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The impact of social capital and government support on farmers' willingness to pay for road governance: a case study of rural road governance in China

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The global environmental governance landscape is currently confronted with complex and pressing challenges, while rural road environments play a crucial role in providing essential services to rural ecosystems, making them a key factor in the success or failure of governance. Based on the 2018 China Labor Dynamic Survey Database (CLDS), this article approaches the issue from the perspective of rural environmental governance and uses the informal social networks of rural farmers as a starting point to construct an analytical framework for social capital and farmers' willingness to engage in environmental governance. Additionally, to examine the close link between welfare policies and farmers' participation in public affairs, this article specifically focuses on the potential moderating effect of government support (agricultural subsidies) and uses the instrumental variable method to mitigate its endogeneity. The study shows that: (1) Both improvements in social networks and social trust can promote farmers' willingness to engage in environmental governance. However, in the process of social participation, exposure to cutting-edge green technologies is essential to precisely activate individuals' willingness to engage in environmental governance. (2) In promoting individual farmer participation in environmental protection public affairs, it is crucial to emphasize the incentives provided by welfare policies, increase agricultural subsidies, and expand their depth and breadth of coverage. (3) Government departments should enhance the industrial vitality in the northeastern regions, accelerate industrial transformation, invigorate economic activity, and prevent population loss from causing disruptions in villages. In the western regions, context-specific cultural intervention measures should be developed. Through long-term and continuous "cultural governance" practices, a bottom-up, progressive approach should be adopted to stimulate public enthusiasm for participation in non-interest-driven public affairs and achieve self-sufficiency in the cultural field.

KEYWORDS

social capital, road governance, agricultural subsidies, regional heterogeneity, willingness to pay

1 Introduction and literature review

Environmental remediation in human settlements is a key component of the modernization of the national governance system. It reflects not only the growing demand of the people for a better life but also the government's commitment to sustainable development and ecological civilization (Zhang et al., 2016). China is a major agricultural country, with rural land covering approximately 21.94 million hectares, accounting for 62.13% of the total national construction land area. Similarly, rural areas in the United States account for approximately 91.4% of the total national land area. Therefore, advancing environmental remediation in rural areas is essential for realizing the global human settlement governance blueprint. In this process, rural roads inject continuous vitality into rural revitalization by optimizing resource allocation, strengthening economic linkages, and improving living standards. They are seen as the main focus of rural development. The Chinese government clearly emphasized in the “14th Five-Year Plan” the need to strengthen rural infrastructure, with a focus on road network construction. Improving the rural road network involves connecting rural roads with national highways, county roads, and other main routes, ensuring that roads reach villages and households, and solving the “last mile” connectivity problem in rural areas. By the end of 2023, the total length of rural roads in China had reached 4.6 million kilometers, accounting for 84.6% of the total road mileage in the country, forming a rural transportation network with extensive coverage, high accessibility, and strong service functions. It is evident that achieving the modernization of rural road environmental governance, actively improving the road environments in front of and behind villagers' homes, and integrating them deeply into the county-level environmental governance system, will not only effectively improve the quality of life of rural residents, but also enhance the

overall and coordinated nature of regional environmental governance. This governance model provides strong support for rural areas to move toward high-quality development, while also laying a solid foundation for the sustainable improvement of human settlement environments, thereby promoting the overall prosperity of rural socio-economic development.

In recent years, the Chinese government has typically adopted a government-led, top-down external governance model for implementing environmental remediation. This model often leads to issues such as a lack of funding, inefficiency, and low farmer participation due to shortcomings like imperfect systems, lack of transparency, and limited channels. To some extent, it also leads to a “government acts, farmers watch” phenomenon, which significantly weakens the effectiveness of rural road remediation (Niu et al., 2022). However, due to regional economic and cultural differences, the government's lack of experience, and the chaotic internal structure of the governance system, relying solely on a single governance entity has proven to be insufficient. These issues have led to government departments being unable to meet the governance demands of over 700,000 administrative villages nationwide, with significant challenges in securing grassroots governance funding. Additionally, considering that poverty alleviation efforts have just been completed, the issue of “unequal distribution of agricultural funds” remains a critical challenge that needs to be addressed. Therefore, in the 20th National Congress report, the Party pointed out that “grassroots governance not only relies on the leadership of Party organizations but also requires the active participation, initiative, and creativity of villagers.” In terms of research content, numerous studies have preliminarily addressed the involvement of farmers in environmental governance, but they mainly focus on topics such as farmland protection (Niu et al., 2022;

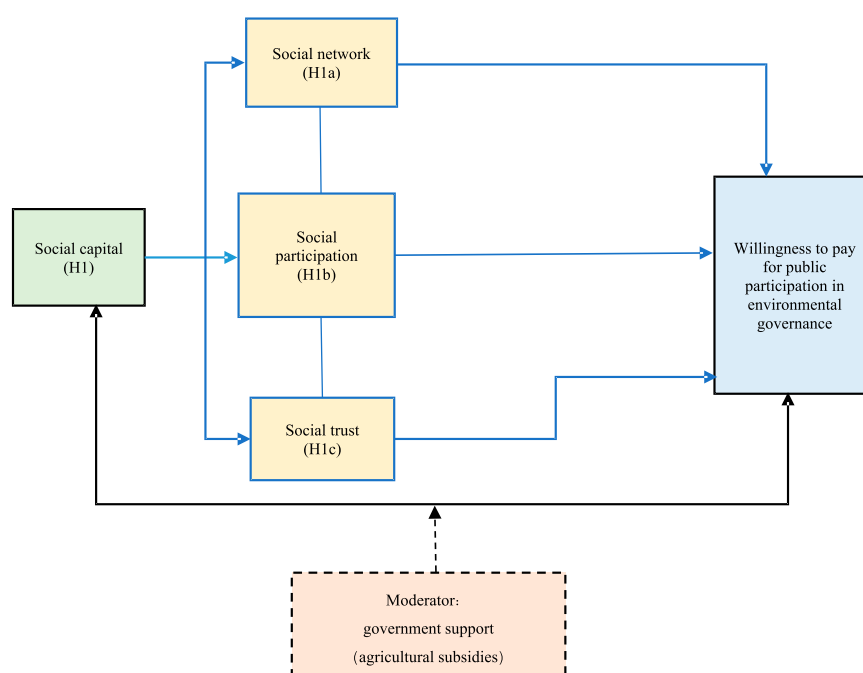


FIGURE 1
Theoretical analysis framework.

Helen and Kaja, 2021), waste management (Niles, 2020; Wang et al., 2019; Zhao and Chen, 2021), and sewage discharge (Huo, 2022; Miner et al., 2016; Wang et al., 2022). In terms of research areas, most scholars have focused on regions with higher levels of economic development or areas with typical characteristics nationwide (Miner et al., 2016; Fan et al., 2022). In terms of research perspectives, both domestic and international scholars focus on economic development (Asher and Novosad, 2020), green sustainability (Li and Zheng, 2021), and policy innovation (Zaitul et al., 2023). However, as a critical element for unblocking the “lifeline” of rural revitalization and securing the “iron rice bowl” of food security, the development of road governance lacks systematic argumentation. In particular, explorations of road governance models and pathways are largely based on macro data, theoretical analyses, and case studies, with a lack of subjective participation analysis and judgment regarding farmers.

Rural roads are not only essential infrastructure connecting towns and villages but are also deeply integrated into the organizational structure and lifestyle of rural society. As the “skeleton” and “network” of rural areas, rural roads not only fulfill the daily production and living needs of farmers but also facilitate interaction and collaboration among people (Xu and Miao, 2022). This network enhances internal and external connections within villages through convenient transportation, strengthens interactions among villagers, reduces the transaction costs of trust and cooperation, and thus boosts community cohesion and collective action capacity. For instance, He et al. (2024) confirmed that improving road conditions facilitates the promotion of farmers’ participation in small-scale water projects and cooperatives in Shanxi Province. It is evident that social capital plays an irreplaceable role in the socio-economic activities of farmers in regions with underdeveloped formal institutions (Zhao and Chen, 2021). However, Borg et al. (2015), based on the rational economic agent hypothesis, argues that farmers, as “rational-economic agents,” “pragmatists,” or “self-interested individuals,” are easily influenced by their social networks, resulting in “free-rider” behavior in situations involving common resource use. Theoretically, farmers’ participation in road governance activities involves numerous individuals from the same region voluntarily choosing to engage under government calls to pursue collective action for mutual benefit. However, in practice, individual choices and collective actions often do not align, leading to difficulties in environmental governance. For example, Li (2024) Asher and Novosad (2020) found that while improving transportation conditions through road network development, the direct impact of road construction assistance on economic interactions and collective action within villages was limited. It requires formal organizational planning, guidance, and incentives, rather than indiscriminate development. However, Li et al. (2024) found that the effectiveness of traditional government environmental campaigns gradually diminished among farmers in Shanxi and Shaanxi. External stimuli, such as various government regulations, may change farmers’ perceptions and subsequently influence their adoption of advanced agricultural technologies, improving soil quality. For example, Shen et al. (2024), in a study of 1,491 farmers in the Yellow River Basin, emphasized that to efficiently promote farmers’ adoption of green technologies (AGPT), strict government regulations (such as fines and criminal responsibility) should constrain farmers’ production behaviors. It is evident from incentive compatibility theory that government

incentive measures must align with individual goals and interests to effectively stimulate farmers’ actions. In other words, individuals are rational economic agents, and traditional policy campaigns cannot effectively advance policy implementation. In contrast, government regulations, as an external environmental stimulus, more directly influence farmers’ cost-benefit analysis and change their perceptions by offering specific, measurable benefits (such as subsidies, tax incentives, etc.) or imposing constraints (such as fines or restrictions on certain fertilizers and pesticides). The above research indicates that the academic community has preliminarily confirmed that, with reasonable government intervention, social networks can effectively increase farmers’ willingness to engage in public affairs. Therefore, social capital formed through long-term interactions among farmers can closely link individual micro-level behaviors with macro-level collective actions, and by enhancing trust, cooperation, and social norms, it can further promote the effective implementation of governance actions. It is evident that thoroughly studying the effects of social capital on farmers’ perceptions, willingness, and behaviors, along with appropriate intervention and constraints from formal organizations, is of significant practical importance for encouraging farmers to actively engage in road environmental governance.

