sustainability

MDPI

Article

Impact of Anti-Corruption on the Sustainability of Local Government Debt in China: The Moderating Role of Fiscal Transparency

Li Yang [1,*], Wenxiu Hu [2], Zhenxing Su [3] and Jianqi Qiao [2]

[1] School of Economics and Finance, Xi'an International Studies University, Xi'an 710128, China
[2] School of Economics and Management, Xi'an University of Technology, Xi'an 710048, China; huwenxiu1964@163.com (W.H.); 1170510005@stu.xaut.edu.cn (J.Q.)
[3] School of Business, Xi'an International Studies University, Xi'an 710128, China; 1180511009@stu.xaut.edu.cn
* Correspondence: 1170510014@stu.xaut.edu.cn

Abstract: In the process of government management, officials may engage in rent-creation and rent-seeking within finance and debt management for personal gain, leading to corruption and jeopardizing government debt sustainability. Can anti-corruption effectively ameliorate this predicament? Based on the growing severity of global debt sustainability, 30 provincial-level administrative regions in China are used as research samples to explore the influence of China's anti-corruption campaign targeting officials on local government debt sustainability and the moderating role of fiscal transparency. The results indicate that enhancing anti-corruption efforts will improve the sustainability of local government debt, while fiscal transparency will magnify this positive impact. Furthermore, regional heterogeneity analysis demonstrates that, in developed regions, the impact of anti-corruption on debt sustainability and the moderating impact of fiscal transparency have been bolstered by effective policy implementation. Our research findings not only unveil the influence of anti-corruption on local government debt sustainability and the crucial role of fiscal transparency, but also offer fresh insights to enable local government authorities to manage debt sustainably.

Keywords: anti-corruption; local government debt sustainability; fiscal transparency; moderating effect

check for updates

Citation: Yang, L.; Hu, W.; Su, Z.; Qiao, J. Impact of Anti-Corruption on the Sustainability of Local Government Debt in China: The Moderating Role of Fiscal Transparency. *Sustainability* **2024**, *16*, 9507. https://doi.org/10.3390/su16219507

Academic Editors: Andrzej Cieslik and Tomasz Misiak

Received: 12 June 2024
Revised: 5 July 2024
Accepted: 19 July 2024
Published: 31 October 2024

Copyright: © 2024 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

1. Introduction

Public debt management is a key concern for national authorities due to its significance in economic development. Since the outbreak of the COVID-19 pandemic in 2019, governments have accrued substantial additional public debts [1]. With the pandemic transitioning into the "Post-Pandemic era", debt risks have started surfacing, jeopardizing debt sustainability [2] and potentially endangering economic development. According to the United Nations, global public debt had risen to a record of $92 trillion by 2022. Among these, developing countries constituted roughly 30%, while China, India and Brazil accounted for nearly 70% of the developing countries' total debt, with China topping the list (Sources: IMF's Global Debt Database (https://www.imf.org/en/News/Seminars/Conferences/2022/12/12/2022-update-of-the-imf-global-debt-database-launch accessed on 12 December 2022) and the 2022 Global Debt Monitor (https://www.imf.org/-/media/Files/Conferences/2022/12/2022-12-12-global-debt-monitor.ashx accessed on 12 December 2022)). As the largest developing country, China's local government debt balance is projected to be approximately CNY 35.06 trillion by 2022 (Source: Ministry of Finance of the People's Republic of China (http://yss.mof.gov.cn/2023zyczys/202303/t20230327_3874818.htm accessed on 27 March 2023)), with a local government debt ratio of 125.3%. This surpasses the globally recognized debt risk threshold, making it imperative not to overlook debt risks. Furthermore, in recent years, China's fiscal deficit rate has consistently exceeded the globally recognized warning threshold of 3% due to the influence of the epidemic (Source: THE STATE COUNCIL THE PEOPLE'S REPUBLIC OF CHINA. (https:

//www.gov.cn/lianbo/fabu/202403/content_6936617.htm accessed on 5 March 2024)). The fiscal situation is less than optimistic, with the government's solvency under threat, and a worrisome overall level of debt sustainability.

Drawing from rent-seeking theory and principal-agent theory, government officials, who serve as the primary administrators, may partake in rent-seeking during government management, thereby fostering corruption in their self-interest [3,4]. Corruption in the fiscal sector results in reduced fiscal revenues and increased fiscal expenditures, worsening fiscal deficits [5]. Moreover, corruption in debt management may lead to an excessive expansion of debt [6]. Consequently, this will diminish the government's solvency, intensify the pressure for debt repayment, and imperil the sustainability of government debt. Anti-corruption measures can effectively suppress government officials' corrupt behavior and mitigate their rent-seeking tendencies in financial and debt management [7]. This contributes to enhancing government debt sustainability and mitigating debt risks.

In China, due to "GDP worship" [8] and the "promotion incentive" [9] of the political and economic system, government officials are encouraged to issue more bonds to stimulate economic growth during their term [10], often ignoring fiscal revenue, expenditure alignment, and long-term debt sustainability. This may lead to official corruption, seriously harming debt sustainability. Chinese authorities recognize the importance and urgency of anti-corruption, targeting government officials. The Beijing Declaration against Corruption and the Joint Convention against Corruption were released in 2014, signifying the initiation of an anti-corruption campaign targeting officials. According to data from China's Central Commission for Discipline Inspection, in 2022, discipline inspection and supervision organs across the nation filed 596,000 cases and penalized 592,000 individuals (Source: State Supervision Commission of the Central Commission for Discipline Inspection. (https://www.ccdi.gov.cn/toutiaon/202301/t20230114_241733.html accessed on 14 January 2023)). Additionally, the notion of the "normalization of anti-corruption" was introduced during the 20th National Congress of that year, further underscoring China's unwavering commitment to combating corruption.

Most existing research on the implications of anti-corruption focuses on the micro (enterprise) level, discussing its influence on enterprise innovation [11], merger and acquisition activities [12], and so on. Research on the macro-level implications of anti-corruption predominantly concentrates on the environment [13], economy [14] and other areas. However, most of these studies begin with enterprises and discuss their influence on the macro level from a micro perspective, rarely involving the anti-corruption efforts of officials. Only a small amount of attention has been paid to the role of anti-corruption efforts by government officials, such as their impact on government performance [15] and credibility [16]. Simultaneously, investigations into the determinants of government debt sustainability have mainly centered on two direct factors: fiscal concerns [17] and debt [18]. There is also emphasis on external shocks, such as the European Central Bank (ECB)'s Pandemic Emergency Purchase Program (PEPP) [19] and the coronavirus pandemic [2]. Nevertheless, there is little research on the impact of China's anti-corruption campaign targeting officials on government debt sustainability. Existing studies have acknowledged that corruption increases government debt [6] and exacerbates fiscal deficits [5]. Therefore, it is necessary and valuable to consider China's anti-corruption campaign targeting officials as an external shock and analyze its impact on government debt sustainability. Furthermore, previous studies indicate that heightened fiscal transparency can mitigate corruption [20], facilitate anti-corruption efforts [21], and be important to debt sustainability [22]. Based on the above practical background and theoretical research, the following research questions are posed in this paper:

Q1: Can the anti-corruption campaign targeting government officials effectively improve the sustainability of local government debt?
Q2: How does fiscal transparency influence the relationship between anti-corruption and debt sustainability?

