

Article

Local Government Debt, Local Government Financing Platforms, and Green Development Efficiency

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Abstract: Local government debt (LGD), an important financing tool for local governments to achieve high-quality development, especially through the expansion of urban investment bonds led by local investment and financing platforms, has a significant impact on green development efficiency (GDE). This article starts from LGD, selects data from 30 provinces from 2010 to 2019, and uses a two-way fixed-effect model and mediation-effect model to empirically analyze the impact of LGD on GDE. The research results show that LGD has a significant inhibitory effect on GDE, and LGD can indirectly affect GDE through the degree of industrialization and the number of the urban population. This article suggests that the government should make even fuller use of LGD funds, optimize the use of relevant funds, standardize the operation of local government investment and financing platforms, reduce debt risks, promote industrial structure upgrading, promote urban population resettlement measures, and improve China's GDE.

Keywords: local government debt; green development efficiency; local government financing platforms; urban population



Citation: Guan, Y.; Wu, J.; He, Y. Local Government Debt, Local Government Financing Platforms, and Green Development Efficiency. *Platforms* **2024**, *2*, 55–67. <https://doi.org/10.3390/platforms2020004>

Academic Editor: Adel Ben Youssef

Received: 7 March 2024

Revised: 11 April 2024

Accepted: 17 April 2024

Published: 22 April 2024



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1. Introduction

Since the reform and opening up, China has created an amazing “Chinese miracle” by leveraging its demographic and resource dividends, and its economic achievements have attracted worldwide attention. However, resource constraints and environmental pressures have largely affected the sustainable development of the economy, which has emerged as a result of the transition of economic development stages. Therefore, in the face of increasingly severe environmental pressures, the 17th CPC National Congress for the first time included “ecological civilization” in the report of the Party Congress; the 18th CPC National Congress included “ecological civilization” in the overall layout of the “five in one”; the Fifth Plenary Session of the 18th CPC Central Committee included green development as one of the “five development concepts”; and the report of the 19th CPC National Congress emphasized the establishment of a sound economic system for green and low-carbon development. In response to the enormous pressure of carbon emissions, China proposed the goals and visions of “carbon peak” and “carbon neutrality” at the United Nations Climate Change Summit held in December 2020. It also promised to achieve peak carbon by 2030 and carbon neutrality by 2060. With the promotion of a series of policies, green development has increasingly become a new development path for achieving economic development and environmental protection. Therefore, unlike previous developments, the cost of green development in consideration of environmental protection is that the government needs to fully play its regulatory role in finance to ensure the orderly implementation of green development.

While local governments implement green development strategies, increasing fiscal pressure and performance expectations for officials further increase the borrowing level

of local governments [1]. Fiscal pressure is the main driving force for large-scale borrowing by local governments and is mainly reflected in the following two aspects [2]. On the one hand, when the liquidity of local governments is insufficient to support existing fiscal expenditures, the fiscal gap expands, increasing fiscal pressure and prompting local governments to promote municipal construction through large-scale debt to support economic development and environmental protection. As a result, local government fiscal expenditures and future principal and interest repayment pressures significantly increase at the same time. On the other hand, local governments with better economic development will gain more development opportunities [3]; this leads to regional development pressure, thereby promoting large-scale borrowing by local governments [4]. At the same time, the promotion of local government officials may undermine the fiscal expenditure incentive mechanism of local governments, leading local governments to prefer to place economic development above environmental protection. In order to alleviate the fiscal budget dilemma, local governments may relax energy-saving regulations or energy consumption restrictions on high-energy-consuming enterprises to stimulate and help their rapid development, resulting in a decrease in green development efficiency (GDE). As an important financial tool to promote economic growth, government debt may have a considerable impact on local GDE.

Local government debt (LGD) can be divided into six categories, with the most important source being the acquisition of bank loans through the establishment of local investment and financing platform companies and the issuance of “city investment bonds”. Due to the “hidden” guarantee role of the government, the city investment bonds issued by local investment and financing platforms are usually regarded as “quasi-municipal bonds”, which are mainly used in municipal public facilities projects with relatively concentrated capital and long repayment periods, and play an important role in the green development and transformation of cities. In recent years, the financing scale of city investment bonds and the proportion of direct financing of the government have both increased rapidly. Therefore, in the context of achieving high-quality development in China, examining the impact of LGD, especially the city investment bonds established by local investment and financing platforms, on the efficiency of regional green development will further supplement the research on the impact of LGD on GDE.