Existing research provides a rich theoretical foundation and empirical reference for a deeper understanding of the internal logic between social capital and farmers’ willingness to participate in road governance. However, there are still several issues that need further exploration: First, existing research on social capital and farmers’ participation behavior mainly focuses on topics such as farmland protection, sewage treatment, air pollution, and waste management, with a lack of exploration in the field of rural road governance, particularly studies directly related to individual non-economic motivations for participation. Second, based on the rational economic agent hypothesis, can government welfare policies (such as agricultural subsidies) enhance farmers’ social identity and motivate them, within the context of complex social networks, to pay for road governance? To what extent is this effect moderated? These questions remain to be further tested. Third, current academic research on social capital and farmers’ behavior is mostly limited to specific policy regions or perspectives, or only focuses on the eastern, western, and central regions, with little attention given to the unique development model of Northeast China and its comparative analysis with other regions. In view of this, this article explores the internal mechanisms of the relationship networks in rural areas and farmers’ willingness to pay for road governance using data from the China Labor Dynamics Survey. The aim is to provide data support and empirical insights for formulating targeted and more effective public participation policies for international communities, particularly developing countries, and to contribute to the improvement of global road governance and environmental governance mechanisms for rural areas.

2 Theoretical analyses and hypotheses

The concept of ‘social capital’ was first introduced and defined by Bourdieu in Social Science Research, where he argued that “social capital is not inherently existing but rather a collection of actual or potential resources embedded within an individual’s resource

endowment.” Later, Putnam extended the concept of social capital into the fields of sociology and economics. He identified social trust, social interaction, social networks, and social norms as the fundamental components of social capital (Putnam, 1993). He also provided a preliminary explanation of the relationship between these four elements, explaining that trust, networks, and norms are dynamic outcomes of social interaction, which interact with each other to form a virtuous cycle that continuously deepens social interaction (Figure 1). It is clear that Bourdieu emphasized how individuals acquire resources within social relationships, while Putnam focused on helping individuals understand the mechanisms and pathways for accumulating resources in these relationships. In this process, individual behavior is not only influenced by economic capital and human capital but is also profoundly shaped and driven by interpersonal relationships, social norms, and social networks. These factors collectively form the foundation for social action. The structured form of this social network has a profound impact on individual decision-making, especially in environments with resource scarcity and information asymmetry, where individual behavior and choices are often deeply shaped by relationships.

H1: Social capital positively influences farmers’ willingness to contribute financially to road governance.

In fact, as a “relationship-based society,” the impact of social capital on rural environmental governance actions is not composed of a single dimension but rather arises from the mutual promotion and interconnection of three dimensions: social trust, social networks, and social participation, which collectively interact within the rural environmental governance system (Putnam, 1993). Therefore, within such a complex relational network, farmers are not only rational “economic agents” but also “social agents” embedded within social relationships. This is particularly true in Chinese society, where the structural relationships of geography, kinship, and business ties may significantly influence farmers’ participation in road improvement projects (Ruan et al., 2022).

2.1 Social network mechanisms

Social networks are formed through communication and interaction between individuals and organizations (Haythornthwaite, 1996), providing an important channel for farmers to access necessary information. In recent years, scholars have widely recognized that relying solely on government-led approaches is insufficient to achieve effective environmental governance. Given the complexity and dynamic nature of governance structures, farmers’ active participation has emerged as a critical factor driving environmental governance. The sharing and transmission of “information channels” among farmers can promote the formation of a multi-stakeholder co-governance model, effectively overcoming bottlenecks in the governance process (Liu and Zheng, 2021). Consequently, scholars have begun to explore the role of social networks in farmers’ participation in environmental governance. Current research generally suggests that the influence of social networks on farmers’ participation is mainly reflected through three mechanisms: (1) the information acquisition mechanism. Individual resource endowments, such as social connections and

resource accessibility, can effectively enable farmers to obtain the resources necessary for participation—including information, knowledge, technology, and methods—through communication and interaction. (2) the learning and communication mechanism. Social networks, as “relational webs” formed among individuals, organizations, and governments, not only facilitate communication and exchange among stakeholders but also inspire and mobilize individuals or organizations that have not yet participated. This, in turn, can encourage their involvement in public affairs activities to a certain extent. (3) the trust mechanism. Social networks help enhance participants’ recognition of norms of mutual reciprocity, thereby laying the foundation for building trust relationships and influencing individuals’ behavioral decisions. It is widely known that the relational characteristics of China’s rural society are mainly interwoven with multiple dimensions, including kinship, family ties, geographical proximity, and occupational connections. These relational networks form effective channels for information sharing, fostering communication and interaction among farmers, and thereby enhancing their enthusiasm for participation in governance. Thus, as carriers of social capital, social networks not only promote information flow and break information “barriers” but also create possibilities for more governance-related information to enter rural areas. This, in turn, may positively influence farmers’ participation in road governance. Based on this, the article proposes Hypothesis H1a.

H1a: Social networks can establish complex information networks to promote farmers’ participation in road governance.

2.2 Social participation mechanisms

Social participation refers to individuals expressing their specific willingness to participate through engagement and intervention in public affairs, including how societal members engage in the processes of government decision-making, the execution and implementation of decisions, and the methods, procedures, content, and levels of public involvement, as well as the resolution of conflicts and contradictions (Liu and Zheng, 2021; Ricardo et al., 2022). In recent years, the positive interaction between social participation and public affairs has gradually been established as a form of social contract, resulting in a pluralistic cooperation model or a polycentric governance mechanism (Francesco and Alain, 2021). Taking rural areas as an example, farmers’ participation in the public affairs of others or other collectives is generally regarded as a typical form of social participation. In this process, farmers, through the exchange and interaction of resource endowments, can not only acquire the relevant information and resources they need but also adjust their decision-making intentions and correct their behaviors in a timely manner. For example, Ayodeji et al. (2021) conducted a study in Nigeria to examine whether individual participation in collective action leads to differentiated decision-making among farmers in their selection of strategies to address climate change. It is evident that organically integrating rural ethical relationships with environmental governance practices is critical. Incorporating social capital into farmers’ participation in rural road governance generally reveals that farmers’ participation, intervention, and

involvement in collective governance activities correlate with a high level of relational networks. This not only mitigates farmers' concerns about potential self-serving behaviors during governance participation but also reduces uncertainty risks in the governance process, enhances farmers' sense of participation and belonging, and promotes socio-economic development.

Drawing on the conclusions of the aforementioned studies, this article argues that social participation, as a key dimension of social capital, extends its relational and network channels through integration with public affairs. This facilitates the dissemination of a sense of responsibility among farmers during their participation in funding rural road governance and enhances their social responsibility. In contexts of frequent social participation, farmers can not only strengthen their emotional connection to their hometown but also enhance collective behavior and a sense of responsibility, thereby encouraging more farmers to actively contribute to funding road governance. Based on this, the article proposes Hypothesis H1b:

H1b: Social participation has a significant impact on farmers' willingness to contribute to funding rural road governance.

2.3 Social trust mechanisms

Social trust is a social resource formed through long-term communication and interaction among individuals in a specific region. It permeates an individual's entire range of social activities and constitutes an essential component of social consensus and norms. Its function effectively enhances the willingness of individuals to cooperate with each other or with collectives, fostering stable cooperative rules and reciprocal mechanisms (Chloupková and Bjornskov, 2002). Particularly in rural areas, this is reflected in the unique, complex, and intensive socio-economic activities characteristic of villages. Through word of mouth, collective activities with shared participation, or social platforms, social trust reduces information asymmetry and enhances the transparency and enthusiasm of farmers for participating in collective interactions. Thus, trust mechanisms serve as an essential foundation for public participation in public affairs.