To address the above research questions, in the context of the current global debt sustainability dilemma, this paper focuses on China's anti-corruption campaign targeting officials and utilizes a sample of 30 provincial-level administrative regions in China to investigate how anti-corruption efforts affect debt sustainability and to assess the moderating influence of fiscal transparency. Additionally, this paper conducts deeper analysis on whether disparities exist in the effects of anti-corruption on debt sustainability and the moderating influence of fiscal transparency across regions with differing levels of economic development in China. On the one hand, this analysis can expand the relevant research on the role of anti-corruption in debt sustainability; on the other hand, this analysis may offer fresh insights into the mitigation of China's present debt challenges and serve as a valuable reference for addressing the global debt sustainability issue.

The subsequent sections of this paper are structured as follows: Part II primarily analyzes the existing research on the impact of anti-corruption, the determinants of debt sustainability, and their interconnections, providing an overview of relevant research progress. Part III scrutinizes the influence of anti-corruption on government debt sustainability, discusses the moderating effect of fiscal transparency, and presents the hypothesis of this study. Part IV outlines the research design, involving variable measurement, data collection, and model construction. Part V analyzes the empirical results of hypothesis testing and analyzes regional heterogeneity. Part VI summarizes our findings and presents policy recommendations, and also acknowledges the limitations of this paper and suggests directions for future research.

2. Literature Review

At present, there is a dearth of research on the connection between anti-corruption and government debt sustainability. Therefore, this paper categorizes and analyzes the existing literature via three dimensions: the impact of anti-corruption, the determinants of local government debt sustainability, and the interplay between them. This review aims to establish a robust research foundation for our study.

Firstly, the majority of studies examining the impact of anti-corruption have focused on its efficacy in reducing corruption, and most have reached a positive conclusion [7]. Some scholars have extended the scope of anti-corruption research to encompass a broader array of areas, primarily categorized into micro and macro perspectives. Micro-level research contains various key perspectives. Recent studies have predominantly concentrated on the green development of enterprises, finding that initiatives can facilitate the green development of enterprises [23], enhancing green innovation [24,25] and the quality of environmental information disclosure [26]. These findings align with the results of studies involving typical enterprises, which demonstrate that anti-corruption can foster corporate innovation [11] and enhance financial reporting quality [27]. Additionally, alternative perspectives have yielded valuable insights, such as the importance of employing anti-corruption measures to facilitate cross-regional mergers and acquisitions [12], lower financing costs [28], and curtail overinvestment [29]. Macro-level studies are comparatively limited, but their focal points are diverse. Some approach anti-corruption from the angle of poverty alleviation and discover that anti-corruption measures can effectively mitigate poverty [30] and elevate local income levels [31]. Some delve into the realms of resources and the environment, uncovering that anti-corruption can ameliorate air pollution [13]. Moreover, from a government perspective, measures have been shown to enhance government performance [15], boost government credibility [16], and stimulate economic development [14,32].

Secondly, the exploration of the factors influencing debt sustainability has largely concentrated on two key aspects. The first aspect concerns the government's fiscal surplus and debt level, both of which are directly linked to debt sustainability. Current assessments of debt sustainability primarily hinge on two factors [33]. Studies indicate that reducing the fiscal deficit [34] or achieving a non-negative fiscal surplus [17] can enhance debt sustainability, while rapid debt accumulation exposes governments to substantial

risks [18,35]. Building on this foundation, some researchers have expanded their research and identified additional factors, such as transfer payments, fiscal imbalances [36], and private sector debt [37], all of which impact debt sustainability. The other aspect focuses on external shocks, primarily in the form of fiscal and monetary policies. Studies suggest that expansionary fiscal policies can pose a threat to debt sustainability [38]. Meanwhile, the impact of unconventional monetary policies remains uncertain. For example, quantitative easing in Japan is not conducive to debt sustainability [39], whereas the ECB's PEPP can enhance debt sustainability [19]. In addition, studies have examined other external shocks, including the COVID-19 pandemic [1,2] and interest rate shocks [40].

Lastly, there is limited research directly addressing the relationship between anti-corruption and debt sustainability. Nevertheless, studies on the association between corruption and debt provide valuable insights for this paper. For instance, research focusing on corruption in relation to debt and fiscal is pertinent, as both debt and fiscal play pivotal roles in determining debt sustainability. Research on corruption and public debt generally concurs that corruption leads to an increase in public debt [6,41]. Nonetheless, a few studies have suggested that moderate corruption is beneficial to the positive impact of debt on the economy [42]. Studies on corruption and fiscal matters indicate that corruption increases public expenditure and decreases public revenue [43], thereby adversely affecting the budget balance and producing fiscal deficits [44]. Some researchers have explored the link between corruption and sustainable government debt, but there is little direct research. Some studies analyze debt sustainability and propose that eliminating corruption is one of best the measures for ensuring debt sustainability [45]. Alternatively, some studies have been analyzed from a fiscal perspective, suggesting that corruption hinders efforts to increase public revenue and fiscal space [5] and hampers the ability of governments to deliver public services and infrastructure while sustaining their fiscal obligations [46], ultimately detrimentally impacting fiscal sustainability. Fiscal space and fiscal sustainability serve as effective indicators of debt sustainability. Therefore, on this basis, some scholars have explored the impact of corruption on government debt sustainability and found that corruption causes debt distress and affects the possibility of debt repayment [47], rendering public sector debt unsustainable [48].

In summary, the existing research has achieved fruitful insights at both the micro and macro levels regarding the impact of anti-corruption. However, its influence on government debt, particularly in terms of debt sustainability, has received limited attention. Simultaneously, research examining the factors influencing government debt sustainability primarily centers on two direct factors: fiscal matters and debt. However, it is also influenced by external policy shocks. However, there is a dearth of research and discussion regarding the impact of China's anti-corruption campaign targeting officials on government debt sustainability. Nonetheless, the existing research has demonstrated that corruption affects finance and debt, both of which are directly connected to debt sustainability, leading to a decrease in debt sustainability. Hence, it is meaningful to investigate the impact of anti-corruption on government debt sustainability within the framework of China's anti-corruption campaign.

