

## Article

# The Role of Public–Private Partnerships in Local Government Debt Is a Potential Threat to Sustainable Cities: A Case from China

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**Abstract:** (1) Background: Public–private partnerships (PPPs) play an essential role in sustainable cities and are widely applied in the public environment, health, and transportation sectors. One of the main functions of PPP projects is to attract private capital to provide better public services and infrastructure. PPP projects require government investment, potentially threatening the debt of local governments. However, few scholars have shown attention to the relationship between PPP projects and local government debt. (2) Methods: Therefore, this study selects data from 36 cities in China from 2014 to 2018. Ordinary least squares (OLS), quantile regression, and placebo tests are used to investigate this claim. (3) Results: This study finds that PPP projects can affect local governments' debt; based on this result, this study further proposes that the effect of PPP projects on local government debt has regional heterogeneity. Compared with eastern regions, PPPs in central and western areas of China have a noticeable impact on local government debt. This study also investigates the effect of different types of PPP projects on local government debt. In terms of the number of new additions, comprehensive urban development PPP projects have the largest effect on the exacerbation of government debt. In terms of the amount of new investment, environmental protection PPP projects have the greatest exacerbating effect on government debt. (4) Conclusion: These findings try to identify PPPs' effect on local government debt. It is of potential reference for sustainable cities and helps to provide better transport, environmental, and health public services.

**Keywords:** sustainable cities; PPPs; debt; China; public service



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## 1. Introduction

Public–public partnerships (PPPs) can be defined as long-term contracts between a private party and a government entity to provide infrastructure and public services. The private sector bears significant risk and management responsibilities [1]. In PPP projects, the private sector's participation can complement public sector financing and allow projects to go forward that otherwise would have been discarded due to fiscal constraints, creating an incentive mechanism aligning the private and public interests [2]. Besides, the private sector's edge in management and technology can also improve the quality and efficiency of infrastructure services, encourage the adoption of advanced practices in the construction phase, and create an environment to foster innovation in infrastructure developments [3]. World leaders gathered at the World Bank's International Conference on Financing in 2015 and identified the critical role of PPPs in the sustainable development agenda. Now, PPP projects have been adopted by 133 countries and are widely applied in the public environment, health, and transportation sectors, as with PPP projects in China, which are described in Appendix A Table A1. There is no denying that PPP projects have become an essential tool for contemporary sustainable cities globally, in

both developed and developing countries [4,5]. Since 2014, China has issued a series of policies to promote PPPs to encourage and guide the private sector's participation in the construction and operation of infrastructure and public utilities, enhance the quality and efficiency of public services, and meet public demand for public products and services [6]. As of December 2020, China's Ministry of Finance reports 9792 PPP projects totaling CNY 14.8 trillion in investment, of which 6546 have been signed and landed, totaling CNY 10.3 trillion in investment. China's public-private partnership model is advancing quickly [7].

However, PPP projects can also pose a threat to the sustainable development of cities. On the one hand, PPP projects have a long cycle time and will face more external uncertainties; the involvement of many stakeholders in PPP projects may lead to project failure due to improper management by the stakeholders in project construction [8], and the failure of the project means the failure of the government's investment. On the other hand, if the government does not control the number of PPP projects and the investment amount, this will result in the government spending above its revenue. The above two aspects may pose a potential threat to government debt [9], and the aggravation of local government debt will undoubtedly hurt sustainable urban development. Therefore, investigating the relationship between PPP projects and local government debt is essential.

To this end, this study selects the data of 36 cities in China from 2014 to 2018. The OLS, quantile regression, and placebo tests are used to investigate PPP projects' effect on local governments' debt. This study aims to answer the following two research questions based on the discussion above. (1) Do PPP projects aggravate local government debt? (2) If local government debt is aggravated, how can we explain this result? The rest of the article is organized as follows. Section 2 describes the literature review. Section 3 describes the theory and hypothesis. The methodology and data are illustrated in Section 4, and Sections 5 and 6 are the results and discussion of this study. The last section is the summary and implications of this article.

## 2. Relevant Literature

Nowadays, cities are facing increasing problems caused by unsustainable cities, such as housing shortages, environmental pollution, limited health care resources, et al. The solution to these problems is often beyond the capacity of the local governments, requiring the cooperation of the private and government sectors. PPPs as a form of cooperation between the government and private sectors were first initiated in the United Kingdom in the early 1980s [10] and emerged worldwide in the late 1990s. Therefore, many scholars pay attention to PPP projects in promoting sustainable cities.

Scholars have underlined the importance of implementing PPP initiatives to create sustainable cities [11]. Kim et al. [12] emphasized the critical significance of PPPs in ensuring the transportation sector's future sustainability; Fell et al. discovered that PPPs are critical if cities are to advance in the direction of sustainable housing development [5,13]; Pero et al. also point to the critical role of PPPs in achieving sustainability in the environmental field [14]. As previously said, scholars are emphasizing the application of PPP projects in various infrastructure and public service areas. Infrastructure and public service projects serve a higher number of people in society, garner more attention, and significantly impact society. Thus, these projects potentially become place-branding, build social, cultural, and symbolic capital, and position the place with regard to internal and external stakeholders and audiences [15,16], just as was the case with the sports place-branding strategy of Qatar studied by scholars [17]. These branding-related efforts tend to boost the visibility of local governments. Visibility frequently increases social capital's trust in the government, attracting additional social capital to PPP initiatives, urging the government to commence their completion, and further encouraging sustainability.

Thus, to promote the contribution of PPP projects to sustainable cities, scholars have performed a lot of research on risk factors to reduce project failures. Previous research on PPP projects mostly focused on the following topics. The first topic focuses on the definition, adoption, and application of PPP projects [18–20]. The second topic focuses

on risk management in PPP projects, risk identification and risk evaluations, and risk transfer (risk allocation) [21]. Those risk factors include political risk factors [22], natural risk factors [23], operational risk factors [24], relationship risk factors [25], and market risk factor [26]. The third topic is contract management in PPP. Contract management mainly focuses on public procurement tendering issues, concession period issues, and government support issues in PPP contracts [27,28]. The fourth topic is focused on identifying the critical success factors (CSFs) and critical failure factors (CFFs) in PPP projects [29–34]. The critical risk factors' operating environment [35], the government [36–38], and the market [35,39] are often the focus of attention. The fifth topic is focused on performance management [40,41].

However, most of the studies mentioned above focus on implementing successful PPP projects for urban development but disregard the impact of PPPs on government debt. Increased government debt will erode the private sector's faith in government. Reduced trust in government by the private sector means less incentive to invest. This will eventually threaten the sustainability of PPP projects. However, most scholars ignore an essential issue: the impact of PPP projects on local debt. Although some scholars have suggested a relationship between PPP projects and government debt, most have conducted qualitative studies with little quantitative verification. This happens to be a research gap that needs to be explored in this study.

### 3. Theory and Hypothesis

#### 3.1. PPP Projects Can Aggravate Local Government Debt

Following a review of the research, it is established that PPP projects primarily have two effects on local government debt:

One is the risk associated with public procurement. According to China's Ministry of Finance guidelines in 2015, the proportion of government financial expenditure on PPP projects should not exceed 10%. It is also explicitly stated that, during the project preparation stage, the "two evaluations and one plan" approach should be continued to ensure project compliance. However, in practice, some local governments circumvent government funds to exceed the rigid requirement of the 10% red line or extend the construction cycle of projects to reduce the government's short-term expenditure responsibility, thereby reducing the government's annual project budget to less than 10% of the total public budget. After being halted, such non-compliant projects are likely to be shelved or possibly collapse, potentially increasing local government debt.