Existing research has demonstrated that trust mechanisms are generally manifested in two forms: social trust and political trust (Fang et al., 2018). First, social trust refers to the trust network established through farmers' repeated reciprocal cooperation with others or other social organizations by fully utilizing their trust capital. Adherence to norms of reciprocity can effectively enhance farmers' sense of social responsibility and identity. Accordingly, strong trust relationships can expand the channels for information dissemination among farmers and reduce the costs of acquiring information. Thus, when farmers contribute to funding rural road governance, strong trust relationships not only reduce barriers to cooperation but also continuously enhance farmers' willingness to participate in payments, establishing a governance framework involving multiple stakeholders. In contrast, the absence of trust elements often leads to both parties becoming self-serving, thereby losing the potential for reciprocal cooperation. In the process of farmers' participation in road governance, issues related to their

personal interests, such as land relocation, waste management, and road adjustments, often arise. If villagers lack trust and lose their sense of social responsibility, focusing solely on their immediate interests, this can lead to low participation enthusiasm, difficulty in raising governance funds, inefficient project implementation, and the emergence of "free-riding" behaviors. Under such circumstances, achieving rural road governance objectives in a timely manner would be nearly impossible. Second, political trust refers to the degree of farmers' trust in formal organizations such as villages or village committees. For example, in the case of village committees, the government enhances trust with villagers by providing farmers with free public service guarantees, including financial, educational, and living support. Additionally, transparent financial management and open decision-making processes are employed to maintain farmers' trust. Against this backdrop, villagers' trust in the government leadership system is gradually established and deepened, forming a stable and closely interactive "trust network." Clearly, establishing, improving, and maintaining a multi-faceted social trust mechanism effectively enhances public awareness of social responsibility, laying a solid foundation for the smooth advancement of public affairs. This also contributes to achieving the goal of "government-citizen integration" and alleviating the phenomenon of mutual hesitation between government and farmers. Based on this, the article proposes Hypothesis H1c:

H1c: Social trust has a significant impact on farmers' willingness to contribute to funding rural road governance.

2.4 Analysis of regional heterogeneity

China is vast, and there are significant differences in resource endowments across provinces and cities, which directly lead to different behavioral perceptions and decision-making approaches among farmers (Ito, 2010). Specifically, regional development in China, based on differences in natural resources, economic levels, and strategic orientation, presents four major economic zones: the Eastern, Central, Western, and Northeastern regions. According to Spatial Heterogeneity Theory, social capital exhibits significant heterogeneity across regions. This heterogeneity is reflected not only in the distribution and form of social capital but also in its influence by multiple factors such as regional economy, social structure, and cultural background, leading to different mechanisms and effects of social capital across various regions (Lignier et al., 2024). In recent years, the role of social capital in areas such as information dissemination, resource integration, and behavioral perception has become increasingly prominent and has attracted widespread attention (Zhang et al., 2020). In recent years, the role of social capital in areas such as information dissemination, resource integration, and behavioral perception has become increasingly prominent and has attracted widespread attention (Zhang et al., 2020). However, the application of traditional social capital has mainly focused on the dissemination of non-economic benefits, with participation perceptions generally exhibiting a more optimistic character, particularly in social activities in non-economic fields. With the diversification of

social capital across different economic, cultural, and resource contexts, and changes in individual behavior patterns in specific regions, the participatory attitudes exhibited by social capital in public affairs involving individual interests have become a key topic of research. Research has shown that social capital plays a significant role in promoting farmers' adoption of green technologies, with higher levels in the Eastern and Central regions and lower levels in the Western region (Han et al., 2022). Additionally, Lai et al. (2021) focused on the spatial heterogeneity of residents' marginal willingness to pay (MWTP) for clean air at the urban level, revealing significant differences in payment willingness across regions. It is evident that the "rational actor" model in the context of public participation in environmental governance based on social capital exhibits significant regional heterogeneity due to differences in regional resource endowments.

In summary, to accurately reflect the regional heterogeneity of social capital in influencing farmers' willingness to contribute to road governance payments, this article divides the country into four major economic zones: Eastern, Central, Western, and Northeastern regions. It explores the mechanisms and factors through which social capital affects farmers' willingness to pay for road governance in each region. In summary, to accurately reflect the regional heterogeneity of social capital in influencing farmers' willingness to contribute to road governance payments, this article divides the country into four major economic zones: Eastern, Central, Western, and Northeastern regions. It explores the mechanisms and factors through which social capital affects farmers' willingness to pay for road governance in each region. Based on this, Hypothesis H1d is proposed.

H1d: Social capital exhibits significant regional heterogeneity in influencing farmers' willingness to pay for rural road governance.

2.5 Analysis of moderating effects

Research has found that welfare policies formulated by the government play a crucial role in motivating individuals to participate in non-economic benefit matters (Swartz et al., 2009). Taking agricultural subsidies as an example, traditional social capital, as a key factor in promoting cooperation and trust, can effectively stimulate farmers' enthusiasm for participating in public affairs. However, the effect of social capital alone often fails to fully reflect farmers' true participation motivations. To systematically explore the internal and external factors influencing farmers' participation in public affairs, it is crucial to address the relationships between the government and the market, as well as between the government and farmers. Zhou et al. (2021) argue that to fully achieve the modernization of agriculture and rural development, the governance of rural living environments must serve as both the starting point and the end goal. This, combined with a scientifically sound and reasonable policy environment from the government, will create a positive scenario of widespread societal participation. Generally, the government integrates into environmental governance through two methods: first, by regulating farmers' behavior and the direction and focus of rural environmental governance through government support (subsidy policies), adjusting relationships among market participants,

farmers, and other stakeholders, and thus allocating social resources. Second, the government allocates fiscal funds or directly subsidizes the project sources of individual farmers or farming enterprises. This action may yield good environmental governance outcomes in the short term. However, in the long term, a lack of goal guidance and clear positioning, as well as issues with insufficient precision and irregular subsidy procedures, may lead to fragmented implementation of this policy, inevitably intensifying conflicts between the stakeholders and rural environmental governance. However, taking government support (farmers' subsidies) as an example, the relationship between farmers' participation in public affairs is influenced by factors such as cognitive ability, living environment, and risk attitudes. Agricultural subsidies, in turn, are key factors affecting farmers' employment and risk attitudes (Jiang and Liu, 2017). In the long run, agricultural subsidy policies meet the long-term development needs of individuals. Subsidized farmers, influenced by environmental responsibility awareness, public consciousness, and career decisions, will consciously participate in rural living environment governance. It is clear that the widespread implementation of agricultural subsidy policies is of direct practical significance in forming farmers' social capital and awareness, thereby promoting individual participation in environmental governance. Based on this, Hypothesis H1e is proposed.

H1e: Agricultural subsidies positively influence the effect of social capital on farmers' willingness to pay for road governance.

3 Data sources, model construction and variable selection

3.1 Data sources

The analysis data used in this study comes from the China Labor-force Dynamics Survey (CLDS) project, initiated in 2012 by the Social Science Survey Center of Sun Yat-sen University. The China Household Finance Survey (CHFS) is one of China's nationally representative surveys, collecting microdata from households and individuals across 29 provinces, excluding regions such as Tibet, Xinjiang, Hong Kong, Macau, and Taiwan. The database contains detailed data on farmers' social capital, including indicators such as household social networks, trust levels, and willingness to cooperate. The extensive data from the CLDS covers farmers' economic conditions, social security participation, and labor market involvement, all of which are closely related to farmers' willingness to pay for road governance. In 2017–2018, the Central Committee of the Communist Party of China and the State Council issued the "Opinions of the Central Committee of the Communist Party of China and the State Council on Implementing the Rural Revitalization Strategy," which comprehensively deployed the rural revitalization strategy, including promoting green development in rural areas. In 2017–2018, the Central Committee of the Communist Party of China and the State Council issued the "Opinions of the Central Committee of the Communist Party of China and the State Council on Implementing the Rural Revitalization Strategy," which comprehensively deployed the rural revitalization strategy,

TABLE 1 Descriptive statistics.

Variable name	Variable definition	Mean	Standard deviation
Social capital			
Willingness to pay	Willingness to pay for road governance (1 = very willing; 2 = somewhat willing; 3 = general; 4 = not very willing; 5 = very unwilling)	1.92	0.83
Social network			
Homogeneous networks	Wedding gifts for relatives and friends in village (1 = all go; 2 = most go; 3 = few will go; 4 = rarely go)	1.92	0.92
Heterogeneous networks	Other people in the village (not relatives and friends) get married and give gifts (1 = all go; 2 = most go; 3 = few will go; 4 = rarely go)	2.68	1.1
Social participation			
Union activities	Are you involved in agricultural trade union activities (1 = yes; 2 = no)?	2.54	0.89
adoption of new technologies	(1 = very willing; 2 = more willing; 3 = average; 4 = less willing; 5 = very unwilling)	1.37	0.48
Social trust			
Neighborhood mutual aid	Number of times you have helped your neighbour (1 = very much; 2 = more; 3 = fair; 4 = less; 5 = very little)	2.54	0.98
Trusting in neighbours	Do you trust your neighbours and other people living in your community (village)? (1 = very trusting; 2 = trusting; 3 = fairly trusting; 4 = not trusting; 5 = very distrustful)	2.28	0.81
Moderator			
Government support	Do you accept government agricultural subsidies (1 = yes; 2 = no)?	1.44	0.50
Control variable			
Gender	1 = male; 2 = female	1.52	0.5
Income	Total revenue in 2017	39015.68	72112.93
Political landscape	1 = Communist Party of China member; 2 = Democratic parties; 3 = Mass	2.86	0.5
Expenditure	Total consumer spending in 2017	55853.99	99975.45

including promoting green development in rural areas. In addition, on the same day, the “Three-Year Action Plan for Rural Living Environment Improvement” was released, focusing on key areas such as rural household waste, domestic sewage treatment, and the improvement of village appearance. The goal was to achieve significant improvement in rural living environments by 2020. Therefore, this article selects cross-sectional data from 2018, focusing on key issues in rural revitalization related to road environmental governance. The study examines the factors influencing farmers’ willingness to pay for rural road governance, with a focus on social capital and farmers’ participation, as well as the moderating effect of agricultural subsidies.

