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Does forestry public-private partnership promote the development of China's forestry economy?

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In 2016, China began to introduce the public-private partnership (PPP) model in forestry to explore the promotion and modern development of the nation's forestry industry. Based on the New Governance Theory, this study explores whether PPP, as an essential investment and financing model, can impact China's forestry economy. Based on provincial-level panel data from 2011 to 2020 in China, this study examines the effects of PPP on China's forestry economy using the difference-in-differences (DID) model. This study tests the robustness of the effects using a multi-stage propensity score matching-DID model and explores the mechanism of the effect. The relevant results are threefold. 1) PPP in forestry can significantly enhance China's forestry economy. 2) PPP in forestry can enhance the forestry economy through industrial structure and technological innovation effects. 3) Although forestry PPP has effectively promoted economic growth in forestry, the initial implementation process will have a negative ecological impact. This study provides a scientific basis for promoting forestry PPP and improving China's forestry economy's high-quality and sustainable development.

KEYWORDS

forestry economy, public-private partnership, social capital, DID, PSM-DID, China

1 Introduction

Forestry is a fundamental issue for sustainable national economic and social development, and only if forestry can develop sustainably can human survival and security, as well as economic and social development, be sustainable. Forests have multiple asset and service values. In February 2011, the United Nations Environment Programme (UNEP) released the first global study on the green economy, "Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication", which identifies forestry as one of the ten critical sectors for global green economic development. The forestry sector plays an irreplaceable role in promoting global sustainable development and global environmental governance, and forestry economic development has become a vital evaluation indicator of global sustainable development. Therefore, how to further realize the overall improvement of the forestry economy is a common problem facing humankind in the 21st century. Public-private partnership (PPP) in forestry is regarded as the key to enhancing the economic growth of forestry (Yu and Nilsson, 2021). PPP refers to the country's government and social capital cooperation. The government introduced a professional social capital party to form a benefit-sharing risk-sharing partnership, which can effectively alleviate the pressure of the government to bear all the risks, but also can play the advantages of social capital in an operational capacity, information capture, and other advantages. The implementation of PPP projects in the field of forestry is, on the one hand, conducive to transforming the functions of each country's government, improving the level of forestry project construction management, and accelerating the transformation of the forestry economy and industry. On the other hand, it can mobilize the enthusiasm for forestry development in each country and promote the employment and income of forestry workers.

In recent years, China has endeavored to enhance the nation's forestry economy using PPP to promote forestry progress. The issuance of a series of policy documents, including the National Reserve Forest System Program, Guidelines for Implementing Government and Social Capital Cooperation Projects in Traditional Infrastructure Areas, and Guidance on Using Government and Social Capital Cooperation Models to Promote Forestry Construction, has promoted the rapid development of PPP in forestry, which is considered to be an important means for enhancing the forestry economy.

The performance of PPP is affected by many factors; thus, some doubt remains regarding whether PPP in forestry can effectively promote China's forestry industry economy. The forestry economy concept refers to a development model that takes the carrying capacity of the forestry ecosystem as the basic constraint and uses forestry resources as the basic means of production to maximize its economic value without destroying the self-balancing and self-healing capacities of the forest system (Dong et al., 2017). Therefore, PPP in forestry considers economic concerns and the constraints of the natural environment and ecology. Forestry projects are affected by natural conditions, such as climatic factors of temperature and precipitation, in addition to the impact of water and soil nutrients in the forest on the economic benefits of forestry (Yi and Cao, 2016; Xue et al., 2017). Furthermore, planting, nurturing, managing and constructing forestry infrastructure requires considerable capital investment to maintain a sustainable operation. The cultivation and growth of forests require long cycles, making forestry a cyclical and risky endeavor. These circumstances have led to fewer forestry projects and a low project success rate. In this context, evaluating the effects of the PPP policy in forestry is crucial to improve its efficiency and quality, perfecting related policies, and promoting the modernization of China's forestry industry.

China formally introduced the concept of PPP in 2014, which has attracted extensive attention from both domestic and international scholars. The focus of PPP research has evolved from the initial analysis of its theoretical and practical implications (Shi, 2016) and analysis of the opportunities and risks that develop during PPP implementation (Cui et al., 2020) to performance evaluation research, which has increasingly become a significant aspect of PPP-related research. Existing analyzes examine PPP performance in healthcare, environment, energy efficiency, and other various fields (Kumar, 2019; Shahbaz et al., 2020; Tang et al., 2021), investigating the macro effects of PPP from a more comprehensive perspective; however, there are minimal studies on PPP in forestry, mainly including three categories. The first category analyzes how PPP applies in forestry projects and an in-depth investigation of the necessity and feasibility of PPP projects in forestry (Guo, 2017; Ngandwe et al., 2017; Wang et al., 2021a). The second category examines the effectiveness of existing forestry PPP projects, identifies the key challenges in the operation of forestry PPP projects, and proposes corresponding solutions for subsequent development (Tricia and Rickenbach, 2014; Tshidzumba et al., 2018; Guevara et al., 2020). The third category summarizes theoretical studies and practical case study experiences related to forestry PPP at domestic and international levels, proposes a framework for PPP governance in China, and provides corresponding policy suggestions (Jiang et al., 2019; Wang et al., 2021b).

In summary, the current research has three areas for improvement. 1) Research on forestry PPP is minimal and in its infancy, and more exploration is needed to practically evaluate the performance of forestry PPP on the forestry economy. 2) Most previous PPP studies in forestry apply qualitative or case study approaches based on practical summaries and need more scientific and reasonable empirical investigation based on macro data. 3) There is also a need for further mechanism testing on the internal channels of forestry PPP. The existing studies only portray the effect of PPP in specific implementation contexts but do not assess behavioral choices made under different channels.

Based on this research gap, this study systematically examines the impact of China's PPPs in forestry on the forestry economy using Chinese provincial panel data from 2011 to 2020, constructing a difference-in-differences (DID) model in a quasi-natural experimental approach and further employing mechanism analysis to explore the potential mechanisms of the effect of implementing PPP on the forestry economy. The contributions of this study are as follows: 1) This study is the first to empirically analyze the impact of PPPs on China's forestry economy based on provincial panel data, which enriches the research and broadens the research approaches for investigating the forestry economy and building a foundation for relevant studies on forestry economics based on a macro perspective. 2) This study combines micro-level data on forestry PPP with macro-level local economic and social data to build integrated micro and macro panel data, to analyze the impact of forestry PPPs on China's forestry economy, and provides innovative empirical evidence and realistic references for further expansion of the PPP model, and is of theoretical value and practical value in contributing to the growth of forestry economies worldwide. 3) To explore the impact of forestry PPP projects on forestry economic growth, this study is not simply limited to the relationship between the two. Further, it analyzes the mechanism of the role of forestry PPP on the forestry economy, providing a scientific basis for promoting strategic forestry PPP projects and improving the forestry economy.

