFTR has activated a household's formal credit access. Second, we measure the amount of household's total formal credit (FC). FC can further confirm whether formal credit activated by CFTR only excluded other types of formal credit or generally improved household participation in the formal credit market.

The CFTR at the household level can be operationalized into two variables. First, to measure the household status of certification, we adopted a household's forestland-use certificates (FUC). FUC refers to the proportion of certified forestland to total household forestland. Second, FORESTLAND (household forestland) denotes the status of forestland access of households after CFTR.

3.2. Channels of impact: How can land reform impact formal credit access

By reviewing the literature, we map two channels of impact wherein certification and land access can impact formal credit access. The first channel of impact is household's willingness to access formal credit. In this respect, initiation of certification and land access can catalyze formal credit mediated through household's willingness. Another channel of impact is the institutional constraints in the formal credit market.

We begin by household's willingness to access formal credit. First, certification may impact a household's willingness to access credit either positively or negatively. On the one hand, motivated by secured expectation of investment through land certification, households may increase willingness to access credit (Besley et al., 2012; Feder and Nishio, 1998). On the other hand, current behavioral research suggests that people are averse to relinquishing their entitlements (Holden and Bezu, 2014). In line with our study, forestland-use certification may stimulate households' land loss aversion, making

Table 2
Expected signs on formal credit access and channels of impact.

Variable	Expected sign on formal credit access	Channels of impact	
		Expected sign on household's willingness to formal credit access	Expected sign on institutional constraint in credit access
Variables of CFTR			
FUC	+/−	+/−	−
FORESTLAND	+	+	−
Forest policy environment			
EFOREST	−	−	−
FINSURANCE	+	+	+
Household characteristics			
EDU	+	+	−
AGE	−	−	+
GENDER	+/−	+/−	+/−
MEMBER	+/−	n/a	+/−
LMIGRATION	+/−	+/−	n/a
HEFOREST	−	n/a	+/−
Community attributes			
CPOP	+/−	n/a	+/−
FORPC	+/−	+	+

Note: "+" refers to expected positive impact.
"−" refers to expected negative impact.
"+/−" refers to positive or negative impact.
"n/a" means concrete expectation is not available.
The expected signs on formal credit access is a synthesis from the expected signs on channels of impact.
Table 2 is produced by authors based on literature review.

households less willing to collateralize forestland for credit. Second, land access is expected to increase households' willingness to access formal credit because greater land access motivates households to invest in improving productivity (Barslund and Tarp, 2008).

Next, we introduce institutional constraints. Certification programs mitigate institutional constraints because financial institutions consider secured land qualified as collateral (Feder and Nishio, 1998; Kemper et al., 2015; Piza et al., 2015). Additionally, a large amount of land increases the likelihood for a household to access to formal credit by meeting credit requirements (Bardhan and Rudra, 1978; Hussain and Thapa, 2012; Menkhoff et al., 2006; Stiglitz, 2016).

In summary, the impact of forestland-use certificates on formal credit access may be either positive or negative because of the opposite impact of the two channels. Moreover, the impact of forestland access on formal credit access is expected to be positive.

Considering variable measurement, we adopted two variables to operationalize the channels of impact. The first variable is the household's willingness to access formal credit (*WILLINGNESS*). WILLINGNESS is designed as an ordered variable: no willingness = 0; uncertain willingness = 1; certain willingness = 2. Another variable is difficulty regarding institutional constraints in formal credit access responded by households (*DIFFICULTY*). DIFFICULTY is designed as an ordered variable: easy = 0, a little difficult = 1, difficult = 2, extremely difficult = 3. Therefore, by using WILLINGNESS and DIFFICULTY, we can clarify whether a change in a household's formal credit access is caused by a household's willingness to overcome institutional constraints in the formal credit market.

3.3. Forest policy environment

As pointed out, the functioning of rural credit market is impacted related government policies. In our case, household' formal credit access is potentially impacted by forest policies which determine the value of forestland. In particular, forest protection policy could influence the value of forestland. In China, forests are officially classified into commercial use and ecological protection. If a parcel of household forestland is designated under ecological protection, timber harvest will be constrained on this parcel of forestland. Therefore, a region with a higher proportion of forests under ecological protection will possibly experience institutional constraints in households' credit access. With respect to measurement, the proportion of ecological forests to total forestland in a county (**EFOREST**) is used to denote the extent to which a household is influenced by official ecological protection.

Forest insurance is another policy which could determine the value of forestland. Following the CFTR, the Chinese government has officially provided forest insurance for local households to lower the risk of household forest management. In this way, forestland with forest insurance is considered reliable collateral, making households more willing to and facilitate their access credit. We use the proportion of forestland with forest insurance (**FINSURANCE**) in a county to measure forest insurance.