Another is the risks associated with investment and funding. One such risk is the effect of the capital debt of the project on the government debt. In the case of government-funded and feasibility-gap-subsidized PPP projects, the government's first objective is to leverage financial resources to increase the project's appeal to social capital. The government's contribution to such initiatives cannot exceed 10% of the total public budget. Suppose the government undertakes numerous PPP projects in the same year. In that case, 10% of spending will be dispersed among the projects, and the amount of investment on the social capital side will be approximately 20–30% of the overall project investment. As a result, there will be a funding gap of around 70% to 80% during the project's building phase. During the early stages of a PPP project's development and construction, the primary funding source is an investment. With a lack of revenue, if the project company's capital chain is broken or there is insufficient capital to meet the investment cost, the project company's liabilities become local government debt [42]. The other risk is the effect of the rate of return of PPP projects on government debt. To alleviate financial difficulties and entice the private sector to participate in PPP projects, the government typically promises the project's minimum rate of return, regardless of whether the project is in its early stages or is near completion. PPP projects are mostly public benefit projects with inherent characteristics such as large project investments, long implementation cycles, the extensive involvement of legal and policy systems, and complex management. In addition, PPP projects are highly susceptible to major emergencies and other impacts. These factors can lead to uncertainty in the rate of return on PPP projects [43]. When PPP projects fall short

of promised returns, it implicitly poses a threat to government debt. Based on the above theoretical analysis, the following hypotheses are proposed in this paper:

**Hypothesis 1.** *PPP projects have an aggravating effect on government debt.*

### *3.2. PPP Projects Have Different Impacts on Local Government Debt*

There are significant differences in the impact of PPP projects on local government debt, which can be stated as follows: to begin, regions exhibit varying degrees of economic development. PPP projects are designed to persuade the private sector to partner with the government and invest in public infrastructure development. Economic development directly affects the number of private enterprises and their participation in PPP projects in a region. Due to the apparent disparities in economic development levels between China's 34 provinces and cities, their participation in PPP projects varies, and private firms operate to varying degrees, resulting in disparate effects on government debt, as evidenced by Xining city in Qinghai Province [28]. Second, local governments have different levels of governance. In China's context, local governments play an important role in initiating, operating, and transferring PPP projects. Due to the influence of numerous factors such as economic development, talent reserves, organizational structure, and so on, there are significant variances in governments' governance levels and capacities across China. The capacity and level of governance are critical in dealing with local government debt. When a government possesses strong governance capabilities, it can minimize the impact of PPP projects on government debt throughout the process of warehousing, operating, and supervising PPP ventures. Otherwise, local government debt may be aggravated. Thirdly, local governments operate under a variety of different social finance regimes. Because the initiation of PPP projects demonstrates a solid commitment to the public benefit and those with low-income levels, the projects cannot generate profits in the short term, which dampens financial institutions' excitement to participate. Although the state has implemented some constructive fiscal policies and actions, the harsh social financing conditions at the regional level remain unresolved. As a result, unfavorable social financing circumstances will work against PPP ventures' ability to reduce local government debt. Based on the theoretical analysis discussed above, this article makes the following hypotheses:

**Hypothesis 2.** *PPP projects have different impacts on local government debt.*

## **4. Data and Methodology**

### *4.1. Data Sources*

This study is based on balanced panel data for 36 Chinese cities from 2014 to 2018. The reason for choosing the study period of 2014 to 2018 is that, in 2014, the Chinese government proposed PPP projects at the national level and issued many policies about PPP projects; the PPP projects in most provinces across the country started in 2014. Thus, this study takes 2014 as the starting point. As we know, COVID-19 broke out in 2019, which had a significant impact on the development of PPP projects and the overall economy in China [23,44]. We thus selected the period from 2014 to 2018. In this study, 36 cities were selected that were considered as medium and large cities in China.

The data of PPP projects from the PPP Project Center of the Ministry of Finance (accessed on 18 March 2022) was developed in 2013 and has now become the largest PPP database worldwide. This database covers all kinds of PPP projects [45]. Due to the availability of data from Hong Kong, Macao, Taiwan, Tibet, and some other cities, these cities are excluded from this study, and the final sample size of 180 is retained. The data for the dependent variables come from the wind database and the China Statistical Yearbooks. The data for the independent variables mainly come from the China Statistical Yearbooks.

#### 4.2. Variables

Table 1 shows the descriptive statistics for all variables. The natural logarithm is taken for some variables with large values. The natural logarithm of variables is obtained so that the standard deviation of most variables is also relatively smaller, eliminating the problem of heteroskedasticity and thus minimizing the bias in the empirical results caused by the heteroskedasticity of variables.

**Table 1.** Variable categories, names, codes, definitions, means, and standard deviations.

Variable Type	Variable Name	Variable Code	Variable Definition	Mean	Standard Error
Dependent Variables	Government Debt	Debt	logarithm	6.69	0.98
	Number of PPP projects	Total PPP		25.13	24.70
	New investment per year	And invest	logarithm	8.67	0.35
	Engineering number	Engineering		11.87	12.24
	Transportation number	Transportation		2.08	3.04
	Environment number	Environment		2.07	3.08
Independent Variables	Urban number	Urban		1.34	2.30
	Education number	Education		0.52	1.14
	Water number	Water		0.52	1.51
	Health number	Health		0.57	1.21
	Tourism number	Tourism		0.30	0.75
	Infrastructure number	Infrastructure		0.37	0.69
	Culture number	Culture		0.40	0.76
	engineering Investment	Engineering1 investments	logarithm	9.56	7.98
	Transportation Investment	Transportation1	logarithm	3.59	9.49
	Environment Investment	Environment1	logarithm	3.14	9.49
	Urban Investment	Urban1	logarithm	1.86	9.45
	Education Investment	Education	logarithm	3.47	7.85
	Water Investment	Water1	logarithm	0.13	3.56
	health Investment	Health1	logarithm	0.62	4.37
	Tourism Investment	Tourism1	logarithm	0.69	4.45
	Infrastructure Investment	Infrastructure1	logarithm	2.16	7.70
	Culture Investment	Culture1	logarithm	2.30	7.90
	Gross Domestic Product	GDP	logarithm	17.90	0.84
	Gross Domestic Product per capita	AGDP	logarithm	11.37	0.36
	Control Variables	Population density	Propensity	logarithm	6.38
Fixed Asset Investment		Fixed	logarithm	17.45	0.75
Level of financial development		Finance	logarithm	18.76	0.87
Industry Structure		Secondary	Share of secondary industry in GDP	0.40	0.09
Number of Schools		School		1170.75	807.76

### 1. Dependent Variable

Based on the research purpose, this paper takes local government debt (Debt) as the dependent variable. The indicator of debt used in this study, which we refer to from the previously mentioned scholars, is the annual increase in investment for PPP projects [46].

### 2. Independent Variables

The number of PPP investment projects and the amount of new investment per year are used as the main variables to measure the size of PPPs. Additionally, to examine the impact of various types of PPP projects on government debt, this paper uses the annual number of new PPP projects and investment amounts for the ten major types of PPP projects as independent variables, in order to demonstrate their impact more clearly on local government debt.