The remainder of this study organizes as follows. Section 2 presents a review of the Frontier literature in the research field. Section 3 reviews the policy background and research hypotheses. Section 4 describes the research design and robustness tests. Section 5 presents the effect mechanism analysis. Sections 6–8 detail the discussion, conclusions, and proposed policy implications, respectively.

2 Literature review

Since Putnam and Leonardi (1994) proposed to develop social capital, this topic has gradually become hot in economics, political science, and sociological research (Robison and Flora, 2003). With the increasingly tricky environmental situation and the accumulation of environmental risks, searching for an effective public environmental governance model has become the key to developing a green economy. Social capital can influence the transaction costs of environmental governance behavior through three mechanisms: shared information, coordinated action, and collective decision-making (Tsai, 2008), determining the success or failure of collective action in environmental governance. Social capital as a non-market force can influence people's preferences and constraints, reduce transaction costs, and facilitate information exchange (Fukuyama, 1995). Existing theoretical studies have pointed out that social capital plays a significant role in enhancing environmental governance. Environmental actions such as community governance and civic governance is driven by social capital are beginning to prevail internationally and have yielded apparent results. There is growing evidence that social capital has an important impact on sustainable economic development.

The model of government-social capital cooperation has attracted widespread attention from academics and governments as a way to improve the efficiency of public provision and alleviate the pressure on government finances (Bjrstig and Sandstr, 2017). Academics generally believe that social capital parties should introduce to participate in environmental governance in addition to the government-led governance model. On the one hand, the PPP model can solve the problem of government funding shortage and inefficiency through the input of social capital, and on the other hand, it can guarantee the smooth implementation of the project through the government's supervision of the social capital party's behavior. Some scholars have studied the issues of applying the PPP model in green environmental protection. Manos et al. (2014) found that PPP has successfully improved agroecological management and solved inequality between urban and rural environmental services. Zhang et al. (2020) found that introducing social capital was important in rural domestic wastewater treatment. Karki et al. (2007) explored whether PPP projects could save water based on 29 projects and found that implementing PPP projects saved water costs compared to traditional schemes. Villani et al. (2017) argue that the PPP model allows for a gradual transfer of government functions to the project, significantly improving project efficiency and pollution control through a combination of payment and performance.

Theoretically, the PPP model has become an essential and popular tool for sustainable development because of its increased project efficiency. In economics, the New Governance Theory emphasizes the plurality of governance subjects, it requires the transformation of management from traditional control governance to regulatory governance, and it emphasizes meta-governance in multi-party participation in governance, as well as focusing on governance instruments. In governance, both the function of government and the active role of market subjects and civil society should be brought into effect, while the problem of alienation and dysfunction of multiple governance subjects should not ignore. Compared with the traditional governance model, the new one is more conducive to government functions, focuses on shared responsibility and balanced rights, and seeks to identify pragmatic and practical governance models through refined analysis. The PPP model brings social capital in project standard-setting, enabling the critical position played by nongovernmental subjects in the management of public affairs and redefining governance subjects in the process. Thus, the PPP model extends the plurality of governance subjects defined by the New Governance Theory. On the one hand, PPP provides a baseline for social capital to choose the regulation method, which is conducive to the realization of the pluralistic value of each subject and protecting the public interest. On the other hand, PPP is conducive to saving administrative resources and avoiding the risks brought by the shirking of government departments and the self-interest attribute of social capital, which promotes the standardized development of cooperative projects and the formation of a networked governance system in the New Governance Theory.

3 Policy background and research hypotheses

3.1 Policy background

The PPP model in China began in the 1980s, but the concept of PPP was only formally introduced in 2014. In 1984, with the *Shenzhen Shajiao B* power plant project as the starting point, China gradually explored applying the PPP model for infrastructure development. However, most of the social capital involved then was foreign capital. After 1994, the PPP model in China officially entered a trial stage, and various domestic experts and scholars in China also began to focus on investigating PPP models. In the spirit of "allowing social capital to participate in urban infrastructure investment and operation through franchising and other means," in the Third Plenary Session of the 18th Central Committee of the Communist Party of China, the Ministry of Finance fully deployed the promotion of PPP projects at the end of 2013. Since 2014, relevant policies have been intensively introduced to ensure the smooth implementation of PPP projects. China's six ministries jointly formulated the Measures for the Management of Infrastructure and Public Utilities Concessions, which established the institutional system under which social capital investors can participate in concessions. Following this, a series of policy documents, such as the Notice on Regulating the Management of Government and Social Capital Cooperation Contracts and the Notice on Regulating the Operation of the Comprehensive Information Platform for Government and Social Capital Cooperation, accelerated the development of PPP in China, and PPP investment opportunities have been expanding from the initial infrastructure approach to natural ecology and environmental protection.

PPPs for forestry in China started late. In 2016, the Opinions of the State Council on Deepening the Reform of the Investment and Financing System proposed to clarify the scope of government investment further, increase financial support for projects in the public service field, such as ecological and environmental protection and urban and rural infrastructure construction; continuously optimize the direction and structure of investment; and improve investment efficiency. On this basis, the government further issued the Guidance on the Promotion of Government and Social Capital Cooperation model in the Field of Public Services, clearly promoting the implementation of forestry PPP. Since then, the government has issued documents such as the Guidance on Using the Government and Social Capital Cooperation model to Promote Forestry Construction and the Guidance on Using the Government and Social Capital Cooperation model to Promote Forestry Ecological Construction and Protection and Utilization to accelerate the development of PPP in forestry. As of the end of 2020, the project management database of China's National PPP Comprehensive Information Platform indicates that the number of forestry PPP project transactions increased by as much as 93% annually, with the number of forestry projects in the database rising from only two prior to the above policy implementation to 156, with an investment amount of 234.4 billion yuan. Forestry PPP has rapidly developed, with an upward trend and the associated operating systems are maturing.