3.4. Household characteristics

Household characteristics could alter household decisions of participating in credit market and determine the qualification of households in credit market. Education level is a critical household characteristic. The education level of households can help a household comprehend financial information and thus increase their willingness to access formal credit. Moreover, education can ease the institutional constraint of households as formal financial institutions may consider the education as indicators of the households' capacity credit repayment (Barslund and Tarp, 2008; Goetz and Gupta, 1996; Mpuga, 2010; Okten and Osili, 2004). Hence, education level of household is expected to have a positive impact on formal credit access. With respect to measurement, education of household head (**EDU**) is used to measure the education level: primary school and below = 0; middle school = 1; high school = 2; college and above = 3.

The second variable is the age of the household head. The age of the household head is negatively associated with willingness to access formal credit as household heads tend to become risk averse along with getting older. Additionally, aging household heads may experience more institutional constraints. Formal financial institutions may consider aging household heads as less capable of repaying credit (Mpuga, 2010; Okten and Osili, 2004). Therefore, in theory, age has a negative impact on formal credit. Age of household head (**AGE**) is measured as the current age of the household head.

The third variable is the gender of the household head. The impact of gender of the household head on the willingness to access to formal credit is indefinite because gender is cultivated by culture (Radhakrishnan, 2015). In addition, some studies reported that women were discriminated in credit markets, while some studies did not reach the conclusion (Goetz and Gupta, 1996; Muravyev et al., 2009; Radhakrishnan, 2015). Hence, gender impacts indefinitely on formal credit access. Finally, the gender of household head (**GENDER**) is measured as follows: male = 1; female = 0.

The fourth variable is household size. Instead of discussing the impact of household size on household willingness, the current literature focuses on institutional constraints wherein household size impacts formal credit. Larger household size may reduce institutional constraints by helping household members locate credit information (Okten and Osili, 2004). On the other hand, when the household size increases, each household member possesses less resources and thus less qualified in credit markets (Mpuga, 2010). In this study, household size (**HSIZE**) is measured as the number of household members officially registered at the same household.

The fifth variable is labor migration. As suggested in the literature, labor migration out of rural communities may stimulate willingness to access credit for sustaining the life of migration (Phan, 2012). In contrast, labor migration is often driven by off-farm jobs with high payment. As a result, household members in rural communities may replace credit access with remittances from migrated household members (De Brauw and Rozelle, 2008). Therefore, the impact of labor migration on formal credit access is contingent. In this study, labor migration (**LMIGRATION**) is measured as the proportion of out-migration labor to total household labor.

The sixth variable is the restriction on households' forestry production. Households with more forestland under ecological protection will be less likely to conduct forestry production, especially timber harvest, experiencing more severe institutional constraints and thus reducing formal credit access (Liu et al., 2016). With respect to measurement, the proportion of ecological forests to total forestland within a household (**HEFOREST**) is used to denote the extent to which a household is influenced by official ecological protection.

3.5. Community attributes

The first variable of community attributes is the community population. With a larger community population, information about credit can spread faster, mediated through social networks and social imitation. Additionally, a larger community population may help households overcome institutional constraints of credit access by scaling up the household's social network. However, a larger community population may exacerbate institutional constraints in credit access. With the growing community population, households may need to increase efforts to maintain ties with the community and thus dampen their productivity, which signals the lack of qualification (Okten and Osili, 2004; Wydick et al., 2011). In this study, the community population (**CPOP**) is measured as the number of people officially registered in a community.

The second variable is the abundance of forest resources. We introduce the abundance of forest resources into the framework because of the debate on whether natural resource abundance is a blessing or curse for financial development. In theory, resource abundance increases the willingness to access formal credit and overcome institutional constraints. However, resource abundance may aggravate institutional constraints when resource abundance induces corruption (Badeeb et al., 2017; Bhattacharyya and Hodler, 2014). Therefore, the abundance of forest resources has a contingent impact on formal credit access. In this study, we introduce forestland per capita in the community (**FORPC**) to denote the abundance of forest resources.

4. Data description

In this study, we used a panel data set of household level in Fujian province produced from a program, Monitoring Program of Collective Forest Tenure Reform (MPCFTR), in 2012, 2013, 2014, 2015, and 2016. The State Forestry Administration (SFA) took the leading work in MPCFTR, using a strategy of stratified random sampling. As the first step, ten

Table 3
Descriptive statistics of variables.

