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Does Local Government Debt Reduce Urban Economic Inequality? Evidence from Chinese Cities

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Abstract

As China pursues sustainable development goals, the rapid accumulation of local government debt raises questions about its impact on economic inequality. Inequality represents a key dimension of sustainability and a core challenge for developing economies. Our paper examines how city-level local government debt influences economic inequality in China. Using a dataset of 1680 city-year observations from 2015 to 2020, we analyze the relationship between local government debt ratios and the Gini coefficient derived from nighttime light intensity data. Our results show that as local government debt rises, urban economic inequality falls. Further mechanism analysis suggests that debt-financed investment reduces inequality through the development of infrastructure, industrial parks and logistics facilities. Our findings contribute to the literature on local government debt, economic inequality, and the political economy of local government behavior in China. Our results suggest that debt-financed investments may serve as a tool for fostering more equitable and sustainable development.

Keywords: local government debt; economic inequality; China

Academic Editor: Michael L. Lahr

Received: 10 July 2025
Revised: 7 August 2025
Accepted: 10 August 2025
Published: 14 August 2025

Citation: Lin, H.; Hu, Y. Does Local Government Debt Reduce Urban Economic Inequality? Evidence from Chinese Cities. *Sustainability* **2025**, *17*, 7340. https://doi.org/10.3390/su17167340

1. Introduction

Local government debt is gaining increasing attention, due in no small part to its role in fueling developing countries' rapid economic development and infrastructure expansion [1]. Over the past two decades, substantial evidence has shown that debt-financed investment fuels China's economic growth [2,3]. Yet the rising debt levels and growing regional disparities raise concerns about the long-term sustainability and equity of this model [4]. These concerns are not unique to China. Cross-country evidence suggests that the relationship between debt accumulation and inclusive growth is complex and depends on institutional contexts and development stages [5].

While China's public finance system has unique features, its experience with rapid, debt-fueled development makes it a valuable case study. Many developing countries across Asia, Africa, and Latin America are pursuing a similar path, using substantial public debt to finance infrastructure [6,7]. Therefore, analyzing how this strategy affects inequality in China offers critical lessons for policymakers worldwide. These leaders face the shared challenge of balancing economic growth with equity, and our study aims to provide such an analysis.

In the current context of global sustainable development, equity has emerged as a central issue [8]. Inequality and sustainability represent fundamental challenges for human

society and constitute key considerations in government policymaking worldwide [9,10]. Since the 2008 financial crisis, economic inequality has regained attention as a critical issue for both academics and policymakers [9]. Economic inequality not only impedes sustainable growth [9,11,12] but also undermines social stability [13], suppresses civic participation [14], and exacerbates environmental degradation [15]. Furthermore, addressing inequality is also a core component of the United Nations Sustainable Development Goals [8].

The Chinese economy has experienced rapid growth, yet this expansion has been accompanied by growing regional economic disparities and widening urban-rural income gaps. These development imbalances have become increasingly pronounced, with China's eastern and western regions exhibiting substantial differences in GDP, per capita income and debt levels [16,17]. Specifically, Figure 1 illustrates these disparities in local government debt levels across China in 2020. Such imbalances pose a significant challenge to the nation's pursuit of sustained and high-quality economic growth in the coming years.

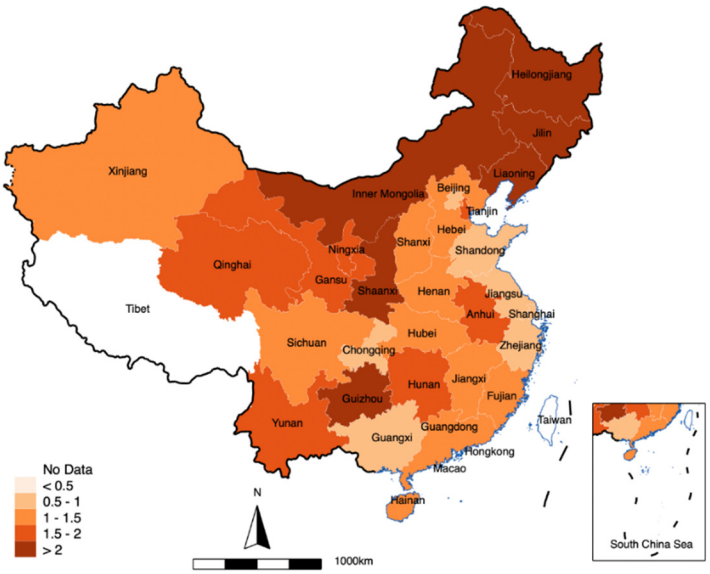

Figure 1. Map of Government Debt Distribution in 2020.

To address regional disparities, the central government has introduced various regional development strategies [18]. However, the persistent mismatch between local governments' revenue capacity and expenditure responsibilities has created significant fiscal constraints. These structural imbalances have driven local governments to rely increasingly on debt financing. Despite evidence that debt-financed investments promote economic growth, few studies have examined whether such borrowing affects regional economic inequality. Our paper fills that gap, proposing that local government debt can reduce urban economic disparities through enhanced public investment in infrastructure, industry, and logistics networks.

We examine the relationship between local government debt ratios and urban economic inequality using prefecture-level data from 2015–2020, a period when local government debt became more prominent in China [19]. We argue that higher local government debt ratio is associated with reduced economic inequality at the prefecture-level city.

The article proceeds as follows. Section 2 develops theory and hypotheses. Section 3 presents research design. Section 4 summarizes and presents empirical results. Section 5 provides discussion and conclusion.

2. Theory and Hypotheses

2.1. Local Government Debt and Regional Economic Inequality

Local government debt serves as an intertemporal instrument that allows governments to borrow future revenues to achieve current policy objectives. The relationship between local government debt and urban economic inequality represents a critical yet unexplored area. In China, local governments have increasingly relied on debt financing to meet expenditure responsibilities [18]. Since the 1994 tax reform, the mismatch between revenue capacity and spending responsibilities has created fiscal pressure on local government. By July 2024, local government debt had reached 42.6 trillion yuan, 62.9 times higher than in 2008 [20].