### 3. Control Variables

Based on prior studies [47], this paper takes gross regional product, gross domestic product per capita, population density, fixed asset investment, financial sector development level, industrial structure, and the number of schools as control variables to minimize the bias of variables on the results. The details are shown in Table 1.

#### 4.3. Model Construction

This study sets the benchmark regression model for PPP projects' effect on government debt with regard to domestic and foreign scholars.

$$Debt_{it} = \alpha_0 + \alpha_1 Totalppp_{it} + \alpha_2 Trol_{it} + \varepsilon_{it} \quad (1)$$

$$Debt_{it} = \alpha_0 + \alpha_1 Addinvest_{it} + \alpha_2 Trol_{it} + \varepsilon_{it} \quad (2)$$

In Equations (1) and (2), subscripts  $i$  and  $t$  represent city and time, respectively,  $Debt_{it}$  is the government debt for city  $i$  at  $t$  year,  $Totalppp_{it}$  represents city  $i$  at  $t$  years of the total number of PPP.  $Trol_{it}$  represents a series of control variables such as individual, city, time, etc.  $\alpha_1, \alpha_2$  denote the coefficients of the corresponding variables, and  $\varepsilon_{it}$  represents the residual term. Drawing on prior research about PPP projects and local government debt [48], this study also takes the benchmark regression model as the reference standard and constructs the following quantile regression model to investigate how the annual number of PPP projects and the annual new investment in PPP projects affect local government debt.

$$Debt_{it} = \alpha_0^{(p)} + \alpha_1^{(p)} Totalppp_{it} + \alpha_2 Trol_{it} + \varepsilon_{it}^{(p)} \quad (3)$$

$$Debt_{it} = \alpha_0^{(p)} + \alpha_1^{(p)} Addinvest_{it} + \alpha_2 Trol_{it} + \varepsilon_{it}^{(p)} \quad (4)$$

The same metrics as described above are not elaborated here.  $0 < p < 1$  indicates the proportion of values less than the  $p$ -quantile.

## 5. Results

### 5.1. Baseline Regression Results

Columns 1 to 3 in Table 2 report the results of the benchmark regressions on the impact of the number of PPP projects. Column 1 shows the baseline regression results without any control variables. The number of PPP projects is positive, passes the 1% significance level test, and indicates that an increase in PPP projects exacerbates local government debt. The regional characteristics and time effects also impact local government debt and induce bias in the results. For this reason, they are sequentially included in the model for analysis as control variables in this paper.

**Table 2.** Basic empirical regression results.

	(1)	(2)	(3)	(4)	(5)	(6)
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Totalppp	0.015 *** (0.0005)	0.008 *** (0.0008)	0.010 *** (0.0006)			
Add invest				0.796 *** (0.1030)	1.259 *** (0.4010)	1.831 *** (0.4810)
GDP		−0.195 (0.1590)	−0.102 (0.1552)		−0.320 (0.2010)	−0.241 (0.1970)
AGDP		0.217 (0.1793)	0.418 (0.2761)		1.574 *** (0.4990)	2.321 *** (0.5312)
Peodensity		−0.285 *** (0.0416)	−0.120 *** (0.0308)		−0.255 *** (0.0479)	−0.050 (0.0912)
Fixed		0.191 *** (0.0528)	0.146 *** (0.0047)		0.129 ** (0.0566)	0.201 *** (0.0524)
Finance		0.920 *** (0.2113)	0.792 *** (0.2244)		1.024 *** (0.2280)	0.931 *** (0.1720)
Secondary		−0.021 *** (0.0030)	−0.015 *** (0.0028)		−0.023 *** (0.0041)	−0.018 ** (0.0070)
School		0.002 *** (0.0003)	0.001 *** (0.0002)		0.002 *** (0.0003)	0.001 *** (0.0002)
2015 year			−0.0262 (0.0187)			−0.279 * (0.1640)
2016 year			−0.0195 (0.0223)			−0.242 (0.1772)
2017 year			−0.294 *** (0.0687)			−0.469 ** (0.2023)
2018 year			−0.200 *** (0.0446)			−0.308 (0.1943)
Middle			0.198 *** (0.0473)			0.232 ** (0.1164)
West			0.438 *** (0.0473)			0.523 *** (0.1360)
Constant	6.305 *** (0.0623)	−9.173 *** (0.6264)	−11.623 *** (1.0642)	−0.197 (0.8331)	−13.482 *** (1.4770)	−17.614 *** (2.0154)
Observations	180	180	180	180	180	180
R-squared	0.146	0.684	0.713	0.085	0.666	0.698

Note: () represents standard errors; \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ .

At the level of the individual characteristics, column 2 adds personal characteristics variables for control. The results of this benchmark regression model show that the number of PPP projects is significant at the 1% statistical level with a coefficient of 0.008, indicating that the number of PPP projects is not conducive to reducing local government debt. (1) In terms of population density, this variable is significant. It has a negative coefficient, indicating that population density decreases local government debt—this finding is in line with prior findings [49]. (2) In terms of fixed-asset investment, the impact of fixed-asset investment on government debt is positive and significant. The reason for this is that fixed-

asset investment requires financial support from the government and thus will further increase government debt. (3) Regarding financial sector development, this variable is significant and positive at a 1% statistical level and indicates that the more developed the financial sector, the higher the government debt. (4) In terms of the number of schools, the estimated coefficient of the number of schools is positive and significantly positive at the 1% statistical level, which indicates that the number of schools is not conducive to reducing government debt. Schools are non-profit organizations that require long-term government support, and education lags, thus increasing government debt. (5) Based on column 2, control variables for time and region are further included in column 3. The results show that the number of PPP projects has a significantly positive effect on government debt, indicating that the government's increasing number of PPP projects increases local government debt. Specifically, at the time level, local government debt decreases over time. This phenomenon occurs because the number of PPP projects increases as time goes on, and their scale effect gradually comes to the fore, which alleviates government debt. This finding is consistent with the actual situation in China. At the regional level, the number of PPPs in central and western Chinese cities exacerbates local government debt compared to cities in the eastern areas. This effect is more pronounced for cities in the western regions. This phenomenon occurs because the economic development in western Chinese regions is relatively backward, and the government has limited financing. PPP projects require large amounts of capital for investment, further leading to government debt creation.

The baseline regression results for the impact of the annual new investment on local government debt are reflected in (4) to (6) in Table 2. Following the analysis in columns 1 to 3, the empirical results in columns 4 to 6 all indicate that the effect of annual new investment amounts on local government debt is significantly positive at the 1% statistical level, showing that the new yearly investment amount by the government increases the government's local debt.

In summary, both PPP projects and the annual increase in investment in PPP projects have an exacerbating effect on government debt, consistent with the validation of Hypothesis 1.

### *5.2. Impact of Different Types of PPP Projects on Local Government Debt*

This section examines the influence of PPP projects on local government debt in ten major areas. Specifically, as can be seen from columns 1 to 4 in Table 3, the annual increase in the number of municipal engineering, transportation, environmental protection, and urban development PPP projects has a statistically significant impact on local government debt at the 1% and 5% levels, and their estimated coefficients are all positive, which indicates that the four types of PPP projects mentioned above have an exacerbating effect on local government debt. This is because the four categories of PPP projects are more concerned with enhancing citizens' quality of life, require a longer project length and a large upfront expenditure, and hence wreak havoc on the government's debt.