Based on the above analysis, there are two main sources of direct impact of LGD on GDE. On the one hand, the pressure of official promotion has led to local governments prioritizing economic development while neglecting environmental protection. On the other hand, that pressure stems from budget constraints, which stimulate local governments to relax their supervision and constraints on high-energy-consuming enterprises.

Of course, achieving high-quality development is still a major task in China at present. In the past, most studies mainly considered how single economic factors, such as government policies [5], urbanization [6], foreign direct investment [7], and green investment, affect local environmental protection [8], but lacked consideration of the synergistic effects of economic development and environmental protection. It is noteworthy that when studying the impact of LGD on urban pollutant emissions, some scholars have paid more attention to sulfur dioxide emissions. For example, Qi et al. [4] experimentally studied the impact of LGD on urban emission reduction using sulfur dioxide emissions in urban exhaust as an explanatory variable. Existing research has not considered the impact of LGD on GDE, and has also overlooked the possibility that LGD can indirectly affect GDE through other means. Therefore, while focusing on the relationship between LGD and GDE, this study also identified two mediating pathways of influence. In addition, empirical analysis was used to confirm the impact of local debt on GDE, and the mediating mechanism was explored.

The innovation of this article lies, first, in paying attention to the impact of LGD, which is mainly carried out by local investment and financing platforms, on the synergistic effect between environmental protection and economic development, and expressing this impact with GDE. This study regards LGD as a factor that affects green development and

its specific level. Second, it explores the impact mechanism of LGD on GDE, providing a theoretical basis for subsequent related research. The research shows that the main ways in which LGD affects GDE are industrial structure, technological innovation, environmental governance investment, and government expenditure scale. Finally, this study combines the existing practical value and relevance of China's green development to reveal appropriate and targeted policies. This study is divided into the following chapters: the second part is a literature review and research hypothesis; the third part explains the data and empirical methods; the fourth part discusses the empirical research and empirical results; and the fifth part contains the research conclusion and policy recommendations.

2. Literature Review and Theoretical Assumptions

2.1. Literature Review

The academic community has not conducted direct research on the relationship between LGD and green development. Most of the existing literature on government debt focuses on the impact of economic variables, such as economic growth, inflation, and real interest rates [9–12]. Only a small amount of the literature has focused on the relationship between government debt and environmental pollution. Therefore, this article mainly reviews the relevant literature from the perspective of the environment. From a macroeconomic perspective, many scholars have shown that there is a statistically significant positive correlation between LGD and environmental quality [13]. Clootens [14] developed a two-stage OLG model to study the link between public debt and pollution conceptually. He found that public debt has a positive impact on environmental quality improvement, but when it exceeds a certain threshold, it will have a negative impact. Zhang [15] found that as the amount of local debt increases, local governments tend to relax relevant environmental regulations to attract private investment, thereby reducing debt pressure and increasing debt repayment income but also exacerbating environmental degradation. Fodha and Seegmuller [13] developed a generational overlapping model that includes consumers, businesses, and the government. They found that as government debt increases, public policies for environmental improvement may lead the economy to fall into an “environmental poverty trap”. This results in the counterproductive effect of government debt on alleviating environmental pressure. In terms of specific micro-measures, based on the group data of 24 European countries from 1996 to 2015, Carratù et al. [16] empirically found that the greater the proportion of public debt in GDP, the smaller the impact of public debt on reducing industrial gas emissions. Using urban panel data, Qi et al. [4] evaluated the emission reduction effect of LGD using SO₂ emissions and urban sewage emissions as indicators. Their research results show that LGD is largely helpful for urban emission reduction, and as urban pollution increases, this promoting effect will rise and eventually decline.

Based on the aforementioned research, current studies on the impact of LGD on environmental improvement, both in terms of macroeconomic impacts and micro-level emission reduction measures, have neglected the integrated development of local governments' economic development and environmental protection—that is, the impact of green development. Therefore, this article focuses on the discussion of GDE.

Through analyses of existing research, scholars at home and abroad currently focus on the concept, measurement, and influencing factors of GDE. GDE is a type of environmental-based economic development efficiency involving three levels of factors: inputs, “good outputs”, and “bad outputs” [17]. There are two types of efficiency evaluation methods: parametric and non-parametric [18]. Currently, the most commonly used method in academia is data envelopment analysis (DEA), which mainly studies factors affecting GDE from four aspects: nature, economy, government, and technology [19,20]. However, most studies have ignored the factor of local debt as a type of environmental-based economic development efficiency with a significant impact on local economic development. Expanding into the field of green development research, the existing literature mainly focuses on the impact of LGD on total green factor productivity. Mao and Failer [21] empirically found

that the expansion of LGD suppresses green total factor productivity using bidirectional fixed effects. However, the relevant literature still overlooks in-depth research on the mediating effect of LGD on green development.