While our study focuses on vertical inequality—disparities between individuals—it is important to acknowledge the distinction from horizontal inequality, which captures disparities between social, ethnic, or political groups [21]. This distinction is particularly relevant in China given the geographic concentration of ethnic minorities. Previous research has shown that horizontal inequalities can be a significant predictor of civil conflict [22,23] and that such group-based disparities tend to persist over time [24]. However, we concentrate on vertical inequality because our nighttime light (NTL) data captures individual-level economic activities rather than group-based disparities.

Theories on government debt's role in economic development and redistribution vary. From a Keynesian viewpoint, debt-financed government spending stimulates aggregate demand and reduces unemployment, potentially benefiting lower-income groups disproportionately [25–28]. Some argue that government borrowing can finance large-scale public investment projects that private capital is reluctant to undertake. These investments in public services can foster economic growth [29]. This borrowing capacity may serve as an equalizing function by enabling lagging regions to catch up with more developed areas.

However, the relationship between debt and economic outcomes may be complex. Existing literature suggests debt-growth relationships may exhibit threshold effects, with national studies finding diminishing returns above 85–90% of GDP [30,31], such thresholds remain contested. Panizza and Presbitero (2013) argue that these supposed nonlinearities lack clear causal logic and depend heavily on sample selection and model specification [32]. For Chinese local governments, evidence on debt thresholds remains mixed. Some studies find U-shaped relationships [33], while others suggest benefits persist below certain thresholds [34].

Empirical evidence on the relationship between government debt and economic inequality remains limited and inconclusive. Moreover, there is little consensus on how to measure economic inequality, and most regions, particularly at the prefecture level, lack reliable data on household income [35]. Therefore, we employ inequality measures based on remotely sensed nighttime light (NTL) data as a proxy for regional economic inequality. Early studies have demonstrated strong correlations between light intensity and economic prosperity [36,37]. The spatial variance of remotely sensed light per person might thus carry a signal of economic inequality [38].

Some studies suggest that while government investment effectively increases growth rates and moderates inflation, it may have an adverse effect on long-run income inequality [39–41]. In the United States, Wolff and Zacharias (2007) found an inverse short-run relationship between debt-financed government expenditure and inequality [42]. Using data from 18 industrialized countries from 1978 to 2009, Agnello and Sousa (2014) demonstrate that fiscal consolidation negatively impacts income inequality, particularly for lower-income households [43]. Research also identifies economic growth [44,45], and revenue-side fiscal policies [46] as key determinants of economic inequality.

Recent studies examining China's unique institutional context provide additional insights into the debt-inequality relationships. Liu (2018) suggests that expanding local debt scales harms resident income growth and worsens income distribution structures [47]. Similarly, Qi and Yang (2019) conclude that public debt exacerbates internal income inequality using cross-national panel data [48]. In contrast, Kou and Chen (2020) propose that government debt in China improves income distribution [49]. Li and Yin (2019) theoretically identify four channels through which local debt affects inequality in China: new rural construction and labor force transfer (which tend to narrow income gaps), income redistribution effects (which widen gaps), and urbanization mechanisms (with ambiguous effects) [50]. Therefore, we present our theoretical framework in Figure 2 and propose:

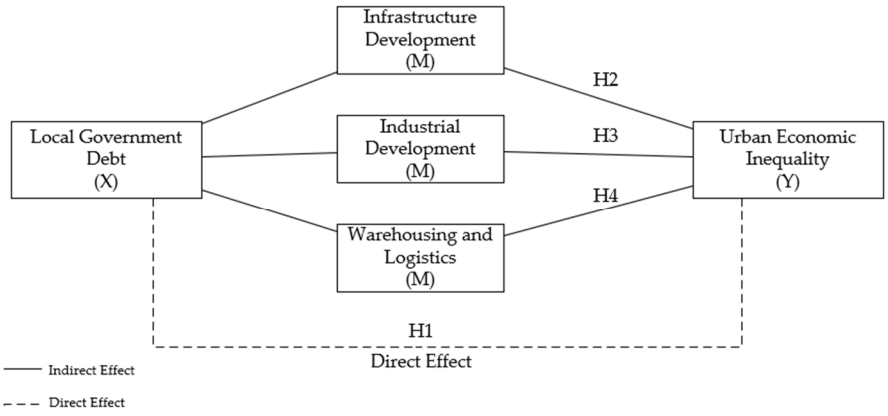

Figure 2. Theoretical Framework and Hypotheses.

H1. *Higher local government debt ratios are associated with lower levels of urban economic inequality.*

2.2. Infrastructure Development as a Mediating Mechanism

Infrastructure investment represents the primary channel through which local government debt affects regional inequality. In China, over 60% of local government debt consists of special-purpose bonds, with approximately 50% allocated to transportation infrastructure, and municipal facilities [51]. This substantial commitment to infrastructure reflects its recognized role in promoting economic development and reducing spatial disparities.

Local government borrowing enables large-scale, capital-intensive projects that would be impossible to finance through current revenues alone. Infrastructure investments require massive upfront expenditure but generate returns only after completion and over extended periods. Debt financing allows local governments to bridge this temporal gap between costs and benefits [52]. Moreover, China's administrative system allows higher-level governments to direct borrowing quotas toward infrastructure projects in less developed areas, creating an implicit regional development mechanism [19].

Infrastructure's effect on inequality operates through multiple channels. Well-developed transportation networks reduce trade costs and improve market access, enabling rural areas to integrate with national and global markets [53]. Basic infrastructure services, including roads, electricity, water, and sanitation, directly improve living standards and create conditions for economic participation [54]. A World Bank study provides compelling evidence that improved infrastructure access significantly narrows gaps between rich and poor regions [55]. Furthermore, enhanced accessibility to infrastructure services contributes to the reduction of income inequality [54,56]. However, some studies caution that such effects depend on implementation: without targeted policies, infrastructure benefits may accrue disproportionately to wealthier segments [57,58]. Research from India and Bangladesh

found only weak correlations between infrastructure investment and income distribution improvements [53,59]. Therefore, we hypothesize that:

H2. *Local government debt reduces economic inequality by enhancing the overall level of infrastructure development.*

2.3. Industrial Development as a Mediating Mechanism

Local government debt can also reduce inequality through industrial development. A significant portion of local government bonds finances industrial park construction and manufacturing facilities [51]. This debt-financed industrial infrastructure creates platforms for economic transformation in less developed regions.