The empirical findings in columns 5, 6, and 10 in Table 3 indicate that annual increases in three categories of PPP initiatives, namely, education, water, and culture, have a moderating effect on local government debt but are not statistically significant. This is because the areas of education, water, and culture all contribute to the development of the local economy by enhancing human capital, transforming productivity, and reinforcing the connections with the country, respectively, and thus easing local debt. On the other hand, despite the growing number of these three types of PPP projects, they are unable to deliver specific economic and social consequences in a short period of time and hence exhibit a lag, rendering them statistically unimportant.

As shown in columns 7–9 of Table 3, the three types of PPP projects—public health, tourism, and infrastructure—have a growing but statistically insignificant influence on local government debt in terms of new projects added each year. This is because the annual number of new PPP projects listed previously are all long-term in nature and hence cannot be statistically significant given the study sample period’s brief duration.

According to columns 1–4 and columns 7–9 in Table 3, the annual additions to urban integrated PPP projects have the highest impact on the exacerbation of government debt (0.084), while the engineering projects have the least impact (0.013). This is because, in comparison to other types of PPP projects, urban integrated PPP projects, which consist of five components such as characteristic towns, land reserves, plant construction, urbanisation construction, and park development, are a relatively complex system that play a significant role. According to the numbers in columns 5, 6, and 8, the annual number of new PPP projects in the category of culture has the greatest influence on debt relief (−0.47), while water conservation measures have the least effect.

**Table 3.** Impact of the annual number of new PPP projects of different types on local government debt.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10
Engineering	0.013 *** (0.0044)									
Transportation		0.044 ** (0.0180)								
Environment			0.041 ** (0.0162)							
Urban				0.084 *** (0.0156)						
Education					−0.031 (0.0295)					
Water						−0.015 (0.0203)				
Health							0.014 (0.0320)			
Tourism								0.063 (0.0602)		
Infrastructure									0.030 (0.0645)	
Culture										−0.047 (0.0468)
Control Variables	YES									
Time Control	YES									
Area Control	YES									
Constant	−16.16 *** (1.9112)	−15.74 *** (1.8694)	−16.51 *** (1.8450)	−14.65 *** (1.8452)	−16.56 *** (1.9631)	−16.40 *** (1.9444)	−16.27 *** (1.9353)	−16.40 *** (1.9270)	−16.25 *** (1.9541)	−16.37 *** (1.9432)
Observations	180	180	180	180	180	180	180	180	180	180
R-squared	0.721	0.719	0.718	0.735	0.708	0.708	0.708	0.709	0.708	0.708

Note: () represents standard errors; \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ .

As shown in columns 2–4 of Table 4, the estimated coefficient values for the increase in annual investment amounts for the three types of PPP projects discussed above, transportation, environmental protection, and urban-comprehensive, are 0.015, 0.016, and 0.012, respectively, and are statistically significant at the 1% and 5% statistical levels, indicating that the increase in annual investment amounts for the three types of PPP projects mentioned above will inevitably occur. The data in columns 1 and 6–9 of Table 4 demonstrate that the annual increase in investment for the five major types of PPP projects, namely municipal engineering, water construction, public health, tourism, and infrastructure, has a catalytic effect on local government debt, i.e., they all increase local government debt with an annual increase in investment. The reason for this is that the investment amount for the above five types of PPP projects is increasing each year, which means that the government

must also invest a certain percentage of funds in the projects each year, and their cycle is relatively long, which invariably increases the likelihood of the government running out of money. Environmental protection has the biggest aggravating effect on the eight types of PPP projects outlined previously, while infrastructure has the least. This is for two reasons: first, it aligns with the Chinese government’s policy of “green water and green mountains are the silver mountains of gold”, implying that the government will boost its expenditure on ecological conservation. The second reason is that the study period, 2014–2018, coincides with China’s period of precise poverty alleviation and eradication, during which the government has already made significant improvements to the infrastructure of major cities through the implementation of infrastructure such as access roads and communications, reducing the amount of new investment in this type of PPP project each year to a minimum.

**Table 4.** Impact of annual new investment in different types of PPP projects on local government debt.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10
Engineering1	0.003 (0.0068)									
Transportation1		0.015 *** (0.0053)								
Environment1			0.016 *** (0.0049)							
Urban1				0.012 ** (0.0052)						
Education1					−0.001 (0.0060)					
Water1						0.002 (0.0063)				
Health1							0.014 *** (0.0053)			
Tourism1								0.006 (0.0069)		
Infrastructure1									0.001 (0.0060)	
InCulture1										−0.004 (0.0059)
Control variables	YES									
Time Control	YES									
Area Control	YES									
Constant	−11.76 *** (1.1554)	−15.56 *** (1.7900)	−16.52 *** (1.7561)	−15.45 *** (1.8293)	−16.37 *** (1.8534)	−16.29 *** (1.8190)	−15.73 *** (1.7872)	−16.33 *** (1.8094)	−16.30 *** (1.8303)	−16.32 *** (1.8112)
Observations	180	180	180	180	180	180	180	180	180	180
R-squared	0.690	0.721	0.726	0.716	0.707	0.708	0.720	0.709	0.707	0.708

Note: () represents standard errors; \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ .

The regression coefficients for the two categories in columns 5 and 10 are −0.001 and −0.004, respectively, indicating that the annual amount of new investment in two categories of PPP projects, education and culture, has a mitigating effect on local government debt, with culture having a greater effect. This is because education is a unique form of culture that may be turned into a variety of forms of output, thereby supporting local economic and social development and thus easing local government debt.

Different types of PPP projects have an exacerbating or moderating influence on government debt, both in terms of the number of new PPP projects added each year and the amount of new investment each year.

### 5.3. Heterogeneity Analysis

The above findings are based on the total sample to empirically prove the impact of PPP projects and the amount of new investment per year on local government debt, but they ignore the regional differences. This section investigates the effects of PPP projects and new investment per year on government debt in different regions. The empirical results are shown in Table 5. The number of PPP projects and the amount of new investment per year in the western region positively impact the government debt of the western cities. They are significant at the 5% and 1% statistical levels. This phenomenon occurs because the eastern part of China has a high level of development and enough local finance to support the number of PPP projects and annual new investments, which is not enough to generate government debt to some extent. In contrast, the economic development in China's central and western regions is at a relatively low level. The increasing number of PPP projects and the significant funds' investments each year cause the government's finances to fall short of its needs, thus creating government debt. This shows significant regional variability in both PPP projects and the annual increase in investment in PPP projects, again supporting Hypothesis 2. These results are also consistent with those described in Figures A1 and A2 in Appendices A and B.

