GEORGE BROWN PRESS
JOURNALS, BOOKS & PROCEEDINGS

Economics and Management Innovation

Article

Study on the Impact of Local Government Debt on Carbon Emissions

Hongyu Zeng [1,*]

[1] School of Economics and Management, SouthWest Petroleum University, Chengdu, 610500, China
* Correspondence: Hongyu Zeng, School of Economics and Management, SouthWest Petroleum University, Chengdu, 610500, China

Abstract: The continuous expansion of local government debt, while promoting regional economic growth, may also have an externality impact on the resource and environmental system, especially exacerbating the carbon emission problem. Based on the panel data of 264 prefecture-level cities from 2006 to 2020, this paper constructs a fixed-effects model to systematically explore the mechanism of the impact of local government debt on urban carbon emission intensity and its heterogeneous performance. The empirical results show that local government debt level significantly and positively affects carbon emission intensity, and debt expansion exacerbates carbon emission pressure to a certain extent. Further robustness tests show that this conclusion holds across cities with different emission levels, and is particularly significant in high-emission regions. Subgroup analyses find that the driving effect of debt on carbon emissions is stronger in general prefectural cities compared to municipalities and provincial capitals, while the effect is weakened after the fiscal system reform in 2014, when institutional regulation is beginning to take effect. This paper enriches the micro-empirical research on the environmental consequences of fiscal behaviour and provides empirical evidence for understanding the relationship between local fiscal expansion and low-carbon development goals. The findings have important policy implications for optimising local debt management and building green fiscal governance mechanisms.

Keywords: local government debt; carbon emission; fiscal system reform

1. Introduction: Local Government Debt

With the in-depth promotion of the carbon peaking and neutrality goals, how to effectively control carbon emissions while promoting economic growth has become the core challenge of China's fiscal policy. Under the fiscal decentralisation system, local governments, as the primary implementers of carbon emission reduction tasks, are increasingly concerned about the impact of their debt behaviour on carbon emissions. China's local government debt has continued to grow in recent years, and data from the Ministry of Finance show that by the end of 2024, the balance of local government debt across the country had reached 47.54 trillion yuan, nearly tripling from 2016. Among them, the local financing platform through the issuance of municipal bonds for non-regulated debt has become one of the main channels, as of the end of 2024, as of the end of 2024, approximately 20,000 municipal bonds were issued, with a total size of about 15.52 trillion yuan, in certain cases, the municipal bond stock size in individual cities has accounted for more than 50% of the total local debt. As an important tool for local governments to boost investment, infrastructure and industrial expansion, Urban investment bonds not only improve short-term economic growth, but also exacerbate energy consumption and carbon emissions to a certain extent. It has been pointed out that local government debt has significantly contributed to economic growth in the past development stage, but also brought about resource mismatch and environmental pressure. However, current research on the

Received: 31 May 2025
Revised: 09 June 2025
Accepted: 30 June 2025
Published: 09 July 2025

relationship between local government debt and carbon emissions is still relatively limited, especially lacking micro-empirical identification at the prefecture-level city scale, particularly with a focus on municipal bonds. This paper systematically assesses the mechanism of local government debt on carbon emissions based on 2006-2020 data of 264 cities, and explores the heterogeneity characteristics under different city levels and time stages. Therefore, it is necessary to test in depth whether local government debt expansion exacerbates carbon emissions in order to assess the degree of coordination between it and green development goals.

2. Literature Review

As an important indicator of regional energy consumption and environmental pressure, the drivers of carbon emissions remain a central issue in environmental economics and public finance research. Domestic academics have conducted more in-depth empirical discussions around variables such as economic growth, industrial structure, energy structure, demographic factors and government behaviour.