In addition, the previous research suggests that fiscal transparency influences both anti-corruption and debt sustainability. Increased fiscal transparency reduces corruption [20], fosters anti-corruption [21], and plays a crucial role in ensuring debt sustainability [22]. Thus, building on the analysis of anti-corruption's influence on government debt sustainability, this paper further explores the impact of fiscal transparency on their relationship, aiming to enrich existing research in this area.

3. Hypothesis Development

3.1. Direct Effect of Local Anti-Corruption on Local Government Debt Sustainability

Currently, the academic community has essentially reached a consensus on the concept of debt sustainability, which is the evaluation of the government's capacity to service debt. This assessment implies that, given an intertemporal budget constraint, the level

of public debt is at most equal to the government's fiscal balance [49]. Therefore, it can be argued that government debt sustainability primarily hinges on two factors, namely, the level of debt and primary balances, with primary balances being contingent on fiscal revenue and expenditure. As the key decision-makers and implementers of government policies, government officials, based on principal-agent theory and rent-seeking theory, can negatively impact government debt levels and fiscal revenue [5,6] when they engage in corruption and prioritize their self-interest over public welfare [50], which further jeopardizes the sustainability of government debt. Therefore, when local governments combat corruption, they can mitigate official corruption driven by self-interest to some extent [7], thereby enhancing the sustainability of local government debt. This paper further analyzes the influence of anti-corruption on debt sustainability from the perspectives of fiscal revenue, fiscal expenditure, and local government debt.

(1) Government fiscal revenue: firstly, drawing from rent-seeking theory, officials engaged in corrupt practices, such as bribery, may facilitate interest exchanges that allow for tax evasion or unfair tax incentives to serve their personal interests [51]. Anti-corruption campaigns targeting officials can effectively curtail such corruption, expressed in bribery and tax evasion by officials. Furthermore, anti-corruption efforts foster public scrutiny of officials' tax-related decisions and implementation [52]. This enhanced oversight results in improved local government tax compliance, preventing tax losses and bolstering tax revenue. Secondly, research indicates that anti-corruption can improve the government's reputation [53] and cultivate a more favorable investment climate. According to investment theory, investors tend to favor markets with greater stability [54]. Consequently, anti-corruption efforts instill confidence in investors and attract capital, promoting local economic development and ultimately increasing government revenue. Hence, when local governments intensify their anti-corruption efforts, government tax compliance will be strengthened and, simultaneously, a more equitable investment environment, which can attract capital inflows to stimulate local economic growth, will be created. These factors will augment local government fiscal revenue, and, in turn, enhance local government solvency and debt sustainability.

(2) Reduce government spending: within China's fiscal decentralization system, local governments possess control over public goods [55]. In this context, officials exploit the information asymmetry between the public and the government for personal gain, engaging in rent-seeking practices through fiscal expenditures [56], such as the process of public procurement [57]. Anti-corruption can curb such behavior. Firstly, anti-corruption initiatives can mitigate corrupt practices, such as corruption and bribery, in the investment processes of public projects. This encourages officials to make judicious project investment choices, preventing excessive investment driven by personal interests [3]. This can avoid the waste of fiscal expenditure, reducing it. Secondly, anti-corruption measures help to eliminate the unfairness and favoritism of officials during the allocation of public resources. This leads to the more efficient allocation of fiscal funds and promotes the establishment of an effective market operation model, increasing the efficiency of fiscal expenditure and reducing expenditure costs. Consequently, local government spending decreases. Therefore, when local governments intensify anti-corruption efforts, officials' behavior is subject to public scrutiny, rent-seeking behavior related to fiscal expenditure is curtailed, expenditures become more reasonable, and fiscal efficiency is improved. This results in an effective reduction in local government spending, increased funds for debt repayment, improved debt repayment capacity, and enhanced debt sustainability.

(3) Decrease government debt: firstly, China's official promotion championship system [58] often incentivizes officials to abuse their power by issuing excessive and unjustifiable debt for the sake of political performance. During the utilization of debt funds, officials may also engage in rent-seeking behavior to serve their own interests. Anti-corruption measures can enhance governance level [59], preventing officials from issuing bonds excessively for political gain. Simultaneously, it can reduce officials'

rent-seeking behavior in the process of arranging debt funds, thereby increasing the efficiency of debt utilization, and effectively curbing the expansion of local government debt. Secondly, anti-corruption initiatives can boost credibility [16], sending a positive signal to the market and elevating investor expectations. This leads to a reduction in the financing costs of local government debt, ultimately contributing to a decrease in government debt levels. Therefore, when local governments intensify their anti-corruption initiatives, they can effectively control the debt's scale and reducing the costs of debt financing. This results in an overall reduction in local government debt levels and an improvement in local government debt sustainability.

To sum up, the strengthening of anti-corruption measures has a two-fold effect. Firstly, it reduces local government fiscal expenditure, increases fiscal revenue, and enhances debt repayment capability. Secondly, it decreases the overall debt level of local governments, alleviates debt repayment pressure, and enhances the sustainability of local government debt. Therefore, based on the preceding analysis, we propose the first hypothesis as follows:

H1: *Anti-corruption improves local government debt sustainability.*

3.2. Moderating Effect of Local Government Fiscal Transparency

Fiscal transparency reflects the extent of a government's information openness. Higher fiscal transparency corresponds to increased disclosure of information by governments, making government-related information more accessible and comprehensible to the public [60]. Corruption is inherently secretive [61], making it challenging to detect. In regions with high fiscal transparency, greater information disclosure makes it difficult for officials to conceal and obscure corruption. Various government affairs, including fiscal revenue and expenditure compliance and debt management, become subject to more supervision, ultimately contributing to improved local government debt sustainability. Therefore, this paper delves further into the role of fiscal transparency in the relationship between anti-corruption efforts and debt sustainability.

Firstly, improvements in fiscal revenue, expenditure, and debt levels are more likely to occur in regions characterized by high fiscal transparency, enhancing the efficacy of anti-corruption efforts in sustaining debt. More specifically, high fiscal transparency can perform the following: (1) foster citizens' tax morale and reduce tax evasion and avoidance [62], thereby bolstering tax compliance [63] and preventing revenue loss; (2) effectively curb excessive public spending [64], enhance the rational allocation of government resources, and reduce fiscal expenditure; and (3) decrease the government debt's scale [65] and lower the cost of government debt financing [66], resulting in better control of the government's debt level. Therefore, in high-fiscal-transparency areas, local governments can more effectively implement anti-corruption measures [21]. Higher fiscal transparency contributes to enhancing the effect of anti-corruption on the increase in fiscal revenue, the reduction in fiscal expenditure, and the level of government debt, ultimately improving government debt sustainability.