Debt-driven government investment may promote local industrial development through several channels. First, borrowed funds enable the construction of industrial parks with necessary utilities, transportation links, and support facilities that attract manufacturing firms [60,61]. Second, debt financing allows local governments to provide subsidies, tax incentives, and other support measures to encourage industrial relocation from developed to developing regions [1].

Empirical evidence supports industrialization's role in reducing regional inequalities. Studies demonstrate that manufacturing development creates formal sector jobs that offer higher wages and greater stability than agricultural or informal employment [62]. Moreover, industrialization drives structural transformation by shifting labor from low-productivity agriculture to higher-productivity manufacturing, thereby reducing income disparities [63]. Researchers found evidence in China that industrial growth has helped narrow income gaps in less developed regions [63,64]. However, some scholars suggest that excessive investment in industrial capacity can lead to inefficiencies, income gaps and higher environmental costs [65,66]. Therefore, we propose:

H3. *Local government debt reduces economic inequality by enhancing the overall level of industrialization.*

2.4. Warehousing and Logistics Infrastructure as a Mediating Mechanism

Warehousing and logistics infrastructure represents an increasingly important but often overlooked channel for reducing regional inequalities. Basic logistics and warehousing facilities often require substantial upfront investment. These investments include construction of logistics parks, temperature controlled storage facilities, distribution centers, and associated transportation links [67]. Modern logistics infrastructure requires large-scale, long-term investment that may not generate profits in the initial years. When governments use debt to fund these projects, they bear the initial risks that would otherwise deter private investors. Approximately 20% of China's special-purpose bonds finance urban-rural cold chain logistics, storage facilities, and distribution networks [51].

Logistics and warehousing parks are typically located in urban peripheries and urban-rural interface zones due to land availability and cost considerations. These strategic locations enable them to serve as bridges between urban and rural economies. Efficient logistics systems lower transaction costs and reduce price disparities between regions. Remote areas can thus access goods at reasonable prices [68]. The construction of logistics and warehousing facilities particularly benefits rural areas through reduced transportation costs.

The sector also generates substantial employment in warehousing, transportation, and related services. These jobs offer new opportunities for residents in peripheral urban areas [69–71]. E-commerce logistics networks have proven especially effective at connecting rural producers with urban consumers [72]. Previously isolated areas now have access

to new income sources [73–75]. However, the distributional effects depend on whether logistics infrastructure serves small producers and large commercial interests, or only the latter [76,77]. Therefore, we propose:

H4. *Local government debt reduces economic inequality by enhancing the overall level of warehousing and logistics infrastructure.*

3. Research Design

To test the relationship between local government debt ratios and economic inequality within cities in China, we construct a comprehensive dataset drawing from multiple authoritative sources. For independent variable, local government debt ratios were calculated based on debt data from municipal finance departments. For dependent variable, urban economic inequality is measured using nighttime light (NTL) data as a proxy, which was widely recognized in the literature as an effective indicator of economic activity and inequalities in development [38,78,79]. The detailed calculation method is provided in the measurement section. Furthermore, our dataset integrates information from the China City Statistical Yearbook and the China Science and Technology Statistical Yearbook, providing rich contextual variables on local economic and technological development. Our study draws from China's 293 prefecture-level cities. After removing observations containing data irregularities or substantial missing values, our analysis comprises 1680 city-year observations spanning 280 prefecture-level cities distributed across all 31 Chinese provinces.

Our analysis begins by examining how local government debt ratio affects regional economic inequality. We measure inequality using the Gini coefficient of NTL data. To account for unobserved factors that might vary across cities but remain constant over time, we use a fixed effects model in our study [80,81]. This approach allows us to control time-invariant characteristics that might otherwise bias our results. We conducted a Hausman test which rejected the null hypothesis that random effects provide consistent estimates ($p < 0.05$). Equation (1) tests the hypothesis that local government debt tends to decrease economic inequalities in prefecture-level city (H1):

$$Gini_{it} = \alpha + \theta \cdot Debt_{it} + \sum_{i=1}^{n} \beta_i \cdot ControlVar_{it} + \mu_i + \lambda_t + \varepsilon_{it} \quad (1)$$

where $Gini_{it}$ and $Debt_{it}$ indicate the degree of urban economic inequality and debt level at city i in year t, respectively. $ControlVar_{it}$, controls for other factors influencing the *Gini* coefficient. μ_i and λ_t represent individual and year fixed effects, respectively, and ε_{it} denotes the confounding term. The following is the matrix of control variables:

$$\beta \cdot \text{ControlVar} = (\beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \beta_6, \beta_7, \beta_8) \cdot \begin{pmatrix} Indl_{it} \\ Inte_{it} \\ Edu_{it} \\ Env_{it} \\ Unem_{it} \\ Hous_{it} \\ Urban_{it} \\ GDPpercapita_{it} \end{pmatrix} \quad (2)$$

To address potential endogeneity concerns arising from bidirectional causality between local government debt and urban economic inequality [82,83], we employ a Two-Stage Least Squares (2SLS) approach with instrumental variables. The detailed implementation and results are presented in Section 4.3.

To test mechanisms H2–H4, we examine how debt affects inequality through different channels. We first examine the relationship between debt ratios and each infrastructure type, then assess how these affect inequality. This approach quantifies the relative contribution of each mechanism. Table 1 presents variable definitions and measurement.

Table 1. Variable Definitions and Measurement.