In terms of the macro-driven mechanism of carbon emissions, early studies mostly used the STIRPAT model or Kaya's constant equation to carry out decomposition analyses. Researchers found, based on inter-provincial panel data, that economic growth is the most important driving force for carbon emissions, followed by the high carbon dependence feature of energy consumption structure, while technological progress and industrial structure upgrading have emission reduction effects to a certain extent [1]. Scholars in Statistical Research further expand the path of identifying carbon emission sources at the micro level by establishing a city-level carbon accounting method [2]. In terms of population and urban form, studies have mostly focused on the nonlinear effects of population density, urban expansion and spatial agglomeration on carbon emissions. Using a panel threshold model, researchers point out that population density has a threshold effect on carbon emissions at different stages of development, with low and medium-density areas showing significant emission reduction advantages, while megacities may cause marginal emissions to rise due to the "congestion effect" [3]. Regarding industrial and energy structures, many scholars have pointed out that a higher share of secondary industry and greater reliance on coal are associated with higher carbon emission intensity. Scholars pointed out that carbon emissions in manufacturing-concentrated regions are significantly higher than those dominated by the service industry, and there is a strong coupling between heavy industry investment and local fiscal expenditure, which provides a theoretical basis for fiscal factors leading to carbon emissions [4]. In recent years, research on the impact of fiscal behaviour on carbon emissions has gradually become a new hot spot in the academic world. In the study of fiscal decentralisation and environmental performance, scholars found that the higher the degree of local fiscal decentralisation, the more likely it is that the governance orientation of "growth preference" will emerge, thus sacrificing environmental quality for short-term GDP increment [5]. In addition, the structure of fiscal expenditure has also been shown to be closely related to the level of carbon emissions. Scholars found that the higher the proportion of infrastructure expenditures, the higher the carbon emission intensity of the city, while education, science and technology expenditures have an indirect inhibitory effect on carbon emissions [6]. On this basis, some studies began to focus on the relationship between local government debt and carbon emissions. Based on the panel data of 148 cities, scholar found that municipal investment debt significantly drives the growth of urban carbon emissions, and the effect is more significant in the western region and cities with greater fiscal pressure [7]. The explanatory mechanisms include debt-driven large-scale infrastructure investment, energy-intensive project steering, and the path-dependent pattern created by land finance dependency. Similarly, researchers show that debt expansion strengthens the development of traditional high-emission industries by increasing the investment capacity of local governments and redirecting capital flows towards emission-intensive sectors [8]. In addition,

a part of the literature also focuses on the moderating role of institutional reforms on the debt-carbon emission relationship. The 2014 Budget Law revision is seen as a key time point. In her study, researcher shows that after the reform, the implicit borrowing of local governments has been curbed to a certain extent, and the new debt is more inclined to flow to areas such as basic education and clean energy, thus weakening to a certain extent the role of debt as a driver of carbon emissions [9]. This finding supports the call from empirical studies for a "fiscal green transition".

Overall, the existing literature has revealed the main drivers of carbon emissions from various perspectives, and have confirmed that the fiscal behaviour of local governments, especially debt expansion, has a significant impact on carbon emissions. However, relevant studies still suffer from the following shortcomings: first, most of the literature focuses on the provincial level and lacks a detailed identification of the prefectural level; second, there is a lack of further differentiation between the debt structure (e.g., special debt, general debt) and the use of funds; and third, the analysis of heterogeneity is still insufficient, and variables such as the local governance capacity and the institutional environment have not been sufficiently included in the analytical framework.

Therefore, based on the sample of prefecture-level cities, this paper selects the municipal investment bonds issued by government financing platforms as proxies for local government debt, systematically identifies the impact mechanism of local debt expansion on carbon emission intensity, and strives to provide more micro-founded and realistic empirical evidence on the basis of existing research.

3. Theoretical Basis and Research Assumptions

3.1. Theoretical Foundation

Under the system of fiscal decentralisation, local governments are responsible for a large number of economic development and public services, but their financial power allocation is relatively limited, which easily leads to the asymmetric structure of upward concentration of administrative authority and downward devolution of fiscal power. This systemic imbalance has prompted local governments to rely on non-tax financing, especially debt raised through government financing platforms, in order to replenish fiscal gaps, expand infrastructure investment and achieve regional economic growth targets. This debt-driven fiscal expansion not only enhances economic growth potential in the short term, but also reshapes the pattern of energy consumption and resource allocation to a certain extent, which may have a far-reaching negative impact on carbon emissions.

From the perspective of theoretical mechanisms, the impact of local government debt on carbon emissions can be realised through the following two paths: one is the infrastructure investment path, and the other is the industrial structure guidance path. First, in the field of infrastructure, local governments focus on investing in transport, municipal engineering, electric power, water conservancy and other projects through debt financing. These projects are generally characterised by high energy dependence and high carbon emissions, especially during the construction phase when they consume large quantities of energy-intensive materials and energy sources, such as steel, cement, and electricity, leading to a significant increase in the level of carbon emissions in the short term. At the same time, debt-driven urban expansion is often accompanied by suburban development and a decline in land-use efficiency, further increasing transport emissions and building energy consumption.