Secondly, from a holistic perspective, high fiscal transparency offers a dual impact. On one hand, drawing from signal theory, regions with high fiscal transparency send positive signals to the market, strengthening government credibility [67]. This magnifies investors' positive expectations brought about by the anti-corruption campaign targeting officials, attracting capital inflows, stimulating economic development, augmenting government revenue, and significantly improving government debt sustainability. On the other hand, guided by principal-agent theory, high fiscal transparency effectively reduces the informational asymmetry between citizens and the government [67] and encourages public engagement in public affairs (supervision, reporting, etc.). This heightened public support and participation in local anti-corruption campaign targeting officials increases the cost and psychological pressure on officials [68], prompting them to reduce or abandon corrupt practices in public fiscal and debt management processes. This significantly enhances government governance performance, improves the government's debt repayment capac-

ity, lowers debt levels, and notably advances government debt sustainability. Therefore, high fiscal transparency amplifies the expectations of investors regarding anti-corruption, augments the positive impact of capital inflows on government revenue, promotes public engagement in anti-corruption, and enhances the improvement of government administration. These measures help to achieve the effect of improving debt solvency and reducing debt level brought about by anti-corruption, thereby more effectively boosting government debt sustainability.

In summary, regions with higher fiscal transparency facilitate the detection and curbing of corruption among officials in fiscal revenue, expenditure, and debt management. They also fuel investor optimism and encourages public participation, thereby amplifying the impact of anti-corruption on debt repayment and debt levels. This, in essence, strengthens the role of anti-corruption in promoting government debt sustainability. Thus, based on the analysis above, this paper proposes the second hypothesis:

H2: *Fiscal transparency has a positive moderating effect on anti-corruption in terms of promoting local government debt sustainability, that is, in areas with high fiscal transparency, anti-corruption has a stronger positive effect on local government debt sustainability.*

The conceptual framework is shown in Figure 1:

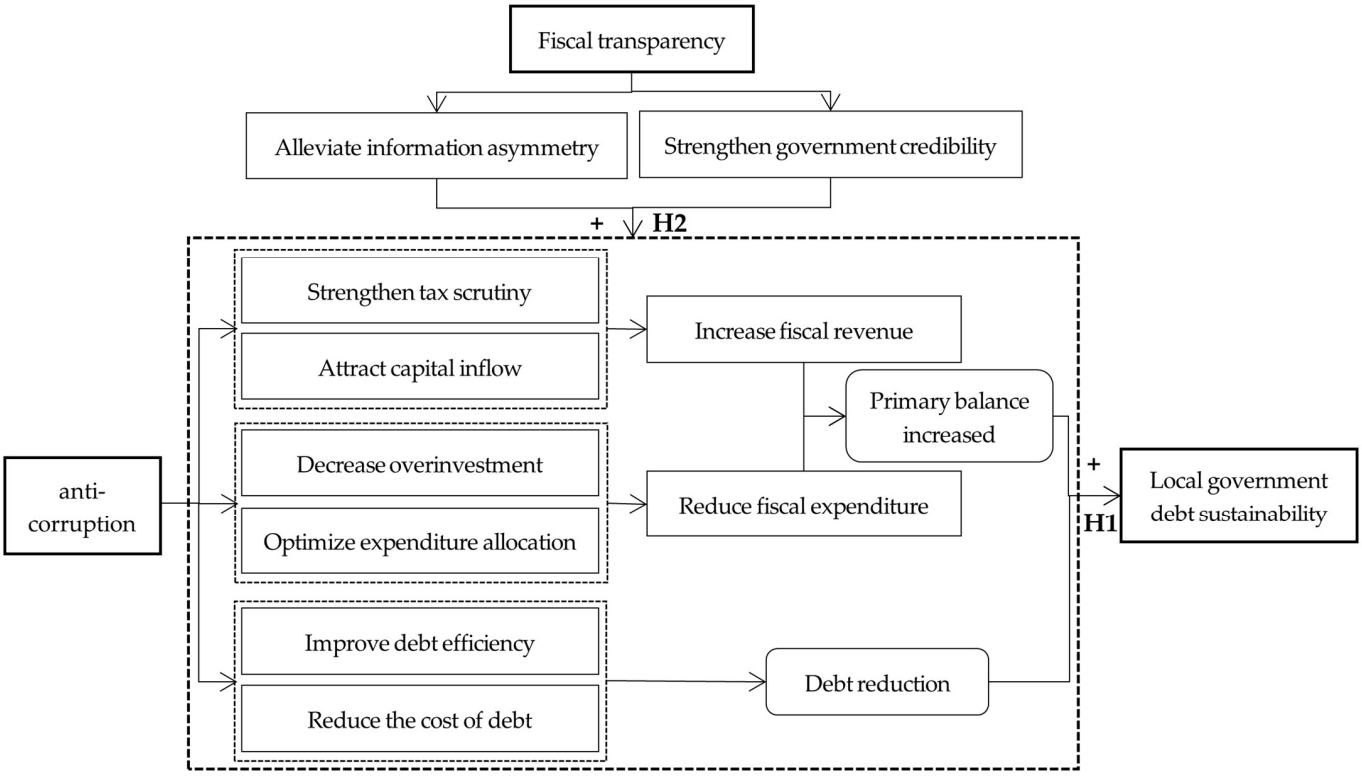


Figure 1. Conceptual framework.

4. Research Design

4.1. Variables

4.1.1. Dependent Variable

Local Government Debt Sustainability (*SUSTAIN*): This paper draws on the work of Xia et al. [69] to measure local government debt sustainability by considering the idea of available fiscal space. Available fiscal space represents the current budgetary space supporting economic development, and Ghosh et al. [33] defined it as the difference between current debt ratios and the computed debt limit. Building upon this definition,

Li and Du [36] introduce a fiscal expenditure efficiency index to construct "effective fiscal space", calculated as follows:

$$SUSTAIN_{i,t} = \frac{d^*_{i,t} - d_{i,t}}{1/fe_{i,t}} \quad (1)$$

where, i denotes the province, t denotes the time, and $d_{i,t}$ denotes the actual government debt ratio of province i in year t. $d^*_{i,t}$ is a sustainable debt ratio, which can also be understood as the debt limit, as determined through a nonlinear fiscal response function. fe signifies the efficiency of government fiscal expenditure, as computed using the DEA model.