3.2 Research hypotheses

The PPP model can alleviate the current forestry development dilemma. The traditional forestry development model faces challenges such as backward industrial structure and insufficient technical management talent that have hindered China's forestry economy. Although the nation's forestry PPPs are still in the beginning stage, the PPP model is inherently applicable to the forestry economy, and adding social capital to forestry projects could be conducive to generating additional economic benefits while fully leveraging the ecological benefits of practical forestry.

This paper is based on the New Governance Theory to explain why PPPs promote economic growth in forestry. The critical feature of the governance model emphasized by the New Governance Theory is its collaborative nature. The government should encourage the development of diversified governance subjects and clarify the responsibilities of the government parties. The PPP model helps the government to develop the subject position of social capital in governance in the project and confirm the legitimacy identity of social capital in the field of governance. It enables the government and social capital to play their respective management advantages and support each other in the multiform cooperation mode of the main body and actively maximize the benefits based on pluralism. This study suggests that forestry PPP positively affects forestry economic growth, which is primarily reflected in the three aspects discussed below.

3.2.1 Alleviate the difficulties of forestry financing

The traditional financing mechanism has yet to meet the needs of the modern forestry economy. For many years, China's forestry economy has confronted the problem of a narrow capital chain (Beljan et al., 2022). Before the application of the PPP model, forestry projects were primarily led by state and local governments, and associated funding sources were government financial allocations, which were relatively limited and caused significant financial pressure on the government. The reason for this poor financing environment is that forestry investment involves natural risks, making its economic returns unstable, with high investment costs, long project cycles, and low return characteristics. Furthermore, the lack of a sound financing guarantee system and the tendency of forest resources assessment to overestimate the valuation of trees causes forestry production operators to be unable to repay loans on time, which leads to mortgaging forest ownership to address such difficulties. Therefore, it has long been not easy to obtain support for forestry projects via financial institutions or social capital.

From the perspective of existing PPP forestry projects, the approach effectively alleviates the investment risks of social capital entering forestry projects. PPP projects primarily adopt the return mechanism of government payment or the feasibility gap subsidy model. If project revenue does not meet the social capital investors' revenue expectations, government departments will support social capital parties through loan concessions and financial subsidies and leverage policy support to ensure reasonable economic returns. Furthermore, the operation rules of PPP enable social capital investors to participate in preparation activities such as feasibility studies. The government must provide inexpensive, quality public products and services to society, undertake administrative functions (i.e., planning, procurement, management, and supervision of PPP projects), and form legal relationships with social capital investors. The government must perform its obligations according to the PPP contract, which reduces investment risks, increasing private investors' enthusiasm to participate in PPP projects and alleviating the current financing difficulties in forestry.

3.2.2 Enhancing the professionalism of forestry projects

Traditional approaches to forestry profitability no longer apply to current circumstances, with three specific problems facing current forestry development. First, the overall forestry industry in China is still in a labor-intensive stage. China's forestry industry has taken advantage of cheap labor for a long time; however, the advantage of cheap labor has gradually disappeared with the rising cost of labor, the challenging environmental conditions of forestry production, relatively low income, and insufficient talent attraction. Second, the adequate supply capacity of China's forestry resources is insufficient. Overall, the *per capita* forest area and *per capita* forest accumulation are far below the world average. Furthermore, the quality of China's forests could be higher. The forest accumulation per unit area is 94.83 m^3/hm^2, notably lower than the world average, and the lack of forestry resources seriously limits the development of the nation's forestry economy. Third, the forestry industry is risky, with long cycles, a slow capital turnover time, the potential to be affected by climate disasters, and other unstable characteristics. The forestry economy faces both natural and market risks, and the benefits of forestry investment are conspicuously low compared to other industries.

The above indicates that China's forestry economy must transform the current development mode and can no longer rely on the increase of factor inputs, but also needs to continuously improve production efficiency and advance the technological upgrade in forestry projects. The PPP model can attract more professional social capital participation in forestry projects and absorb the strengths of private enterprises in management and technology, combining the advantages of social capital for advancing management and technology with the policy advantages of government departments. The government has a dominant position in the entire project construction process of forestry projects, which is prone to inefficiency and high transaction costs, minimizing the role of market mechanisms. Under the coordination of the government, PPP can enable social capital investors to participate in investment fields that were initially inaccessible and stimulate the increased mobilization of social capital. The primary purpose of social capital participation is to obtain profits. Given the reasonable return mechanism, social capital investors can be motivated to introduce more advanced management methods and technologies into PPP projects. By leveraging the financial, technical, and information advantages of PPP, a project's entire life cycle cost can be minimized. The professional skills of grassroots forestry workers can also be continuously driven to improve the productivity of forestry projects.

3.2.3 Improve profitability of forestry projects

The forestry industry is an essential industry representing a public welfare undertaking, and direct government investment is the primary source of funds for forestry projects in China. Under this management, most forestry projects are influenced by China's planning system, and the ability to mobilize market forces needs to be improved; thus, such projects generally face the challenge of poor profitability and low return on investment. A development model in which the government is the primary source of investment makes the government's financial burden significant. The government is often not inclined to upgrade technological innovation and management methods. The government has inherent limitations on resource integration and cannot maximize resource utilization, resulting in resource waste. In addition, because the government will prioritize ecological benefits, resulting in unclearly defined public welfare and economic attributes of forestry, such projects are prone to excessive public welfare characteristics, limiting economic revenue. Therefore, the current forestry economy must integrate market economic mechanisms using PPP for structural optimization, transformation, and upgrading.

Therefore, based on the New Governance Theory, the government's position as a meta-governance subject governance is not to have the government control everything but to promote the government's management style from command-based to monitoring-based, and to better play the leading role of the government. Social capital in the PPP model should be made to have the administrative governance subject status appropriate to its governance role as soon as possible. Government departments and social capital investors are collaboratively involved in the decision-making process of PPP forestry projects, and both parties influence decisions regarding projects' return mechanisms. In PPP projects, the government seeks to maximize social benefits, whereas social capital investors seek to maximize economic profits. The two sides form different divisions of responsibility, with government departments responsible for decision-making on macro issues, such as project planning schemes, primarily focusing on the public welfare aspects of a project. At the same time, social capital investors are responsible for decision-making on specific issues, such as technical schemes and economic benefits. For example, in a river management PPP project, the initiative's profit-seeking nature can optimize and integrate the project structure with the assistance of professional planning departments, integrating activities that enhance public welfare benefits with nonpublic welfare projects while also increasing the profitability of the project. Implementing forestry PPP projects can effectively promote the market operation mechanism in the forestry industry and feed into environmental protection and public welfare to achieve sustainable forestry development.