Variables	Label	Measurement
Dependent Variable		
Gini coefficient	Gini	
Independent Variable		
Local government debt ratio	Debt	Total debt outstanding divided by comprehensive fiscal capacity
Control Variables		
Industrialization level	Indl	The ratio of industrial added value to gross regional product
Internet penetration rate	Inte	Number of internet users per hundred people
Education level	Edu	Number of students enrolled in higher education institutions/total population at the end of the year
Environmental regulation	Env	Comprehensive utilization rate of general industrial solid waste
Extent of unemployment	Unem	Number of individuals enrolled in unemployment insurance
Average house price	Hous	Average residential property prices
Urbanization level	Urban	Urban population/Total population
GDP per capita	GDP	Log GDP per capita
Instrumental Variables		
Administration cycle	Adm	Mayor's term duration
Lagged debt ratio	Lag	$Debt_{t-1}$
Mechanism Analysis		
Infrastructure Development	Infc	Per Capita Road Area (Unit in square meters)
Industrial Development	Indc	Value Added of the Tertiary Industry/Value Added of the Secondary Industry
Warehousing and Logistics Construction	Ware	Total Freight Volume (Including Civil Aviation Freight, Waterway Freight, Railway Freight, and Highway Freight, unit in 10,000 tons)

3.1. Dependent Variables

Our study measures urban economic inequality using the Gini coefficient calculated from nighttime light intensity (NTL) data, a widely adopted proxy for economic activity [36,38,79]. We acknowledge the limitations of single-parameter inequality measures like the Gini coefficient, particularly it may be unable to capture important information concerning income distributions [84].

However, we justify its use in this study for two primary reasons. First, while traditional inequality measures rely on self-reported household income data, such data are often unavailable or unreliable at regional level, particularly at developing countries [85,86]. Following Mirza et al. (2021), we employ remotely sensed NTL data as an innovative approach to capture spatial economic disparities [38].

Second, extensive empirical evidence demonstrates that NTL correlate with economic activity [36,79]. Mirza et al. (2021) further reveal that when households of different income levels live in segregated areas, spatial variations in per capita light intensity could be a reasonable estimator for economic inequality [38].

For this analysis, we obtained NPP-VIIRS (Visible Infrared Imaging Radiometer Suite on the Suomi National Polar-orbiting Partnership) nighttime light data from Harvard Dataverse, which offers superior spatial resolution and wider radiometric detection range compared to earlier DMSP-OLS data [87]. This allows detection of low-intensity lights from residential areas and better captures variations in economic activity across urban landscapes.

There are several significant limitations to this approach. NTL is admittedly not a perfect measure of inequality. Critically, the validity of using NTL data to proxy economic inequality rests on a still-developing and highly debated body of evidence [37,38,88,89]. While we build on the work of Mirza et al. (2021), we admit that their analysis shows a Pearson correlation of only 0.50 between NTL patterns and income inequality across U.S.

states, implying that NTL data explains only a quarter (R^2 = 0.25) of the variation [38]. Moreover, neighborhood-level justification in the literature leans on studies with specific contexts, such as Smith and Wills' (2018) work on oil-producing regions, which may not be generalizable to the broader context of urban China [37]. While other large-scale studies that use NTL data as a proxy for economic activity do so with considerable caution, its link to the distribution of income is more complex and less direct [88,89]. Taken together, the evidence supporting this relationship remains tenuous across various spatial scales.

Furthermore, other technical challenges exist. Urban saturation effects may compress variation in highly developed areas, potentially underestimating inequality in major metropolitan regions. Besides, our Gini-based approach cannot explicitly distinguish whether an observed inequality reduction occurs through poverty alleviation (raising incomes at the bottom), constraining high-income growth, or other structural shifts in the distribution [84]. Nevertheless, this approach allows us to measure inequality in cities lacking household income data. Moreover, because light data are collected independently from surveys, this approach provides a different way to verify inequality patterns. Our findings should thus be interpreted with these limitations firmly in mind.

Regional economic inequality is calculated by measuring the area between the Lorenz curve and the line of equality. Assuming the population sample can be divided into n groups, let w_i and p_i represent the NTL data and population frequency of the i-th group (i = 1, 2, . . ., n), respectively. The Gini coefficient (*Gini*) can be calculated using Equation (3):

$$Gini = 1 - \sum_{i=1}^{n} 2B_i = 1 - \sum_{i=1}^{n} p_i(2Q_i - w_i) \quad (3)$$

$$Q_i = \sum_{k=1}^{i} w_k$$

where Q_i represents the cumulative proportion of NTL from 1 to i. B represents the area between the Lorenz curve and the line of perfect equality. The sums of w_i and p_i from 1 to n, equal 1 respectively. When the number of observations is sufficiently large, $p_i = n_i/\Sigma n_i$ will approach zero.

Our light-based Gini coefficient thus serves as a spatial proxy for economic inequality. Higher values indicate greater concentration of economic activity, while lower values suggest more even distribution. These values differ from income-based Gini coefficients but capture similar inequality patterns and enables comparisons across Chinese cities.

3.2. Independent Variable

We measure local government debt ratio as the total debt outstanding divided by comprehensive fiscal capacity. Following China's 2015 Budget Law revision, local governments began issuing standardized bonds through a 'self-issuance and self-repayment' mechanism [90,91]. The 2015 regulatory change led local governments to transition from implicit to explicit debt financing [91].

Our debt measure includes both general bonds (for non-revenue-generating public welfare projects) and special-purpose bonds (for revenue-generating public welfare projects), as disclosed by local fiscal departments [92]. We exclude implicit government debt, and debt from local government financing vehicles (LGFVs) for two reasons. First, comprehensive data on implicit debt remains unavailable at the prefectural city level, particularly for LGFV debt that relies primarily on bank loans rather than publicly traded bonds. Second, the representativeness of LGFV debt has diminished significantly since 2015 as standardized government bonds became the primary financing mechanism [91].

Following Diao (2017), we calculate the debt ratio as total bond outstanding divided by comprehensive fiscal capacity, which comprises 'general public budget revenue' and 'government fund budget revenue' [93]. This ratio directly reflects the relationship between

debt stock and repayment capacity. Our sample period begins in 2015, when municipal finance departments first began systematic disclosure of standardized government debt data.