**Table 5.** Analysis of regional heterogeneity.

Variables	(1) Eastern Region <sup>1</sup>	(2) Midwest Region <sup>2</sup>	(3) Eastern Region	(4) Midwest Region
	Model 1	Model 2	Model 3	Model 4
Total ppp	0.009 (0.0042)	0.007 ** (0.0029)		
Add invest			1.129 (0.6914)	1.517 *** (0.5433)
Control variables	YES	YES	YES	YES
Time Control	YES	YES	YES	YES
Area Control	YES	YES	YES	YES
Constant	−10.95 *** (1.9541)	−21.11 *** (3.7850)	−13.97 *** (3.0374)	−24.58 *** (3.6863)
Observations	95	85	95	85
R-squared	0.772	0.848	0.770	0.837

Note: () represents standard errors, \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ .<sup>1</sup> In this paper, Chinese cities are divided into eastern and central-western regions according to the level of economic development. Eastern Region: 17 cities, including Beijing, Dalian, Fuzhou, Guangzhou, Haikou, Hangzhou, Jinan, Nanjing, Ningbo, Qingdao, Shantou, Shanghai, Shenzhen, Shenyang, Shijiazhuang, Tianjin, and Zhuhai, as is described in Table A2 in Appendix D. <sup>2</sup> Cities in the Midwest Region: 19 cities including Changchun, Changsha, Harbin, Hefei, Nanchang, Taiyuan, Wuhan, Zhengzhou, Chengdu, Guiyang, Hohhot, Kunming, Lanzhou, Nanning, Urumqi, Xi'an, Xining, Yinchuan, and Chongqing, as is described in Table A2 in Appendix D.

### 5.4. Robustness Tests

In this paper, a replacement for the measurement method and placebo test were used to test the robustness of the baseline regression results.

#### 1. Replacement Measurement Method

As shown in Table 6, the absolute values of government debt incidence from the 10% quantile to the 90% quantile of government debt are 1.09%, 0.97%, 0.99%, 0.97%, and 1.05%, in order, which indicates that the incidence of government debt is increasing with the increasing number of PPP projects. According to the results in Table 7, the impact of annual new investment on government debt is significantly positive in the 10 to 50 percent quartile of government debt. In contrast, it is not significant in the 75 per cent to 90 per cent quartile of government debt. As the quartile ratio continues to increase, government debt is influenced by multiple factors such as laws and regulations, the level of regional economic development, the level of government governance, and regional social financing conditions.

Multiple factors interact with each other, which leads to the annual investment in PPP projects being statistically insignificant in the 75% to 90% quartile of government debt.

**Table 6.** Quantile regression of the impact of PPP investment projects on government debt.

Variables	OLS	QR_10	QR_25	QR_50	QR_75	QR_90
Totalppp	0.0098 *** (0.0024)	0.0109 *** (0.0034)	0.0097 *** (0.0033)	0.0099 *** (0.0032)	0.0097 *** (0.0031)	0.0105 *** (0.0034)
Control variables	YES	YES	YES	YES	YES	YES
Time control	YES	YES	YES	YES	YES	YES
Urban control	YES	YES	YES	YES	YES	YES
Constant	−11.624 *** (1.5524)	−13.001 *** (1.9443)	−16.423 *** (2.0322)	−9.814 *** (2.4482)	−9.252 *** (1.6843)	−8.787 *** (2.0161)
N	180	180	180	180	180	180

Note: () represents standard errors; \*\*\*  $p < 0.01$ .

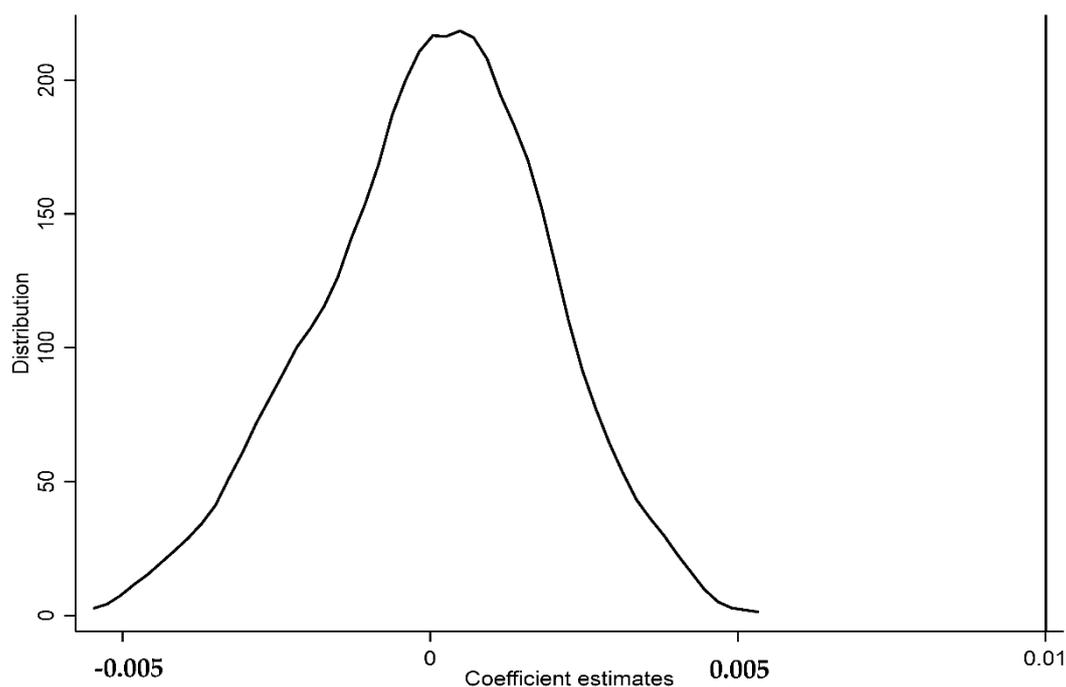
**Table 7.** Quantile regression of the impact of new investment amounts on government debt per year.

Variables	OLS	QR_10	QR_25	QR_50	QR_75	QR_90
Add invest	1.831 *** (−0.4814)	3.314 *** (−0.5893)	2.401 *** (−0.5354)	1.730 *** (−0.6342)	0.988 (−0.7681)	0.892 (−0.5984)
Control variables	YES	YES	YES	YES	YES	YES
Time control	YES	YES	YES	YES	YES	YES
Urban control	YES	YES	YES	YES	YES	YES
Constant	−17.61 *** (−2.0154)	−26.56 *** (−2.4672)	−24.18 *** (−2.2440)	−17.33 *** (−2.6563)	−11.87 *** (−3.2192)	−9.99 *** (−2.5084)
N	167	167	167	167	167	167

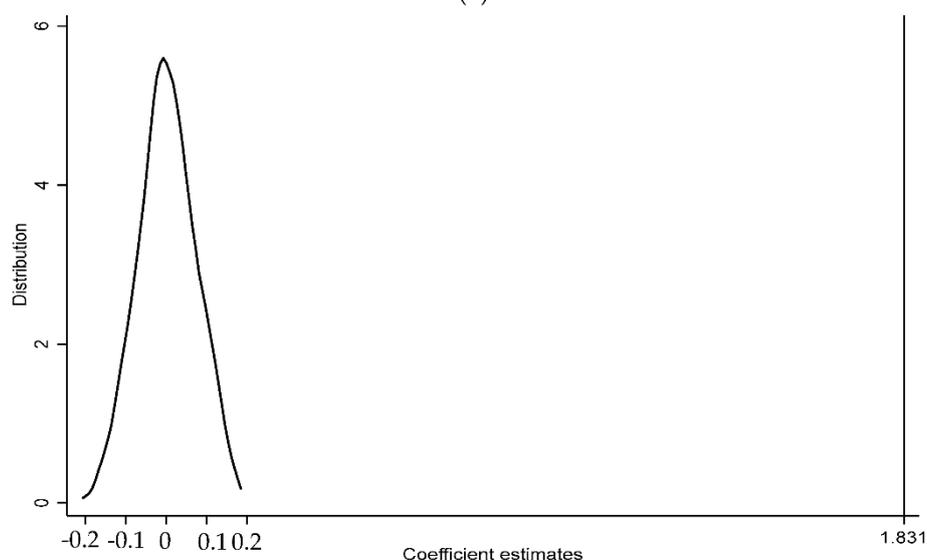
Note: () represents standard errors; \*\*\*  $p < 0.01$ .