The article processes the data as follows in relation to the research content: First, in terms of survey data selection, a multi-stage, multi-level, and comprehensive approach is employed using a probability sampling method proportional to the labor force size. Second, in sample selection, the authors refer to Miao et al. (2015) to select rural residents aged 18 and above with certain behavioral capabilities who are part of the agricultural labor force. Third, samples with missing key information such as age, household income, social capital, and political affiliation are excluded. Based on this, the final effective sample size of the study is 11,547, with an effective rate of 95.09%.

3.2 Variable selection

First, the dependent variable. In recent years, to effectively address governance, funding, and technical challenges, the “crowdfunding” governance model has gradually emerged in rural areas. Given this, the article refers to the research conclusions of Zhang et al. (2020) and Miao et al. (2015), and selects farmers’ willingness to participate in road governance (donating to repair hometown roads) as a multinomial virtual variable. The willingness levels of farmers represent a ranked, multi-category intention. The variable definition and assignment are detailed in Table 1 below.

Second, the independent variables. The article refers to the measurement methods of social capital used by Putnam (1995), Zhang et al. (2020), and Miao et al. (2015). The authors divide its dimensions into three characteristics: social networks, social trust, and social participation. This approach helps to better identify patterns and structures in the data, reduce errors in data processing, and facilitates precise analysis of the factors influencing farmers’ willingness to pay, as affected by social capital.

In summary, the article follows the approach of Liang et al. (2015) by using “gifting for celebrations organized by relatives and friends in the village” and “gifting for celebrations organized by

other villagers (non-relatives)” as proxy variables for homogenous and heterogeneous networks within social networks. The possible reason is that in rural areas, where social networks are close-knit, the information network platform created by celebratory events helps facilitate communication between villagers and migrant workers, enhancing a sense of rural identity. Drawing on the approach of Ayodeji et al. (2021), the study selects “respondent participation in agricultural union activities” and “farmers’ active adoption of new agricultural technologies” as proxy variables for social participation. The possible reason is that the communication and interaction generated through farmers’ active participation in public affairs form relational networks, which not only help local farmers gain successful experiences but also maintain the hometown connection for migrant workers, thereby enhancing their willingness to contribute to the village’s development. Moreover, a well-maintained road environment is vital for connecting rural towns to urban areas, serving as a bridge for migrant workers returning to their hometowns to start businesses and as a crucial link in ensuring farmers’ access to various key information. Therefore, migrant agricultural workers, considering the economic development and industrial transformation trends in rural areas, participate in rural road governance to adapt to policy adjustments. Following the approach of Liu and Zheng (2021), the study selects “number of neighborly assistance interactions” and “whether the farmer trusts their neighbors” as proxy variables for social trust. Trust capital is an important influencing factor for farmers’ participation in public affairs. Trusting neighbors and engaging in mutual assistance increases farmers’ sense of rural identity and belonging, which in turn increases the likelihood of their participation in road governance.

Before conducting the factor analysis, the article used Stata 15.0 software to calculate the KMO value of the survey data, which was 0.53. This indicates that the sample is suitable for factor analysis (generally, a KMO value greater than 0.5 is considered acceptable). Common factor 1 had higher loadings on indicators 5 and 6, with a variance contribution rate of 27.29%, reflecting social networks. Common factor 2 had higher loadings on indicators 1 and 2, with a variance contribution rate of 23.76%, reflecting social participation. Common factor 3 had higher loadings on indicators 3 and 4, with a variance contribution rate of 17.11%, reflecting social trust. Finally, using the variance contribution rate of each factor as a weight, the comprehensive social capital index is calculated using the following formula: Social Capital = (27.29% × Social Networks + 23.76% × Social Participation + 17.11% × Social Trust)/68.17%.

Third, the moderating variables. Research indicates that government support is a key driver in rural living environment governance and is a core factor in motivating farmers to actively participate in public affairs. The infrastructure construction and improvement of rural living environments largely depend on government fiscal subsidies. Based on the regional differences in culture, values, and economic levels, the literature focuses on agricultural subsidy policies, exploring their moderating effect on social capital and farmers’ willingness to participate in public affairs in rural areas.

Fourth, the control variables. Research shows that farmers’ behavior is influenced by both internal resource endowments and external environmental factors. The specific study is as follows:

several influencing factors were selected as control variables. First, household head characteristics: gender, political affiliation, and 2017 income. Second, family characteristics: 2017 household income. The definitions of the variables and the results of the descriptive statistical analysis are presented in Table 1.

3.3 Model construction

The article follows the study by Litman (2014), using “whether farmers are willing to pay for rural road governance costs” as a proxy variable to measure public participation willingness. To ensure the authenticity and reliability of the empirical results, a stepwise analysis method is used to verify the impact of social capital and its multidimensional heterogeneity on farmers’ willingness to pay for road governance (Ayodeji et al., 2021; de, 2017):

First, considering the possible correlation between the proxy variables for social networks, social participation, and social trust within social capital. Therefore, to prevent severe multicollinearity issues between variables in this study, the authors follow the approach of Zhang et al. (2020) by selecting six independent variables as proxies for this study. These variables are then transformed into latent common factors using Peterson’s factor analysis method, narrowing the research scope to three characteristic dimensions, which helps alleviate empirical result errors. The specific form is as follows:

$$Y_i = \mu_i + a_{i1}f_1 + \dots + a_{im}f_m + \delta_i, (m \leq p) \quad (1)$$

In Equation 1, f_1, f_2, \dots, f_p represents a common factor, which is an unobservable variable in the empirical model, and this coefficient is expressed in the form of factor loadings. Additionally, ϵ_i is a random error term, which is a specific factor that cannot be included in the common factor. μ_i represents the constant term. a_{i1} aims to assess the specific impact coefficient of social capital on farmers’ willingness to participate in road governance.

Secondly, given that farmers’ willingness is divided into multiple ordered categories, the article uses an ordered multinomial logistic model for empirical analysis. The specific formula derivation is as follows:

$$p_j = p(y \leq j | x) = \frac{\exp\left(\alpha_j + \sum_{i=1}^n \beta_i x_i\right)}{1 + \exp\left(\alpha_j + \sum_{i=1}^n \beta_i x_i\right)} \quad (2)$$

In Equation 2, y represents “farmers’ willingness to pay for road governance”; α_j is the constant term regression coefficient; β_i is the coefficient; x_i represents the independent variable social capital (social networks, social participation, and social trust) ($i = 1, 2, \dots, n$); $j = 1, 2, 3, 4, 5$, represents the five levels of willingness.

The article systematically analyses different dimensions of social capital in order to further deepen the role of social capital in farmers’ participation in environmental governance. It aims to target and improve the effectiveness and quality of farmers’ participation and promote the sustainable development of rural road governance. Specifically, the stepwise regression method is used to explore the operation mechanism of farmers’ resource endowment represented

by social network, social participation and social trust, and the specific model is as follows (2a-c):

$$p_j = p(y \leq j | \text{Social_net}) = \frac{\exp\left(\alpha_j + \sum_{i=1}^n \beta_i x_{\text{Social_net}}\right)}{1 + \exp\left(\alpha_j + \sum_{i=1}^n \beta_i x_{\text{Social_net}}\right)} \quad (2a)$$

$$p_j = p(y \leq j | \text{Social_par}) = \frac{\exp\left(\alpha_j + \sum_{i=1}^n \beta_i x_{\text{Social_par}}\right)}{1 + \exp\left(\alpha_j + \sum_{i=1}^n \beta_i x_{\text{Social_par}}\right)} \quad (2b)$$

$$p_j = p(y \leq j | \text{Social_tru}) = \frac{\exp\left(\alpha_j + \sum_{i=1}^n \beta_i x_{\text{Social_tru}}\right)}{1 + \exp\left(\alpha_j + \sum_{i=1}^n \beta_i x_{\text{Social_tru}}\right)} \quad (2c)$$

Where $i = 1$ stands for j_i , i.e., social network; $i = 2$ stands for Social_par, i.e., social participation; $i = 3$ stands for Social_tru, i.e., social trust, and the other variables are consistent with (2).

Finally, based on the exploration of the impact of social capital on farmers' willingness to participate in road governance, the author follows the approach of Bo et al. (2021) to further investigate the moderating effect of agricultural subsidies on the relationship between social capital and farmers' participation in road governance. The specific form of the model is as follows:

$$y_i = \beta_0 + \beta_1 \text{Social_cap} + \beta_2 \text{Demo_change} + \beta_3 \text{Social_cap} \times \text{cha} + \delta_i \quad (3)$$

(3) where y_i represents the dependent variable farmers' willingness to pay for road management; Social_cap represents the independent variable social capital; Demo_change represents the moderator variable government support (agricultural subsidies), and Social_cap \times cha represents the interaction term between social capital and Internet perceptions, and δ_i is the error term.