In summary, this study proposes research hypothesis H1: Forestry PPP improves China's forestry economy regarding financing, professionalism, and profitability.

Based on the above analysis, China's forestry industry currently needs help with problems such as backward infrastructure, low production efficiency, and return on investment. PPP projects can influence the forestry economy through three channels industrial structure, technological innovation, and ecological effects. First, PPP is a financing tool (Tan and Zhao, 2019). The government can use a small number of monetary funds in forestry PPP projects to provide a relatively stable and standardized forestry investment and financing channel for social capital, which will further rationalize the relationship between the government and the market, establish constraints on government behavior, and promote the forestry economy following the market economy, transforming the previous forestry financing mechanism. The current structure could be more stable and favorable to the sustainable development and use of forest resources, among other challenges (Nurrochmat et al., 2022). PPP offers a potentially effective approach to advancing the sustainable development of the forestry economy.

Second, PPP can attract substantial social capital into the forestry industry, effectively alleviate the problem of the low resource utilization rate under the dual pressure of the resource shortage and the demand gap in the forestry industry, and achieve superior output by improving technological innovation with the same combination of input factors. Social capital investors can provide more technical support and integrate innovative technology to plant, develop, and protect forestry resources more rationally by bringing funds and advanced skills into PPP projects. In addition, the infusion of social capital effectively alleviates the financial constraints that limit development and attract more professional and technical talent to address the technical talent limitations in China's forestry development process. Therefore, forestry PPP can promote the forestry economy by enhancing the technological innovation effect.

Finally, the development of forestry balances ecological and economic benefits. When social capital enters PPP projects, the profit-seeking behavior of social capital investors may reduce the ecological benefit standards previously regulated by the government based on forestry as a public good. In contrast, from another perspective, social capital can improve the trading market under the government's macro-regulation, encourage more social capital investors to enter the ecological and environmental protection field and maximize the motivation and creativity of the ecological market through price leverage and competition mechanisms, rearranging factors and resources to enhance ecological benefits more effectively.

In summary, this study proposes research hypothesis H2: Forestry PPP improves China's forestry economy through three channels, including industrial structure, technological innovation, and ecological effects.

4 Materials and methods

4.1 Sample processing and data sources

Currently, 21 provinces in China have begun implementing forestry PPPs, including Guangdong, Fujian, Zhejiang, Jiangsu, Shandong, Hebei, and Tianjin in the eastern region of China; Jiangxi, Anhui, Shanxi, Henan, Hubei, and Hunan in the central region of China; Guangxi, Sichuan, Inner Mongolia, Guizhou, Yunnan, Ningxia, and Xinjiang in the western region of China; and Liaoning in China's northeast region. Provinces that have not started implementing PPP projects in forestry, the eastern region includes Beijing, Shanghai, and Hainan; the western region includes Shaanxi, Chongqing, Gansu, and Qinghai; and Jilin and Heilongjiang in the northeast region.

The selection of the sample region" in 'his study and the basis for the selection are as follows: ① A region has provinces that have implemented forestry PPP projects and those that have not, making it easy to identify a control group. Every province in the central region of China has implemented forestry PPP projects; thus, the sample includes only the eastern, western, and northeastern regions of China. ② The sample size of the northeast region is too narrow to have empirical value, the economic development of the eastern region has begun to show significant polarizing differences in recent years, and the provinces in the western region differ less in various aspects and have relatively high homogeneity. The sample in this study must include provinces with similar development, following the hypothetical conditions of the DID model; therefore, provinces in China's western region that have implemented forestry PPP projects and those that have not been selected as the treatment and control groups. Because some of the data for Sichuan, Inner Mongolia, and Xinjiang in the central region are missing, these three provinces are not included in the study sample. In summary, the final sample areas selected are the eight provinces of Guangxi, Chongqing, Guizhou, Yunnan, Shaanxi, Gansu, Qinghai, and Ningxia. Furthermore, 30 provinces in China are used for a multi-period DID model robustness test. Data from Hong Kong, Macao, Taiwan, and Tibet are excluded because of incoherence. Considering the policy timing of China's emphasis on forestry PPP, this study takes 2011–2020 as the time dimension. The data are obtained from the China Forestry Statistical Yearbook, the China Energy Statistical Yearbook, the China Labor Statistical Yearbook, the China Environment Statistical Yearbook, and China's National PPP Comprehensive Information Platform.

4.2 Difference-in-differences model setting

Regarding the starting time of forestry PPP implementation, Guizhou began in 2013, and Ningxia, Yunnan, and Guangxi started in 2016. Accordingly, Guizhou, Ningxia, Yunnan, and Guangxi are the treatment group, as the provinces started forestry PPP implementation before 2017, and Chongqing, Shaanxi, Gansu, and Qinghai, which did not implement forestry PPP projects, are taken as the control group. The specific settings of the variables are as follows:

$$\boldsymbol{Treat_i} = \begin{cases} \boldsymbol{1, If\ the\ province_i implemented\ forestry\ PPP} \\ \boldsymbol{0, If\ the\ province_i has\ not\ implemented\ forestry\ PPP} \end{cases} \tag{1}$$

where $Treat_i = 1$ indicates that the province started forestry PPP and is taken as part of the treatment group, and $Treat_i = 0$ indicates that the province did not start forestry PPP and is taken as the control group.