Based on this, this article takes local debt as the entry point, utilizes provincial panel data from 2010 to 2019, and analyzes the mechanism and transmission path of local debt on GDE while measuring GDE, especially the industrialization and the role played in it by the urban population, with a view to providing policy recommendations for improving environmental conditions, promoting industrial transformation, and achieving green development.

2.2. Theoretical Assumptions

Generally speaking, pressure on regional development is mainly applied by national promotion incentives and the regions' own economic and social conditions. Since the 1980s, the promotion mechanism of the government has led to a situation of "growth for growth" among local governments, and competition for job promotion has gradually evolved into economic growth competition between regions. Through relevant empirical research, Zhou Li'an proved that government officials with excellent economic performance throughout their tenure have greater promotion prospects, which puts pressure on regional economic development. This escalation of development pressure has prompted municipal governments to expand their debts to alleviate the financial pressure generated by further development. In order to win the promotion "tournament", many local governments actively seek borrowing and take various measures to seize financial resources to enrich the available resources [8].

In order to achieve more significant results in economic development, local governments have increased their public expenditure in a relatively short period of time, which has further increased the amount of local debt. In particular, the increasing debt of local financing platforms and the increasingly fierce investment competition have forced local governments to continuously lower the threshold for enterprises to enter in order to attract high-consumption, high-pollution, low-value-added industrial enterprises to enter, thus increasing the pressure on environmental protection. In terms of debt repayment, Zhang and Zhao [15] concluded that the expansion of government debt and the increase in repayment risks of local financing platforms have put tremendous pressure on debt repayment. In order to obtain funds for debt repayment, especially for urban investment bonds, and to drive economic development, local governments may lower environmental access standards to attract foreign investment. This further exacerbates environmental pollution and hinders the implementation of relevant environmental protection policies.

Based on the above discussion, this paper proposes Hypothesis 1: The higher the level of LGD, the lower the GDE. In particular, the accumulation of debt by local government investment and financing platforms will also have a negative impact on GDE.

Local governments have self-selectivity in using fiscal funds to develop the economy. For a long time, they have mainly aimed to increase revenue, so heavy industries with high pollution but high output values have become the first choice. In this case, the investment is difficult to reverse for a period of time. Although the central government can impose sanctions through supervision, local governments will try their best to escape the sanctions of the central government, or use local debt funds under the guise of green development to develop the secondary industry, such as heavy industry, which will aggravate environmental damage. As a public pool resource, the cost spillover of local debt will weaken the internal incentives for the use of funds. In addition, it is difficult for the central government to judge whether local debt funds are used in a targeted manner. In the case of asymmetric information, the use of local debt funds is more random and inefficient, making it difficult to achieve the expected goals. Although local debt funds give local governments more fiscal autonomy, it is also easy to cause rent-seeking and corruption, which greatly reduces the effectiveness of local debt funds in achieving green development. In summary, the

effect of local governments’ influence on green development through debt funds may not be ideal, which is mainly reflected in the improvement of industrialization.

Based on the above discussion, this paper proposes Hypothesis 2: LGD reduces GDE by increasing the degree of industrialization.

In theory, the revenue effect generated by LGD will also stimulate local government behavior, correct local government revenue and expenditure behavior, promote regional economic growth while protecting the local ecological environment, and achieve green development. If local governments obtain more local debt funds, they can relax soft budget constraints and take into account environmental benefits when designing institutional arrangements to increase revenue. However, with the development of urban industrialization, a large number of people have moved from rural areas to cities [22], and the urban population is growing. The transfer of labor from agriculture to industry and services has increased energy consumption and greenhouse gas emissions. At the same time, the growth of the urban population has also brought demands for travel, consumption, and various types of energy, which in turn stimulate urban carbon emissions. This is obviously detrimental to the green development of cities. Therefore, LGD can reduce GDE by increasing the number of the urban population.

Based on the above discussion, this paper proposes Hypothesis 3: LGD can reduce GDE by increasing the number of urban residents.

