



Research article

Institutional quality, economic development, and the sustainable outcomes of PPP projects: An empirical analysis of failed PPP projects in China from 2014 to 2020

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ABSTRACT

The trajectory of China's PPP market since 2014, characterized by rapid expansion and a high failure rate, now plunges into a state of limbo and uncertainty. Through a quantitative analysis of failed PPP projects in China from 2014 to 2020, this study investigates the impact of local government institutional quality, private capital business environment, local economic development, and local fiscal affordability on the development and implementation of PPP projects. The findings reveal that larger government size is associated with a higher likelihood of PPP project failure, while a favorable private capital business environment can mitigate the failure rate of local PPP projects. Furthermore, empirical results demonstrate a positive relationship between local fiscal affordability and the success rate of PPP projects. The analysis underscores the significant influence of the institutional environment on the effectiveness of PPP projects and provides policy recommendations for local governments to enhance the business environment and other key factors contributing to the resilience of PPP projects.

1. Introduction

Over the past two decades, the Public-Private Partnership (PPP) model has gained substantial traction as a widely adopted framework for infrastructure investment and the provision of public services in numerous countries around the world. Extensive scholarly research [1–5] attests to the pervasiveness of this model, which has emerged as a viable alternative to traditional procurement methods. In China, the implementation of the PPP model has undergone a distinct phase of reform since 2014, with the release of policy documents by key governmental bodies such as the State Council, the National Development and Reform Commission (NDRC), and the Ministry of Finance. This new round of reform signifies a departure from earlier PPP projects during the 1980s and 1990s, which primarily aimed to address funding shortages for infrastructure development through private or foreign capital injections. The current wave of PPP reform in China places heightened emphasis on the rapid expansion of project scale and the establishment of institutional frameworks, aiming to strengthen the overall effectiveness and efficiency of PPP implementation [6–8].

The impact of these comprehensive reform efforts and policy interventions has been striking, leading to a remarkable surge in

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China's PPP market. March 2017 marked the peak of this growth, with a staggering 12,287 PPP projects nationwide, boasting a cumulative investment value of 14.6 trillion RMB (205.7 billion USD).¹ This exponential growth underscores the pivotal role assumed by the PPP model as a prominent and effective means of facilitating infrastructure development and addressing public service demands in China.

The significant growth observed in China's Public-Private Partnership (PPP) market can be attributed to two key factors that have shaped the country's infrastructure landscape. Firstly, China's unique economic model has created a pressing demand for infrastructure development. As the world's second-largest economy, China has experienced rapid urbanization and industrialization, leading to a considerable need for robust and efficient infrastructure systems. This demand arises from various factors, including the expansion of cities, the modernization of transportation networks, the provision of utilities, and the development of social infrastructure such as healthcare and education facilities. Secondly, China's distinctive model of state-market interaction has played a crucial role in driving the expansion of PPP models. China's economic system blends elements of a state-dominated economy with market-oriented reforms, for instance, a majority of the PPPs in China are contracted with state-owned enterprises (SOEs). The government maintains significant control over key sectors, including infrastructure development, while also encouraging private sector participation. Within this unique 'PPP model with Chinese characteristics', the government provides regulatory frameworks, policy support, and financial incentives to attract private investment, while the private sector brings in expertise, technology, and financial resources.

From a theoretical standpoint, the PPP model offers distinct advantages over traditional government procurement approaches. By adhering to the principles of risk sharing and benefit sharing, various stakeholders, including local governments, construction enterprises, investors, and banks, actively participate in PPP projects. Among other benefits, it allows for the utilization of private sector expertise, technical capabilities, and managerial efficiencies [9], while also facilitating improved risk allocation [10]. Meanwhile, in practical terms, the adoption of the PPP model in China has proven beneficial in addressing the challenge of limited financial resources faced by local governments. Consequently, the adoption of the PPP model has become a preferred approach in China.

However, in 2018, with the Ministry of Finance's issuance of the Circular on Regulating Project Database of the National PPP Integrated Information Platform (Cai Ban Jin [2017] No. 92), stakeholders of PPP projects began to re-examine PPP projects. Many projects cannot continue to be implemented using the PPP model due to problems such as improper project design and delays in procurement and financial closure. Furthermore, with the introduction of the new regulation of the asset management industry, it is prohibited to continue the models of rigid payments and "debt investment in the name of equity investment" (disguised debts) in PPP investments, and it is more difficult to finance PPP projects.