3.3. Control Variables

To control other urban characteristics affecting economic inequality, we include eight control variables: (1) industrialization level (log),measured as the ratio of industrial added value to gross regional product; (2) internet penetration rate (log), measured by the number of internet users per 100 people; (3) education level (log), measured number of students enrolled in higher education institution divided by total population; (4) environmental regulation (log), measured by the comprehensive utilization rate of general industrial solid waste; (5) extent of unemployment (log), number of individuals enrolled in unemployment insurance; (6) average house price (log), measured as average residential property prices; (7) urbanization level, measured by urban population divided by total population; (8) GDP per capita (log).

4. Empirical Results

4.1. Descriptive Results

Table 2 provides the descriptive statistics for the Gini coefficient, local government debt ratio, and various control variables and instrumental variables. The average debt ratio (1.551) suggests that, on average, local governments have a debt that is about 155.1% of their comprehensive fiscal capacity. The standard deviation (SD) of 1.142 indicates substantial variability in the debt ratios across different cities. The mean Gini coefficient (0.622) indicates a significant degree of inequality in the distribution of light intensity.

Table 2. Descriptive statistical analysis of variables.

Variables	Mean	SD	Min	Max	Data
Dependent Variable					
Gini coefficient	0.622	0.164	0.024	0.905	a
Independent Variable					
Local government debt ratio	1.551	1.142	0.018	8.789	b
Control Variables					
Industrialization level (Log)	0.311	0.096	0.097	0.693	c
Internet penetration rate (Log)	3.271	0.424	2.211	4.433	d
Education level (Log)	0.019	0.024	0.001	0.125	d
Environmental regulation (Log)	4.28	0.493	0.215	4.902	c
Extent of unemployment (Log)	12.701	1.013	8.294	16.395	c
Average house price (Log)	8.795	0.492	7.466	10.997	e
Urbanization level (Log)	1.895	0.165	0.521	2.178	c
GDP per capita (Log)	10.844	0.525	9.304	12.281	c
Instrumental Variables					
Administration cycle	2.502	1.362	1	5	f
Lagged debt ratio	1.505	1.087	0.018	7.494	a
Mechanism Analysis					
Infrastructure Development (Log)	2.930	0.362	1.335	4.071	c
Industrial Development (Log)	0.745	0.220	0.302	1.848	c
Warehousing and Logistics Construction (Log)	9.397	1.426	0	13.512	c

Notes. Data sources: a = nighttime light data is sourced from the Operational Linescan System (OLS) sensor aboard the Defense Meteorological Satellite Program (DMSP) operated by the United States; b = municipal finance department; c = China City Statistical Yearbook; d = China Science and Technology Statistical Yearbook; e = Anjuke statistics; f = manually coded by the author.

4.2. Regression Analysis

Table 3 presents the estimates of the effect of local government debt ratios on urban economic inequality. Column 1 reports the baseline specification without controls. Column 2 introduces individual fixed effects, and column 3 adds year fixed effects to the specification in column 2. Column 4 presents our preferred specification with the full set of control variables. The coefficient on the debt ratio is negative and statistically significant at the 1 percent level across all specifications. A one percentage point increase in the debt ratio is associated with a decrease in the Gini coefficient of 0.00567 (column 1), 0.00684 (column 2), 0.00616 (column 3), and 0.00438 (column 4), respectively. These results suggest that local government debt is associated with a reduction in urban economic inequality. These correlations are consistent with the hypothesis that debt-financed public investment may generate positive spillovers that narrow the urban-rural inequality. This pattern may reflect improved infrastructure development and public goods provision, which we explore further in the mechanism section. We also estimate specifications with one- and two-year lags of the debt ratio, reported in Appendix A Table A1. The model fit rise significantly, with R-squared rising to 0.11 and 0.30 respectively.

Table 3. Basic Regression Results.

Independent Variable	Gini Coefficient (Nighttime Light Intensity)			
	(1)	(2)	(3)	(4)
Local Government Debt Ratio	−0.00567 ***	−0.00684 ***	−0.00616 ***	−0.00438 ***
	(0.00111)	(0.00112)	(0.00112)	(0.00118)
Individual Fixed Effects	N	Y	Y	Y
Time Fixed Effects	N	N	Y	Y
Control Variables	N	N	N	Y
Constant	0.6309 ***	0.63241	0.63394 ***	0.52822 ***
	(0.0094)	(0.0019)	(0.0023)	(0.1201)
Year	2015–2020	2015–2020	2015–2020	2015–2020
Observations	1680	1680	1680	1680
R^2	0.0244	0.0261	0.0285	0.0880

Note. Standard errors in parentheses; *** $p < 0.01$. Standard errors are reported in parentheses.

4.3. Instrumental Variable Estimation

To address endogeneity concerns in estimating the causal effect of debt on income inequality, we employ a Two-Stage Least Squares (2SLS) approach. Although our basic regression controls for unobservable fixed effects, it does not account for the potential bidirectional causality between local government debt and economic inequality. We use two instrumental variables that satisfy the relevance and exclusion restrictions:

Administration cycle: We measure mayors' tenure cycles on a scale of 1–5, where 1 indicates a newly appointed mayor and higher values represent longer tenure [94]. China's cadre promotion system creates strong incentives for mayors to prioritize short-term economic growth through visible projects, particularly early in their terms. Thus, newly appointed mayors may accelerate borrowing in years 1–2 tenure. As tenure progresses, debt accumulation moderates as initial projects near completion. The timing of leadership changes is determined by political processes exogenous to local economic conditions [95], making it a valid instrument.

The exclusion criteria requires that tenure does not influence economic inequality through other channels. Extensive literature documents that local officials engage in tournament-style competition focused predominantly on GDP growth and fiscal revenue, not distributional outcomes [96–98]. During our sample period (2015–2020), officials had neither explicit incentives nor established policy tools to directly target inequality. This institutional feature makes it unlikely that tenure systematically influences inequality

through channels other than debt-financed infrastructure development. Nevertheless, we acknowledge that unobservable policies correlated with tenure cycles could potentially violate the exclusion restriction.

Lagged debt ratio: Following Cecchetti et al. [31], we use the previous year's debt ratio as an additional instrument. The strong persistence in local government debt provides a natural relevance relationship. Debt accumulation follows an incremental process where existing obligations shape current borrowing capacity and needs. Cities with higher past debt have ongoing infrastructure projects requiring continued funding.