Second, in terms of industrial development, local governments, in order to achieve their economic growth targets, invest in industrial parks, investment promotion, and infrastructure in development zones through debt funds in order to attract high-input, high-output secondary industry projects. This orientation in industrial structure is prone to resource mismatch and overcapacity, exacerbating regional energy intensity and carbon emissions per unit of GDP. In addition, there are obvious differences among different tiers of cities in terms of debt use efficiency and governance capacity. Large cities with strong

governance capacity and high resource allocation efficiency are more likely to steer their debt to low-carbon areas such as green infrastructure and scientific and technological innovations, whereas the average prefecture-level city, driven by fiscal pressures and performance orientations, tends to be more reliant on traditional infrastructures and industrial investments, resulting in a stronger emissions-push effect in the use of their debt funds.

In addition, institutional changes have a significant moderating effect on local debt behaviour. In particular, the 2014 Budget Law reform established a local government debt management system established a local government debt management system that formalizes approved borrowing channels while restricting off-the-books and hidden borrowing practices, promoting the inclusion of local debt in budget reviews, establishing a debt limit system, and restricting hidden debt raising through financing platforms. To a certain extent, this institutional adjustment has strengthened the normality and transparency of debt use, and may also affect its carbon emission effect by optimising the path of capital allocation. Therefore, under different institutional backgrounds and time stages, there may be dynamic changes in the effect of local government debt on carbon emissions, which deserve further identification.

While local government debt promotes urban economic development, there is a potentially complex mechanism for its impact on carbon emission levels, which is mainly manifested in the rise in energy consumption caused by infrastructure investment and the structural pressure caused by the industrial orientation in favour of high-energy-consumption areas. In addition, the city hierarchy and institutional environment also regulate the path between debt and carbon emissions to a certain extent. These theoretical foundations provide the theoretical underpinning for the empirical analyses in this paper.

3.2. Research Hypothesis

In summary, this paper puts forward the following research hypotheses based on the existing theoretical framework and realistic observations:

1) H1: Local government debt has a significant positive impact on carbon emissions, and the larger the debt scale, the higher the level of urban carbon emissions.
2) H2: The effect varies between different city tiers. In cities with stronger economic governance (e.g., municipalities and provincial capitals), the positive effect of debt on carbon emissions is weaker and may not even be significant, while in general prefecture-level cities, the positive effect is more significant.
3) H3: In the time dimension, after 2014 (after the reform of the fiscal system), the extent of the effect of local government debt on carbon emissions has decreased compared with that before the reform.

4. Research Design and Variable Description

4.1. Model Construction

In order to analyse the impact relationship between local government debt and carbon emissions, this paper constructs the benchmark regression model as follows:

$$lnGe_{it} = \beta_0 + \beta_1 lnGd_{it} + \beta_2 Dp_{it} + \beta_3 Is_{it} + \beta_4 Ed_{it} + \mu_i + \gamma_t + \epsilon_{it}$$

Where Ge_{it} denotes carbon emissions; Gd_{it} denotes the scale of local government debt; Dp_{it} denotes population density; Is_{it} denotes industrial structure; Ed_{it} denotes the level of economic development; μ_i denotes individual fixed effects; γ_t denotes time fixed effects; and ε_{it} denotes the random perturbation term. Considering the differences in the level values of different variables and in order to reduce the influence of heteroskedasticity, the explanatory and interpreted variables in the econometric model are natural logarithms.

4.2. Description of Variables

4.2.1. Explained Variables

Carbon Emissions (Carbon Emissions). Referring to the method published in Statistical Research; urban carbon emissions are divided into direct energy consumption and indirect energy consumption (electricity and heat) [10]. Carbon emissions from direct energy consumption (gas, LPG, natural gas) are calculated using the relevant conversion factors provided by IPCC2006. Carbon emissions from electricity consumption are calculated using the baseline emission factors for each regional grid and urban electricity consumption. Carbon emissions from thermal energy consumption are first converted into equivalent standard coal quantities and then calculated using the standard coal conversion factor.

4.2.2. Explanatory Variables

Local government debt (Government Debt). Considering some opacity in local government debt statistics, this paper uses the total annual issuance of municipal bonds by government financing platforms (local government-backed financing entities, distinct from state-owned enterprises) in each prefecture-level city from the Wind database as a proxy for local government debt, and takes the natural logarithm of the variable to weaken the influence of extreme values.

This variable reflects, to some extent, the level of annual new debt of cities, and is an effective proxy for the expansionary fiscal operations of local governments through financing channels.