## 2. Placebo Test

To further verify whether some chance factors caused the results of the previous benchmark model test, this paper takes a randomly generated virtual number of PPP projects and annual new investment amounts to conduct a placebo test (Placebo test). To this end, this paper draws on the treatment of Liu and Chang et al. (2020) to construct a placebo test to determine whether the number of PPP projects and the amount of new investment per year, or other random factors, cause the government debt effect of the new investment amount per year. In Figure 1, the results for the Table 2 benchmark regression model 4 and model 8 are shown as the left vertical lines in (a) and (b). The absolute values of the estimated coefficients obtained from our 500 Monte Carlo simulations are smaller than those obtained using actual data (0.010 and 1.831) and are typically distributed as centered at 0. Thus, it can be concluded that the baseline regression results are not caused by some chance factors, verifying the reliability of the baseline results.



(a)



(b)

**Figure 1.** Placebo test: (a) Placebo test for the impact of the number of PPP projects on government debt. (b) Placebo test for the impact of additional annual investment on government debt.

## 6. Discussion

To investigate the effect of PPP on local government debt, data for 36 cities from 2014 to 2018 are used to explain this issue. This study concludes the following findings through the constructed model regarding the relationship between PPP projects and local debt. The result shows that many PPP projects and new investments have negatively affected governments' debt each year. These results are consistent with previous findings [50,51]. The study used two variables, the number of PPP and the annual new investment of PPP, making the results more explanatory. Besides, this impact represents regional heterogeneity. Compared with central and western Chinese regions, the number of PPP projects and the annual new investment have less impact on the eastern region. At the top level, local

government debt decreases over time. The other result is also worth our attention, showing that the regression coefficients of GDP, population density, and industrial structure were negative (excluding GDP), thus indicating that the above variables were conducive to alleviating government debt. To some extent, it is confirmed that reducing government debt depends on a combination of different factors. The improvement of GDP, the expansion of population density, and the adjustment and optimization of the industrial structure are all critical factors contributing to reducing government debt.

Our study makes four essential contributions. First, along with prior studies focusing on the PPP projects' effects on local government debt [52], this study provides insights into the literature on the relationship between local government debt and PPP projects. Second, this study underscores that PPP projects aggravate local government debt. This finding is consistent with a prior study, which found that the public–private partnership model has not reduced local governments' debt but aggravated it [53]. Compared with previous studies on governments and debt, those only suggested the potential for PPP projects to affect government debt [54]. However, this study confirmed this opinion by conducting an empirical analysis and clarifying our understanding of PPP projects' effect on local government debt. More importantly, we further use the annual new investment as a substitute variable, and the same result appears, enhancing the robustness of this result. Third, different types of PPP projects have different effects on the impact on government debt. In terms of the number of new additions per year, comprehensive urban development PPP projects have the largest effect on the exacerbation of government debt, while culture PPP projects have the greatest effect on the alleviation of government debt. In terms of the amount of new investment per year, environmental protection PPP projects have the greatest exacerbating effect on government debt; however, culture PPP projects have a mitigating effect on local government debt. Fourth, this study further performs a regional and time heterogeneity analysis based on the finding that PPP projects can aggravate local debt. The results show that PPP projects have a more significant impact on local debt in central and western cities in China than in eastern cities.

## 7. Conclusions

PPP projects are a potential contributor to sustainable cities and play a vital role in providing public services such as for the environment, transportation, and health. The sustainability of PPP projects is closely related to government debt. This study concludes the following findings through quantitative analysis to clarify the relationship between PPP projects and government debt. An increasing number of PPP projects will aggravate local government debt. The same finding is concluded by replacing the number of PPP projects with the annual new investment of PPP projects, although this effect on local government debt diminishes over time. Besides, this study performs a regional heterogeneity analysis and finds that the number of PPP projects and the amount of new investment per year in the western region of China positively impact the government debt of western cities. However, there was no noticeable impact on the eastern region. Different types of PPP projects also show differences regarding the impact of the new quantity and investment amount on local debt. Among them, the impact of municipal engineering projects and environmental protection PPP projects are most prominent.

Based on these conclusions, we propose the following policy recommendations. First, the number of PPP projects and new investments has positively affected governments' debt each year. So, the government should reasonably control the number of PPP project developments in the central and western regions to prevent them from pursuing short-term local development, sowing hidden debts, and affecting sustainable development. The quantity can be controlled within a precise, reasonable range depending to the local economy. Second, considering regional differences, the effect has a more negligible impact on the eastern regions in China. We can encourage the eastern region to adopt more PPP project models and use the finance for development of other areas. Third, governments should strengthen the management of PPP projects in China and significantly expand the scope of social

capital. Especially compared with western countries, “social capital” in China includes not only the private sector but also state-owned enterprises (SOEs), potentially threatening the financial viability of the government [42,51], although these potential problems have not dampened local governments’ enthusiasm for PPP projects. Based on provincial results from China, using a cooperation mode for PPP projects can enable local governments to bypass the investment budget and improve their competitiveness [55]. The impeccability of these government motives often leads to the low efficiency of PPP.

This study sheds light on the influence of public–private partnerships on local government debt. However, the following limitations exist. To begin, this paper addresses the impact of the ten major categories of PPP projects on local government debt in China, but due to a lack of data, this study could not conduct a further breakdown of each major area, such as the transportation areas involving toll roads, light rails, bus rapid transits (BRT), etc. Second, this study examines the impact of PPP projects on the local government debt of significant Chinese cities, not all Chinese cities. Finally, while this study tries to examine the factors that influence the impact of PPP projects on government debt, the absence of data on relevant laws, rules, processes, and procedures precludes an examination of their impact on the relationship between PPP projects on government debt. Subsequent research could be expanded and strengthened based on these three ideas.

**Author Contributions:** Conceptualization, L.F. and H.S.; methodology, Y.M. and H.S.; software, H.S. and Y.M.; validation, L.F., Y.M. and J.L.; formal analysis, H.S.; investigation, H.S. and J.L.; resources, H.S. and L.F.; data curation, H.S. and Y.M.; writing—original draft preparation, L.F. and H.S.; writing—review and editing, H.S. and Y.M.; visualization, L.F.; supervision, L.F.; project administration, L.F. and H.S.; funding acquisition, L.F. All authors have read and agreed to the published version of the manuscript.

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**Data Availability Statement:** Publicly available datasets were analyzed in this study. These datasets can be found here: <https://www.cpppc.org:8082/inforpublic/homepage.html---/project> public (accessed on 18 March 2021).