The validity requires that past debt affects current inequality only through current debt levels. This assumption is plausible because debt affects inequality through current spending and policies. For example, today's infrastructure projects create employment opportunities. While past debt created these conditions, its effect on today's inequality operates through today's debt service and spending patterns. Figure 3 demonstrates the correlation between local government debt and its one-year leg ratio, confirming the relevance criteria.

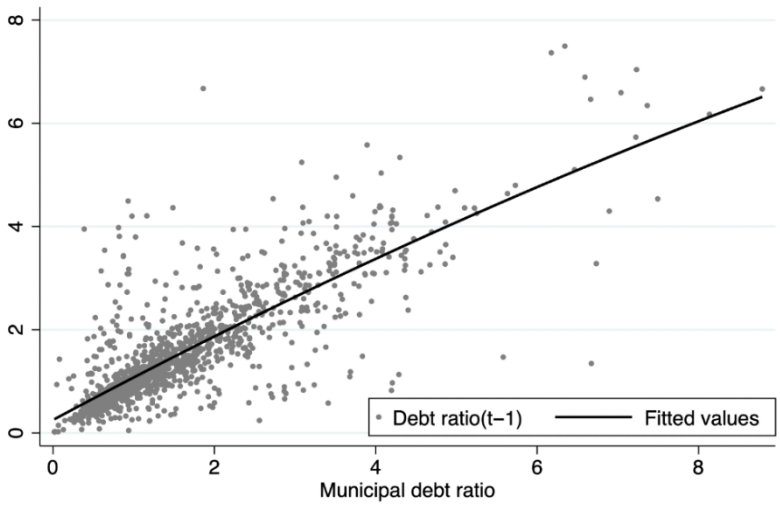

Figure 3. The correlation of local government debt ratio and $Debt_{t-1}$.

We employ a Two-Stage Least Squares (2SLS) approach with the following specification:

$$Debt_{it} = \alpha + \gamma Z_{it} + \sum_{i=1}^{n} \beta_n \cdot ControlVar_{it} + \varepsilon_{it} \quad (4)$$

$$Gini_{it} = \alpha + \rho \cdot Debt_{it} + \sum_{i=1}^{n} \gamma_n \cdot ControlVar_{it} + \mu_{it} \quad (5)$$

where $Debt_{it}$ represents the debt level for city i in year t, $ControlVar_{it}$ is a vector of covariates. Z_{it} is the instrumental variable, representing the administration cycle or lagged debt ration from the previous year. $Gini_{it}$ is the degree of urban economic inequality. The instrument Z_{it} serves as our excluded instrument that affects debt but has no direct effect on economic inequality except through its impact on debt. If the error term in the inequality equation, μ_{it} is correlated with debt levels due to, for instance, omitted variables or reverse causality, OLS estimates of ρ would be biased.

Tables 4 and 5 present the 2SLS regression results. First-stage results (Table 3) confirm the relevance of our instruments. The administration cycle shows a statistically significant negative relationship with local government debt ratios (coefficient of -0.0754, $p < 0.01$), indicating that mayors reduce borrowing as their terms progress. This behavior reflects strategic fiscal management aimed at signaling competence to higher authorities. The lagged debt ratio exhibits strong positive correlation (0.2778, $p < 0.01$), confirming debt persistence due to multi-year project commitments and budget constraints.

Table 4. First-Stage Regression Results.

Indipendent Variable	Administration Cycle		Lagged Debt Ratio	
	(1)	(2)	(3)	(4)
Instrumental variables	−0.0645 ***	−0.0754 ***	0.2898 ***	0.2778 ***
	(0.021)	(0.019)	(0.027)	(0.0274)
Constant	1.666 ***	11.649 ***	2.9207 ***	9.2458 ***
	(0.087)	(0.541)	(0.261)	(2.162)
Control variables	N	Y	N	Y
Year fixed effects	Y	Y	Y	Y
Individual fixed effects	N	N	Y	Y
R-squared	0.0149	0.2253	0.8143	0.8196

Note. Standard errors in parentheses; *** $p < 0.01$. Standard errors are reported in parentheses.

Table 5. Second-Stage Regression Results.

Independent Variable	Administration Cycle Model	Lagged Debt Ratio Model
	(5)	(6)
Local government debt ratio	−0.074 **	−0.0197 ***
	(0.036)	(0.004)
Constant	3.157 ***	0.711 ***
	(0.427)	(0.098)
Control variables	Y	Y
Year fixed effects	Y	Y
Individual fixed effects	N	Y
Cragg–Donald Wald F-statistic	16.443	102.585
	$p = 0.000$	$p = 0.000$
R-squared	0.1717	0.9813

Note. Standard errors in parentheses; *** $p < 0.01$, ** $p < 0.05$.

Second-stage results (Table 4) reveal that the instrumented debt ratio has a negative and statistically significant effect on economic inequality. In the administration cycle model (Column 5), the coefficient is −0.074 ($p < 0.05$), while the lagged debt ratio model (Column 6) yields a coefficient of −0.0197 ($p < 0.01$). The Cragg-Donald Wald F-statistics (16.443 and 102.585) exceed conventional thresholds, confirming instrument strength and alleviating weak instrument concerns.

While individual fixed effects effectively control for time-invariant unobserved factors, they may attenuate the administration cycle instrument's effectiveness when its impact primarily varies over time. Therefore, Model 5 employs time fixed effects rather than individual fixed effects to preserve the instrument's identification power, while Model 6 includes both types of fixed effects given the stronger relevance of the lagged debt instrument.

These findings suggest that debt-financed expenditures contribute to reducing urban economic inequality in China. The instrumental variable approach helps mitigate endogeneity concerns, allowing us to interpret this relationship as potentially causal rather than merely associative. However, we acknowledge that our instruments may not fully address all endogeneity issues. Unobserved policies or economic shocks correlated with both mayoral tenure and inequality could bias our estimates. Despite these limitations, the consistency of results across multiple instruments and mediation mechanisms provides reasonable confidence that local government debts could potentially mitigate inequality.