In addition to this, taking into account the multidimensional heterogeneity of social capital, the article delves into the expression of different dimension-specific models (3a-c):

$$y_i = \beta_0 + \beta_1 \text{Social_net} + \beta_2 \text{Demo_change} + \beta_3 \text{Social_net} \times \text{cha} + \delta_i \quad (3a)$$

$$y_i = \beta_0 + \beta_1 \text{Social_par} + \beta_2 \text{Demo_change} + \beta_3 \text{Social_par} \times \text{cha} + \delta_i \quad (3b)$$

$$y_i = \beta_0 + \beta_1 \text{Social_tru} + \beta_2 \text{Demo_change} + \beta_3 \text{Social_cap} \times \text{cha} + \delta_i \quad (3c)$$

Where Social_net, Social_par and Social_tru represent social network, social participation and social trust respectively. Social_net \times cha, Social_par \times cha and Social_tru \times cha are interaction terms between social network, social participation, social trust and agricultural subsidy respectively. The other variables are consistent with Equation 3.

4 Results and analyses

4.1 Results of social capital analysis

Based on the previous analysis, the article follows Miao et al. (2015) by using the comprehensive social capital score as a proxy

variable to examine the impact of social capital on farmers' willingness to pay for road governance. Accordingly, Model 1 primarily analyzes the overall impact of the comprehensive social capital score and control variables on farmers' willingness to participate in road governance. Models 2 through 5 respectively examine the impact of social networks, social participation, and social trust within social capital on farmers' willingness to pay for road governance. The detailed analysis is presented in Table 2.

As seen in Model 1 in Table 2, social capital has a positive impact on farmers' willingness to pay for road governance, with a coefficient of 0.650*** that is statistically significant at the 1% level ($P > 0.05$). The conclusion rejects the null hypothesis (that social capital has no effect on farmers' willingness to pay for road governance), validating Hypothesis H1. This research conclusion is based on the framework of the Collective Action Paradox theory, providing empirical support for Olson's (2012) early theory. Olson's theory posits that due to the "free-rider" problem, farmers generally exhibit a passive attitude towards participating in non-benefit public affairs. However, with the spread of complex social capital in rural areas, farmers' attitudes towards participating in such public affairs have significantly changed, with their enthusiasm for participation gradually increasing. Social capital, by fostering trust, cooperation, and collective action among farmers, not only increases their participation in public affairs but also significantly enhances their willingness to pay for projects such as road governance. Particularly in rural communities, the positive role of social capital can effectively compensate for individuals' economic limitations and drive farmers to make collective decisions based on shared interests. This research result indicates that as social capital increases, farmers' willingness to voluntarily participate in village road repairs also shows a clear upward trend.

4.2 Social network analysis results

As seen in Model 2 and Model 5 in Table 2, Hypothesis H1a is validated. The behavior of "gifting for celebrations organized by relatives and friends in the village" in both homogenous and heterogeneous networks is statistically significant at the 1% level ($P < 0.05$). The conclusion rejects the null hypothesis (that social networks have no effect on farmers' willingness to pay for road governance). Similarly, the act of gifting for celebrations organized by other villagers (non-relatives or friends) ($P < 0.05$) also shows a positive influence on farmers' participation in road governance. The study further shows that the higher the frequency of farmers' participation in relatives' (and non-relatives') celebrations, the more significant the social networks formed through communication, interaction, and learning. These networks significantly increase farmers' willingness to pay for village road repairs (0.125***). This finding highlights the profound impact of social interaction and network relationships on farmers' behavior. It is worth noting that, compared to heterogeneous networks, homogenous networks have a more significant role in driving village environmental improvement (0.492***). This phenomenon further validates Buijs et al. (2023) viewpoint in Psychological Bulletin, which argues that a higher degree of self-other overlap, particularly in close kinship relationships, makes it more likely for individuals to help those close to them. In rural areas of China, due

TABLE 2 Social capital and farmers' willingness to pay for road management.

Variable name	Model 1	Model 2	Model 3	Model 4	Model 5
Social capital					
Comprehensive indicators	0.650*** (0.15)				
Social networks					0.347*** (0.09)
Homogeneous networks		0.492*** (0.03)			
Heterogeneous networks		0.125*** (0.02)			
Social participation					0.109*** (0.09)
participation in the adoption of new agricultural technologies			0.590*** (0.13)		
Participate in agricultural union activities			0.056 (0.22)		
Social trust					0.208*** (0.11)
Neighborhood mutual aid				0.128*** (0.03)	
Trust in neighbors				0.361** (0.03)	
Control variable					
Gender	−0.151 (0.23)	0.085*** (0.04)	−0.138 (0.23)	0.039*** (4.69)	−0.165 (0.23)
Income	−3.30 (2.25)	3.18 (4.76)	1.49 (2.24)	3.82 (4.69)	−8.81 (2.25)
Political landscape	0.173 (0.14)	0.281*** (0.05)	0.239 (0.139)	0.251*** (0.50)	0.156 (0.14)
Expenditure	−2.16 (1.76)	−1.34 (2.85)	−3.08 (1.77)	−2.71 (2.86)	4.55 (1.77)

Note: *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

to the complex kinship and familial ties, collective behavior is profoundly influenced by these factors. Therefore, to effectively promote civic participation in public affairs, especially in rural areas, efforts can start with the elder groups in the village. Encouraging their active participation not only helps enhance their own willingness to engage but also, through their influence, indirectly promotes collective behavioral changes throughout the entire village.

4.3 Results of the social participation analysis

As seen in Model 3 in Table 2, Hypothesis H1b is partially validated. The variable “respondent’s active participation in adopting new agricultural technologies” (0.590***) positively affects farmers’ willingness to pay for road governance ($P < 0.05$). This indicates that the more actively respondents engage in adopting new agricultural technologies, the stronger their willingness to contribute to repairing rural roads. The variable “respondent participation in agricultural union activities” (0.056) does not significantly affect farmers’ behavior ($P > 0.05$), indicating that union activities in rural areas do not influence farmers’ willingness to pay for road governance. The conclusion partially rejects the null hypothesis (that social participation has no effect on farmers’ willingness to pay for road governance). The possible reason is that, on one hand, agricultural unions in rural areas are mostly informal social groups spontaneously organized based on common interests. The members of these unions are generally older local residents who may have insufficient awareness of

environmental responsibility, hindering the active involvement of union members in rural road governance. Additionally, in rural areas, due to the deep-rooted traditional agricultural background, farmers’ economic levels and development concepts are uneven, resulting in insufficient conditions for farmers to contribute to the repair of hometown roads. On the other hand, the acceleration of urbanization has promoted industrial and technological innovation, attracting a large number of young rural surplus laborers. Most agricultural workers have abandoned traditional farming and moved their families to towns, resulting in a sharp decline in both the quantity and quality of union members, leading to the current situation of low farmer participation in road governance. Accordingly, the proxy variable selected in this study, “participation in agricultural union activities,” does not have a significant impact on farmers’ willingness to pay for rural road governance.

4.4 Results of social trust analysis

As seen in Model 4 in Table 2, the variables “trust in neighbors” and “neighborly assistance” are both significant at the 1% level, with positive coefficients ($P < 0.05$). The conclusion rejects the null hypothesis (that social capital does not have significant regional heterogeneity in farmers’ willingness to pay for road governance). The conclusion rejects the null hypothesis (that social trust has no effect on farmers’ willingness to pay for road governance). The study finds that, across all age groups, both neighborly assistance and trust in neighbors strengthen the trust bonds between individuals and effectively enhance the level of social trust. Moreover, high-quality

TABLE 3 Regional heterogeneity.

Variable name	Model 6	Model 7	Model 8	Model 9
Eastern region	0.412*** (0.45)			
Central region		0.298** (0.05)		
Western region			−0.624*** (0.05)	
Northeast region				0.041 (0.09)
Control variables				
Gender	0.074* (0.04)	0.084* (0.04)	0.075* (0.04)	0.076* (0.04)
Income	9.68 (4.69)	6.69 (4.73)	−9.05 (4.74)	5.38 (4.68)
Political landscape	0.291*** (0.05)	0.276*** (0.05)	0.274*** (0.05)	0.284** (0.05)
Expenditure	−2.73 (2.83)	−1.54 (2.83)	−2.40 (2.84)	−1.58 (2.83)

Note: *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

trust levels foster closer connections between individuals. For example, McClurg (2003) suggests that neighbors' public participation behaviors (such as voting and attending meetings) have a significant "peer effect" on individuals, who tend to subtly imitate their neighbors' participation behaviors.

From different research perspectives and theoretical frameworks, "neighborhood" is typically defined as a social organization composed of people living in close geographical proximity. It usually includes shared boundaries, public facilities, and social networks, emphasizing a larger geographical and social space. On the other hand, "neighbors" more commonly refer to direct relationships between individuals, such as people living in the same building or on the same street. Neighborhood relationships encompass a more complex and expansive network space. They are influenced by traditional culture or social backgrounds, containing more intricate social relations but lacking deep emotional connections (Van, 2012). In contrast, relationships between neighbors are more intimate, based on pure emotional ties. These relationships mainly stem from the practical needs and conveniences of daily life, and over time, they influence individuals' values and social views. It is clear that, compared to neighborhood relationships, relationships between neighbors have closer geographical and occupational connections, and thus hold higher emotional value in the process of influencing individual behavior. Therefore, whether through neighborly assistance or trust in neighbors, both effectively promote farmers' willingness to participate in road governance, thus validating Hypothesis H1c.