In the meantime, the implementation of PPP projects encountered various issues stemming from the top-level system design, including the fragmented involvement of multiple government departments and sluggish progress in legislation. Additionally, the recognition of the fiscal expenditure responsibility associated with PPP projects as hidden public liabilities has remained contentious within the National Audit Office.

Combining these factors, since the release of Cai Ban Jin [2017] No. 92, PPP projects nationwide have undergone re-examination and retirement, resulting in an overall decline in both the scale and growth rate of PPP initiatives. As of September 2022, based on statistics from the Project Database of the National PPP Integrated Information Platform, the accumulated PPP project pool amounted to 10,331, with a total investment of 16.5 trillion RMB (232.5 billion USD). Among these, there were 8430 signed projects with an investment amount of 13.8 trillion RMB (194.5 billion USD), and 6651 projects had commenced construction, with an investment amount of 11 trillion RMB (155.0 billion USD). Between March 2017 and September 2022, there has been a noticeable decline, highlighting the downward trend in the scale and growth rate of PPP projects in China since the peak.

The trajectory of China's PPP market from a period of growth in 2014 to its current state of stagnation reveals several underlying challenges. These include issues related to land financing, transformations in the role of local government financing vehicles, the irrational expansion of private PPP enterprises, and the financial sector deleveraging.

Firstly, land financing in China plays a significant role in the development of Public-Private Partnership (PPP) projects and has a profound impact on their overall success. The availability and cost of land have a direct influence on the feasibility and attractiveness of PPP ventures. In China, land is typically owned by the government, and the cost associated with land acquisition can significantly impact the financial viability of the project. Secondly, the challenge arises from transformations in the role of local government financing vehicles. These entities, commonly known as LGFVs, have historically played a crucial role in facilitating local infrastructure financing and investment. However, changes in regulations and policies have led to shifts in their roles and functions, impacting the availability and accessibility of financing for PPP projects. Thirdly, the irrational expansion of private participation in PPP projects has posed challenges to the PPP market. While private sector involvement is crucial for mobilizing resources, expertise, and innovation in PPP projects, the rapid growth of private involvement has sometimes resulted in a lack of transparency, vicious competition, inadequate risk assessment, and insufficient project management capabilities. These issues have led to project delays, cost overruns, and other operational challenges, affecting the overall performance of PPP initiatives. Last but not least, the ongoing process of the financial sector deleveraging has also influenced the PPP market. Measures aimed at reducing excessive debt and addressing financial risks have resulted in tightened credit conditions and stricter lending requirements. This has affected the financing environment for PPP projects, making it more challenging for project sponsors to secure funding and causing delays or cancellations of planned initiatives.

¹ Number and investment volume of PPP projects according to China PPP Center (www.cpppc.org). Exchange rate according to the central parity exchange rate published by the People's Bank of China on April 12, 2024, 1 USD = 7.0967 RMB. Similarly hereinafter.

Understanding and addressing these challenges is crucial for the sustainable development of the PPP market in China. While this paper is constrained by space and cannot provide an in-depth analysis of all the factors, it primarily focuses on two influential elements: local *institutional quality* and local *economic development*.

Local governments play a vital role in driving economic growth and development within their jurisdictions in China [11,12]. However, factors such as differing levels of economic and industrial structure, historical context, and cultural influences result in variations in governance capacity, administrative efficiency, and regulatory frameworks across different local governments [13]. These differences shape the business and investment environment for PPP projects. Additionally, the pattern of economic development, specifically the demand for infrastructure represented by the economic scale and growth rate, as well as the availability of local fiscal resources for infrastructure supply, plays a crucial role in determining the success or failure of PPP projects. Understanding the interplay between institutional quality and economic development is crucial for comprehending China's PPP market dynamics. This study aims to explore their influence and shed light on broader factors impacting PPP project performance in China.

Since the onset of the COVID-19 pandemic in early 2022, global economic growth has been significantly impeded. The recurrence of the epidemic has further intensified these effects, impacting various sectors, including infrastructure development in China. In April 2022, recognizing the challenges posed by the pandemic, the eleventh meeting of the Central Financial and Economic Affairs Commission (CFEAC) of the Chinese Communist Party (CPC) reiterated the imperative of bolstering infrastructure investment and emphasized the urgent need to "promote the standardized development and efficient operation of the PPP model." This policy directive serves as a crucial stimulus for the steady and healthy advancement of the PPP market, highlighting its pivotal role in enhancing local infrastructure quality and expanding public services.