4.4. Heterogeneity Analysis

The effect of local government debt on economic inequality may vary across different regions. We divide our sample into four regions following the State Council's classification: Eastern, Northeaster, Central, and Western China. We then conduct empirical tests on these subsamples, with Table 6 presenting the results.

The results reveal notable regional heterogeneity in how local government debt affects economic inequality. Northeastern and Western regions show negative and statistically significant coefficients at the 1% level (−0.00466 and −0.00522, respectively), while the Central

region displays a negative coefficient significant at the 5% level (−0.00330). In contrast, the Eastern region exhibits a negative coefficient (−0.00462) that lacks statistical significance.

Table 6. Heterogeneous Effects of Debt on Local Economic Inequality by Region.

	(1)	(2)	(3)	(4)
	Eastern China	**Northeastern China**	**Central China**	**Western China**
Local Government Debt Ratio	−0.00462	−0.00466 ***	−0.00330 **	−0.00522 ***
	(0.00479)	(0.0092)	(0.00150)	(0.00100)
Control Variables	Y	Y	Y	Y
Individual Fixed Effects	Y	Y	Y	Y
Time Fixed Effects	Y	Y	Y	Y
Constant	−1.80685 ***	−0.42515 ***	−0.04114 ***	0.77255 ***
	(1.43755)	(0.33578)	(0.21320)	(0.12375)
Year	2015–2020	2015–2020	2015–2020	2015–2020
Observations	502	194	471	474
R^2	0.0944	0.5894	0.2151	0.2089

Note. Standard errors in parentheses; *** $p < 0.01$, ** $p < 0.05$.

Our findings suggest that local government debt reduces inequality more effectively in less developed regions. Several factors explain this pattern. First, Eastern coastal areas possess mature private capital markets that offer alternative financing sources, reducing reliance on government-led investments. Second, public investment yields higher returns in Western and Northeastern China due to their infrastructure gaps and lower capital stock. In less developed regions, government debt primarily funds infrastructure and social programs that benefit low-income households.

4.5. Mechanism Analysis Result

To examine the mechanisms through which local government debt affects income inequality, we employ a mediation analysis based on Baron and Kenny (1986) and subsequent methodological improvements [99,100]. This approach allows us to further investigate how local government debt influences economic inequality through various channels. We tested three potential pathways: infrastructure development, industrial development, and warehousing and logistics construction. We present our results in Table 7.

In Model 1 in Table 7, we regress infrastructure development (log) on local government debt ratio. The results show that debt slightly increases infrastructure investment. In Model 2, we regress the Gini coefficient on both debt and infrastructure development. Infrastructure development is negatively associated with the Gini coefficient. Infrastructure development is also negatively associated with the Gini coefficient ($\beta = -0.017$, $p < 0.05$), while the direct effect of debt remains significant ($\beta = -0.004$, $p < 0.01$). This indicates that infrastructure development partially mediates the relationship between debt and inequality. In other words, part of debt's effect on inequality operates through its impact on infrastructure investment. Therefore, H2, which posits that infrastructure development mediates the debt-inequality relationship, is supported.

In Model 3, we find a moderate positive relationship between debt and industrial development. In Model 4, when both debt and industrial development are included as predictors of inequality, industrial development shows a significant negative effect on the Gini coefficient ($\beta = -0.029$, $p < 0.01$), which suggests that industrial growth helps reduce inequality. These results indicate that industrial development partially mediates the relationship between debt and inequality, supporting H3.

Models 5 and 6 test the logistics infrastructure channel. Debt has a strong positive effect on logistics development ($\beta = 0.058$, $p < 0.01$), representing a 5.8% increase in logistics investment for each percentage point increase in debt ratio. When included together in Model 6, logistics development significantly reduces inequality ($\beta = -0.032$, $p < 0.01$),

while debt maintains its direct effect (β = −0.004, $p < 0.01$). The substantial coefficient on logistics development suggests this channel may play an important role in mitigating inequality. Enhanced logistics infrastructure connects rural areas to urban markets and thereby reduces transaction and storage costs and may raises rural incomes.

Table 7. Mechanism analysis result.

Variables	(1)	(2)	(3)	(4)	(5)	(6)
	Infc	Gini	Indc	Gini	Ware	Gini
Local Government Debt Ratio	0.025 ** (0.016)	−0.004 *** (0.002)	0.031 ** (0.017)	−0.004 *** (0.001)	0.058 *** (0.025)	−0.004 *** (0.001)
Infrastructure Development (Log)		−0.017 ** (0.005)				
Industrial Development (Log)				−0.029 *** (0.002)		
Warehousing and Logistics Construction (Log)						−0.032 ***
Individual fixed effects	Y	Y	Y	Y	Y	Y
Year fixed effects	Y	Y	Y	Y	Y	Y
Control Variables	Y	Y	Y	Y	Y	Y
Constant	1.163 * (0.641)	0.541 *** (0.120)	1.964 *** (0.351)	0.585 *** (0.121)	4.456 *** (2.493)	0.528 *** (0.120)
Observations	1680	1680	1680	1680	1680	1680
R^2	0.252	0.103	0.566	0.112	0.131	0.139

Note. Standard errors in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Standard errors are reported in parentheses.

The inclusion of mediator variables moderately improves model fit, with R-squared values increasing across all specifications. This confirms the presence of meaningful mediation effects.

Following Krull and MacKinnon (2001), we decompose the total effect of local government debt on income inequality into direct and indirect components [101]. The indirect effect is calculated as the product of two path coefficients: (a) the effect of debt on the mediator, and (b) the effect of the mediator on inequality, controlling for debt. The mediation proportion represents the percentage of the total effect that operates through each specific channel. The results are represented at Table 8.

Table 8. Mediation Analysis Results.

Mediator Variable	Indirect Effect	Direct Effect	Total Effect	Mediation Proportion
Infrastructure Development	−0.0004	−0.004	−0.0044	9.60%
Industrial Development	−0.0009	−0.004	−0.0049	18.35%
Warehousing and Logistics	−0.0019	−0.004	−0.0059	31.69%

Notes: Calculated based on Krull & MacKinnon (2001) [101].