4.5 Results of regional heterogeneity analysis

As seen in Models 6–9 in Table 3, the impact of social capital on farmers' willingness to pay for road governance shows significant regional heterogeneity. The conclusion rejects the null hypothesis (that social capital does not have significant regional heterogeneity in farmers' willingness to pay for road governance).

First, the impact of social capital on farmers' willingness to participate in road governance in the Eastern region is significant at the 1% level, with a positive coefficient. This finding preliminarily

confirms Hypothesis H1d, showing that social capital has a promoting effect on farmers' willingness to participate in road governance in the Eastern region. Second, the impact of social capital on farmers' willingness to participate in road governance in the Central region is significant at the 5% level, with a positive coefficient, confirming that Hypothesis H1d holds true. Third, the impact of social capital on farmers' willingness to participate in road governance in the Western region is significant at the 1% level, with a negative coefficient. This finding disproves Hypothesis H1d, showing that social capital has a significant negative impact on farmers' willingness to participate in road governance in the Western region. The possible reason is that, on one hand, the Western region is a large autonomous region primarily populated by ethnic minorities, with higher cultural differences and lower education levels. This area, which focuses on agriculture, livestock farming, and some nomadic practices, emphasizes local interests and a conservative attitude, which is not conducive to open collective action. On the other hand, in the remote mountainous areas of the Western region, due to inconvenient transportation and information isolation, farmers often struggle to obtain important information about government projects, such as road governance. Over time, this leads to a lack of trust and interest in government projects. Secondly, based on Putnam's (2000) "weak ties" theory of social capital, ethnic minorities in the Western region tend to gather in tight networks bound by family or kinship ties. The characteristics of these social networks mean that they are less involved in community-level cooperation and public affairs. Furthermore, Tarrow (1996) argues that this close kinship network makes them more likely to view external policies and projects as "external intervention," thereby reducing farmers' willingness to accept and participate. Similarly, Fukuyama (2000) suggests that the utility of social capital is not universally effective but is constrained by specific social and cultural contexts, preventing it from fully realizing its potential in promoting participation in public affairs. This further impacts farmers' enthusiasm for rural road governance. Fourth, the impact of social capital on farmers' willingness to participate in road governance in the Northeastern region is not significant, disproving Hypothesis H1d. The possible reason is that, influenced by the strategic positioning of the Northeastern region, most industries are concentrated in peripheral areas far from urban

TABLE 4 Moderating effects of government support.

Variable type	Model 10	Model 11	Model 12	Model 13
Social_cap	−0.023 (0.29)			
Social_net		−0.063 (0.18)		
Social_par			0.029 (0.18)	
Social_trust				0.173 (0.22)
Moderator				
demo_change	0.466 (0.42)	0.463 (0.42)	0.471 (0.42)	0.430 (0.42)
Interaction terms	1.121* (0.63)			
Social_cap × cha		1.138* (0.63)		
Social_net × cha			1.125* (0.62)	
Social_trust × cha				1.158* (0.63)
Control variables				
Gender	−0.840* (0.48)	−0.823* (0.47)	−0.845* (0.469)	−0.908* (0.48)
Income	0.00* (6.52)	0.000* (6.25)	0.000* (6.43)	0.000* (6.33)
Political landscape	0.523* (0.31)	0.525* (0.31)	0.517* (0.31)	0.452 (0.32)
Expenditure	−2.71 (3.93)	−2.72 (3.86)	−2.77 (3.90)	−2.22 (3.83)

Note: *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

centers, and the population is widely distributed across a large geographical span with harsh climate conditions. This unique geographical and climatic environment leads to a lack of confidence among farmers in road environmental governance, which in turn prevents social capital from forming an effective communication network, failing to significantly increase farmers' willingness to participate in road governance in the Northeastern region. Additionally, Yan et al. (2022) points out that while the Northeastern region also has characteristics of vast land and sparse population, it differs from other regions in that the area has experienced significant rural population loss, and agricultural diversification is particularly prominent. A large number of farmers have migrated to economically developed cities such as Beijing, Dalian, and Jilin, forming a family-based social structure. This population flow and structural change have led to a gradual weakening of the connection between farmers and rural road governance. Especially regarding funding for rural road governance, farmers' willingness to participate has significantly decreased, impacting the advancement of rural public affairs. Therefore, the role of social capital in this context is further weakened, failing to effectively stimulate farmers' willingness to engage in collective action.

4.6 Results of the moderating effects analysis

From the results of the moderating effect in Table 4, it is clear that social capital, social networks, social participation, and social trust all have significant intrinsic connections with agricultural

subsidies. The conclusion rejects the null hypothesis (that agricultural subsidies do not moderate the effect of social capital on farmers' willingness to pay for road governance).

Among these, the effect on social trust is the strongest, followed by social networks, with social participation having the weakest effect. This is likely due to the long-term impact of agricultural subsidy policies in strengthening internal trust and cooperation within villages. Agricultural subsidy policies directly affect economic welfare, and individual economic benefits are closely tied to active public participation in public affairs. Only strong economic capacity can support villagers' participation in such non-public welfare activities that involve personal funds. Additionally, agricultural subsidies can enhance the welfare of community members, strengthening their sense of belonging to the community and commitment to shared goals, thus promoting broader participation. In other words, in examining the influence of social capital on farmers' willingness to pay for road governance, the more government subsidies farmers receive, the more their relational networks facilitate their participation in funding road governance. Finally, agricultural subsidy policies directly alleviate farmers' economic pressure on a macro level and improve their livelihood conditions. This favorable policy motivates farmers to participate in more government activities, strengthens their policy recognition, and increases their support and identification with government projects.

4.7 Endogeneity test

To ensure the logical consistency, scientific rigor, and accuracy of the empirical results, the article delves into

TABLE 5 IV-reg2 regression results.

Variable type	Model 14		Model 15		Model 16		Model 17	
	—	—	—	—	—	—	—	—
Social capital		0.157 (0.29)						
Social networks				0.074 (0.14)				
Social participation						0.157 (0.29)		
Social trust								−1.136 (3.81)
Fitness level	0.182*** (0.04)		0.390*** (0.08)		0.182 (0.04)		0.025 (0.06)	
Control variables	Control	Control	Control	Control	Control	Control	Control	Control
Gender	0.160* (0.06)	−0.101 (0.09)	0.299* (0.15)	−0.098 (0.09)	0.160 (0.09)	−0.101 (0.09)	−0.072 (0.14)	0.006 (0.34)
Income	−1.54 (5.68)	−3.49 (8.61)	1.52 (1.02)	−4.29 (8.43)	−1.54 (5.68)	−3.94 (8.61)	−2.81*** (7.70)	−3.61 (0.00)
Political landscape	0.068 (0.05)	0.112* (0.05)	0.054 (0.08)	0.120* (0.05)	−0.068 (0.04)	0.113* (0.05)	0.200 (0.63)	0.35 (0.75)
Expenditure	−4.99 (6.20)	3.72 (8.09)	−2.89 (8.07)	2.96 (8.34)	−4.99 (6.20)	3.72 (8.09)	4.16 (8.17)	7.66 (2.31)
Constant term	−0.754*** (0.19)	1.78*** (0.20)	−1.400*** (0.32)	1.76*** (0.19)	−0.754*** (0.19)	1.785*** (2.00)	−0.458* (0.29)	1.146 (1.98)

Note: The first stage explanatory variable is social capital, and the second stage explanatory variable is farmers’ participation in road governance behavior.

potential endogeneity issues. Theoretically, farmers’ participation in public affairs can effectively build new relational networks, which may affect their social capital, creating a potential bidirectional causal relationship between the two. The author refers to Wang and Yan (2022) study and selects “health level” as an instrumental variable, using the Iv-reg2 model for endogeneity testing. The Iv-reg2 model not only reflects the essence of the instrumental variable but is also the most efficient instrumental variable method when the spherical disturbance terms are independently distributed.

According to social capital theory, an individual’s health level has an interactive relationship in the operation of social capital. In empirical research, referencing Wang and Tian (2021) who used the COVID-19 pandemic as the research subject, it is argued that social capital is not only influenced by individual health levels and the scale of social capital, but also depends on the quantity of health-level capital in an individual’s interactions. It is clear that farmers’ health levels can directly affect the scale of their social capital. Furthermore, the OLS regression shows that the variable is uncorrelated with its error term, satisfying the requirements for an instrumental variable in this study. According to Model 14, the health level has a significant impact on social capital at the 1% level. At the same time, the article conducts a weak instrument variable test on “farmers’ health level” and finds that the F-statistics are 16.669 and 16.470, both greater than 10% and 15%, meaning the obtained instrument is not a weak instrument. Moreover, after the second-stage DWH test, the article finds that the P-value rejects the null hypothesis, indicating that there is no endogeneity problem between the variables studied. The research results are shown in Table 5 below.