As the PPP model continues to regain prominence and capture the attention of central policy-makers, this research paper provides valuable insights. By thoroughly examining the relationships involved, this study aims to offer actionable recommendations that can enhance the resilience of PPP projects and contribute to the success of infrastructure initiatives in today's dynamic environment.

2. Research backgrounds

In academia, two common approaches can be observed for analyzing the factors that determine the success or failure of PPP projects. The first approach involves a project-based case analysis, which assumes that certain unique or shared characteristics exist among specific projects or project types. It posits that these characteristics and features directly contribute to the success or failure of the analyzed project or project type [14,15]. Project-based analysis in the context of PPP projects generally focuses on several key factors. These factors encompass the risk allocation of the PPP project, the level of government support provided, the project's economic and social utility, the actual demand for the project, and the characteristics of the industry environment in which it operates [16,

Table 1
PPP failure rate and average GDP growth rate by provinces.

Province	No. of failed projects	No. of total projects	PPP failure rate (2014–2020)	GDP growth rate (2014–2020 average)
Gansu	15	26	57.69 %	4.98 %
Tianjin	1	2	50.00 %	−2.15 %
Heilongjiang	3	9	33.33 %	−2%
Hainan	7	23	30.43 %	8.69 %
Liaoning	5	17	29.41 %	−2.74 %
Neimenggu	15	53	28.30 %	−0.64 %
Ningxia	3	12	25.00 %	6.37 %
Qinghai	3	12	25.00 %	5.19 %
Chongqing	1	4	25.00 %	10.60 %
Guangxi	5	21	23.81 %	6.26 %
Hunan	13	58	22.41 %	8.01 %
Guizhou	11	52	21.15 %	12.60 %
Jiangxi	5	24	20.83 %	9.52 %
Jiangsu	6	32	18.75 %	8.89 %
Shan(3)xi	7	43	16.28 %	7.83 %
Zhejiang	6	38	15.79 %	9.19 %
Jilin	5	34	14.71 %	−3.21 %
Yunnan	13	94	13.83 %	13 %
Shandong	12	91	13.19 %	3.64 %
Fujian	7	55	12.73 %	12.00 %
Beijing	2	17	11.76 %	10.64 %
Anhui	7	60	11.67 %	12.23 %
Hubei	7	64	10.94 %	11 %
Henan	10	92	10.87 %	9.20 %
Hebei	7	65	10.77 %	3.60 %
Xinjiang	4	41	9.76 %	7.95 %
Sichuan	4	54	7.41 %	10.31 %
Guangdong	2	32	6.25 %	9.69 %
Shan(1)xi	1	20	5.00 %	5.94 %
Shanghai	0	2	0.00 %	10.12 %
Xizang	0	1	0.00 %	13.02 %

17]. Furthermore, detailed analyses can be undertaken by examining each phase of the project, including project design (D), construction (B), financing (F), and operation (O). This approach allows for a more comprehensive understanding of the project's success factors and challenges at each stage [18]. These reasons include the absence of necessary conditions for implementing the PPP model, changes in macro policies, challenges in financing PPP projects, alterations in local government authorities and policies, difficulties in project coordination, and failure to complete procurement processes within the designated timeframe [14–16].

In a different approach, this paper utilizes an institutional analysis framework that delves into regional variations. By examining elements such as the government efficiency, business environment, investment policies, ease of investment and financing, the structure of economic and social development, and even the level of talent absorption within the system, this analytical approach posits that macro-level characteristics, such as industry, region, or country, exert a comprehensive influence on PPP projects within those particular contexts [19,20]. The argument is further substantiated by statistics shown in Table 1, which provide insights into the provincial distribution of failed PPP projects. These statistics uncover a notable negative correlation (-0.52 correlation coefficient) between the failure rate of PPP projects and the GDP growth rate spanning from 2014 to 2020. These findings highlight the presence of macro-level factors that contribute to both the failure of PPP projects and the stagnation of economic growth.

Empirical analysis of the sustainable outcomes of PPP projects can be traced back to studies conducted by Hammami et al. (2006) [21] using the World Bank PPI project database [22], which relates the level of PPP development in different countries to government finance, political environment, market conditions, macroeconomic stability, institutional quality, legal system, and PPP implementation experience. Banerjee et al. (2006) [23] used the database to analyze the impact of institutional factors such as private investment and bureaucracy, private property rights protection, and corruption on PPP projects, with a focus on developing economies. Reside (2009) [24] and Reside and Mendoza (2010) [25] also used the database to analyze the relationship between political institutions and the success or failure of PPP projects across countries, finding that exchange rate changes, short-term loan-to-export ratios, and government guarantees increase the failure rate of PPP projects, while GDP per capita, fiscal surpluses, the degree of openness of the country, and support from multilateral institutions can reduce the failure rate of PPP projects. In addition, several other scholars have delved into the impact of institutional quality on the success rate of PPP projects, focusing on the country where the projects are located [26–28]. On the regional level, Hammami et al. (2015) [29], Qiao (2017) [30], and Ma and Li (2019) [31] have specifically examined the provincial and municipal disparities within China. Their studies shed light on the varying influences of institutional factors on the outcomes of PPP projects.