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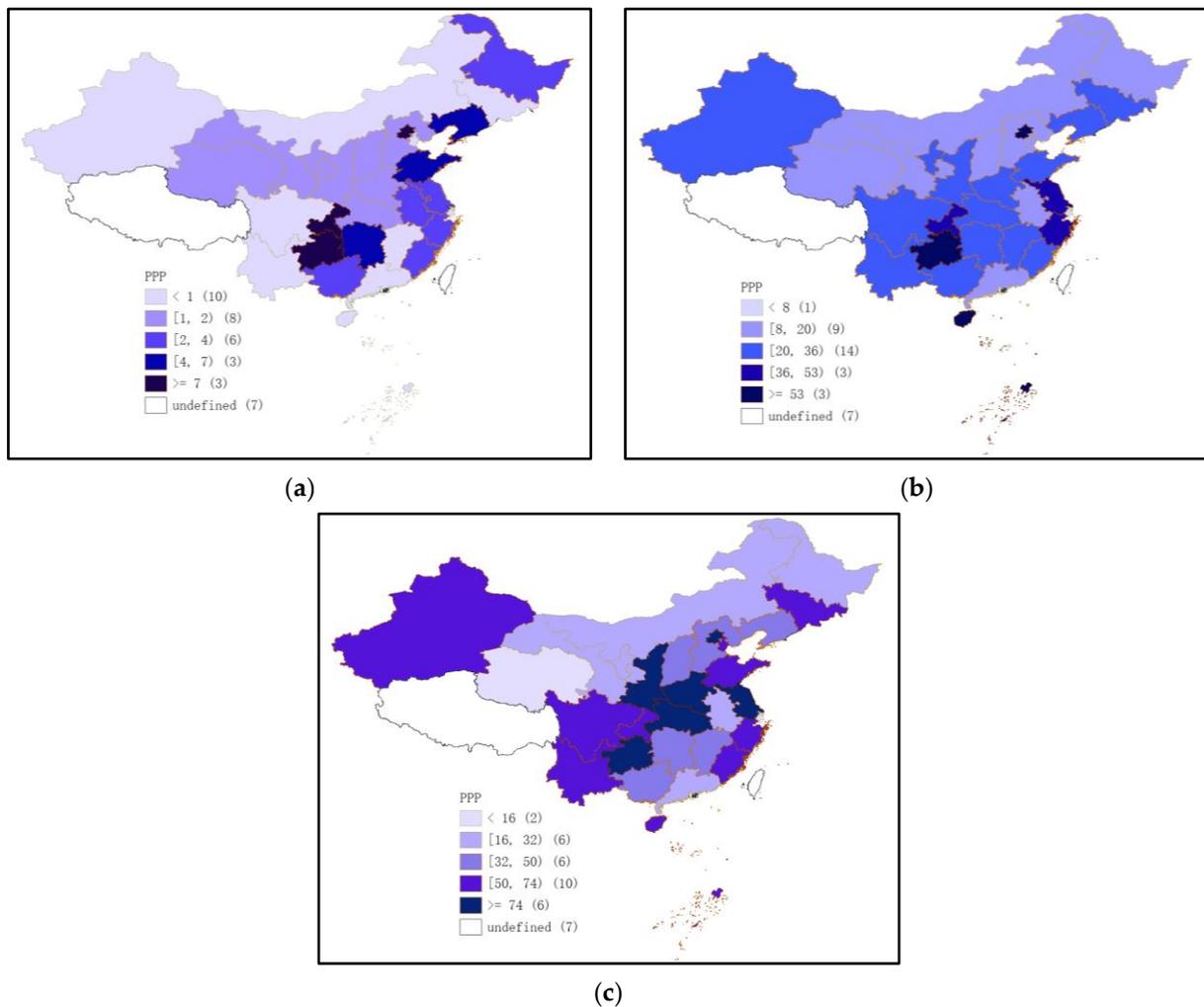
**Conflicts of Interest:** The funders had no role in the design of the study, in the collection, analysis, or interpretation of data, in the writing of the manuscript, or in the decision to publish the results.

## Appendix A

**Table A1.** Main areas of PPP project application from 2014 to 2018.

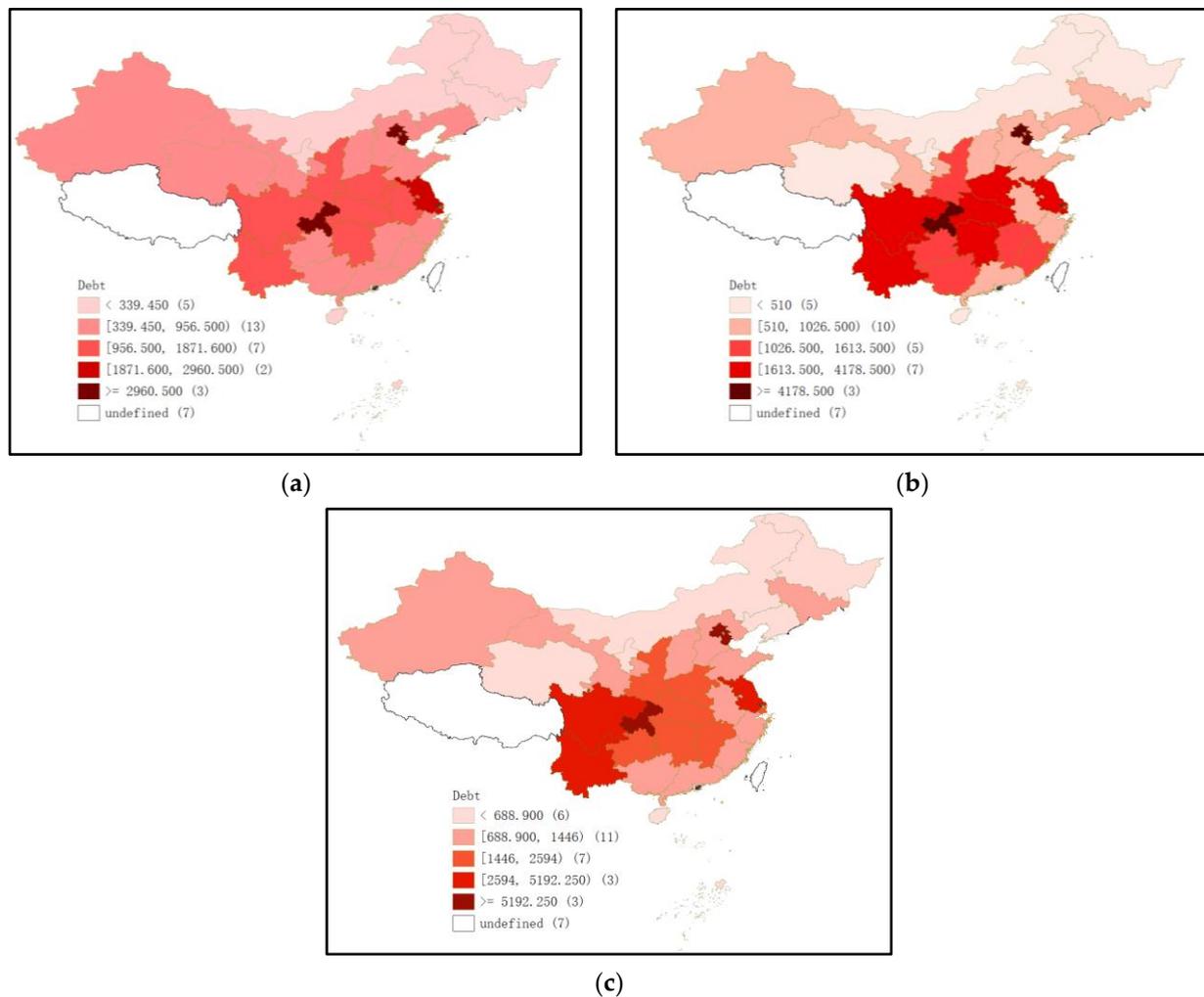
Applied Areas	Number
Municipal engineering	2977
Transportation	1097
Environmental protection	739
Comprehensive urban development	442
Education	351
Water construction	318
Public health	277
Tourism	215
Infrastructure	170
Culture	147

## Appendix B



**Figure A1.** The distribution of the number of PPP projects in 2014, 2016 and 2018: (a) number of PPP projects in 2014; (b) number of PPP projects in 2016; (c) number of PPP projects in 2018. (PPP projects have been initiated in China since 2014. This paper's research purpose is whether PPP projects have aggravated local governments' debt. This study describes the PPP projects of 30 provinces in China (represented by selected cities) in 2014, 2016, and 2018. From Figure A1, we can conclude two findings: First, the number of PPP projects increased year by year from 2014 to 2016. Secondly, in terms of regional distribution, PPP projects show an increasing trend from west to east (except for a few provinces, such as Xinjiang, Guizhou, and Hainan)).