$$\boldsymbol{Dummy_t} = \begin{cases} \boldsymbol{1, t > 2016, after\ forestry\ PPP\ implementation} \\ \boldsymbol{0, Else, before\ forestry\ PPP\ implementation} \end{cases} \tag{2}$$

where $Dummy_t = 1$ indicates after participation in forestry PPP and $Dummy_t = 0$ indicates before participation in forestry PPP. Thus, the DID model can be constructed as follows:

$$\begin{aligned}\boldsymbol{FGDP_{it}} &= \boldsymbol{\alpha_0 + \alpha_1 Dummy_t + \alpha_2 Treat_i + \alpha_3 Dummy_t \times Treat_i} \\ &\quad \boldsymbol{+ \alpha_4 C_{it} + \delta_{it}}\end{aligned} \tag{3}$$

where $FGDP_{it}$ is the ratio of value-added of the forestry industry to the total GDP of $province_i$ in year t. $Dummy_t$ is a Dummy variable denoting whether a province participated in forestry PPP, and $Treat_i$ is a Dummy variable for the treatment intervention. $Dummy_t \times Treat_i$ is the interaction term; C_{it} is a set of control variables; $\alpha_1, \alpha_2, \alpha_3$, and α_4 are all coefficients to be estimated; and δ_{it} represents the random disturbance term. Then we have the following:

$$\begin{aligned}\boldsymbol{DID} &= \boldsymbol{[E(FGDP_{i1}/Treat_i = 1) - E(FGDP_{i0}/Treat_i = 1)]} \\ &\quad \boldsymbol{- [E(FGDP_{i1}/Treat_i = 0) - E(FGDP_{i0}/Treat_i = 0)]} \\ &= \boldsymbol{[(\alpha_0 + \alpha_1 + \alpha_2 + \alpha_3) - (\alpha_0 + \alpha_2)] - [(\alpha_0 + \alpha_1) - \alpha_0] = \alpha_3}\end{aligned} \tag{4}$$

where α_3 is the result after applying the DID model, which indicates the pure effect of forestry PPP on the forestry economy. Considering that panel data are used in this study, the above model is transformed into a panel data DID model with two-way fixed effects as follows:

$$\boldsymbol{FGDP_{it} = \alpha_0 + \alpha_3 Dummy_t \times Treat_i + \alpha_4 C_{it} + \gamma_i + \varphi_t + \delta_{it}} \tag{5}$$

where γ_i is the individual fixed effect, φ_t is the time fixed effect, δ_{it} represents the random disturbance term, and the remaining variables and parameters have the same meaning as in Eq. 3. Two issues must be noted when using this model to assess the impact of forestry PPP on the forestry economy.

(1) The DID attributes the difference between the treatment and control groups to whether or not a forestry PPP was initiated, which requires the model to satisfy the common trend hypothesis, requiring that treatment and control groups have the same trend over time except for the policy intervention. In this study, we include control variables to reduce the influence of non-policy factors. The choice of control variables considers the economic and natural factors that can affect the forestry economy. Referencing previous studies (Valade et al., 2017; Guan et al., 2019), we include control variables (C_{it}) representing the forestry economy's industry

TABLE 1 Descriptive statistics of variables in the two-stage model.

Variable	Mean	Std.	Maximum	Minimum
FGDP	8.647	7.707	0.745	34.579
Dummy×Treat	0.250	0.436	0.000	1.000
Findustry	0.167	0.140	0.009	0.613
Fire	0.162	0.196	0.012	0.881
TE	0.617	0.356	0.115	1.268
ES	0.447	0.104	0.232	0.692
Forest	0.266	0.178	0.079	0.703
FS	0.198	0.128	0.029	0.788

structure, forest fire incidence, technological innovation efficiency, energy structure, *per capita* forest savings, and forestry scale.

(2) Different provinces do not initiate forestry PPPs at the same time; thus, the multi-period DID method is used to obtain more reliable conclusions. The establishment of this model and its robustness test will be discussed below.

4.3 Variable definitions

The explained variable, explanatory variable, and control variables of this study are as follows:

(1) Explained variable. The explained variable in this study is each province's forestry economy (FGDP) of each province. Due to the different stages of economic and forestry development patterns in each province, the ratio of forestry GDP to provincial GDP is chosen to mitigate the influence of the dimension and volatility on the estimation of regression results.
(2) Explanatory variable. In this study, we choose whether a province implemented PPP projects in forestry and agriculture to measure forestry PPP. If the province implemented forestry PPP, it is identified as part of the treatment group with Treat = 1; otherwise, it is considered part of the control group with Treat = 0. The explanatory variable is the interaction term (*Dummy×Treat*), which examines the circumstances before and the impact after the implementation of forestry PPP on the forestry economy.
(3) Control variables. Considering the influence of economic and natural factors on the forestry economy, the control variables include forestry industry structure (Findustry), which is measured by the proportion of the added value of the tertiary forestry to forestry GDP in each province. Forest fires incidence (Fire) is measured by the ratio of forest fires to the forest area in each province. Technological innovation efficiency (TE) is measured by referring to the efficiency of forestry green technology innovation in each province as measured using the slacks-based measure data envelopment analysis method used in previous studies (Shang and Yang, 2022). Energy structure (ES) measurement uses the ratio of coal consumption to total energy consumption in each province. Per capita forest savings (Forest) is measured using the ratio of forest area to resident population in each province. The forestry scale (FS) is measured using the ratio of individuals employed in forestry to the total employed population in each province.

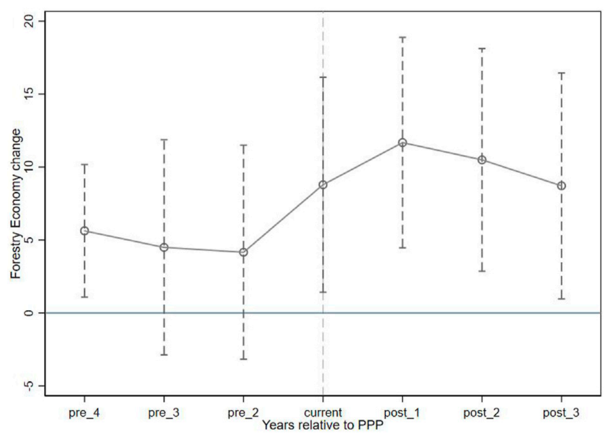

FIGURE 1
Results of parallel trend test.

TABLE 2 Regression results of the two-stage DID models.

Name	Model 1	Model 2
Dummy×Treat	4.070***	4.585***
	(3.56)	(3.92)
Constant	5.371***	23.934***
	(5.95)	(3.97)
Control variables	NO	YES
Province FE	YES	YES
Year FE	YES	YES
R^2	0.498	0.658
Group	8	8
N	80	80

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

The descriptive statistics of the variables of concern are presented in Table 1. Table 1 shows that the average value of the forestry economy (FGDP) is 8.647, which shows that the level of economic development of China's forestry industry is still in its initial stage. The minimum value of the forestry industry structure (Findustry) is 0.009, and the maximum value is 0.613, indicating a significant gap in the industrial structure among provinces and still needs national macro-control. The gap between the minimum and maximum values of *per capita* forest savings (Forest) and forestry scale (FS) are also significant, indicating that the current distribution of forest

TABLE 3 Regression results of counterfactual test.