Variable	Mean	S.D.	Unit
Formal credit access			
FCCF	8073	82 531	Yuan
FC	34 505	182 855	Yuan
Channels of impact			
WILLINGNESS	0.652	0.911	Multinomial
DIFFICULTY	1.229	1.364	Multinomial
Variables of CFTR			
FUC	0.639	0.425	0–1 decimal
FORESTLAND	5.228	18.43	Ha
Forest policy environment			
EFOREST	0.222	0.100	0–1 decimal
FINSURANCE	0.583	0.259	0–1 decimal
Household characteristics			
EDU	0.872	0.787	Multinomial
AGE	51.520	11.190	Unit: years
GENDER	0.958	0.201	Binary
MEMBER	4.717	1.820	Unit: count
LMIGRATION	0.249	0.331	0–1 decimal
HEFOREST	0.111	0.273	0–1 decimal
Community attributes			
CPOP	1497	1088	Person
FORPC	1.287	1.416	Ha per capita

Note: Please refer to Table 1 and Section 3 for more detailed description of the variables.

counties in Fujian province were randomly selected. As the second step, five rural communities were randomly selected from each county. Finally, ten households were randomly surveyed from each rural community each year. Therefore, each cross section of our panel data comprises 500 households from 50 rural communities in 10 counties.

The data structure is an unbalanced panel data set. 1124 households were surveyed from 2012 to 2016. The data set contains 2435 observations. In each year, some households were rotated out from survey, and some were rotated in because of household changes. A total of 410 households were surveyed more than once during the five years, accounting for 36.48% of 1124 households.

The MPCFTR is particularly suitable for our analysis because of its large sample size and comprehensive survey questions for monitoring CFTR. In terms of our analysis, MPCFTR contains detailed data well in line with our research question, conceptual framework, and variables. In addition, the panel data with a large sample size gives us confidence in analyzing our research question consistently and robustly.

Table 3 reports the descriptive statistics. With respect to the dependent variables of credit access, the mean of the household's formal credit by collateralizing forestland was 8073 Yuan, while the standard deviation was 82,531 Yuan, reflecting a considerable variation in credit status among households. A similar and even more considerable variation was observed in the total amount of household's formal credit. Regarding core independent variables, an average of 63.9% of household forestland was titled with forestland-use certificates. The mean of the household forestland was approximately 5.2 ha. We will further discuss the annual trend of the above dependent variables and core independent variables in Table 3.

Additionally, Table 3 lists the statistical description of the forest policy environment, household characteristics, and community attributes. On forest policy environment, the average proportion of ecological forests to forestland was 22%, and the average of forestland with forest insurance to forestland was 58.33%. With regard to household characteristics, the mean EDU was approximately 0.9, indicating that the average education level of the household head was between primary school and middle school; the average age of the household head was approximately 52 years; approximately 95.8% of household heads were male; a household averagely had 4.7 members with 24.9% of labor; approximately 11.1% of household forestland was protected as ecological forests. Regarding community attributes, a rural community had an average of 1497 community members; forest per capita was 1.287 ha.

Table 4 lists the annual trends of the dependent and core independent variables. In general, the variables listed in Table 3 showed a relatively stable trend with fluctuation. With respect to households' formal credit access, the number of households having formal credit by collateralizing forestland fluctuated around 20, accounting for approximately 4% of respondents each year; households having formal credit accounted for slightly more than 20% of respondents each year.

Table 4
Annual trend of formal credit access.

	2012	2013	2014	2015	2016
Total observations	484	485	492	489	485
Formal credit access					
FCCF>0	21	19	18	25	20
FC>0	105	109	114	101	113

5. Analytical approach

Following the theoretical framework and variables, we employed two types of econometric approaches to examine the impact of FUC and FORESTLAND on households' formal credit access and channels of impact, respectively. First, dependent variables FCCF and FC, are left censored at zero. Only two types of formal credit can be observed: zero and positive amount of formal credit. Ordinary least squares regression (OLS) cannot produce consistently unbiased estimations. As an alternative to OLS, the Tobit model can produce a consistent estimation when the dependent variable is censored (Cameron and Trivedi, 2010). Therefore, a Tobit model for panel data was used to examine the impact of FUC and FORESTLAND on households' formal credit access. The equation of the Tobit model is as follows:

$$y_{it} = \alpha FUC_{it} + \beta FORESTLAND_{it} + X_{i,t}\gamma + u_i + \varepsilon_{i,t} \tag{1}$$

where y_{it} represents the FC or FCCF of household i in period t; FUC_{it} refers to the status of the forestland-use certificates of household i in period t; $FORESTLAND_{it}$ refers to forestland of household i in period t; $X_{i,t}$ is the set of other independent variables; u_i is the individual effect of each household; $\varepsilon_{i,t}$ is the random distribution.