3. Determinants of project outcomes

This paper analyzes four key dimensions: local government institutional quality, the private capital development environment, local economic development, and local fiscal capacity. These dimensions operate as interconnected paths, mutually influencing one another [25]. While local governments may share similar economic endowments (such as natural resources, population, labor force, etc.), their levels of economic development and enterprise growth can vary significantly [32]. In recent years, optimizing the business environment and promoting economic development has been one of the top priorities for government local officials [29]. Therefore, comprehending the underlying factors that drive the effectiveness of PPP projects necessitates an examination of the intricate relationship between the government and the market within China's economic and social development landscape.

3.1. Relationship between the local government and the market

The first set of variables in this study, as summarized in Table 2, focuses on the government-market relationship. Government

Table 2
Indicators for relationship between the local government and the market.

1. Relationship Between the Local Government and the Market			
No.	Indicators	Description	Source of Data
1.1	Government Share in Allocating Economic Resources(GS)	The share of government expenditures (including general public budget expenditures and government fund expenditures) in GDP can reflect the share of government-allocated resources. A lower share of government spending corresponds to a higher share of market-allocated resources.	National Bureau of Statistics/China Marketization Index Database
1.2	Government Intervention (GI)	The index was based on the results obtained through a survey of a sample of enterprises in the province, with the question "Is there too much government intervention in administrative approval, enforcement and inspection, industry access, investment, and other areas?"	China Marketization Index Database
1.3	Size of the Government (SI)	The relative size of the government is reflected by the ratio of the number of employees in public administration, social security, and social organizations (the number of employees in state agencies, political party organs, and social organizations before 2002) to the total population of each province according to the provincial bureau of statistics	National Bureau of Statistics/China Marketization Index Database
1.4	Rule of Law (RL)	The index was obtained through a survey of a sample of enterprises in the province, and the survey question was "Do the public prosecution and law enforcement agencies enforce the law fairly and effectively to protect the legitimate rights and interests of enterprises and business operators?"	China Marketization Index Database

quality and governance efficiency have long been recognized as influential factors in explaining provincial disparities in economic growth [33], and this extends to the effectiveness of PPP projects. In China, PPP practitioners commonly acknowledge that the government plays a dominant role in the government-private cooperation model [34]. The traditional approach, familiar to local governments, involves boosting the local economy through infrastructure investments funded by government spending. However, over-reliance on this government spending model can hinder the government's ability to adapt to the PPP model, which entails contracting with enterprises and necessitates a balanced distribution of rights, responsibilities, and risks as agreed upon in the PPP contract. Failure to achieve this balance can lead to unsustainable PPP contracts and project failures. This effect is measured using the indicator of Government Share in Economic Resources (**GS**), which represents the ratio of government expenditure to the local economy in terms of GDP.

Another indicator of the government-market relationship is the extent of the local government's involvement and intervention in the market, as well as its ability to shape a business-friendly legal environment. The China Marketization Index has conducted comprehensive surveys targeting enterprises at the municipal level. Two survey questions specifically inquire about government intervention (**GI**) and the rule of law (**RL**). The survey results provide valuable insights into the opinions of local entrepreneurs regarding their actual business environment and their perceptions of conducting business in that particular location. Another significant indicator of this involvement is the proportion of government employment relative to the total number of employed individuals in society. A larger size of government (**SI**) signifies a deeper level of government involvement in the overall economic operation process. The government-oriented administrative logic often results in inefficient management of economic operations. This is further evidenced by the local government's biased policies favoring local state-owned enterprises and urban investment companies in recent years.