3. Model Construction and Data Analysis

3.1. Model Settings

Based on the theoretical analysis in this article, in order to verify the relationship between LGD and GDE according to the Hausman test, this article uses a two-way fixed effect model:

$$lngd_{it} = \alpha_0 + \alpha_1 lnDEB_{it} + \alpha_2 lnX_{it} + \eta_i + \mu_t + \varepsilon_{it} \tag{1}$$

In Formula (1), i and t represent provinces and years, respectively. gd_{it} is the dependent variable, representing the efficiency of regional green development. DEB_{it} is the core explanatory variable, representing LGD. X_{it} is a control variable used to eliminate the impact of economic and environmental heterogeneity. ε_{it} is a random disturbance term.

In order to clarify the transmission effect of LGD on GDE, this article uses the industrial structure as an intermediary variable based on Zhu et al.’s [23] research, and adopts the mediation effect model for empirical analysis based on Baron and Kenny’s analysis [24]. The specific econometric model is as follows:

$$lngd_{it} = \beta_0 + \beta_1 lnDEB_{it} + \beta_2 lnX_{it} + \eta_i + \mu_t + \varepsilon_{it} \tag{2}$$

$$m_{it} = \gamma_0 + \gamma_1 lnDEB_{it} + \gamma_2 lnX_{it} + \eta_i + \mu_t + \varepsilon_{it} \tag{3}$$

$$lngd_{it} = \delta_0 + \delta_1 lnDEB_{it} + \delta_2 m_{it} + \delta_3 lnX_{it} + \eta_i + \mu_t + \varepsilon_{it} \tag{4}$$

where β , γ and δ are estimated coefficients and m_{it} is the mediating variable. The specific empirical testing steps are as follows: First, regress local government bonds on GDE using Equation (2)—a significant coefficient indicates that local government bonds have an impact on GDE; second, explore the impact of local government bonds on the mediating variable using Equation (3)—a significant coefficient indicates that local government bonds have an effect on the mediating variable; finally, put local government bonds and the mediating variable together into the model using Equation (4)—if the coefficient of local government bonds is not significant, or is significant but the coefficient size decreases, local government bonds are proved to affect GDE through the mediating variable.

3.2. Variable and Data Description

3.2.1. The Dependent Variable

According to the research of Tone [25], this article selects a non-expected output SBM model with variable returns to scale based on non-radial and non-angular dimensions to

measure GDE (gd). This model is a relatively complete DEA extension model that solves the slack problem and the biased evaluation of non-expected output efficiency in traditional DEA models. The specific model structure is as follows:

Suppose that each of the m decision units has three factors: input variables, expected outputs, and non-expected outputs, represented by $x \in R^n$, $y^g \in R^{s_1}$, and $y^b \in R^{s_2}$, respectively. Define the matrix $X = [x_1, x_2, \dots, x_m] \in R^{m \times n}$, $Y^g = [y_1^g, y_2^g, \dots, y_m^g] \in R^{m \times s_1}$, and $Y^b = [y_1^b, y_2^b, \dots, y_m^b] \in R^{m \times s_2}$. Assume that $X \geq 0$, $Y^g \geq 0$, and $Y^b \geq 0$.

$$\rho = \min \frac{1 - \frac{1}{n} \sum_{i=1}^n \frac{s_i^-}{x_{i0}}}{1 + \frac{1}{s_1 + s_2} \left(\sum_{r=1}^{s_1} \frac{s_r^g}{y_{r0}^g} + \sum_{r=1}^{s_2} \frac{s_r^b}{y_{r0}^b} \right)} \tag{5}$$

The conditions are $x_0 = X\lambda + s^-$, $y_0^g = Y^g\lambda - s^g$, $y_0^b = Y^b\lambda + s^b$, $s^- \geq 0$, $s^g \geq 0$, $s^b \geq 0$, and $\lambda \geq 0$, where s^- , s^g , and s^b represent the slack variables corresponding to inputs, expected outputs, and undesirable outputs, respectively. ρ is the target efficiency value, and λ is the weight variable of the decision-making unit. When $s^- = 0$, $s^g = 0$, $s^b = 0$, and $\rho = 1$, the decision-making unit is relatively efficient; when $0 \leq \rho < 1$, the decision-making unit is relatively inefficient.

Based on the above measurement methods, this article draws on the research of Eyraud [26] and Wen [27] to establish a system of input and output indicators for GDE in Chinese provinces, as shown in Table 1. In terms of investment, three indicators are selected: capital, labor, and energy. Capital is measured by the total fixed assets investment of the whole society, and a depreciation rate of 10.96% is selected according to the perpetual inventory method. Labor input is selected as the number of employees in the whole society at the end of the year. Energy input is selected as electricity consumption. The expected output is measured by the actual gross domestic product (GDP) converted based on the 2010 base period. Considering the impact of waste emissions on the efficiency of regional green development, this article selects indicators, including industrial wastewater emissions, industrial sulfur dioxide emissions, and industrial smoke emissions, as undesirable outputs.