Second, the dependent variables of the channels of impact, WILLINGNESS and DIFFICULTY, are multinomial variables. Such variables are not suitable for estimation using both near probability or binary probability models. Additionally, FUC and FORESTLAND and the other independent variables may not have a linear impact on WILLINGNESS and DIFFICULTY. Therefore, the multinomial logit model is suitable for analyzing the channels of impact in this study (Cameron and Trivedi, 2010). The probability equation of the multinomial logit model is as follows:

$$\Pr(y_{it} = j) = \frac{\exp(\alpha_j FUC_{it} + \beta_j FORESTLAND_{it} + Z_{i,t}\gamma_j)}{\sum_{l=0}^{m} \exp(\alpha_l FUC_{it} + \beta_l FORESTLAND_{it} + Z_{i,t}\gamma_l)}, j = 0, \ldots, m \tag{2}$$

where y_{it} represents WILLINGNESS or DIFFICULTY of household i in period t; FUC_{it} refers to the status of forestland-use certificates of household i in period t; $FORESTLAND_{it}$ refers to forestland of household i in period t; $Z_{i,t}$ is the set of other independent variables; m is equal to 2 or 3 when the dependent variable is WILLINGNESS or DIFFICULTY, respectively.

In Eq. (2), the multinomial logit model cannot be identified directly because more than one solution to coefficients, α_j, β_j, and γ_j. To identify the model, we need to set one category of the dependent variable as the base category. Therefore, when WILLINGNESS is the dependent variable, "no willingness" is set as the base category. Similarly, when DIFFICULTY is the dependent variable, "easy" is set as the base category. The coefficients of independent variables can be interpreted as a change in the relative likelihood of other categories to the base category of the dependent variable. For example, when "no willingness" is set as the base category, α_1 contributes to the changed likelihood of "uncertain willingness" relative to base category "no willingness", and α_2 contributes to the changed likelihood of "certain willingness" relative to the base category, "no willingness".

In addition to the selection of econometric approaches, obtaining consistent estimation remains in omitted variables (Pan and Zhang, 2018; Zhang and Zhang, 2020; Zhang et al., 2020). If omitted variables are correlated with core independent and dependent variables, the estimated coefficients of the core independent variables, FUC and FORESTLAND, will be biased. In this study, such a challenge was minimized in three ways. First, household characteristics and community attributes were included based on the literature. Second, the dummy variables of the counties in Fujian were introduced to represent unobserved and fixed county-level factors. Third, dummy variables for the different years were introduced to capture unobserved time-varying factors.

6. Econometric results

6.1. Regressions on formal credit access

Table 5 reports the regressions analyzing the impact of CFTR reform on household's formal credit access. Columns (1) and (2) included the regressions with the amount of household formal credit by collateralizing forestland and household total formal credit, respectively. We observed a heterogeneous impact of the forestland-use certificates on formal credit access. In column (1), the estimated coefficient of forestland-use certificates was significantly positive at the 1% level, whereas the estimated coefficient of forestland-use certificates in column (2) was insignificantly positive. Additionally, the estimated coefficients of household forestland were consistently positive at the 1% level in columns (1) and (2).

Table 5
Determinants of household's formal credit access.

Variables	(1) FCCF	(2) FC
Variables of CFTR		
FUC	143,926***	13,814
	(40,481)	(18,278)
FORESTLAND	4869***	1781***
	(657.8)	(319.6)
Forest policy environment		
EFOREST	−5,384,000*	−1,604,000*
	(2,857,000)	(956,465)
FINRURANCE	10,182	11,063
	(81,046)	(48,200)
Household characteristics		
EDU	−13,094	21,612**
	(17,249)	(9716)
AGE	−1992	−4053***
	(1550)	(827.5)
GENDER	849,908	2227
	(20,290,000)	(33,698)
MEMBER	−4108	5221
	(8054)	(4303)
LMIGRATION	30,499	−13,585
	(40,402)	(23,862)
HEFOREST	−31,389	35,478
	(59,189)	(24,785)
Community attributes		
CPOP	31.43	17.31
	(25.12)	(11.10)
FORPC	23,290**	−673.6
	(11,746)	(7273)
Dummies of county	YES	YES
Dummies of year	YES	YES

Notes: Standard errors in parentheses.
*Significance level at 10%.
**Significance level at 5%.
***Significance level at 1%.

Forest policies, household characteristics, and community attributes had heterogeneous impacts on households' formal credit access by collateralizing forestland and total formal credit. In column (1), only the proportion of ecological forests to forestland was significantly negative and forestland per capita in the community was significantly positive. In column (2), the proportion of ecological forests to forestland remain significantly negative. Considering household characteristics, both education of household heads and household members significantly and positively impacted households' total formal credit. The coefficient of age of the household head was significantly negative. Relative to the community attributes, the coefficient of the community population was significantly positive, while the coefficient of forestland per capita in the community was insignificant.