4.2.3. Control Variables

Population density, calculated as the number of residents divided by the area of the city's administrative division, measured in persons per square kilometre. Urban population density directly affects energy use and transport demand, and is an important structural factor in carbon emission intensity.

Industry Structure. Measured by the share of value added of the secondary industry in the Gross Domestic Product (GDP), measured by the share of value added of the secondary industry in GDP, which reflects the level of industrialization. A higher share of industry usually means a higher level of energy consumption and a higher carbon intensity.

Economic Development. Expressed as the natural logarithm of GDP per capita, it is used to measure the stage of economic development of the city and the level of resource use per capita. According to the Environmental Kuznets Curve (EKC) hypothesis, carbon emissions rise in the early stages of economic development and tend to decline in the later stages.

4.3. Data Sources

The panel data used in this paper covers 264 prefecture-level cities in China, spanning from 2006 to 2020, and the main data sources include: China Urban Statistical Yearbook, China Energy Statistical Yearbook, China Regional Economic Statistical Yearbook, Database of National Bureau of Statistics, and Wind Financial Terminal. Among them, the carbon emission data are calculated based on energy consumption and IPCC carbon emission factors, and the local government debt data are proxied by the annual issuance of municipal bonds by local financing platforms in each city from the Wind database. The rest of the control variables, such as population density, the proportion of the secondary industry, and GDP per capita, are calculated from the public statistics released by the National Bureau of Statistics.

5. Analysis of Empirical Results

5.1. Descriptive Statistics

Table 1 demonstrates the descriptive statistics of the main variables selected in this paper. Among them, the mean and standard deviation of carbon emission (Ge) of the sample cities are 872.24 and 1557.05 respectively, and the maximum value is far more than the mean value, showing obvious right-skewed distribution characteristics, which indicates that there are huge differences in the carbon emission levels among different cities; the local government debt (Gd) also shows high dispersion, and its distribution tends to be centralised after logarithmic transformation (lnGd); among control variables, the fluctuations of population density (Dp) and economic development level (Ed) are relatively small. Among the control variables, population density (Dp) and economic development level (Ed) have relatively small fluctuations, while industrial structure (Is) varies significantly across cities. This distributional feature reflects the high heterogeneity of the sample and lays the foundation for the subsequent heterogeneity test.

Table 1. Descriptive Statistics of Different Variables.

Variables	Number of observations	Mean value	Standard deviation	Minimum value	Maximum value
Ge	3960	872.24	1557.05	7.53	35582
lnGe	3960	6.063071	1.145134	2.018992	10.4796
lnGd	3960	3.542975	1.710092	0.059029	9.993363
Dp	3960	5.753423	0.9368849	0.6830968	7.881601
Is	3960	0.4002391	0.0999358	0.0000732	0.838682
Ed	3960	10.48607	0.7082781	4.59512	13.05569

5.2. Benchmark Regression Results

Table 2 shows the baseline regression results under the two-way fixed effects model. For every 1% increase in local government debt, the carbon emission intensity rises by 0.184% on average, which significantly supports the hypothesis that debt expansion pushes up carbon emission through increasing infrastructure investment; Population density and improvement of industrial structure significantly reduce carbon intensity with coefficients of −0.202 and −0.313, reflecting the positive effects of economies of scale and industrial upgrading on emission reduction. At the same time, every 1% increase in per capita economic development corresponds to a 0.428% increase in carbon emission intensity, indicating that the growth pattern during the study period remains highly dependent on high-carbon industries; The R^2 within the model is 0.27, indicating a moderate explanatory power of the two-way fixed-effects setup for the variation in carbon emissions. The result verifies the first research hypothesis (H1) proposed in the thesis, that is, there is a significant positive relationship between local government debt expansion and carbon emissions.

Table 2. The Baseline Regression Results under the Two-Way Fixed Effects Model.

Local government liabilities (lnGd)	**0.184*** (0.035)**
Population density (Dp)	-0.202** (0.098)
Industrial structure (Is)	-0.313*** (0.090)
Level of economic development (Ed)	0.428*** (0.075)
Urban fixed effects	Yes

Year fixed effects	Yes
Observed	3,960
Number of individuals	264
R^2within group	0.27

Note: ***/**/* denote 1%/5%/10% significance levels, respectively; year fixed effects are included, and the following tables are identical.

5.3. Robustness Test

Tail trimming is performed first to eliminate the effect of extreme values, followed by quantile regression as a robustness test.