Table 1. GDE measurement index.

Variable Type	Variable Name	Variable Measurement	Variable Unit
Input Variables	Capital (k)	Fixed assets investment volume	Billion Yuan
	Labor (l)	Number of Employees in the Whole Society at the End of the Year	Million
	Energy Source (e)	Electricity Consumption	Billion Kilowatt Hours
Output Variables	Expected Output (g)	Real Gross Domestic Product	Billion Yuan
	Undesirable Output (b)	Industrial Wastewater Emissions	Million Tons
		Industrial Sulfur Dioxide Emissions	Million Tons
Industrial Soot Emissions		Million Tons	

3.2.2. Core Explanatory Variables and Mediating Variables

The core explanatory variable is LGD. Due to the particularities of the composition and development of LGD in China, LGD in China consists of urban investment bonds and local government bonds, with most of the urban investment bonds in most provinces accounting for the majority of the overall debt balance. According to the research of Zhao et al. [28], the debt balance of provincial-level local governments can be used to represent the debt situation of the province, as only provincial-level governments in China are allowed to

engage in debt financing. This method is expanded accordingly, and the debt balance is used to measure the level of LGD. For local investment and financing platforms, urban investment bonds are used to represent the debt. The impact of this part will be expanded and analyzed in the robustness test section.

We choose industrialization level (*is*) and urban population (*URBP*) as mediating variables. The industrialization level is represented by the ratio of industrial sector output value to GDP in the region in the current year. Under certain conditions, the higher the industrial output value, the more detrimental it is to green development. The urban population is measured using the provincial urban population data published in the China Statistical Yearbook.

In order to avoid the endogenous problem caused by missing variables, it is necessary to control for the factors that affect the GDE. Therefore, the control variables selected in this article include: environmental pressure (*epres*), represented by the ratio of sulfur dioxide emissions to GDP, which controls the impact of environmental pollution factors on GDE; infrastructure construction (*infr*), represented by the per capita road area—transportation infrastructure is an important source of environmental pollution and will have an impact on GDE; energy consumption structure (*en*), represented by the ratio of regional coal consumption to regional energy consumption—different energy consumption structures will have different effects on economic green development; population density (*pe*), represented by the ratio of the resident population to the total administrative area, logarithmically processed to maintain data stability. Generally speaking, the greater the population density, the stronger the environmental damage and the lower the GDE.

Based on the model establishment and indicator selection mentioned earlier, the selected model and data comply, on one hand, with the general norms of economic research. On the other hand, for the object of this study, bidirectional fixed-effects and mediation-effects models are selected. This can not only eliminate unnecessary endogenous effects but also improve the credibility of the research based on previous research. The selected data indicators have been validated to have considerable reliability, which can help this article achieve its research objectives better.

3.2.3. Data Sources and Descriptive Statistics

This paper selects 30 provinces in China (omitting Xizang, Hong Kong, Macao, and Taiwan), and the time span is 2010–2020. All the original data are from the China Financial Yearbook, China Statistical Yearbook, China Environmental Yearbook, Wind Energy Database, CEIC database, EPS database, and statistical yearbooks of various provinces (autonomous regions, municipalities directly under the central government) over the years. The missing data for some provinces are supplemented by the average growth rate method. Descriptive statistics are shown in Table 2.

Table 2. Descriptive statistics.

Variable	Sample Size	Average Value	Standard Deviation	Minimum Value	Median Value	Maximum Value
GDE	330	−0.9120	0.5565	−1.61	−1.12	0.00
LGD	330	7.2662	1.6789	2.71	7.48	10.37
Ambient pressure	330	0.0071	0.0081	0.00	0.00	0.05
Energy consumption structure	330	0.9451	0.4441	0.02	0.86	2.46
Population density	330	7.8754	0.4158	6.64	7.89	8.67
Infrastructure construction	330	15.3258	4.6797	4.04	14.77	26.20

4. Empirical Results and Analysis

4.1. Basic Regression Analysis

This article uses a two-way fixed-effect model for empirical analysis. The regression results are shown in Table 3. Columns (1) to (5) are the results of gradually adding control

variables. According to the regression results, regardless of whether control variables are added, the impact coefficient of local debt on GDE is always negative and passes the significance test. According to the results in column (5), other conditions remaining the same, every increase of 1 unit in local debt will reduce the GDE by 0.022 units, indicating that fiscal decentralization has a significant inhibitory effect on the GDE of the region, which is consistent with Hypothesis 1 of this article. Due to the pressure of the “promotion tournament”, local governments will disregard environmental pollution and vigorously develop the regional economy in order to achieve the goal of increasing revenue, resulting in a failure to achieve green development. In terms of improving the GDE of the region, it mainly depends on the behavior choices of local governments.