3.2. Business environment for private capital

The second set of variables, as summarized in Table 3, pertains to the environment for private capital development. The initiation of PPP in modern China can be traced back to the Third Plenary Session of the 16th CPC Central Committee, which facilitated market access liberalization and the entry of non-public capital into infrastructure and public utilities [35]. However, the development of private capital has always been influenced by administrative regulations and the business environment. The favorable development environment for non-public enterprises can be assessed from multiple perspectives, including investment opportunities, employment absorption capacity, the impact of local protection policies, and equitable access to financing. PPP projects typically involve long-term collaborations and significant fixed-asset investments. Therefore, the willingness of private capital to invest (**PI**), employ (**PE**), and the ability to access favorable financing conditions (**FI**) are critical factors that reflect the local environment for private capital development [36,37].

Furthermore, certain local governments may employ explicit or implicit discriminatory policies in the bidding process for PPP projects, favoring local enterprises over enterprises from other municipalities. This uncompetitive bidding environment can result in the selection of private capital lacking the necessary qualifications and capabilities to effectively implement PPP projects, thereby becoming a significant contributing factor to PPP project failures. The China Marketization Index conducted a survey to assess the level of local protectionism and fairness in the business environment (**FA**).

3.3. Local economic development

The third set of variables, as summarized in Table 4, focuses on local economic development. The success of both user-pay projects and government-pay projects relies heavily on the level of local economic development [38]. User-pay projects typically encompass operational initiatives such as toll roads and utilities. The condition of the local economy and the affordability of PPP projects by users significantly impact the success or failure of such projects. While certain PPP projects may initially depend on government payments or feasibility gap subsidies, long-term viability, and sustainable operation necessitate a robust economic foundation and a stable tax revenue base. Therefore, within this group of variables, it is essential to consider not only the total GDP but also the GDP growth rate (**GRW**). The growth rate and its forecast play a crucial role in evaluating the viability of PPP projects and significantly influence the

Table 3
Indicators for business environment for private capital.

2. Business Environment for Private Capital			
No.	Indicators	Description	Source of Data
2.1	Private Investment (PI)	The proportion of the non-state-owned economy in the total investment in fixed assets of the whole society	National Bureau of Statistics/China Marketization Index Database
2.2	Private Employment (PE)	The proportion of urban employees employed by non-SOEs	National Bureau of Statistics/China Marketization Index Database
2.3	Local Protection and Fairness to Compete (FA)	The index was obtained through a survey of a sample of enterprises in the province, and the question was "Do different ownership types of enterprises enjoy the same conditions of fair competition?"	China Marketization Index Database
2.4	Financial Institutions to Support Non-SOEs (FI)	The share of non-SOEs' liabilities in total enterprises' liabilities. The higher this indicator is, the more it reflects an increased allocation of credit funds through market mechanisms.	China Marketization Index Database

Table 4
Indicators for local economic development.

3. Local Economic Development			
No.	Indicators	Description	Source of Data
3.1	GDP	Since the economy of each province in China is affected by the COVID-19 pandemic to varying degrees starting in 2020, the gross domestic product (GDP) of each province in 2019 is used.	National Bureau of Statistics
3.2	GDP Growth (GRW)	Since the economy of each province in China has been affected by the COVID-19 pandemic to varying degrees starting in 2020, the compound annual growth rate of GDP of each province from 2014 to 2019 is used.	National Bureau of Statistics

government's assessment of the project's future operability when formulating the financial model and implementation plan.

3.4. Local fiscal affordability

The fourth set of variables, as summarized in Table 5, pertains to local fiscal affordability. Aside from user-pay projects, most PPP projects rely on government payments and viability gap fundings (VGFs) as their revenue sources [39,40]. In accordance with the current PPP policy, the aggregate fiscal expenditure responsibility of all PPP projects at the local level should be below 10 % of the total general public budget expenditure. Consequently, higher general public budget expenditure implies greater financial resources available for supporting PPP projects. However, numerous local governments face a substantial disparity between their general public budget expenditure (GPBS) and general public budget income (GPBI), leading to deficits that are compensated by the central government. This redistribution of central government income involves significant transfers from wealthier regions to poorer regions, ensuring financial support for the latter. To assess fiscal sustainability, this study also utilizes the ratio of general public budget expenditure to general public budget income (GPBR). Statistics of GPBR indicate a minimum value of 1.15 (observed in Shanghai, where expenditure and income are more balanced) and a maximum value of 10.00 (observed in Tibet, where expenditure significantly exceeds revenue and is unsustainable).

Lastly, it is important to emphasize that each PPP project possesses its own unique characteristics. Additionally, there may be other project-specific factors that influence the outcome, such as limited awareness among PPP participants or insufficient capacity of PPP consultants. These specific factors, including project investment amount, duration, payment source, and more, cannot be captured by the model used in this study. It is essential to recognize the limitations of the model in fully accounting for all the intricacies and complexities of individual projects.