5 Concluding recommendations

5.1 Conclusion

The article uses survey data from the 2018 China Labor Dynamics Survey (CLDS), which includes 399 villages and 11,547 farmers, to systematically analyze the impact of social capital and its multidimensional heterogeneity on farmers’ willingness to pay for road governance, and to verify the regional heterogeneity of social capital’s impact on farmers’ willingness to participate in road governance. In this process, we focused on the moderating effect of agricultural subsidies through theoretical derivation, and in the conclusion, we mitigated endogeneity using instrumental variables. The conclusions are as follows: 1) Social capital has a significant and positive impact on farmers’ willingness to pay for road governance. It is worth noting that participation in some public welfare organizations, such as unions, does not effectively influence farmers’ willingness to participate in road governance. (2) Agricultural subsidies have a positive effect on the relationship between social capital and farmers’ willingness to participate in road governance. Specifically, the more often farmers receive agricultural subsidies or the larger the subsidies, the stronger the effect of their resource endowments on their willingness to pay for road governance. (3) Considering the regional heterogeneity of social capital, the Eastern and Central regions show a positive influence, while the Western region shows a negative trend. In the Northeastern region, resource endowments have no significant impact on farmers’ participation in governance.

In summary, the conclusions of this study further explore the impact of social capital on farmers’ participation in short-term non-benefit activities, building upon existing literature. This research not only verifies, supplements, and improves previous theoretical frameworks

but also consolidates academic achievements in the field of farmers' behavioral studies. It also derives new findings with an international perspective from the research conclusions, providing new perspectives and theoretical support, especially for issues in developing countries. First, traditional agricultural union organizations, as non-profit social entities, cannot serve as effective information dissemination channels for farmers. In the future, the government should collaborate with village committees and farmers' cooperatives, enhancing farmers' collective consciousness, increasing information transparency, clarifying economic returns, and establishing reasonable incentive mechanisms to encourage farmers to pay for road governance. Second, in culturally rich regions with a strong sense of localism, it is urgent to develop highly adaptable cultural intervention measures based on local conditions. This intervention should aim at achieving self-sufficiency in the cultural sector, and through long-term, continuous "cultural governance" practices, take a bottom-up progressive approach to stimulate and strengthen public enthusiasm for participation in non-benefit-driven public affairs. Third, in mechanized production areas characterized by modernization and industrialization, social capital is influenced by enterprise-led production, where farmers play a smaller role. They may have unclear recognition of the responsibility to pay. Furthermore, small-scale farmers often believe that enterprises bear most of the environmental governance responsibility, leading farmers to adopt a "free-rider" mentality, assuming they can benefit from the payment behavior of others. Therefore, in more modern rural areas, policymakers may need to stimulate farmers' participation by clarifying responsibility allocation, enhancing their awareness of environmental governance, and providing incentives to increase their willingness to pay. Fourth, to increase farmers' willingness to pay for public governance, the government should implement targeted agricultural subsidy policies to encourage farmers to join cooperatives and collective actions, while also fostering social capital, promoting trust, and enhancing cooperation. By linking subsidies to environmental governance and encouraging agricultural enterprises to take on more social responsibility, the government can achieve mutual development for farmers, enterprises, and communities, promoting a sustainable rural governance model.

5.2 Policy recommendations

First, under the current situation of "acquaintance society" in China, given the positive impact of social capital on farmers' willingness to pay for road governance, traditional cultural resources in the region should be fully utilized to build information dissemination platforms for rural communities that facilitate communication and supervision among villagers. This will promote emotional and trust exchanges among farmers and actively leverage the important roles of social networks, social participation, and social trust.

Second, the government should promptly adjust the activities of agricultural unions, strengthen cooperation with village committees or cooperatives, and encourage more public interest-oriented activities, such as rural road governance promotion, education, and participation projects. The role of the union in serving the public interest should be reinforced. Meanwhile, regular reports on union activities and financial statements should be published to allow farmers to understand the progress of union work and resource distribution.

Third, it is necessary to refine, institutionalize, standardize, and model agricultural subsidy policies, creating a "warmth effect" nationwide, which can be transformed into informal constraints to encourage farmers' active participation in public affairs. Additionally, relevant departments should strengthen the construction of village-level grassroots agricultural technology promotion associations, village women's federations, and village committees, and ensure the proper construction of village-level network platforms centered around the village party organization.

Fourth, based on the regional heterogeneity of farmers' social capital, the government should attract relevant industrial sectors to the Western region while developing green production-scale industrial chains. Environmental governance concepts should be deeply ingrained, and the importance of farmers' participation in road environmental governance should be actively promoted. Additionally, to address the issue of the non-significant impact of social capital on farmers' participation in road governance in the Northeastern region, the government should develop policies for talent introduction based on the planning of the Western region. This could include the establishment of county-level poverty alleviation experimental points to promote the importance of road governance at the grassroots level, changing farmers' traditional thinking, and thus enhancing their willingness to participate in road governance.

5.3 Limitations and future directions

Due to limitations in data availability, this study did not include data from Xinjiang, Hong Kong, and Taiwan, resulting in an inability to achieve comprehensive coverage of regional data in China. Additionally, in the analysis of social capital and its multidimensional heterogeneity, the potential correlation between social networks, social trust, and social participation may affect the accuracy of the research results.

In future research, we will further improve data collection efforts to address the gaps in the current data. We will also conduct time series analysis based on existing data to explore the potential patterns between social capital and farmers' willingness to participate in road governance, revealing the dynamic impact of social capital on farmers' behavior at different time points.

Data availability statement

The original contributions presented in the study are included in the article/[Supplementary Material](#), further inquiries can be directed to the corresponding author.

Author contributions

XZ: Data curation, Funding acquisition, Methodology, Supervision, Writing – review and editing. MH: Conceptualization, Investigation, Resources, Software, Visualization, Writing–original draft, Writing – review and editing. YW: Formal Analysis, Project administration, Validation, Writing – review and editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