Table 3. Basic regression results.

	(1)	(2)	(3)	(4)	(5)
	GDE	GDE	GDE	GDE	GDE
LGD	−0.036 * (−1.68)	−0.045 ** (−2.01)	−0.053 ** (−2.35)	−0.047 ** (−2.07)	−0.046 ** (−2.08)
Ambient pressure		−3.058 (−1.34)	−1.432 (−0.61)	−0.683 (−0.29)	−3.517 (−1.38)
Infrastructure construction			0.195 ** (2.32)	0.200 ** (2.41)	0.233 *** (2.81)
Energy consumption structure				0.135 *** (2.75)	0.115 ** (2.35)
Population density					−0.017 *** (−2.74)
Constant term	−0.660 *** (−6.11)	−0.583 *** (−4.78)	−0.750 *** (−5.33)	−1.852 *** (−4.37)	−1.482 *** (−3.37)
Provincial fixed effect	YES	YES	YES	YES	YES
Time fixed effect	YES	YES	YES	YES	YES
N	330	330	330	330	330
R-Square	0.105	0.111	0.129	0.154	0.178

Annotation: *, ** and *** indicate significance at the 10%, 5% and 1% levels, respectively. The values in parentheses are standard errors.

From the perspective of other control variables, the impact coefficient of environmental pressure is significantly negative, indicating that the increase in sulfur dioxide emissions will cause damage to the regional environment; the impact of infrastructure construction on green total factor productivity is significantly negative at the 1% level, which may be due to certain resource waste and environmental pollution in transportation infrastructure construction, which will hinder the improvement of GDE; the impact coefficient of energy consumption structure on GDE is negative but not significant, indicating that the current high consumption of coal resources in China has a blocking effect on green development, and it is urgent to accelerate the transformation of energy consumption structure; the impact coefficient of population density is positive and significant, which may be due to the high demand for greening and other infrastructure in areas with high population density, which to some extent promotes green development.

4.2. Mechanism Analysis

Based on the previous analysis, LGD will have an impact on the relationship between industrialization, technological innovation, and GDE. Therefore, mediating variables are added to the model. The regression results of industrialization are shown in Table 4. The analysis results are shown in columns (1) to (3) of Table 4. Column (1) indicates that LGD has an inhibitory effect on GDE, which is consistent with the previous analysis. Column (2)

indicates that LGD will accelerate the development of industrialization. Local governments try to gain promotional advantages by introducing industries with high pollution but high short-term benefits. According to column (3), after adding GDE, LGD, and industrialization degree to the model simultaneously, the impact of LGD on GDE remains negative and significant, but the effect is less than the result of column (1). This indicates that the impact of LGD on GDE has a partial mediating effect. A possible explanation is that local officials will vigorously develop the economy in order to promote their careers. The secondary industry, as an industry with a short cycle and a high output value, is more likely to be favored by local governments. Local governments guide resource inflows by introducing capital and increasing expenditures. Under the supervision of the central government, they have a willingness to tilt toward the direction of green development. However, compared with the secondary industry, which is more polluting and does not meet the requirements of green development, its development will be inhibited. Hypothesis 2 is confirmed.

Table 4. Results of the mechanism of industrialization.

	(1)	(2)	(3)
	GDE	Industrialization Degree	GDE
LGD	−0.046 ** (−2.08)	0.010 ** (2.30)	−0.038 * (−1.71)
Industrialization degree			−0.794 *** (−2.60)
Control variable	YES	YES	YES
Constant term	−1.482 *** (−3.37)	0.615 *** (6.91)	−0.993 ** (−2.10)
Provincial fixed effect	YES	YES	YES
Time fixed effect	YES	YES	YES
N	330	330	330
R-Square	0.146	0.663	0.152

Annotation: *, ** and *** indicate significance at the 10%, 5% and 1% levels, respectively. The values in parentheses are standard errors.