Name	2012	2013	2014
Dummy×Treat	1.990	2.990	2.736
	(1.24)	(1.36)	(1.58)
Constant	15.107*	16.756*	12.190*
	(2.02)	(2.07)	(2.07)
Control variables	YES	YES	YES
Province FE	YES	YES	YES
Year FE	YES	YES	YES
R^2	0.577	0.636	0.624
Group	8	8	8
N	48	48	48

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

TABLE 4 Regression results of the placebo test.

Name	Model 1	Model 2
Dummy×Treat	2.937	0.947
	(1.21)	(0.36)
Constant	8.282***	16.39
	(6.04)	(0.56)
Control variables	YES	YES
Province FE	YES	YES
Year FE	YES	YES
R^2	0.296	0.530
Group	8	8
N	80	80

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

resources in China is not uniform, which is related to the resource endowment of each region.

4.4 Empirical results and analysis

4.4.1 Parallel trend test

The use of DID estimation presupposes a parallel trend, i.e., the trend of forestry economic change in the treatment and control groups before the implementation of the forestry PPP project is the same, and a parallel trend test is needed to exclude other factors interfering. This paper draws on Boler et al. (2015) to analyze the parallel trend of forestry PPP implementation using event analysis. The results of the parallel trend test are shown in Figure 1, the regression coefficients before the implementation of forestry PPP are not robustly significant, and both are significant after the implementation of the policy, which indicates that there is no significant difference in the trend of the forestry economic situation between the two groups before the implementation of the policy, and the parallel trend assumption is satisfied.

4.4.2 Regression results

The results of the DID model are presented in Table 2. First, for model 1, which represents only the *Dummy* × *Treat* explanatory variable of forestry PPP, the coefficient of *Dummy* × *Treat* is 4.070, which is significant at the 1% level, indicating that the implementation of PPP projects in forestry has a positive effect on forestry economic development. Second, considering that the DID model must satisfy the common trend hypothesis, to make the results more rigorous, we add control variables to obtain the estimation results of model 2, and *Dummy* × *Treat* remains significant at the 1% level, with a coefficient of 4.585, indicating that the implementation of PPP projects in forestry has a positive effect on the forestry economy. The estimation results of the above two models validate hypothesis H1 of this study, indicating that implementing forestry PPP has a significant promotional effect on China's forestry economy.

4.5 Robustness tests

We apply three robustness testing methods to test the credibility of our research results. First, a counterfactual test is conducted for the DID model. Second, considering the limitations of the DID model, a multi-period DID model is established for testing. Third, a propensity score matching (PSM)-DID model is established for testing, alleviating sample selection bias.

4.5.1 Counterfactual test

The counterfactual hypothesis assumes that if the time point of implementing forestry PPPs changes, then the results of the DID model will change accordingly. The assumption in the previous DID model uses 2017 as the start time of forestry PPPs. The counterfactual test supposes that forestry PPP occurred before 2017, selecting data from 2011 to 2016 as the study sample and repeating the estimation of the DID model with 2012, 2013, and 2014 as the start times of forestry PPPs, respectively. If the results are insignificant, this indicates that the trend of the treatment and control groups is relatively stable without the start of forestry PPP, and the common trend hypothesis is satisfied. The results of the counterfactual tests at different time points are presented in Table 3, demonstrating that the estimated coefficients of the *Dummy* × *Treat* explanatory variable are not significant when 2012, 2013, and 2014 are used as the start times, which indicates that the provinces had a common trend prior to the implementation of PPPs in forestry.

4.5.2 Placebo test

This study further conducts a placebo test on the two-stage model. The placebo test examines whether the impact of PPP implementation on the forestry economy was due to the event itself or whether other unobserved factors had an additional impact on the treatment group. DID methods typically include two types of placebo tests: One way is to change the timing of policy implementation, including the timing of policy implementation in the antecedent treatment group. In this case, the placebo test acts the same as the counterfactual test, testing the significance of the

TABLE 5 Descriptive statistics of variables in the multi-stage model.

Variable	Mean	Std.	Maximum	Minimum
FGDP	7.812	5.678	0.129	34.579
Dummy×Treat	0.300	0.459	0.000	1.000
Findustry	0.157	0.109	0.001	0.613
Fire	0.179	0.247	0.005	2.059
TE	0.646	0.382	0.115	1.720
ES	0.393	0.149	0.007	0.692
Forest	0.198	0.209	0.003	1.032
FS	0.202	0.295	0.007	1.666

coefficient on the time dummy variable in the base regression of the pre-policy implementation with the treatment group interaction term, and the test passes if it is not significant. This study refers to the second method. The second method is to randomly sample the control group of the two-stage model and then estimate it using the same DID model (Wang and Li, 2020). The results show that none of the estimated coefficients of the *Dummy* × *Treat* explanatory variable passed the significance test. The results after replacing the control group with Shanghai, Jilin, Heilongjiang, and Hainan are presented in Table 4. The results of replacing the control group also failed the significance test and are shown here agglomerated. The test results indicate that the provinces have a common trend before participating in forestry PPPs, indicating that the estimation results of the DID model are robust.

4.5.3 Multi-period DID model test

The multi-period DID model is developed based on data from 30 provinces in China (excluding Hong Kong, Macao, Taiwan, and Tibet) for two reasons. First, the starting times of provinces' participation in forestry PPPs differ, and the multi-period DID model can overcome this difference. Second, the multi-period DID model reduces the restriction on selecting treatment and control groups, and the sample can be expanded to all provinces in China.

The descriptive statistical analysis of the relevant variables for the 30 Chinese provinces is presented in Table 5.

The estimation results of the multi-period DID model are presented in Table 6. Model 1 is the regression result when only the *Dummy* × *Treat* variable is included. Its coefficient is 0.881, which is significant at the 5% level, indicating that the implementation of forestry PPPs has an improving effect on the

TABLE 6 Regression results of the multi-stage DID model.