6.2. Regressions on channels of impact

Table 6 reports determinants of one channel of impact — willingness to access to formal credit. Columns (1) and (2) used "uncertain willingness" and "certain willingness" as independent variables, respectively, both with "no willingness" as the base category. Regarding the variables of CFTR reform, the coefficient of forestland-use certificates on "uncertain willingness" was significant and positive in column (1), while the coefficient on "certain willingness" was insignificant in column (2). In contrast, household forestland was estimated to have significant and positive impact on "certain willingness" but not on "uncertain willingness".

Next to the variables of CFTR reform, forest policy environment, household characteristics, and community attributes had distinctly heterogeneous impacts on "uncertain willingness" and "certain willingness" to access formal credit. In column (1), no coefficients of forest policy environment, household characteristics, and community attributes were found to be significant. In contrast, in column (2), three variables of household characteristics were noted: education level of the household head had a significantly positive impact on "certain willingness"; the age of the household head had a significantly negative impact on "certain willingness"; lastly, compared to female household heads, "certain willingness" versus "no willingness" among male household heads was significantly higher.

Table 6
Determinants of channel of impact: willingness to formal credit access.

Variables	(1) Uncertain willingness (base category: no willingness)	(2) Certain willingness (base category: no willingness)
Variables of CFTR		
FUC	0.591**	0.00247
	(0.260)	(0.131)
FORESTLAND	−0.0270	0.00978*
	(0.0204)	(0.00512)
Forest policy environment		
EFOREST	23.91	−4.525
	(15.47)	(6.319)
FINSURANCE	−0.198	−0.179
	(1.271)	(0.400)
Household characteristics		
EDU	0.0818	0.181***
	(0.149)	(0.0699)
AGE	0.00540	−0.0284***
	(0.0109)	(0.00568)
GENDER	1.148	0.573*
	(1.032)	(0.300)
MEMBER	−0.0766	−0.0363
	(0.0714)	(0.0307)
LMIGRATION	0.198	−0.230
	(0.354)	(0.171)
HEFOREST	0.155	0.169
	(0.428)	(0.201)
Community attributes		
CPOP	−0.000173	0.0000443
	(0.000175)	(0.000076)
FORPC	−0.0558	0.0778
	(0.156)	(0.0546)
Dummies of county	YES	YES
Dummies of year	YES	YES

Notes: Robust standard errors in parentheses.
*Significance level at 10%.
**Significance level at 5%.
***Significance level at 1%.

[Table 7](#) presents regressions on another channel of impact — difficulty in collateralizing forestland for formal credit. We observed that most of the variables were consistent in sign but varied in significance among the three categories of the dependent variables. With respect to CFTR reform, forestland-use certificates had significantly negative impact on "a little difficult" over "easy" and "difficult" over "easy" at 10% but remained insignificantly negative in column (3). In other words, the forestland-use certificates helped households to access formal credit easily. However, the coefficients of household forestland in columns (1)–(3) were neither significant nor consistent.

In addition, we observed some significance in the coefficients of household characteristics. First, the proportion of ecological forests to forestland was estimated to be significantly positive in columns (2) and (3). The proportion of forestland with forest insurance to forestland was significantly positive in column (2). The coefficients of gender of the household head were significantly positive in columns (1) and (3) but not in column (2); the coefficients of household members were significantly positive in columns (1) and (2), but not in column (3). The proportion of labor migration to total household laborers had significantly positive impact on the category "difficult" over "easy". The proportion of ecological forests to household forestland had a significantly negative impact on the category "a little difficult" over "easy". Finally, no variables of community attributes were significant.

7. Discussion

This study attempted to analyze the impact of CFTR on households' formal credit access. Specifically, CFTR was specified as issuing forestland-use certificates and increasing household forestland. One of our main results showed the mixed impact of forestland-use certificates on households' formal credit access. When the formal credit was measured by a household's formal credit by collateralizing forestland, the impact of forestland-use certificates was significantly positive. On the other hand, when the measurement was measured by a household's total formal credit, the impact of the forestland-use certificates was only insignificantly positive. Regarding one channel of impact – willingness to access formal

Table 7

Determinants of channel of impact: institutional constraint in formal credit access.