## Appendix C



**Figure A2.** Government debt in 2014, 2016, and 2018: (a) government debt in 2014; (b) government debt in 2016; (c) government debt in 2018. (PPP projects have been initiated in China since 2014. This paper's research purpose is whether PPP projects have aggravated local governments' debt. This study describes the government debt of 30 provinces in China (represented by selected cities) in 2014, 2016, and 2018. From Figure A2, we can conclude two findings: First, the amount of debt increased year by year from 2014 to 2016. Second, the trend is the same as with the number of PPP projects mentioned above; debt also increases from west to east in China (except for Chongqing, Beijing, and Tianjin)).

## Appendix D

Table A2. Main data of the 30 provinces in China (represented by selected cities) in 2014, 2016 and 2018.

N	City	Province	GDP (Hundred Million)			Population Density (Thousand/Sq.Km.)			Fixed Asset Investment (Hundred Million)			Finance (Hundred Million)			Share of Second-Industry (%)		
			2014	2016	2018	2014	2016	2018	2014	2016	2018	2014	2016	2018	2014	2016	2018
1	Beijing	Beijing	2,133,083	2,566,913	3,031,998	813	831	839	7511	7889	8062	90,546	132,792	157,092	21	19	19
2	Dalian	Liaoning	765,558	681,020	766,848	473	474	449	6774	1436	1653	11,614	14,179	13,485	48	42	42
3	Fuzhou	Fujian	516,916	619,764	785,681	517	542	574	4389	5184	5823	9731	12,077	13,827	46	42	41
4	Guangzhou	Guangdong	1,670,687	1,954,744	2,285,935	1133	1170	1248	4890	5704	594	35,469	42,844	52,647	33	32	27
5	Haikou	Hainan	109,170	125,767	151,051	724	725	778	822	1272	1416	3153	4851	4843	20	19	18
6	Hangzhou	Zhejiang	920,616	1,131,372	1,350,915	431	444	459	4953	5842	649	23,950	32,515	38,810	42	36	34
7	Jinan	Shandong	577,060	653,612	785,656	777	791	820	3063	3974	478	11,744	15,033	16,572	39	36	36
8	Nanjing	Jiangsu	882,075	1,050,302	1,282,040	985	1007	1058	5431	5534	6215	20,162	27,634	33,741	41	39	37
9	Ningbo	Zhejiang	761,028	868,649	1,074,546	595	602	614	3989	4961	500,958	13,307	16,196	18,533	52	51	51
10	Qingdao	Shandong	869,210	1,001,129	1,200,152	692	701	725	5766	7455	7777	11,370	14,007	15,532	45	42	40
11	Shantou	Guangdong	171,651	208,097	251,205	2648	2542	2588	1003	1580	2006	2664	3125	3540	53	51	51
12	Shanghai	Shanghai	2,356,770	2,817,865	3,267,987	2269	2287	2306	6013	6752	7246	73,882	103,164	112,616	35	30	30
13	Shenzhen	Shenzhen	1,600,182	1,949,260	2,422,198	1664	1928	2278	2717	4078	5147	32,498	59,562	68,698	43	40	41
14	Shenyang	Liaoning	709,871	554,645	629,240	568	571	580	6564	1632	1484	12,310	14,243	17,554	50	39	38
15	Shijiazhuang	Hebei	517,027	592,773	608,262	782	795	620	4884	5678	6353	9125	11,078	13,225	47	45	38
16	Tianjin	Hebei	1,572,693	1,788,539	1,880,964	853	876	920	11,626	12,756	11,275	23,959	29,041	29,911	49	42	40
17	Zhuhai	Guangdong	186,721	222,637	291,474	639	664	732	1135	1390	1662	4571	5689	7117	50	49	49
18	Changchun	Jilin	534,243	598,642	717,571	366	366	365	3746	4659	5195	8723	11,034	11,476	53	49	49
19	Changsha	Hunan	782,481	935,691	1,100,341	568	589	617	5436	6693	756,777	11,119	15,460	18,634	54	48	42
20	Harbin	Heilongjiang	534,007	610,161	630,048	186	181	179	4176	5040	5396	8884	9804	11504	33	31	27
21	Hefei	Anhui	518,056	627,438	782,291	623	638	662	5303	6501	6351	9143	2893	15338	55	51	46
22	Nanchang	Jiangxi	366,796	435,499	527,467	700	707	719	3434	4540	5115	7296	9503	10606	55	53	50
23	Taiyuan	Shanxi	253,109	295,560	388,448	529	530	540	1746	2028	2166	10,011	11,070	12,020	40	36	37
24	Wuhan	Hubei	1,006,948	1,191,261	1,484,729	966	973	1032	6963	7040	7817	16,269	21,793	25,720	48	44	43
25	Zhengzhou	Henan	677,699	811,397	1,014,332	1260	1111	1160	5260	6999	7573	13,956	19,001	21,767	51	47	44
26	Chengdu	Sichuan	1,005,659	1,217,023	1,534,277	999	976	1030	6620	8353	9404	26,798	31,434	36,656	45	43	42
27	Guiyang	Guizhou	249,727	315,770	379,845	476	499	520	2336	3381	3851	6992	9928	11357	39	39	37
28	Hohhot	Neimenggu	289,405	317,359	290,350	138	138	143	1736	1849	1491	4724	6179	5771	29	28	28
29	Kunming	Yunnan	371,299	430,008	520,690	262	266	272	3138	3920	4218	10,582	12,676	13,619	41	39	39
30	Lanzhou	Gansu	200,094	226,423	273,294	286	248	249	1274	1991	1315	6618	8623	8716	41	35	34
31	Nanning	Guangxi	314,830	370,333	402,691	328	338	347	2887	3759	4308	7064	8902	10093	40	39	30
32	Urumqi	Xijiang	246,147	245,898	309,977	194	194	161	1526	1608	2020	6234	7407	8428	37	29	31
33	Xi'an	Shaaxi	549,264	625,718	834,986	808	816	901	5825	5097	7556	15,064	19,074	20,948	40	35	35
34	Xining	Qinghai	106,578	124,817	128,641	265	265	272	1152	1376	1600	3105	3756	3787	50	48	36
35	Yinchuan	Ningxia	138,862	161,771	190,148	217	204	214	1372	1708	1719	2609	3343	3705	54	51	46
36	Chongqing	Chongqing	1,426,260	1,774,059	2,036,319	410	412	413	13,106	17,246	17,441	24,502	31,216	35,652	46	45	41

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