Firstly, the nonlinear fiscal response function is employed to compute d^*. Drawing from Bohn's [70] linear financial response function, Ghosh et al. [33] proposed the nonlinear fiscal response function, grounded in the concept of fiscal fatigue, to assess the response of the base balance to lagging debt. On this basis, integrating insights from Li and Du [36], this study incorporates the lagged primary balance to formulate the nonlinear fiscal response function as follows:

$$pb_{i,t} == \rho pb_{i,t-1} + \lambda f(d_{i,t-1}) + = \varphi X_{i,t} + \mu_{i,t} \quad (2)$$

where $pb_{i,t}$ signifies the fiscal primary balance ratio of province i in year t; $pb_{i,t-1}$ represents the one-period-lagged fiscal primary balance ratio; $d_{i,t-1}$ represents the one-period-lagged real government debt ratio (i.e., the real government debt ratio of province i in year $t-1$); and $f(d_{i,t-1})$ represents the cubic function of the government debt ratio, as given in Equation (3). $X_{i,t}$ represents a set of vectors encompassing factors that could influence the fiscal primary balance ratio and $\mu_{i,t}$ denotes the residual terms of the model.

$$f(d_{i,t-1}) = \lambda_1 d_{i,t-1} + \lambda_2 d^2_{i,t-1} + \lambda_3 d^3_{i,t-1} \quad (3)$$

Referring to Ghosh et al. [33] and Debrun et al. [49], the debt and fiscal primary balance also adhere to the government budgetary constraints, meaning total government spending must be covered by revenues and bond issuance. In conjunction with Xia et al. [69], the following can be inferred:

$$d_t - d_{t-1} = (r_t - g_t)d_{t-1} - pb_t \quad (4)$$

where d signifies the government debt ratio, pb denotes the fiscal primary balance ratio, g stands for the real GDP growth rate, and r represents the real interest rate on all debt balances.

If and only if the difference between the current debt ratio and the previous period's debt ratio is 0, the debt ratio reaches a maximum value, which is expressed as follows:

$$d_t - d_{t-1} = (r_t - g_t)d_{t-1} - pb_t = 0 \quad (5)$$

By combining Equations (2), (3) and (5), the maximum debt ratio can be determined, and the largest real solution of the cubic equation represents the debt limit d^*.

Secondly, following the approach of Li et al. [3], the DEA model is employed to compute the efficiency of government fiscal expenditure fe. The input–output indicators are categorized into economic and social input–output. Economic input indicators encompass the per capita fixed-asset input, while output indicators comprise economic development strength, capability, stability, rationality and outward orientation. Social input indicators include per capita expenditure for infrastructure, education expenditure, science and technology, health care, social security, and the ecological environment, with corresponding output indicators involving public infrastructure, education, science and technology, health care, social security, and the ecological environment.

Finally, *SUSTAIN* is derived by substituting d^* and fe into the Equation (1). The detailed calculation steps are provided in Appendix A.

4.1.2. Independent Variable

Anti-corruption efforts (*ACORR*): The most widely used measure of anti-corruption efforts is the "Corruption Perception Index" released by Transparency International. However, this index assesses anti-corruption at the national level, and it does not account for variations within specific regions, provinces, or cities. Furthermore, it primarily focuses on the corruption referred to as "abuse of public office for personal gain" (The corruption perception index measures corruption and content from the Transparency International.). Wedeman's [71] research has demonstrated that corruption in China includes not only traditional bribery and the abuse of public power for personal gain but also malfeasance. Therefore, some scholars have attempted to gauge anti-corruption efforts by employing the number of corruption cases, yielding meaningful conclusions [16,23].

Hence, as proposed by Zhou and Li [23], this paper adopts the number of corruption cases per 10,000 public officials as an indicator of the anti-corruption efforts of the local government authority. The number of corruption cases includes investigations into local public officials for embezzlement, bribery, power peddling, malfeasance, and similar offenses (Material from The Supreme People's Procuratorate of the People's Republic of China). To ensure equitable comparisons across regions with differing numbers of government officials, it is reasonable to employ the ratio of corruption cases to the total number of public officials within a given region. The number of public employees in each region is presented in terms of individuals employed in urban units of public administration, social security, and social organizations.

4.1.3. Moderating Variable

Local government fiscal transparency (*FT*): The widely recognized concept of fiscal transparency, as introduced by Kopits and Craig [72], pertains to the extent to which a government discloses to the public information about its functions, organizational structure, fiscal policies, financial budgets, and public accounts, as well as other reliable and timely data. Most existing research employs this concept to construct evaluation systems that support fiscal transparency from various dimensions. Although the transparency score issued by the International Budget Promotion Council is frequently employed, these data operate at the national level and are not suited for use in regional research within a country. Consequently, many scholars develop indicators grounded in the concept of fiscal transparency to assess the transparency of local governments within the nation.

This paper, drawing on the work of Deng et al. [60], utilizes the fiscal transparency index from the China Fiscal Transparency Report, which is published by Shanghai University of Finance and Economics, to gauge the fiscal transparency of local governments. Deng et al. [60] evaluated fiscal transparency scores for the 31 provincial-level administrative regions on the Chinese mainland. Their evaluation was based on the comprehensiveness and hierarchy of financial information accessibility, involving an analysis of 113 specific questions. These findings are also presented in the China Fiscal Transparency Report, which also includes precise fiscal transparency evaluation indicators, methodologies, and calculation procedures. As a result, a fiscal transparency score is derived for each provincial-level administrative region, as graded on a 100-point scale, with higher scores indicating a greater level of fiscal transparency.

4.1.4. Control Variable

In addition to the dependent variable, independent variable, and moderating variable, there should theoretically be other factors affecting local government debt sustainability. Drawing on Li and Du [36] and Klutse et al. [2], considering the availability of data, this paper introduces the following four control variables: (1) GDP growth rate (GGDP), indicated by the annual GDP growth rate of each province; (2) GDP per capita (PGDP), calculated as the ratio of each province's GDP to the resident population at the year-end; (3) fiscal decentralization (FD), measured by the proportion of per capita local government fiscal revenue to the sum of per capita local government fiscal revenue and per capita

central government fiscal revenue; and (4) the fixed-asset investment growth rate (GFIX), represented by the growth rate of fixed-asset investment in each province.

All variables in this paper are summarized in Table 1:

Table 1. Definitions and descriptions of variables.

Type	Variable	Abbreviation	Definition	Resources
Independent variable	Local government debt sustainability	*SUSTAIN*		Calculated using Nonlinear Financial Response Function
Dependent variable	Local anti-corruption	*ACORR*	Number of corruption cases/(number of public officials/10,000)	China Statistical Yearbook, Work Statements of Procuratorates
Moderating variable	Fiscal transparency	*FT*	Fiscal transparency score	China Fiscal Transparency Report, released by Shanghai University of Finance and Economics
Control variable	GDP growth rate	*GGDP*	Year-on-year growth rate of GDP	China Statistical Yearbook
	Per capita GDP	*PGDP*	GDP/year-end resident population	China Statistical Yearbook
	Fiscal decentralization	*FD*	Per capita local government fiscal revenue/(per capita local government fiscal revenue + per capita central government fiscal revenue)	China Statistical Yearbook
	Fixed-asset investment growth rate	*GFIX*	Year-on-year growth rate of fixed-asset investment	China Statistical Yearbook

4.2. Data

Due to differences in economic systems, this paper excludes three regions, Hong Kong, Macao and Taiwan. It selects the remaining 31 provincial-level administrative regions as research objects to analyze the impact of anti-corruption efforts on local government debt sustainability. Initial data collection indicates that the relevant data on the number of corruption cases for the independent variable are only available up to 2017, while data for calculating local government debt sustainability as the dependent variable are valid from 2010. Consequently, the initial sample period is selected from 2010 to 2017, using annual data frequency.