The mediation analysis shows varying degrees of explanatory power across channels. Infrastructure development accounts for 9.60% of the total effect, while industrial development explains 18.35%. Notably, warehousing and logistics infrastructure demonstrates the strongest mediating role, accounting for 31.69% of the total effect.

Most notably, warehousing and logistics infrastructure emerges as the dominant mediating mechanism. This substantially exceeds our initial expectations and may underscore the critical role of distribution networks in China's spatial economy. This findings align with recent evidence on how e-commerce and modern logistics systems bridge urban-rural divides [75,77]. The relatively modest mediating roles of infrastructure and industrial development, suggest that these traditional investments may be reaching diminishing returns

in China's current development stage. This pattern is consistent with concerns raised in the literature about infrastructure benefits accruing disproportionately to already-developed areas and the potential for industrial overcapacity [65,66]. These results indicate that, as China's economy matures, the channels for reducing inequality are changing. Heavy infrastructure and manufacturing play smaller roles, while logistics services that bridge geographic divides have become the primary mechanism.

5. Discussion and Conclusions

Local governments across China increasingly rely on debt to finance public investments. Our paper investigates how this financing affects urban economic inequality. Our findings suggest that debt-financed public investment, when properly targeted, can promote more equitable regional development.

Building on existing literature, we developed and tested a theoretical framework linking local government debt to urban economic inequality. We proposed that debt-financed public investment reduces inequality through infrastructure construction, industrial development, and logistics networks. We then empirically tested this framework using panel data from 280 Chinese cities (2015–2020) and instrumental variable methods.

Our results show that high local government debt level moderately reduces urban economic inequality. Among the three channels, logistics infrastructure plays the dominant mediating role, followed by industrial development and traditional infrastructure. Our findings reflect China's evolving development stage. As the economy matures, connecting rural areas to markets through modern distribution networks is proving to be more effective at reducing spatial disparities than traditional heavy infrastructure.

We also find that the effects of debt financing are not uniform across regions. Debt is most effective at reducing inequality in less-developed Western and Northeastern China, where critical infrastructure gaps persist. In contrast, the effect is statistically insignificant in the highly developed Eastern region. This pattern implies that uniform debt policies across regions may be inefficient and that policies should be tailored to regional developmental needs.

Our study makes three contributions to the existing literature. First, we identify specific mechanisms—infrastructure, industry, and logistics—to explain how government debt affects inequality. Second, we employ large-sample data from Chinese cities to validate our theoretical model. Third, we establish that logistics infrastructure, rather than traditional channels, serves as the primary mechanism for reducing inequality in contemporary China.

Although our study is situated in the Chinese context, our study offers broader policy lessons. First, we show that targeted public investment, especially in logistics, can reduce inequality between regions. This is crucial for other developing nations seeking to enhance market connectivity for their underserved regions. Furthermore, we find that regional diversity makes uniform debt policies ineffective. Fiscal policies should instead be adapted to local development needs. In sum, our study contributes to the global conversation on sustainable development by providing evidence that well-designed fiscal policies can successfully balance the goals of economic growth and social equity.

Our study has several limitations that need future research. First and foremost is the challenge of measuring economic inequality using nighttime light (NTL) data. As we discuss in detail in Section 3.1, while this approach allows us to overcome the absence of reliable income data at the prefecture level in China, the evidence supporting NTL as a robust proxy for inequality remains contested. The relationship between spatial patterns of light and the distribution of household income is indirect and, as Mirza et al. (2021) argue, neither NTL-based nor survey-based measures can be considered a perfect

"gold standard" [38]. Thus, our findings should be viewed as providing preliminary and exploratory evidence. Future research, ideally leveraging newly available micro-level household survey data is needed to validate or refine the conclusions drawn from NTL-based proxies.

A second limitation, related to the first, is that the Gini coefficient, as a single number, oversimplifies how inequality is structured [84]. For example, our measure cannot distinguish whether inequality is caused by a few extremely wealthy areas versus a more widespread divide between rich and poor neighborhoods. Third, while our instrumental variables address some endogeneity concerns, unobserved policies correlated with mayoral cycles may still bias our estimates. Forth, our study focuses solely on economic inequality. Future research should explore whether debt-financed development affects minority groups differently, especially in western regions where such populations are concentrated. Broader research into how local government debt impacts other dimensions of social welfare, such as human rights, public health and environmental quality [21,102–104], would offer a deeper understanding for policymakers. As China continues its economic transition, understanding these relationships becomes increasingly important for sustainable and inclusive development.

Author Contributions: Conceptualization, Y.H.; methodology, Y.H. and H.L.; validation, H.L.; data curation, H.L.; writing—original draft preparation, H.L.; writing—review and editing, Y.H.; visualization, Y.H. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by National Social ScienceFund of China, grant number 24BGL227.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: The data that supports this manuscript are available from Yingjia Hu upon reasonable request.

Acknowledgments: The authors are grateful to all the funding agencies, the editors, Zhihe Vincent Zhang and the anonymous referees for valuable comments and suggestions.

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

Appendix A

Table A1. Basic Regression Results with One and Two-year lag.

Independent Variable	Gini Coefficient (Nighttime Light Intensity)		
	(1)	(2)	(3)
Local Government Debt Ratio	−0.00438 ***	−0.00342 ***	−0.00334 ***
	(0.00118)	(0.00132)	(0.00059)
$Debt_{t-1}$		−0.00348 **	−0.00289 ***
		(0.00125)	(0.00054)
$Debt_{t-2}$			−0.00197 ***
			(0.00048)
Individual Fixed Effects	Y	Y	Y
Time Fixed Effects	Y	Y	Y
Control Variables	Y	Y	Y
Constant	0.52822 ***	0.49169 ***	0.65891 ***
	(0.1201)	(0.1272)	(0.06567)
Year	2015–2020	2015–2020	2015–2020
Observations	1680	1362	1082
R^2	0.0880	0.1052	0.2982

Note. Standard errors in parentheses; *** $p < 0.01$, ** $p < 0.05$. Standard errors are reported in parentheses.

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