The results in Table 3 show that. After the shrinkage treatment, lnGd is consistently positive and significant in the OLS-FE and 25%, 50%, and 75% quantile regressions, and as shown in Table 3, the coefficient increases incrementally from 0.162 to 0.283 — suggesting that the debt effect is more prominent in cities in the high carbon emission quartile. The sign and significance of the control variables remain consistent for population density and economic development level, further enhancing the robustness of the benchmark results. In addition, the coefficient of industrial structure increases in the high quantile test, implying that the industrial structure of high emitting cities is more sensitive to the impact of carbon emissions. These findings corroborate the universality of the debt-emission relationship and its non-homogeneity under different emission levels.

Table 3. Robustness Test Results after Shrinking Tail Treatment.

Variable	OLS-FE	Q25	Median	Q75
lnGd	0.184***	0.162***	0.162*** 0.215***	0.283***
	(0.035)	(0.041)	(0.038)	(0.052)
Dp	-0.202**	(0.038) (0.052) Dp -0.202** -0.098*	0.123** -0.157**	-0.157**
	(0.098)	(0.051)	(0.049)	(0.049) (0.063)
Is	-(0.063) Is	(0.063) Is - 0.313*** -0.184***	0.184*** -0.226***	0.226*** -0.271***
	(0.090)	(0.048)	(0.052)	(0.061)
Ed	0.428***	0.102***	0.145***	0.198***
	(0.075)	(0.028)	(0.031)	(0.042)
Sample size	3,850	3,850	3,850	3,850
Model	Double fixed effects	25% quantile	50 per cent quartile	75 per cent quantile

5.4. Heterogeneity Analysis

The group regression results (Table 4) show that the lnGd coefficient of other prefecture-level cities is 0.321, significantly higher than that of municipalities/capital cities (0.132), suggesting that the marginal effect of debt on carbon emissions is stronger in general prefecture-level cities with weaker governance or higher financial dependence; meanwhile, municipalities/capital cities show stronger effects of population density and industrial structure, reflecting their spatial agglomeration and industrial upgrading governance advantages. This result supports the second research hypothesis (H2) proposed in the thesis from the regional level, that is, the difference in city tiers significantly affects the marginal effect of debt on carbon emissions.

Table 4. Regression of City Heterogeneity.

Variable	Municipalities/capital cities	Other cities
lnGd	0.132***	0.321***
	(0.053)	(0.042)
Dp	-0.352*** (0.053) (0.042)	-0.102

	(0.112)	(0.087)
Is	0.418*** -0.203***	-0.203**
	(0.105)	(0.091)
Ed	0.512***	0.512*** (0.105) (0.091)
	(0.092)	(0.078)
Observations	465	3495
Number of cities	31	233
R^2 within group	0.402	0.318

After dividing the sample into two periods before and after 2014 (Table 5), it is found that the lnGd coefficient is 0.278 in the pre-reform period, and decreases to 0.152 in the post-reform period, and the latter is still significant at the 5 per cent level, indicating that after the revision of the Budget Law in 2014, the driving effect of debt on carbon emissions has been suppressed but not completely eliminated. This trend verifies hypothesis H3, indicating that institutional changes have mitigated the environmental externality of debt expansion to a certain extent, but further strengthening of green debt management and performance assessment mechanisms is still needed.

Table 5. Time Heterogeneity Regression.

Variables	2006-2013	2014-2020
lnGd	0.278***	0.152**
	(0.043)	(0.061)
Dp	-0.118	-0.291***
	(0.095)	(0.108)
Is	0.187** -0.375*** (0.395) (0.108)	-0.375*** (0.089)
	(0.089)	(0.102)
Is -0.187** -0.375*** (0.089)	0.263***	0.482***
	(0.071)	(0.093)
Observations	2112	1848
Number of cities	264	264
R^2 within group	0.305	0.387

6. Conclusions and Policy Recommendations

Based on the panel data of 264 prefecture-level cities from 2006 to 2020, this paper constructs a fixed-effects model and systematically analyses the impact of local government debt on carbon emission intensity. It is found that the level of local government debt significantly and positively affects urban carbon emission intensity, indicating that the current expansion of local debt in China has strengthened the high-carbon path of urban energy consumption structure while promoting investment and growth. Further robustness tests show that the relationship exists significantly in cities with different emission levels, and the marginal effect of debt on carbon emissions is especially larger in cities with higher carbon emission intensity. The results of heterogeneity analysis show that the driving effect of debt on carbon emissions is significantly higher in general prefecture-level cities than in municipalities and provincial capitals, reflecting the moderating role of factors such as local governance capacity and the structure of capital use in the carbon emission effect of debt. In the time dimension, after the fiscal system reform in 2014, the effect has been mitigated but still exists, indicating that the institutional norms have an initial effect on mitigating environmental externalities.