References

- Asher, S., and Novosad, P. (2020). Rural roads and local economic development. *Am. Econ. Rev.* 110 (3), 797–823. doi:10.1257/aer.20180268
- Ayodeji, O., Ayodeji, K., Ashok, M., and Ogundej, A. (2021). Impacts of farmers’ participation in social capital networks on climate change adaptation strategies adoption in Nigeria. *Heliyon* 7 (12), e08624. doi:10.1016/j.heliyon.2021.e08624
- Bo, Q. W., Zou, B., and Guo, F. (2021). Environmental scanning perspective: the moderating effects of organizational risk and government subsidy in innovation search process. *Sci. Public Policy* 48 (4), 531–540. doi:10.1093/scipol/scab041
- Borg, R., Toikka, A., and Primmer, E. (2015). Social capital and governance: a social network analysis of forest biodiversity collaboration in Central Finland. *For. Policy Econ.* 50, 90–97. doi:10.1016/j.forpol.2014.06.008
- Buijs, V. L., Jeronimus, B. F., Lodder, G. M. A., Riediger, M., Luong, G., and Wrzus, C. (2023). Interdependencies between family and friends in daily life: personality differences and associations with affective well-being across the lifespan. *Eur. J. Personality* 37 (2), 154–170. doi:10.1177/08902070211072745
- Chloupková, J., and Bjørnskov, C. H. (2002). Could social capital help Czech agriculture? *Agric. Econ.* 64 (6), 245–250. doi:10.17221/5312-AGRICECON
- de Krom, M. P. M. (2017). Farmer participation in agri-environmental schemes: regionalisation and the role of bridging social capital. *Land Use Policy* 60, 352–361. doi:10.1016/j.landusepol.2016.10.026
- Fan, W., Yan, L., Chen, B. Y., Ding, W., and Wang, P. (2022). Environmental governance effects of local environmental protection expenditure in China. *Resour. Policy* 77, 102760. doi:10.1016/j.resourpol.2022.102760
- Fang, L., Qing, W., Fang, M. S., Xu, D., and Sun, C. H. (2018). Farmers’ willingness to participate in the management of small-scale irrigation in China from a social capital perspective. *Irrigation Drainage* 67 (4), 594–604. doi:10.1002/ird.2208
- Francesco, C., and Alain, D. (2021). Bounded rationality, social capital, and technology adoption in family farming: evidence from cocoa-tree crops in Ivory Coast. *Sustainability* 13 (13), 7483. doi:10.3390/su13137483
- Fukuyama, F., and Social Capital and Civil Society, (2000). IMF Working Paper No. 00/74, Available at SSRN: <https://ssrn.com/abstract=879582> 2. New York City: Simon & Schuster.
- Han, M., Liu, R., Ma, H., Zhong, K., Wang, J., and Xu, Y. (2022). The impact of social capital on farmers’ willingness to adopt new agricultural technologies: empirical evidence from China. *Agriculture* 12 (9), 1368. doi:10.3390/agriculture12091368
- Haythornthwaite, C. (1996). Social network analysis: an approach and technique for the study of information exchange. *Libr. Inf. Sci. Res.* 18 (4), 323–342. doi:10.1016/s0740-8188(96)90003-1
- He, X., Wu, Y., and Wei, J. (2024). The status of collective action among rural households in underdeveloped regions of China and its livelihood effects under the background of rural revitalization—evidence from a field survey in Shanxi Province. *Sustainability* 16 (15), 6575. doi:10.3390/su16156575
- Helen, P., and Kaja, P. (2021). Role of environmental awareness in implementing farmland conservation measures. *J. Rural Stud.* 87, 58–66. doi:10.1016/j.jrurstud.2021.08.021
- Hou, X. S. (2022). Can public-private partnership wastewater treatment projects help reduce urban sewage disposal? Empirical evidence from 267 cities in China. *Int. J. Environ. Res. Public Health* 19 (12), 7298. doi:10.3390/ijerph19127298
- Ito, J. (2010). Inter-regional difference of agricultural productivity in China: distinction between biochemical and machinery technology. *China Econ. Rev.* 21 (3), 394–410. doi:10.1016/j.chieco.2010.03.002
- Jiang, X., and Liu, W. P. (2017). “The impact of labor transfer on farm households’ adoption of forestry technology—based on the survey data in Hunan, Jiangxi, and Fujian provinces,” in *Proceedings of the 2017 9th international economics, management and education technology conference (IEMETC 2017)*, 301–304.
- Lai, Z., Liu, X., Li, W., Li, Y., Zou, G., and Tu, M. (2021). Exploring the spatial heterogeneity of residents’ marginal willingness to pay for clean air in Shanghai. *Front. Public Health* 9, 791575. doi:10.3389/fpubh.2021.791575
- Li, Q., Lv, S., Cui, J., Hou, D., Liu, Y., and Li, W. (2024). Sustainability constraints on rural road infrastructure. *Sustainability* 16 (16), 7066. doi:10.3390/su16167066
- Li, S., and Liu, J. (2024). How does government regulation affect farmers’ soil remediation behavior? based on a mediation effect analysis of farmers’ cognition. *Copernic. Meet.* doi:10.5194/egusphere-egu24-14064
- Liang, Q., Huang, Z., Lu, H., and Wang, X. (2015). Social capital, member participation, and cooperative performance: evidence from China’s Zhejiang. *International Food and Agribusiness Management Review*, 18 (1), 49–77. doi:10.22004/agecon.197768
- Lignier, P., Jarvis, D., Grainger, D., and Chaiechi, T. (2024). Spatial heterogeneity and subjective wellbeing: exploring the role of social capital in metropolitan areas using multilevel modelling. *Journal of Happiness Studies*, 25 (5), 52.
- Litman, T. (2014). Evaluating public transportation local funding options. *J. Public Transp.* 17 (1), 43–74. doi:10.5038/2375-0901.17.1.3
- Liu, C., and Zheng, H. (2021). How social capital affects the willingness of farmers to accept low-carbon agricultural technology (LAT)? A case study of Jiangsu, China. *Int. J. Clim. Change Strategies Manag.* 13 (3), 286–301. doi:10.1108/ijccsm-09-2020-0100
- Liu, C. H., and Zheng, H. W. (2021). How social capital affects the willingness of farmers to accept low-carbon agricultural technology (LAT)? A case study of Jiangsu, China. *Int. J. Clim. Change Strategies Manag.* 13 (3), 286–301. doi:10.1108/ijccsm-09-2020-0100
- McClurg, S. D. (2003). Social networks and political participation: the role of social interaction in explaining political participation. *Political Res. Q.* 56 (4), 449–464. doi:10.2307/3219806
- Miao, S. S., Heijman, W., Zhu, X. Q., and Lu, Q. (2015). Social capital influences farmer participation in collective irrigation management in Shaanxi Province, China. *China Agric. Econ. Rev.* 7 (3), 448–466. doi:10.1108/caer-05-2014-0044

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Supplementary material

The Supplementary Material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/fenvs.2025.1514402/full#supplementary-material>

- Miner, C. A., Tagurum, Y. O., Hassan, Z., Afolaranmi, T. O., Bello, D. A., and Dakhin, A. (2016). Knowledge and practice of sewage disposal in abattoir community of jos south LGA plateau state, Nigeria. *Research Journal of Health Sciences*, 4 (1), 74–82. doi:10.1007/s10902-024-00765-4
- Niles, M. T. (2020). Majority of rural residents compost food waste: policy and waste management implications for rural regions. *Front. Sustain. Food Syst.* 3, 123. doi:10.3389/fsufs.2019.00123
- Niu, S. D., Xiao, L. Y., and Gu, G. Z. (2022). What is the operation logic of cultivated land protection policies in China? A grounded theory analysis. *Sustainability* 14 (14), 8887. doi:10.3390/su14148887
- Olson, M. (2012). The logic of collective action [1965]. *Contemp. Sociol. Theory* 124, 62–63.
- Putnam, R. (1993). The prosperous community: social capital and public life. *Am. Prospect* 13, 35–42. doi:10.2307/3824796
- Putnam, R. D. (1995). Bowling alone: America's declining social capital. *J. Democr.* 6 (1), 65–78. doi:10.1353/jod.1995.0002
- Putnam, R. D. (2000). *Bowling alone: the collapse and revival of American community*. Simon and Schuster.
- Ricardo, C. D., Delgado, L. E., Langle, F. A., Perevotchikova, M., and Marin, V. H. (2022). A systematic review of social participation in ecosystem services studies in Latin America from a transdisciplinary perspective, 1996–2020. *Sci. Total Environ.* 828, 154523. doi:10.1016/j.scitotenv.2022.154523
- Ruan, H. B., Chen, J., Wang, C., Xu, W., and Tang, J. (2022). Social network, sense of responsibility, and resident participation in China's rural environmental governance. *Int. J. Environ. Res. Public Health* 19 (11), 6371. doi:10.3390/ijerph19116371
- Shen, Y., Shi, R., Yao, L., and Zhao, M. (2024). Perceived value, government regulations, and farmers' agricultural green production technology adoption: evidence from China's Yellow River Basin. *Environ. Manag.* 73 (3), 509–531. doi:10.1007/s00267-023-01893-y
- Swartz, T. T., Blackstone, A., Uggen, C., and McLaughlin, H. (2009). Welfare and citizenship: the effects of government assistance on young adults' civic participation. *Sociol. Q.* 50 (4), 633–665. doi:10.1111/j.1533-8525.2009.01154.x
- Tarrow, S. (1996). Social movements in contentious politics: a review article. *Am. Political Sci. Rev.* 90 (4), 874–883. doi:10.2307/2945851
- Van Eijk, G. (2012). Good neighbours in bad neighbourhoods: narratives of dissociation and practices of neighbouring in a 'problem' place. *Urban Stud.* 49 (14), 3009–3026. doi:10.1177/0042098012439110
- Wang, C., Feng, B. B., Wang, P., Guo, W., Li, X., Gao, H., et al. (2022). Revealing factors influencing spatial variation in the quantity and quality of rural domestic sewage discharge across China. *Process Saf. Environ. Prot.* 162, 200–210. doi:10.1016/j.psep.2022.03.071
- Wang, H. F., and Tian, Z. Z. (2021). A review of the application of Bourdieu's social practice theory in health promotion at home and abroad. *J. Med. Soc.* 34 (07), 47–51. doi:10.13723/j.xysh.2021.07.010
- Wang, L., Yan, D. Y., Xiong, Y., and Zhou, L. (2019). A review of the challenges and application of public-private partnership model in Chinese garbage disposal industry. *J. Clean. Prod.* 230, 219–229. doi:10.1016/j.jclepro.2019.05.028
- Wang, X. M., and Yan, T. W. (2022). Technology cognition, environmental regulation, and farmers' adoption of straw returning technology. *World Agric.* (04), 57–68. doi:10.13856/j.cn11-1097/s.2022.04.006
- Xu, Z., and Miao, S. (2022). Effect of public space on collective action for rural waste management and the mediating effects of social capital. *Agriculture* 12 (7), 1020. doi:10.3390/agriculture12071020
- Yan, Z., Wei, F., Deng, X., He, Q., and Qi, Y. (2022). Feminization of agriculture: do female farmers have higher expectations for the value of their farmland? empirical evidence from China. *Agriculture* 12 (1), 60. doi:10.3390/agriculture12010060
- Zaitul, Z., Ilona, D., and Novianti, N. (2023). Good governance in rural local administration. *Adm. Sci.* 13 (1), 19. doi:10.3390/admsci13010019
- Zhang, L., Mol, A. P. J., and He, G. (2016). Transparency and information disclosure in China's environmental governance. *Curr. Opin. Environ. Sustain.* 18, 17–24. doi:10.1016/j.cosust.2015.03.009
- Zhang, R., Zheng, H. W., Zhang, H., and Hu, F. (2020). Study on the influence of social capital on farmers' participation in rural domestic sewage treatment in Nanjing, China. *Int. J. Environ. Res. Public Health* 17 (7), 2479. doi:10.3390/ijerph17072479
- Zhao, L. Y., and Chen, H. S. (2021). Exploring the effect of family life and neighbourhood on the willingness of household waste sorting. *Sustainability* 13 (24), 13653. doi:10.3390/su132413653
- Zhou, Z., Duan, J. Q., Li, W. X., and Geng, S. (2021). Can rural road construction promote the sustainable development of regional agriculture in China? *Sustainability* 13 (19), 10882. doi:10.3390/su131910882