4. Model specification and data description

4.1. Data description

The data used in this study consists of cross-sectional data from 31 provincial-level provinces, cities, and autonomous regions. The project failure rates are derived from the Project Database of the National PPP Integrated Information Platform (<https://www.cpppc.org/>), which aligns with the findings of Chen et al. (2011) [14]. The original data for the independent variables are sourced from the China Statistical Yearbook by the National Bureau of Statistics and the China Marketization Index database (<https://cmi.ssap.com.cn/>). However, it is worth noting that the collection and evaluation of economic data and government behavior have been impacted by the recurrence of the COVID-19 epidemic from 2020 to the beginning of 2023. As a result, for consistency and reliability, the institutional and economic data are uniformly sampled as 2019 data. Table 6 presents the descriptive statistics of both the dependent and independent variables.

4.2. Model specification

This paper employs a linear regression model (OLS) based on Stock and Watson (2011) [41] to analyze the failure rate of PPP projects. Four groups of variables are incorporated sequentially in models 1, 2, 3, and 4, represented by equations (1)–(4) below to

Table 5
Indicators for local fiscal affordability.

4. Local Financial Affordability			
No.	Indicators	Description	Source of Data
4.1	General Public Budget Income (GPBI)	General public budget income (GPBI) includes tax revenue and non-tax revenue, excluding governmental fund revenue.	National Bureau of Statistics
4.2	General Public Budget Expenditure (GPBS)	General public budget expenditures, excluding governmental fund expenditure	National Bureau of Statistics
4.3	Fiscal Affordability (GPBR)	The indicator used to assess this situation is the ratio of GPBS to GPBI. A higher ratio signifies a situation where expenditures exceed income, indicating insufficient revenue to cover expenses. This imbalance raises concerns about fiscal sustainability and long-term affordability, as it compromises the government's ability to meet financial obligations in the long run.	National Bureau of Statistics

Table 6
Data description.

No.	Indicators	Label	No. of Obs.	Average	St. D.	Min.	Max.
1	Failure rate	FR	31	0.187742	0.127298	0	0.58
2	Government share in allocating economic resources	GS	31	5.102677	1.026309	0.328	6.012
3	Government intervention	GI	31	3.672032	2.218959	-1.994	8.963
4	Size of government	SI	31	3.152194	0.963474	-0.859	4.027
5	Rule of law	RL	31	10.41065	1.985921	6.085	14.397
6	Private investment	PI	31	9.603581	2.112755	1.797	11.43
7	Private employment	PE	31	12.96932	0.665348	11.814	14.062
8	Local protection and fairness to compete	FA	31	4.000581	2.4668	-0.927	10.519
9	Financial institutions to support non-SOEs	FI	31	18.83032	6.944318	7.062	32.615
10	GDP	GDP	31	31784.94	25949.28	1697.82	107671.1
11	GDP Growth	GRW	31	0.07129	0.048836	-0.03	0.13
12	Fiscal Affordability	GPBR	31	2.978426	1.74218	1.149839	10.00462
13	General Public Budget Income	GPBI	31	3140.726	2535.548	220.99	10143.16
14	General Public Budget Expenditure	GPBS	31	6793.015	3544.107	1480.36	17430.79
15	Total No. of Projects	TNS	31	37.03226	26.81975	1	94

examine the relationship between government and market, private capital development environment, local economic development, and local fiscal affordability. Furthermore, in models 4 and 5, represented by equations (4) and (5) below, an attempt is made to construct a combination of two out of the three indicators: general public budget income (GPBI), general public budget expenditure (GPBS), and fiscal affordability (GPBR). To address potential endogeneity concerns, a variable such as the total number of local PPP projects was introduced, which serves as a proxy for local experience in conducting PPP projects, which is expected to enhance the success rate of PPP projects. The specific model is presented as follows:

$$FR = \beta_1 GS + \beta_2 GI + \beta_3 SI + \beta_4 RL + \beta_5 TNS + \mu_i, \tag{1}$$

$$FR = \beta_1 GS + \beta_2 GI + \beta_3 SI + \beta_4 RL + \beta_5 PI + \beta_6 PE + \beta_7 FA + \beta_8 FI + \beta_9 TNS + \mu_i, \tag{2}$$

Table 7
Model results.