Combined with the above empirical results, there is indeed a tension between current local government debt management and carbon emission control. Therefore, it is urgent to achieve coordinated development of both through institutional optimisation and policy guidance. To this end, this paper puts forward the following policy recommendations.

First, strengthen the debt constraint mechanism and standardise debt behaviour. The local government debt limit management system should be further improved, the budget responsibility should be compressed, and hidden debt should be avoided through financing platforms. At the same time, green performance indicators such as carbon emission intensity should be incorporated into the assessment system for the use of debt funds to enhance the environmental constraints of project review and curb high-emission investment behaviour.

Second, optimise the structure of debt fund use and increase the proportion of green inputs. Through the establishment of green special bonds, the development of climate bonds, etc., to guide the funds to energy conservation and environmental protection, clean energy, green transport and other low-carbon areas tilt, and promote debt and "dual-carbon" goal synergies. At the same time, improve the performance evaluation system of fiscal expenditure, and incorporate the results of carbon emissions into the green budget and project review.

Third, improve the synergy mechanism between fiscal and environmental policies, and promote green governance according to local conditions. For general prefecture-level cities, the matching of fiscal authority and expenditure responsibility should be strengthened to reduce the reliance on debt expansion; for cities with stronger governance capacity, they should be encouraged to explore pilot green fiscal reforms, such as carbon asset management and green fiscal labelling system, to form a demonstration-driven effect.

In conclusion, local government debt as an important financial tool to regulate the pace of investment and development, its potential impact on carbon emissions should not be ignored. Through institutional reform and policy guidance, incorporating debt resources into the green governance system can help realise the synergy between fiscal sustainability and low-carbon transformation.

References

1. X. Dong, X. Yu, T. Shi, and D. Qiao, "Nexus between carbon emissions and local debt risk: Evidence from China's prefecture-level cities," *Int. Rev. Financ. Anal.*, vol. 93, p. 103232, 2024, doi: 10.1016/j.irfa.2024.103232.
2. Y. Guan, J. Wu, and Y. He, "Local government debt, local government financing platforms, and green development efficiency," *Platforms*, vol. 2, no. 2, pp. 55–67, 2024, doi: 10.3390/platforms2020004.
3. Y. Zhang, "The impact of local government debt governance on carbon emissions: Evidence from Chinese cities," SSRN, 2024, doi: 10.2139/ssrn.5031022.
4. Z. Qi et al., "The impact of local government debt on urban environmental pollution and its mechanism: Evidence from China," *PLoS One*, vol. 17, no. 3, p. e0263796, 2022, doi: 10.1371/journal.pone.0263796.
5. M. Zhou, K. Jiang, and Z. Chen, "The side effects of local government debt: Evidence from urban investment bonds and corporate pollution in China," *J. Environ. Manag.*, vol. 344, p. 118739, 2023, doi: 10.1016/j.jenvman.2023.118739.
6. H. Xie, W. Zhang, and H. Liang, "Can local government debt decrease the pollution emission of enterprises? — Evidence from China's industrial enterprises," *Sustainability*, vol. 15, no. 11, p. 9108, 2023, doi: 10.3390/su15119108.
7. Y. Xu et al., "The impact of local government competition and green technology innovation on economic low-carbon transition: New insights from China," *Environ. Sci. Pollut. Res.*, vol. 30, no. 9, pp. 23714–23735, 2023, doi: 10.1007/s11356-022-23857-1.
8. H. Liu et al., "Assessing Chinese governance low-carbon economic peer effects in local government and under sustainable environmental regulation," *Environ. Sci. Pollut. Res.*, vol. 30, no. 22, pp. 61304–61323, 2023, doi: 10.1007/s11356-021-17901-9.
9. S. Chen, H. Mao, and J. Sun, "Low-carbon city construction and corporate carbon reduction performance: Evidence from a quasi-natural experiment in China," *J. Bus. Ethics*, vol. 180, no. 1, pp. 125–143, 2022, doi: 10.1007/s10551-021-04886-1.
10. X. Liu et al., "Can green finance policy reduce corporate carbon emissions? Evidence from a quasi-natural experiment in China," *Br. Account. Rev.*, 2024, p. 101540, doi: 10.1016/j.bar.2024.101540.