Variables	(1) A little difficult (base category: easy)	(2) Difficult (base category: easy)	(3) Extremely difficult (base category: easy)
Variables of CFTR			
FUC	−1.040*	−1.325*	−1.078
	(0.547)	(0.797)	(0.850)
FORESTLAND	0.00118	−0.00392	−0.0733
	(0.00461)	(0.00555)	(0.0589)
Forest policy environment			
EFOREST	4.467	216.9***	170.0*
	(52.38)	(67.46)	(96.95)
FINSURANCE	0.277	6.063*	−0.805
	(1.548)	(3.542)	(2.363)
Household characteristics			
EDU	0.227	0.205	−0.166
	(0.264)	(0.388)	(0.436)
AGE	−0.0125	0.0119	0.0345
	(0.0236)	(0.0308)	(0.0300)
GENDER	16.93***	1.853**	16.34***
	(0.773)	(0.769)	(1.192)
MEMBER	0.254*	0.450***	−0.000992
	(0.154)	(0.172)	(0.206)
LMIGRATION	0.759	1.546	0.0772
	(0.830)	(0.983)	(1.394)
HEFOREST	−1.748**	−1.301	−0.935
	(0.862)	(1.010)	(1.375)
Community attributes			
CPOP	0.000332	−0.0000759	0.000119
	(0.000306)	(0.000380)	(0.000480)
FORPC	0.155	0.103	0.229
	(0.172)	(0.217)	(0.321)
Dummies of county	YES	YES	YES
Dummies of year	YES	YES	YES

Notes: Robust standard errors in parentheses.
*Significance level at 10%.
**Significance level at 5%.
***Significance level at 1%.

credit – the impact of forestland-use certificates was significantly positive on households' "uncertain willingness" to access formal credit over "no willingness" but not significantly positive on households' "certain willingness" to access formal credit over "no willingness". Regarding institutional constraint, the impact of forestland-use certificates was significantly negative on "a little difficult" over "easy" and "difficult" over "easy" but not significant on "extremely difficult" over "easy".

Another main result showed the consistently positive impact of household forestland on formal credit access which was measured by a household's formal credit by collateralizing forestland and household's total formal credit. Regarding willingness to access formal credit, the impact of household forestland was significantly positive on households' certain willingness to access formal credit over "no willingness: but not significantly on households' "uncertain willingness" to access formal credit over "no willingness". Regarding institutional constraints, the impact of household forestland was not significant for any category over "easy".

The results of channels of impact showed that education of the household head and age of the household head changed household willingness to access to formal credit but did not significantly change institutional constraint on formal credit access. The possible explanation is that education of the household head and age of the household head could motivate household's participation in formal credit market but not by collateralizing forestland. Additionally, gender of household head significantly increased household's willingness to formal credit access but significantly increased institutional constraint of formal credit access. The result is that gender of household head did not significantly impact on formal credit access.

The main results could contribute to studies on CFTR. Some studies discovered that formal credit access by collateralizing forestland significantly could increase household forestry investment significantly and positively (Liu et al., 2017; Xie et al., 2014; Yi et al., 2014). Our analysis corroborates that CFTR enabled household's formal credit access by providing households with qualified collaterals. However, our analysis shows two limitations of CFTR. First, the main results only partly coincide with our conceptual framework. Particularly, forestland-use certificates only had a significant and positive

impact on households' formal credit by collateralizing forestland but insignificant impact on households' total formal credit. This insignificant impact seems to be due to the failure of the forestland-use certificates to increase households' certain willingness towards formal credit. Despite of this, our evidence confirmed that forestland-use certificates helped households overcome institutional constraints in the formal credit market. Second, household forestland only significantly increased households' certain willingness but did not significantly decrease difficulty on institutional constraints. The main results discovered that the impact of household forestland was significantly positive on both formal credit by collateralizing forestland and total formal credit. Therefore, household willingness to access formal credit and institutional constraints might function differently in formal credit access. A household' s willingness may dominate the household's decision on the total amount of formal credit, while institutional constraints may dominate in households' selection of credit sources.

In addition to the main results, the estimated signs of forest policy environment, household characteristics, and community attributes were consistent with the conceptual framework but provided nuanced findings. In particular, the impact of education of the household head was significantly positive on households' total formal credit but not on formal credit by collateralizing forestland. Next, the age of the household head had significantly negative impact on households' total formal credit but not on formal credit by collateralizing forestland. The results of channels of impact showed that education of the household head and age of the household head changed household willingness to access to formal credit but did not significantly change institutional constraint on formal credit access. The possible explanation is that education of the household head and age of the household head could motivate household's participation in formal credit market but not by collateralizing forestland. Additionally, gender of household head significantly increased household's willingness to formal credit access but significantly increased institutional constraint of formal credit access. The result is that gender of household head did not significantly impact on formal credit access. Finally, forestland per capita in the community had significantly positive impact on formal credit by collateralizing forestland but not on total formal credit. In summary, the expected signs of household characteristics are held on total formal credit, while the abundance of forest resources are held on formal credit.

Our study provides a reflection on devolved forest tenure reform. In current studies, devolved forest tenure reform could improve local forest management by easing institutional constraints (Adam and Eltayeb, 2016; Dang et al., 2018; Xu and Hyde, 2018). Our analysis contributes to current studies by showing the importance of financial instruments in devolved forest tenure reform. Devolving forests to local households is not the finale during reform. Instead, it is necessary to further increase the availability of financial resources and proper financial instruments.