Variables	(1)	(2)	(3)	(4)	(5)
	FR	FR	FR	FR	FR
GS	-0.013 (0.043)	0.038 (0.053)	0.027 (0.054)	0.03 (0.052)	-0.141 (0.088)
GI	-0.014 (0.013)	-0.007 (0.015)	-0.009 (0.015)	-0.007 (0.015)	-0.012 (0.015)
SI	0.077* (0.043)	0.14** (0.066)	0.155** (0.067)	0.176** (0.066)	0.216*** (0.069)
RL	-0.026* (0.014)	-0.02 (0.015)	-0.021 (0.015)	-0.019 (0.015)	-0.018 (0.014)
TNS	-0.002** (0.001)	-0.003** (0.001)	-0.003** (0.001)	-0.002** (0.001)	-0.004*** (0.001)
PI		-0.038 (0.032)	-0.052 (0.033)	-0.053 (0.033)	-0.08** (0.035)
PE		-0.107 (0.068)	-0.075 (0.071)	-0.145* (0.078)	-0.138* (0.071)
FA		-0.009 (0.014)	-0.003 (0.016)	0.001 (0.015)	0.01 (0.016)
FI		0.007 (0.005)	0.008 (0.006)	0.007 (0.006)	0.005 (0.006)
GDP			-4.72*10 ⁽⁻⁷⁾ (1.59*10 ⁽⁻⁶⁾)	4.69*10 ⁽⁻⁶⁾ (3.49*10 ⁽⁻⁶⁾)	6.98*10 ⁽⁻⁶⁾ * (3.84*10 ⁽⁻⁶⁾)
GRW			-0.766 (0.522)	-0.627 (0.506)	-1.046* (0.496)
GPBI				5.63*10 ⁽⁻⁶⁾ (0.0000281)	-0.0000754* (0.000038)
GPBS				-0.000402* (0.0000214)	
GPBR					-0.118** (0.052)
_cons	0.401** (0.164)	1.565* (0.806)	1.312 (0.821)	2.21** (0.926)	3.457** (1.213)
Observations	31	31	31	31	31
R-squared	0.418	0.529	0.578	0.653	0.68

Note: Ordinary standard errors are in parentheses, ***p < 0.01, **p < 0.05, *p < 0.1 indicate significant at the 10 %, 5 %, and 1 % levels, respectively.

$$FR = \beta_1 GS + \beta_2 GI + \beta_3 SI + \beta_4 RL + \beta_5 PI + \beta_6 PE + \beta_7 FA + \beta_8 FI + \beta_9 GDP + \beta_{10} GRW + \beta_{11} TNS + \mu_i, \quad (3)$$

$$FR = \beta_1 GS + \beta_2 GI + \beta_3 SI + \beta_4 RL + \beta_5 PI + \beta_6 PE + \beta_7 FA + \beta_8 FI + \beta_9 GDP + \beta_{10} GRW + \beta_{11} GPBI + \beta_{12} GPBS + \beta_{13} TNS + \mu_i, \quad (4)$$

$$FR = \beta_1 GS + \beta_2 GI + \beta_3 SI + \beta_4 RL + \beta_5 PI + \beta_6 PE + \beta_7 FA + \beta_8 FI + \beta_9 GDP + \beta_{10} GRW + \beta_{11} GPBI + \beta_{12} GPBR + \beta_{13} TNS + \mu_i, \quad (5)$$

5. Results and discussion

5.1. Analysis of the empirical results

Through a comparison of models (1)–(5) in Table 7, it becomes evident that the inclusion of additional variables leads to a progressive increase in the R-squared value, indicating a higher explanatory power of the model. Specifically, the R-squared gradually improves from 42 % to 68 % as more variables are incorporated.

First, our focus is on the significant effects of government size and the total number of projects (representing PPP project experience) on the effectiveness of PPP projects. Larger government size tends to be associated with project failure, while PPP project experience tends to enhance project success. Second, when comparing model (4) with model (5), we observe that the inclusion of fiscal affordability, measured by the ratio of general public budget expenditure to income, yields better results compared to the inclusion of general public budget expenditure alone. This may be because, prior to regulatory tightening, a significant number of PPP projects were primarily funded through governmental funds, and not general public budget expenditure. Therefore, the use of the revenue-to-expenditure ratio provides a more comprehensive reflection of the financial health of the local government. Finally, model (5) demonstrates optimal performance in terms of overall model explanatory power and the significance of different variables. It is worth noting that variables measuring the institutional quality of the local government, such as government intervention, rule of law, local protection, and fairness, as assessed through surveys, do not show significant effects. This may be attributed to potential distortions in the survey's inquiry about government behavior. In other words, discrimination against private enterprises may be more subtle and implicit rather than overt.