Name	Model 1	Model 2	Model 3	Model 4	Model 5
Dummy×Treat	0.881**	0.807**	0.732*	0.772*	0.778*
	(2.16)	(2.00)	(1.72)	(1.82)	(1.83)
Findustry		1.707***	1.805***	1.752***	1.748***
		(5.47)	(5.35)	(5.19)	(5.16)
Fire			0.026	0.187	0.173
			(0.04)	(0.31)	(0.28)
TE			0.520	0.381	0.405
			(0.68)	(0.49)	(0.52)
ES				−6.670*	−6.808*
				(-1.94)	(-1.97)
Forest				14.20	14.74
				(1.43)	(1.48)
FS					−0.890
					(-0.50)
Constant	5.952***	8.300***	8.484***	8.546***	8.675***
	(17.73)	(9.92)	(8.37)	(3.27)	(3.29)
Province FE	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES
R^2	0.218	0.308	0.318	0.333	0.334
Group	30	30	30	30	30
N	300	300	300	300	300

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

TABLE 7 Results of balance test.

Variable	Unmatched matched	Mean		%Bias	*t*-test	
		Treated	Control		*t*-Value	*p*-value
Findustry	Unmatched	0.169	0.139	30.6	2.19	0.03
	matched	0.161	0.155	5.9	0.65	0.52
Fire	Unmatched	0.212	0.092	56.6	3.75	0.00
	matched	0.167	0.158	4.3	0.50	0.62
TE	Unmatched	0.590	0.751	−42.6	−3.34	0.00
	matched	0.610	0.668	−15.4	−1.79	0.08
ES	Unmatched	0.434	0.319	81.9	6.41	0.00
	matched	0.426	0.433	−4.9	−0.62	0.54
Forest	Unmatched	0.180	0.278	−48.1	−3.60	0.00
	matched	0.188	0.181	3.4	0.35	0.73
FS	Unmatched	0.131	0.418	−85.5	−7.99	0.00
	matched	0.137	0.123	4.0	0.89	0.37

TABLE 8 Regression results of the PSM-DID model.

Outcome variable		Mean		*t*-test	
		Coef.	S. Err.	*t*-Value	*p*-value
Before	Control	16.389			
	Treated	15.953			
	Diff (T-C)	−0.437	0.629	−0.69	0.488
After	Control	15.651			
	Treated	18.945			
	Diff (T-C)	3.294	1.184	2.78	0.006***
Difference-in-differences		3.731	1.324	2.82	0.005***

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

forestry economy. Models (2)–(5) show the results after adding relevant control variables sequentially. The coefficients of *Dummy* × *Treat* are positively significant at 5% and 10% levels after adding some control variables. In summary, the findings show that the results obtained from the previous DID model are robust.

4.5.4 PSM-DID model test

To reduce the effects of data bias and confounding variables for a more reasonable comparison between treatment and control groups, the PSM model is applied to select treatment and control groups. The PSM requires testing whether the variables in the treatment and control groups become balanced after matching. We use the kernel matching PSM method using the six variables of Findustry, Fire, TE, ES, Forest, and FS. The group variable changes before and after matching are presented in Table 7. Significant biases are revealed for all variables among different provinces before matching, which is significant at the 1% level. The variables' bias decreased after PSM, and only the TE bias was insignificant at the 5% level. In comparison, all other variables were insignificant at the 10% significance level, indicating that using the PSM-DID method in this study is justified.

The balance test illustrates that the selection of treatment and control groups can eliminate the bias to the maximum extent through PSM under the kernel matching method. DID is then performed on the matched samples, and the results are presented in Table 8, where the regression coefficient of forestry PPP on the forestry economy is 3.731, which is positively significant at the 1% level, again confirming that the effect of implementing forestry PPP on the forestry economy is highly robust.

The above robustness tests demonstrate that the estimation results of the DID model are robust, indicating that the implementation of forestry PPP positively impacts the forestry economy, once again validating H1.

5 Mechanism analysis of forestry PPP on the forestry economy

This study further analyzes the impact mechanism of forestry PPPs on the forestry economy. Provinces primarily initiate forestry PPPs through industrial structure, technological innovation, and ecological effects. A DID model with two-way fixed effects is established as follows:

$$\boldsymbol{Y_{it}} = \boldsymbol{\alpha_0} + \boldsymbol{\alpha_3 Dummy_t} \times \boldsymbol{Treat_i} + \boldsymbol{\alpha_4 C_{it}} + \boldsymbol{\gamma_i} + \boldsymbol{\varphi_t} + \boldsymbol{\delta_{it}} \tag{6}$$

where Y_{it} is measured by $Findustry_{it}$, TE_{it}, and $Forest_{it}$, which represent forestry industry structure, green technology innovation efficiency, and *per capita* forest savings, respectively, to examine the industry structure, technology innovation, and ecological effects of implementing forestry PPPs. α_3 represents the estimated coefficient, γ_i is the entity fixed effect, φ_t is the time fixed effect, δ_{it} is the random

TABLE 9 Regression results of mechanism analysis.

Name	Industrial structure effect	Technological innovation effect	Ecological effect
Dummy×Treat	0.069***	0.102*	−0.014*
	(3.70)	(1.80)	(-1.90)
Constant	−0.148	0.604***	0.0220
	(-0.89)	(9.16)	(0.52)
Control variables	YES	YES	YES
Province FE	YES	YES	YES
Year FE	YES	YES	YES
R^2	0.695	0.462	0.383
Group	8	8	8
N	80	80	80

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

disturbance term, C_{it} is a set of control variables, and the meanings of other variables are the same as in Eq. 5. The control variables in the model testing the industrial structure effect include environmental regulation, social security, forestry investment, and forestry scale; the control variables for the technological innovation effect include forestry investment and FS; and the control variables for the ecological effect include the incidence of forest fires, the population employed in the forestry field, and the level of urbanization.

The regression results of the mechanism analysis are presented in Table 9. The regression coefficient of the effect of forestry PPP on industrial forestry structure is 0.069, which is positive and significant at the 1% level, indicating that forestry PPP implementation can promote the internal restructuring, transformation, and upgrading of the forestry industry, which is conducive to enhancing industrial vitality, enhancing the forestry economy. The regression coefficient of the effect of forestry PPP on forestry technological innovation is 0.102, which is positively significant at the 10% level, indicating that forestry PPP can provide a robust external incentive for environmental technology research and development. The mechanism of the technological innovation effect is primarily reflected in technological progress and increased human capital, which advances the high-quality development of the forestry economy driven by technological innovation. The regression coefficient of forestry PPP on the ecological effect is −0.014, which is negatively significant at the 10% level, indicating that forestry PPP has a negative effect on ecology, suggesting that forestry PPP may hinder ecological sustainability and special attention must be paid to environmental protection in future forestry PPP projects. The empirical results confirm hypothesis H2.