The results of the effect of the numbers of the urban population as an intermediary variable are shown in Table 5. The analysis results are shown in columns (1) to (3) of Table 5. Column (1) indicates that LGD has an inhibitory effect on GDE, which is consistent with the previous analysis. Column (2) indicates that LGD will promote an increase in the urban population. The expansion of LGD promotes infrastructure and industrial development, attracting population inflows. According to column (3), after adding GDE, LGD, and urban population quantity to the model, the impact of LGD on GDE is negative but not significant, while the urban population has a significant negative impact on GDE. This indicates that the impact of LGD on GDE has a complete mediating effect. A possible explanation is that the expansion of LGD improves urban industrialization capacity and infrastructure levels, attracting population inflows and leading to an increase in carbon emissions, thus causing a decrease in GDE. Hypothesis 3 is confirmed.

4.3. Robustness Testing

4.3.1. Adding Control Variables

Adding control variables, the results are shown in column (1) of Table 6. Some studies have also found that urbanization and industrial development have a long-term positive impact on per capita carbon emissions [29], which may affect GDE. In order to improve the quality of the regression results and reduce errors caused by missing dependent variables, we controlled for the impact of urbanization and industrialization on carbon emissions. According to the estimated results, there is no difference between these results and the baseline results.

Table 5. The results of the mechanism of the urban population.

	(1)	(2)	(3)
	GDE	Urban Population	GDE
LGD	−0.046 ** (−2.08)	0.033 *** (5.59)	−0.001 (−0.04)
Urban population			−1.370 *** (−6.27)
Control variable	YES	YES	YES
Constant term	−1.482 *** (−3.37)	7.693 *** (65.64)	9.056 *** (5.23)
Provincial fixed effect	YES	YES	YES
Time fixed effect	YES	YES	YES
N	330	330	330
R-Square	0.178	0.894	0.288

Annotation: ** and *** indicate significance at the 5% and 1% levels, respectively. The values in parentheses are standard errors.

Table 6. Robustness test.

	(1) Adding Control Variables	(2) Excluding Autonomous Regions	(3) Substitution Variables
	GDE	GDE	GDE
LGD	−0.045 ** (−2.03)	−0.050 ** (−2.19)	−0.096 *** (−4.34)
Control variable	YES	YES	YES
Constant term	−1.357 *** (−2.92)	−0.750 (−2.43)	0.500 (0.28)
N	330	297	330
R-Square	0.181	0.194	0.225

Annotation: ** and *** indicate significance at the 5% and 1% levels, respectively. The values in parentheses are standard errors.

4.3.2. Excluding Autonomous Regions

The regression analysis of the model for non-minority autonomous regions is shown in column (2) of Table 6. Minority areas have different specific administrative authorities, and due to the uniqueness of their systems and regions, they prefer environmental policies that are different from those in other regions. To avoid this effect, we conducted our regression analysis without considering the three ethnic autonomous regions of Inner Mongolia, Ningxia, and Guangxi. These results were consistent with the above regression results.

4.3.3. Substitution Variables

The regression was conducted using alternative measures of LGD. Liang et al. [30] proposed using urban investment bonds as a proxy variable for LGD. The results are shown in column (3) of Table 6. Using different measures of LGD does not change the results of GDE. It can be seen that the impact of urban investment bonds on GDE is also negative, and it is significant at the 1% level. The specific reasons are also consistent with expectations and logic. For local governments, the financing behavior of local government investment and financing platforms faces greater debt risks, and the crowding out of social resources is relatively more serious. Therefore, under the dual influence, the government tends to introduce high-polluting enterprises that can bring more economic benefits to deal with debt risks and development needs.

4.4. Heterogeneity Analysis

Considering the differences in urban resource endowments, the attitudes and enthusiasm of local governments in different regions toward increasing fiscal budgets through borrowing debt are also different. Therefore, it is important to analyze the impact of LGD on GDE in different regions. As shown in column (1) of Table 7, for the eastern region, LGD inhibits the improvement of GDE, and the effect is significant, indicating that the eastern region has a high level of economic development and can actively cooperate with the central government’s requirements to implement green development requirements. However, due to the existence of the aforementioned promotion competition, there is still a certain bias toward economic development, which inhibits the GDE. Column (2) shows that LGD in the central region has promoted the improvement of GDE, which may be due to stable economic development in the central region, and appropriate government debt has a certain promoting effect on its stable and coordinated development. Column (3) shows that the impact of LGD on GDE in the western region is negative and significant, indicating that an increase in LGD in the western region will further reduce GDE. Because the economy in the western region is relatively backward compared to other regions, higher local governments will tend to favor economic development rather than environmental protection. Overall, the impact of LGD on GDE varies from region to region. Of course, there are still many areas worth further research in this study, such as whether there is still a mediating effect of the path between local debt and GDE, which is worth further research to supplement.