The primary data sources used to calculate local government debt sustainability are mainly derived from the China Statistical Yearbook, China Fiscal Yearbook, Population Census, China Statistical Yearbook on Science and Technology, The National Bureau of Statistics of China, and WIND databases. Specific data sources for each indicator are detailed in the Appendix A. The relevant data on anti-corruption efforts are obtained from the China Statistical Yearbook and the research reporting on provincial and municipal procuratorates. Fiscal transparency data are sourced from the China Fiscal Transparency Report released by the Public Policy Research Center of Shanghai University of Finance and Economics. Control variable data are derived from the China Statistical Yearbook.

It should be noted that the data on the number of corruption cases primarily represent the sum of corruption, bribery, and dereliction of duty cases disclosed by regional procuratorates. The data released in 2012 and 2017 are cumulative figures for the previous five years. Therefore, the data for corruption cases in these two years are derived by subtracting the data of the preceding four years from the five-year total.

Due to insufficient data availability in the Tibet Autonomous Region, this region was excluded from the sample, leaving 30 provincial-level administrative regions. Multiple imputation methods were applied to address concerns regard minor missing data. This

process yielded a final dataset consisting of 240 panel data samples from 2010 to 2017 across the 30 provincial-level administrative regions.

4.3. Model

To examine the direct impact of anti-corruption efforts on local government debt sustainability (H1), this paper formulates the following econometric model:

$$\begin{aligned} SUSTAIN_{i,t} &= \alpha_0 + \alpha_1 ACORR_{i,t} + \alpha_2 GGDP_{i,t} + \alpha_3 PGDP_{i,t} + \alpha_4 FD_{i,t} + \alpha_5 GFIX_{i,t} \\ &+ Pro + Year + \varepsilon_{i,t} \end{aligned} \quad (1)$$

where i denotes the province, t denotes the time, and $X_{i,t}$ represents the value of the variable X in the year t for province i. $SUSTAIN_{i,t}$ is the local government debt sustainability in the year t for province i. *Pro* and *Year* denote provincial and time-fixed effects, respectively. $\varepsilon_{i,t}$ is the residual term, and α_i is the parameter to be estimated. α_1 is the pivotal parameter in model (1), signifying the direct influence of anti-corruption efforts on local government debt sustainability. If α_1 is significantly positive, this indicates that intensified anti-corruption efforts leads to improved local government debt sustainability, supporting H1.

To examine the moderating effect of fiscal transparency on the relationship between anti-corruption strength and local government debt sustainability (H2), this paper, drawing on Hayes [73], employed two methods and formulated the following econometric model. The two methodologies were principal techniques that are widely utilized in studies assessing moderation effects. They not only bolster hypothesis validation but also act as complementary validations, serving as a robustness test to guarantee the steadfastness and reliability of the outcomes.

Method 1 involves introducing interaction terms of *ACORR* and *FT* to model (1), yielding the model (2):

$$\begin{aligned} SUSTAIN_{i,t} &= \beta_0 + \beta_1 ACORR_{i,t} + \beta_2 ACORR_{i,t} \times FT_{i,t} + \beta_3 FT_{i,t} + \beta_4 GGDP_{i,t} \\ &+ \beta_5 PGDP_{i,t} + \beta_6 FD_{i,t} + \beta_7 GFIX_{i,t} + Pro + Year + \varepsilon_{i,t} \end{aligned} \quad (2)$$

The meaning of the variable symbol is the same as that in model (1). $FT_{i,t}$ indicates the government fiscal transparency in year t for province i. $ACORR_{i,t} \times FT_{i,t}$ is the interaction item between anti-corruption and fiscal transparency. $ACORR_{i,t}$ and $FT_{i,t}$ are centralized. β_2 is the crucial parameter in model (2), indicating the presence and direction of the moderating effect of fiscal transparency on the relationship between anti-corruption efforts and local government debt sustainability. If β_2 is significantly positive, this suggests the existence of a positive moderating effect, providing preliminary support for H2. Furthermore, in conjunction with model (1)'s results, if α_1 is significantly positive, it can be inferred that fiscal transparency reinforces the positive impact of anti-corruption efforts on local government debt sustainability, supporting H2.

Method 2 involves constructing a grouped regression model (3) based on model (1):

$$\begin{aligned} SUSTAIN_{i,t} &= \gamma_0 + \gamma_1 ACORR_{i,t} + \gamma_2 GGDP_{i,t} + \gamma_3 PGDP_{i,t} + \gamma_4 FD_{i,t} + \gamma_5 GFIX_{i,t} \\ &+ Pro + Year + \varepsilon_{i,t} \quad (FT \geq FT_M \text{ or } FT < FT_M) \end{aligned} \quad (3)$$

The meaning of the variable symbol is the same as in model (1). FT_M is the grouping threshold of the moderating variable *FT* after being set to the median of *FT*. The key parameter in model (3) is γ_1, signifying the impact of anti-corruption efforts on local government debt sustainability under varying levels of fiscal transparency. The presence and direction of the moderating effect are primarily assessed by comparing the difference between $FT \geq FT_M$ (higher fiscal transparency) and $FT < FT_M$ (lower fiscal transparency). If $FT \geq FT_M$, γ_1 is significantly positive. When $FT < FT_M$, and γ_1 is ither negative, positive but not significant, or positive and significant but with low significance, this indicates the existence of a moderating effect of *FT*. The positive relationship between *SUSTAIN* and *ACORR* is strengthened, affirming that fiscal transparency enhances the

promotion of anti-corruption efforts in terms of the debt sustainability of local government, thus verifying H2.

5. Empirical Analyses

5.1. Basic Statistics

The descriptive statistics of each variable during the sample period are presented in Table 2, providing an initial basis for the analysis of anti-corruption efforts, debt sustainability, and fiscal transparency in 30 provincial-level administrative regions in China.

Table 2. Descriptive statistics of variables.

Variable	Obs	Mean	Std. Dev.	Min	Median	Max
SUSTAIN	240	0.066	0.273	−0.493	−0.041	0.743
ACORR	240	22.604	6.604	7.661	21.459	42.043
FT	240	32.785	13.967	14	27.795	77.7
GGDP	240	0.118	0.06	−0.04	0.106	0.265
PGDP	240	4.552	2.254	1.288	3.906	13.617
FD	240	0.51	0.124	0.304	0.487	0.833
GFIX	240	0.141	0.107	−0.566	0.145	0.406

The results in Table 2 reveal the following findings:

(1) The mean value of *SUSTAIN* is 0.066, with a median of −0041. This suggests that the overall debt sustainability of China's 30 provincial-level administrative regions is positive, with most regions in a sustainable state and facing limited risks. However, the minimum and maximum values are −0.493 and 0.743, respectively, with a standard deviation of 0.273, indicating significant variations between regions. Some regions are already experiencing unsustainable (negative) debt, which implies greater debt risk.