6 Discussion

The PPP model is not new and has long attracted widespread attention internationally, and there is relatively good experience in applying the PPP model in the field of environmental protection nationwide; for example, the PPP model has become a standard means of sustainable rural development in Europe (Bjrstig and Sandstr, 2017), as well as many countries have started implementing PPP earlier for projects with fixed benefits such as domestic waste and wastewater treatment (Zhang, 2015), however, whether these experiences apply to the development of forestry economy remains to be studied. An important reason for the controversy of the PPP model is that different areas of PPP implementation target different segments and use different approaches. Therefore, there needs to be more research on applying the PPP model to forestry in China and abroad. Unlike the existing studies that mostly take resource endowment as the starting point to study the drivers of forestry economic growth, this study is based on the perspective of New Governance Theory, takes China as the research object, and incorporates more influencing factors for research, providing a new way of thinking for forestry economic development and government governance, and deeply discusses the impact of public-private investment on forestry economic growth. In order to draw more reliable conclusions, in this study, the micro-level forestry PPP project data and macro-level local economic and social data from 2011 to 2020 are integrated to construct combined micro and macro panel data, and a quasi-natural experiment method is used to apply a DID model. A counterfactual test, a multi-period DID model, and a PSM-DID model are used for robustness testing, and further mechanism analysis is conducted to analyze the impact of forestry PPP on the forestry economy. To further investigate how the development of PPP plays a role in promoting forestry economic growth, the study further analyzes the mechanism of PPP in detail from three perspectives: industrial structure upgrading, technological progress and ecological effects, and it shows more clearly the path through which the PPP model affects economic growth. This study enriches the research in this field.

However, there are some limitations to this study. This paper is only a fundamental study of the relationship between PPP implementation and economic growth in China's forestry industry. The data for this study is limited by time and space, with the existing sample of studies being limited to Chinese provinces, whereas the study of PPP is a common long-term study worldwide. To extend our study, on the one hand, the government needs to collect relevant data to clarify the impact of different development situations and technology choices on PPP implementation and different categories of PPP projects cannot be generalized, so the collected data can support subsequent scientific studies. On the other hand, data should be obtained to monitor project implementation on time, paying particular attention to whether social capital enters the project during implementation rather than self-interested behavior to satisfy selfish desires. Only the projects jointly operated by the government and social capital sustainably are the focus of our research. Future research can be continued in the following aspects. First, it is to continue the multidimensional impact study of PPP on economic growth and obtain the data on a global scale so that more data can support the impact mechanism behind the PPP model. The corresponding optimization policies can be designated according to the different national conditions of each country. Second, it is based on the New Governance Theory perspective to explore the moderating role of the impact of PPP on economic growth is still to be explored. Forestry PPP implementation is a long-term development strategy, and the research is also worth exploring in depth with the accumulation and improvement of relevant data.

7 Conclusion

This paper takes China's forestry economy as the research object, puts forward two primary hypotheses on the relationship between forestry PPP on forestry economic growth and its mechanism of action, combines the current development dilemma of the forestry economy and conducts research on the current development model based on the perspective of New Governance Theory, and finds that forestry economic development not only requires the government to assume the responsibility of the most critical governance subject but also requires the government to lead social capital to participate in governance actively. This study complements the plurality of governance subjects emphasized by the New Governance Theory. It advocates the formation of a mutually constraining system of cooperative governance rules in the forestry field in the future. The study reaches three main conclusions. First, forestry PPP can significantly enhance the forestry economy, positively relieving the pressure of forestry financing and stimulating the market mechanism of forestry. In the process of studying forestry economic growth, we found that forestry industry structure, forest fire incidence, technological innovation efficiency, energy structure, *per capita* forest savings, and forestry scale all have an impact on the forestry economy, which indicates that in future governance, we should not only focus on model improvement, but also pay attention to resource endowment and science and technology improvement, and only the joint progress of "resource - technology - management" can improve forestry economy in all aspects. Second, the implementation of forestry PPP primarily enhances the economy through two mechanisms of industrial structure and technological innovation effects, indicating that the entry of social capital into forestry PPP projects will lead to industrial structure upgrading and technological progress, enhancing the forestry economy. Finally, a negative ecological effect is evident during the implementation of forestry PPP projects, indicating that the profit-seeking behavior of social capital investors does not focus on the public welfare nature of forestry economic development and further regulatory oversight is needed.

8 Policy implications

Based on the findings of the study, the following policy recommendations are proposed:

(1) Policymakers must develop a transparent return scheme and legal system, which is fundamental to forestry PPP. Profitability is the most severe concern of social capital participation in forestry projects, and the assurance of a reasonable return is essential for attracting social capital investors. Potential project problems should be regulated through laws, and penalties for violations should be established to avoid disputes during PPP project implementation. Social capital investors should be given maximum power outside the regulatory space so that inherent technical and management capabilities can be effectively exercised to maximize benefits. In the operation process, particular attention must be paid to the relevant policy documents, fully leveraging policy flexibility to obtain the maximum return on investment under the established legal framework.
(2) Policymakers should actively and strategically select professional social capital parties. The motives for social capital participation in forestry PPP projects are complex, and some social capital investors may seek personal profit under the guise of participating in PPP projects. Therefore, the government must examine prospective investors' professional capabilities to ensure they have the ability and motivation to achieve project objectives. Specifically, the government can effectively stimulate the market competition mechanism in selecting social capital links to establish an environment of equal competition among capital parties and ensure that they can compete under a common standard, which can accelerate the selection of eligible social capital investors to participate in forestry PPP projects. The government can establish a public information system for the operation of PPP projects, requiring investors to regularly publicize projects' progress and engage in formal assessment practices to remove unqualified investors on time to ensure that projects are efficiently conducted.
(3) Policymakers should strengthen environmental supervision in forestry PPP projects, which prevents environmental damage in forestry PPP projects. Developing a complete environmental supervision plan, setting strict and precise emission standards, and providing more comprehensive pollution control for projects are necessary. Ecological returns should also be

included in investors' performance assessments. Access standards could be relaxed for those with good environmental performance in project bidding to guide more social capital investors to prioritize ecological benefits and strive to simultaneously achieve economic and ecological benefits of forestry.

Data availability statement

The raw data supporting the conclusion of this article will be made available by the authors, without undue reservation.

Author contributions

For Conceptualization and funding acquisition, HS; methodology, data collection and analysis, CY; writing—review and editing, CY and HS. All authors contributed to the article and approved the submitted version.

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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.

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