8. Conclusion

This study analyzed the impact of CFTR on households' formal credit access. At the household level, CFTR was empirically measured as forestland-use certificates and household forestland. Our econometric analysis showed four main results. First, forestland-use certificates only had a significantly positive impact on the households' formal credit access measured as formal credit by collateralizing forestland. Second, household forestland had a significantly positive impact on the households' formal credit access measured as total formal credit and formal credit by collateralizing forestland. Third, regarding channels of impact, the households' willingness to access credit is significantly and positively impacted by forestland certificates and household forestland, although the impact of household forestland was more certain. Fourth, on another channel of impact, the institutional constraint of formal credit access was significantly and positively impacted by forestland-use certificates but not by household forestland. In addition to the main results, the education and age of the household head and abundance of community forest resources had impacts on households' formal credit access.

Our analysis contains implications on the appropriate use of formal credit as a financial instrument in devolved forest tenure reform. Government policies could further correct institutional constraints related to credit access, e.g., asymmetric information in credit markets. In addition, financial institutions should provide valid information for rural households about the formal credit by collateralizing forestland.

Our analysis could shed light upon future research. Future research could further investigate potential channels of impact through which devolved forest tenure reform could impact on household's formal credit access for Households. Finally, future research could analyze whether household's credit access could improve the sustainable use of forest resources.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

Adam, Y.O., Eltayeb, A.M., 2016. Forestry decentralization and poverty alleviation: A review. Forest Policy Econ. 73, 300–307.
Arts, B., de Koning, J., 2017. Community forest management: An assessment and explanation of its performance through QCA. World Dev. 96, 315–325.
Badeeb, R.A., Lean, H.H., Clark, J., 2017. The evolution of the natural resource curse thesis: A critical literature survey. Resour. Policy 51, 123–134.

Bardhan, P., Rudra, A., 1978. Interlinkage of Land, Labour and credit relations: An analysis of Village Survey Data in East India. Econ. Political Wkly. 13, 367–384.

Barslund, M., Tarp, F., 2008. Formal and informal rural credit in four provinces of Vietnam. J. Dev. Stud. 44, 485–503.

Besley, T., 1995. Property rights and investment incentives: Theory and evidence from Ghana. J. Political Econ. 103, 903–937.

Besley, T., Burchardi, K., Ghatak, M., 2012. Incentives and the de soto effect. Q. J. Econ. 127, 237–282.

Bhattacharyya, S., Hodler, R., 2014. Do natural resource revenues hinder financial development? The Role of Political institutions. World Dev. 57, 101–113.

Boucher, S.R., Barham, B.L., Carter, M.R., 2005. The impact of market-friendly reforms on credit and land markets in honduras and nicaragua. World Dev. 33, 107–128.

Cameron, A.C., Trivedi, P.K., 2010. Microeconometrics using Stata. Stata press College Station, TX.

Central Committee of Communist Party of China, Council, S., 1981. The resolution on several issues concerning Forest Protection and Development (in Chinese).

Central Committee of the Communist Party of China, State Council, 2008. Decision on collective Forest Tenure Reform (in Chinese).

Dang, T.K.P., Visseren-Hamakers, I.J., Arts, B., 2018. Forest devolution in Vietnam: From rhetoric to performance. Land Use Policy 77, 760–774.

De Brauw, A., Rozelle, S., 2008. Migration and household investment in rural China. China Econ. Rev. 19, 320–335.

Deinlnger, K., Binswanger, H., 1999. The evolution of the World Bank's Land policy: Principles, experience, and future challenges. World Bank Res. Obs. 14, 247–276.

Dong, J., Liang, W., Liu, W., Liu, J., Managi, S., 2020. Does forestland possession enhance households' access to credit?—Examining China's forestland mortgage policy. Econ. Anal. Policy 68, 78–87.

Fao, 2016. Global Forest Resources Assessment 2015. Food and Agriculture Organization of the United Nations, Rome.

Feder, G., Nishio, A., 1998. The benefits of land registration and titling: Economic and social perspectives. Land Use Policy 15, 25–43.

Goetz, A.M., Gupta, R.S., 1996. Who takes the credit? Gender, power, and control over loan use in rural credit programs in Bangladesh. World Dev. 24, 45–63.

Holden, S., Bezu, S., 2014. Land Valuation and Perceptions of Land Sales Prohibition in Ethiopia.

Hussain, A., Thapa, G.B., 2012. Smallholders' access to agricultural credit in Pakistan. Food Secur. 4, 73–85.