(2) The average value of *ACORR* is 22,604, with a median of 21,459, showing relative stability in the overall level of anti-corruption efforts across regions. This aligns with the concept of the "normalization of anti-corruption", which was introduced in the 2023 government work report. The anti-corruption effort of each region is generally favorable, but substantial differences exist between regions, as evident from the minimum value of 7.661, the maximum value of 42.043, and the standard deviation of 6.604.

(3) The average *FT* stands at 32,785, with a median of 27,795, reflecting a generally low level of fiscal transparency in each region, with limited financial information disclosure by local governments. Nevertheless, there is an overall upward trend in fiscal transparency, with improvements gradually addressing the issue of fiscal opacity. The range spans from a minimum value of 14 to a maximum of 77.7, with a standard deviation of 13.967. These results highlight the substantial variations between regions, which are even more pronounced than those of *SUSTAIN* and *ACORR*.

(4) The statistical characteristics of the control variables *GGDP, PGDP*, *FD* and *GFIX* align with those of existing studies, with no apparent anomalies. The selected variables included in this paper demonstrate sound statistical distribution properties, allowing for further statistical analysis.

In summary, the initial descriptive statistics reveal substantial variations in debt sustainability, anti-corruption efforts, and fiscal transparency across different regions and years, which is potentially attributable to geographic and economic disparities. Consequently, more in-depth panel data analysis is essential in order to investigate the impact of anti-corruption efforts on local government's debt sustainability.

5.2. Results Analysis

Based on the static panel data in this study, and to address issues of heteroscedasticity and serial correlation in the model, the panel feasible generalized least-squares method (FGLS) is employed for data processing and analysis, as suggested by Li et al. [3], except for in the robustness test. Table 3 presents the empirical results of the hypothesis test.

Table 3. Estimation results of the direct and moderating effect.

	(1)	(2)	(3)	(4)
Variable	*SUSTAIN*	*SUSTAIN*	*SUSTAIN* ($FT < 27.795$)	*SUSTAIN* ($FT \geq 27.795$)
ACORR	0.00556 **	0.00454 **	0.00100	0.00828 ***
	(2.46)	(1.98)	(0.28)	(2.87)
ACORR × *FT*		0.000332 **		
		(2.12)		
FT		−0.000169		
		(−0.15)		
GGDP	2.685 ***	2.754 ***	2.905 ***	2.623 ***
	(8.26)	(8.47)	(5.64)	(5.77)
FD	0.166	0.147	0.0473	−0.00886
	(0.74)	(0.63)	(0.12)	(−0.03)
PGDP	0.00401	0.00567	0.0233	0.00636
	(0.33)	(0.45)	(1.01)	(0.42)
GFIX	0.643 ***	0.630 ***	0.549	0.693 ***
	(3.84)	(3.68)	(1.35)	(3.60)
Cons	−0.534 ***	−0.411 ***	−0.459 **	−0.519 ***
	(−4.85)	(−4.72)	(−2.27)	(−3.50)
Year	Control	Control	Control	Control
N	210	210	90	120
Wald	204.6 ***	213.5 ***	79.80 ***	120.9 ***

Note: *z* statistics in parentheses, ** $p < 0.05$, *** $p < 0.01$.

In Table 3, column (1) examines the direct impact of anti-corruption efforts on local government debt sustainability. The regression results reveal a significant positive correlation between *ACORR* and *SUSTAIN* ($\alpha_1 = 0.00556$, $p < 0.05$), demonstrating that stronger anti-corruption efforts lead to higher local government debt sustainability. In other words, anti-corruption significantly enhances the sustainability of local government debt, confirming H1. This outcome is attributed to the effective control of official corruption in certain areas, with robust anti-corruption efforts made during fiscal revenue, expenditure, and debt management. This, in turn, improves the solvency of local governments, reduces debt levels, and enhances local government debt sustainability.

Column (2) examines the moderating effect of fiscal transparency on the relationship between anti-corruption efforts and local government debt sustainability. The regression results show a significant positive correlation between the interaction term *ACORR* × *FT* and *SUSTAIN* ($\beta_1 = 0.000332$, $p < 0.05$), signifying the existence of a positive moderating effect of fiscal transparency and providing preliminary support for H2. When combined with the results of column (1), where *ACORR* significantly and positively correlates with *SUSTAIN* ($\alpha_1 = 0.00556$, $p < 0.05$), it can be inferred that fiscal transparency positively moderates the relationship between anti-corruption efforts and local government debt sustainability. This implies that greater fiscal transparency strengthens the positive impact of anti-corruption efforts on local government debt sustainability, confirming H2. This is because fiscal transparency amplifies the role of anti-corruption in enhancing debt sol-

vency and debt management by facilitating regional anti-corruption efforts and bolstering investor and public expectations, ultimately making it easier for anti-corruption to enhance government debt sustainability.

Columns (3) and (4) assess the moderating effect of fiscal transparency on the relationship between anti-corruption efforts and local government debt sustainability through group regression. The results show that when $FT \geq 27.795$, *ACORR* and *SUSTAIN* exhibit a significant positive correlation ($\gamma_1 = 0.00828$, $p < 0.01$), suggesting that in regions with high fiscal transparency, anti-corruption efforts significantly promote local government debt sustainability. In contrast, when $FT < 27.795$, the positive correlation between *ACORR* and *SUSTAIN* is present but statistically insignificant, indicating that the impact of anti-corruption efforts on local government debt sustainability is not significant in regions with low fiscal transparency. Combining these results, when $FT \geq 27.795$, γ_1 is significantly positive, and when $FT < 27.795$, γ_1 is positive but not significant. It is evident that the moderating effect of fiscal transparency is present. Furthermore, it positively moderates the positive relationship between *ACORR* and *SUSTAIN*, emphasizing that fiscal transparency strengthens the impact of anti-corruption efforts on the sustainability of local government debt. This reaffirms H2 and is consistent with the conclusion drawn from column (2).

Based on the regression results, it can be determined that the moderating effect is significant. To further analyze this effect, a simple slope test is conducted, employing the Mean $\pm$ 1 SD (standard deviation) method to generate the moderating effect plot (simple slope plot), as depicted in Figure 2.