Table 7. Heterogeneity analysis.

	(1) Eastern Region	(2) Central Region	(3) Western Region
	GDE	GDE	GDE
LGD	−0.066 * (−1.75)	0.152 * (1.80)	−0.052 ** (−2.43)
Control variable	YES	YES	YES
Constant term	1.967 * (1.77)	−2.317 * (−1.83)	−3.096 *** (−7.26)
N	132	99	99
R-Square	0.154	0.320	0.753

Annotation: *, ** and *** indicate significance at the 10%, 5% and 1% levels, respectively. The values in parentheses are standard errors.

5. Conclusions and Policy Recommendations

Although some research has been conducted on the link between LGD and GDE, research on LGD’s direct impact on GDE is still in its early stages. This article empirically examines the impact of LGD on the GDE of China’s provinces from 2010 to 2019, and examines the unique impact path of LGD. The research results are as follows: first, LGD reduces GDE; second, industrialization and urban population are both key ways in which LGD reduces GDE; and finally, LGD has heterogeneity on GDE, and the inhibitory effect of LGD on GDE in eastern and western regions of China is far stronger than in other regions.

Based on these findings, this study proposes some policy implications. First, based on the direct impact of LGD on the GDE, the performance evaluation method should be changed. A performance evaluation system that includes additional indicators must be established. The number of environmental and green development indicators in performance evaluations should also be increased. At the same time, the state should appropriately increase the level of transfer payments and provide financial subsidies to subordinate governments to minimize the debt level of local governments. The phenomenon that local governments put development above the environment should be corrected. In addition, it is necessary to prevent local governments from developing industries with high emissions, high pollution, and high energy consumption, regardless of the actual situation in the

region, to reduce carbon emissions. Second, based on heterogeneity analysis targeting the current situation of imbalanced regional development in China, local governance should promote regional cooperation. Coastal areas with higher levels of economic development have less financial pressure and receive more attention from the central government. In contrast, urban development strategies focus more on the growth of economic quality and the steady improvement of environmental quality. Therefore, for developed regions, appropriately increasing investment in environmental governance can better curb carbon emissions. For non-coastal regions, although economic development is the most important task at present, the quality of the ecological environment cannot be ignored. At present, most noncoastal regions still rely on industrial enterprises as the pillar industries of the region. Therefore, in order to have a better inhibitory effect on carbon emissions, we should shift the economic development model from relying on natural resource endowments to technological innovation on the basis of maintaining the existing industrial level. At the same time, due to the existence of space, advanced green production technologies can be exchanged through strengthening exchanges and cooperation with surrounding areas. Together, we can promote the comprehensive improvement of regional environmental quality and achieve a significant reduction in China's total carbon emissions. Third, in terms of government expenditure, especially in planning for industrialization, investment in environmental governance should be increased to encourage local governments to carry out environmental governance to enhance their motivation and ability to control environmental pollution. While reducing LGD, a large amount of funds should be invested to support the innovation of low-carbon technology products and the development of new energy. In addition, we should use conceptual innovation and technological innovation to build a green, safe, and efficient regional production system to reduce carbon emissions. Fourth, we should reduce the risk of government debt to ease the pressure on local governments to repay debts. Local governments should standardize the use of local financing platforms and rationally issue urban investment bonds to reduce the pressure and risk of debt repayment. The issuance of bonds should be comprehensively considered based on local financial resources and stability.

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

Funding: This research was funded by the National Social Science Foundation (Approval number: 20FJYB029), the Graduate Education Teaching Reform Research Project of Jiangsu Province (Project number: JGKT22_C032), and the University Philosophy and Social Science Research Project of Jiangsu Province (Project number: 2023SJYB0266).

Data Availability Statement: This paper selects 30 provinces in China (omitting Xizang, Hong Kong, Macao, and Taiwan), and the time span is 2010–2020. All the original data are from the China Financial Yearbook, China Statistical Yearbook, China Environmental Yearbook, Wind Energy Database, CEIC database, EPS database, and statistical yearbooks of various provinces (autonomous regions, municipalities directly under the central government) over the years. The missing data for some provinces are supplemented by the average growth rate method.

Conflicts of Interest: The authors declare no conflict of interest.

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