K. Petracco, C., Pender, J., 2009. Evaluating the Impact of Land Tenure and Titling on Access to Credit in Uganda. IFPRI Discussion Papers, International Food Policy Research Institute (IFPRI).

Kemper, N., Ha, L.V., Klump, R., 2015. Property rights and consumption volatility: Evidence from a land reform in Vietnam. World Dev. 71, 107–130.

Liu, C., Liu, H., Wang, S., 2017. Has China's new round of collective forest reforms caused an increase in the use of productive forest inputs? Land Use Policy 64, 492–510.

Liu, C., Wang, S., Liu, H., Zhu, W., 2018. Reprint of: Why did the 1980s' reform of collective forestland tenure in southern China fail? Forest Policy Econ..

Liu, P., Yin, R., Li, H., 2016. China's forest tenure reform and institutional change at a crossroads. Forest Policy Econ. 72, 92–98.

Menkhoff, L., Neuberger, D., Suwanaporn, C., 2006. Collateral-based lending in emerging markets: Evidence from Thailand. J. Bank. FinancePerspect. Int. Corp. Finance 30, 1–21.

Mpuga, P., 2010. Constraints in access to and Demand for Rural Credit: Evidence from Uganda. Afr. Dev. Rev. 22, 115–148.

Muravyev, A., Talavera, O., Schafer, D., 2009. Entrepreneurs' Gender and financial constraints: Evidence from International Data. J. Comp. Econ. 37, 270–286.

Nygren, A., 2005. Community-based forest management within the context of institutional decentralization in Honduras. World Dev. 33, 639–655.

Okten, C., Osili, U.O., 2004. Social networks and credit access in Indonesia. World Dev. 32, 1225–1246.

Pan, D., Zhang, N., 2018. The role of agricultural training on Fertilizer use knowledge: A randomized controlled experiment. Ecol. Econ. 148, 77–91.

People 's Bank of China, Ministry of Finance, China Banking Regulatory Commission, China Insurance Regulatory Commission, State Forestry Administration, 2009. Guidance on Collective Forestry Tenure Reform and Forestry Finance (in Chinese).

Phan, D., 2012. Migration and Credit Constraints: Theory and Evidence from Vietnam. Wiley-Blackwell: Review of Development Economics, p. 16.

Phelps, J., Webb, E.L., Agrawal, A., 2010. Does REDD+ Threaten to Recentralize Forest Governance? Science 328, 312–313.

Piza, C., José, M., Moura, S.B., 2015. How does land title affect access to credit? Empir. Evid. Emerg. Econ..

Radhakrishnan, S., 2015. Low profile or entrepreneurial? Gender, class, and cultural adaptation in the global microfinance industry. World Dev. 74, 264–274.

Sikor, T., Nguyen, T.Q., 2007. Why may forest devolution not benefit the rural poor? Forest entitlements in Vietnam's Central Highlands. World Dev. 35, 2010–2025.

Stiglitz, J.E., 2016. New theoretical perspectives on the distribution of income and wealth among individuals. In: Basu, K., Stiglitz, J.E. (Eds.), Inequality and Growth: Patterns and Policy: Volume I: Concepts and Analysis. Palgrave Macmillan UK, London, pp. 1–71.

Wydick, B., Karp Hayes, H., Hilliker Kempf, S., 2011. Social networks, neighborhood effects, and credit access: Evidence from rural guatemala. World Dev. 39, 974–982.

Xie, Y., Gong, P., Han, X., Wen, Y., 2014. The effect of collective forestland tenure reform in China: Does land parcelization reduce forest management intensity? J. Forest Econ. 20, 126–140.

Xie, Y., Wen, Y., Zhang, Y., Li, X., 2013. Impact of property rights reform on household forest management investment: An empirical study of southern China. Forest Policy Econ. 34, 73–78.

Xu, J., Hyde, W.F., 2018. China's second round of forest reforms: Observations for China and implications globally. Forest Policy Econ..

Yi, Y., K O Hlin, G., Xu, J., 2014. Property rights, tenure security and forest investment incentives: evidence from China's Collective Forest Tenure Reform. Environ. Dev. Econ. 19, 48–73, %\2019-2007-2026 2023:2014:2000.

Yin, R., Yao, S., Huo, X., 2013. China's forest tenure reform and institutional change in the new century: What has been implemented and what remains to be pursued? Land Use Policy 30, 825–833.

Zhang, N., Ren, R., Zhang, Q., Zhang, T., 2020. Air pollution and tourism development: An interplay. Ann. Tour. Res. 85, 103032.

Zhang, G., Zhang, N., 2020. The effect of China's pilot carbon emissions trading schemes on poverty alleviation: A quasi-natural experiment approach. J. Environ. Manag. 271, 110973.