In summary, models (1)–(5) have confirmed the following conclusions: i. larger government size, which implied a decrease in government efficiency, is positively associated with the failure of PPP projects; ii. A favorable environment for private capital development as indicated by increased investment and employment by private capital reduces the failure rate of local PPP projects; iii. Economic development indicators, such as total GDP and GDP growth rate, have an impact on the success rate of PPP projects. Higher GDP growth rates have a significant, albeit not highly significant (significant at the 10 % level), effect in reducing the project failure rate; iv. The empirical results also demonstrate that higher local fiscal affordability and a more balanced expenditure-income ratio are associated with a higher probability of success for local PPP projects. Overall, the analysis presented in this paper highlights the significant effects of institutional environment and economic development on the sustainable outcomes of PPP projects.

5.2. Policy implications and recommendations

This paper employs empirical analysis to examine the influence of institutional quality and economic development on the failure rate of PPP projects in various provinces. From an institutional perspective, enhancing the efficiency of PPP projects necessitates reducing the size of government, while local governments should foster an environment that encourages private capital investment and business development. Regarding the economic aspect, a positive correlation is observed between the GDP growth rate and the success rate of projects; however, it is crucial to also address the financial affordability of local governments. Building upon these findings, the paper proposes the following recommendations:

Firstly, it is important to acknowledge that there exist variations in institutional quality among local governments. However, the critical institutional infrastructure required for successful implementation of the PPP model lies at the national level, encompassing government procurement, budgeting, and relevant laws, rules, regulations, and normative documents established by ministries involved in promoting the PPP model. Unfortunately, the delayed introduction of PPP legislation and insufficient legal protection for private capital create an unequal playing field for local governments when it comes to executing PPP projects. To address this issue, the central government should take proactive measures to clarify and regulate the conduct and standards of local governments involved in PPP projects. Such actions will not only enhance the confidence of enterprises to invest more resources but also encourage their active participation in PPP initiatives.

Secondly, since the 18th National Congress of the CPC, the government has embarked on the “management and service” reform of government roles, wherein the PPP model serves as an innovative means to facilitate the government's functional transformation [42]. While it is crucial for the government to minimize implicit or explicit interventions in the construction and operation of PPP projects, it must concurrently establish effective supervision and management mechanisms for such initiatives. Ensuring effective management of the PPP model presents a significant challenge, requiring the government to exhibit strong governance capabilities and management efficiency. Without proper management, the government risks falling into the predicament of encountering chaos if the model is released without oversight, or facing failure if it is overly controlled.

Thirdly, when implementing PPP projects, it is crucial for local governments to consider not only the economic aspects of the individual projects but also their broader impact on the local economy and finances. The sustainability of both economic and financial factors is the bedrock of the PPP model, particularly as the number of such projects continues to grow. It becomes imperative to assess

the collective influence of all PPP projects at this level comprehensively. Failing to do so may result in a situation where private capital withdraws en masse due to concerns regarding the local system's quality and economic development. Consequently, a multitude of PPP projects may encounter difficulties or require renegotiation simultaneously. To mitigate such risks, a holistic approach should be adopted, ensuring careful consideration of the overall impact and sustained viability of these PPP projects [43].

6. Conclusions

The objective of this research was to investigate the effects of several factors on the development and implementation of PPP projects in China. The specific factors examined included local government institutional quality, the business environment for private capital, local economic development, and local fiscal affordability. To establish a strong theoretical foundation, the study selected relevant determinants based on a comprehensive review of existing literature. A robust quantitative analysis was then conducted to evaluate the sustainability of PPP projects, generating reliable and comprehensive outcomes. The findings highlight that larger government size increases the likelihood of PPP project failure, while a favorable business environment for private capital can help mitigate the failure rate of local PPP projects. Furthermore, the empirical analysis reveals a positive correlation between local fiscal affordability and the success rate of PPP projects. These results emphasize the significant influence of the institutional environment on the effectiveness of PPP projects, offering valuable policy recommendations for local governments to enhance the business environment and other critical factors that contribute to the resilience of PPP projects. However, it is important to recognize the limitations of this study. Each PPP project possesses unique characteristics, and there may be additional project-specific factors that influence outcomes. As the research focuses solely on China, its findings might not be directly applicable to other countries with different political, economic, and institutional contexts.

Data availability statement

The data that supports the findings of this study are available in the supplementary material of this article.

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CRediT authorship contribution statement

Zilin Li: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Haotian Wang:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization.

Declaration of competing interest

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

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