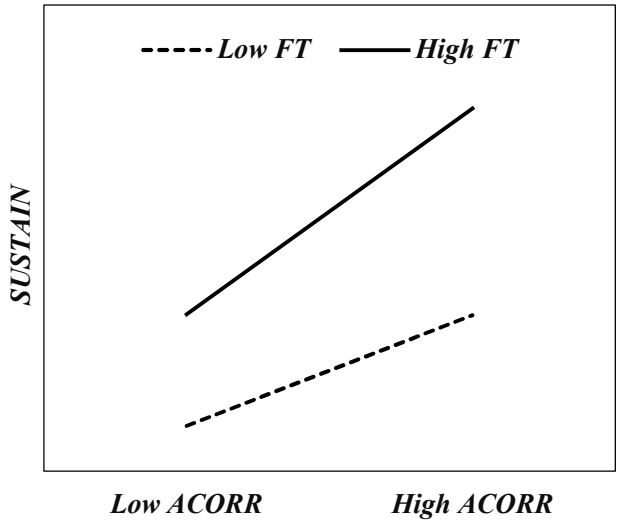


Figure 2. Moderating effect plot of fiscal transparency.

In Figure 2, the dotted line corresponding to low *FT* illustrates that *SUSTAIN* is lower at low *ACORR* levels and higher at high *ACORR* levels, indicating the positive effect of *ACORR* on *SUSTAIN*. Similarly, the solid line corresponding to high *FT* also demonstrates the positive effect of *ACORR* on *SUSTAIN*.

Comparing the slope variations in the two lines corresponding to low *FT* and high *FT*, it becomes evident that the dotted line for low values displays a gentler slope with a lower effect, whereas the solid line for high *FT* exhibits a steeper slope with a higher effect. Both lines slope from the lower left to the upper right, indicating the positive slope of the moderating variable. Consequently, it can be concluded that the moderating effect of *FT* is positive, signifying that *FT* positively moderates the positive relationship between *ACORR* and *SUSTAIN*. This further reinforces the robustness of the moderating effect.

5.3. Heterogeneity Analysis

According to the descriptive statistical results, notable differences exist among the variables, likely stemming from variance in regional economic development. To delve

deeper into the variations in the impact of anti-corruption efforts on government debt sustainability in different regions, this paper divides the sample into sub-samples for eastern, central, and western regions. It further analyzes the heterogeneity of the direct effect of anti-corruption on government debt sustainability and the moderating effect of fiscal transparency in these regions. The regression outcomes for the three regions are presented in Table 4.

Table 4. Regional heterogeneity results of direct and moderating effects.

Region	Eastern Region		Central Region		Western Region	
	(1)	(2)	(3)	(4)	(5)	(6)
Variable	*SUSTAIN*	*SUSTAIN*	*SUSTAIN*	*SUSTAIN*	*SUSTAIN*	*SUSTAIN*
ACORR	0.0101 *	0.00743	0.00597 **	0.00583 *	0.00300	0.00353
	(1.79)	(1.33)	(1.98)	(1.92)	(0.85)	(0.93)
ACORR × *FT*		0.000753 **		0.000130		−0.000405
		(2.06)		(0.61)		(−1.17)
FT		−0.00301		0.00253		0.000608
		(−1.45)		(1.29)		(0.28)
GGDP	3.620 ***	3.325 ***	1.922 ***	1.984 ***	2.692 ***	2.618 ***
	(4.30)	(4.07)	(4.16)	(4.30)	(6.66)	(6.60)
FD	0.304	−0.158	−0.0868	0.133	−0.501	−0.699
	(0.77)	(−0.37)	(−0.23)	(0.34)	(−1.13)	(−1.52)
PGDP	−0.00914	0.0132	−0.0173	−0.0271	0.0108	0.0205
	(−0.49)	(0.65)	(−0.61)	(−0.89)	(0.33)	(0.61)
GFIX	0.373	0.408	1.132 ***	1.426 ***	0.672 ***	0.812 ***
	(1.25)	(1.41)	(3.10)	(3.50)	(2.97)	(3.34)
Cons	−0.649 ***	−0.250	−0.361*	−0.338 *	−0.221	−0.120
	(−2.59)	(−1.33)	(−1.78)	(−1.90)	(−1.43)	(−0.83)
Year	Control	Control	Control	Control	Control	Control
N	77	77	70	70	63	63
Wald	49.40 ***	60.21 ***	91.26 ***	98.04 ***	146.3 ***	156.7 ***

Note: *z* statistics in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

In Table 4, columns (1) and (2) present the regression results for the eastern region, demonstrating a significant positive correlation between *ACORR* and *SUSTAIN* ($\alpha_1 = 0.0101$, $p < 0.1$). This implies that anti-corruption efforts enhance government debt sustainability in the eastern region. Additionally, the interaction terms *ACORR* × *FT* and *SUSTAIN* display significant positive effects ($\beta_1 = 0.000753$, $p < 0.05$), indicating the presence of a positive moderating effect for fiscal transparency. This aligns with the results observed for the entire sample.

Columns (3) and (4) depict the regression results of the central region, indicating a significant positive correlation between *ACORR* and *SUSTAIN* ($\alpha_1 = 0.00597$, $p < 0.05$). This underscores that intensified anti-corruption efforts lead to improved government debt sustainability, consistent with the findings of the entire sample test. The coefficients of the *ACORR* × *FT* and *SUSTAIN* are positive ($\beta_1 = 0.000130$), but they do not pass the statistical test, suggesting the absence of a moderating effect of fiscal transparency in the central region.

Columns (5) and (6) detail regression results for the western region. The coefficients of *ACORR* and *SUSTAIN* are positive ($\alpha_1 = 0.00300$), but they do not meet the statistical significance threshold, indicating that the direct impact of anti-corruption efforts on government debt sustainability is not significant in the western region. Likewise, *ACORR* × *FT* is positively correlated with *SUSTAIN* ($\beta_1 = 0.000130$), but it does not reach statistical

significance, signifying the absence of a significant positive moderating effect for fiscal transparency in the western region.

Comparing the results from the three regions reveals two key observations: (1) In terms of the direct effect of anti-corruption efforts on government debt sustainability (columns (1), (3), (5)), the coefficients for *ACORR* and *SUSTAIN* are positive in all three regions, suggesting that enhanced anti-corruption efforts positively influence government debt sustainability. However, statistically, only the coefficients for *ACORR* and *SUSTAIN* in the western region fail the statistical test. This implies that, compared to the eastern and central regions, the direct impact of anti-corruption efforts on government debt sustainability is less significant in the western region. Moreover, the coefficients for *ACORR* and *SUSTAIN* in the eastern region are larger than those in the central region (0.0101 > 000597), indicating that anti-corruption efforts in the eastern region have a more substantial impact on government debt sustainability than those in the central region. Thus, the influence of anti-corruption efforts on local government debt sustainability progressively increases from the western to central and, finally, eastern regions—from no direct impact to a direct impact, culminating in a more robust direct impact.

(2) Concerning the moderating effect of fiscal transparency on the relationship between anti-corruption efforts and government debt sustainability (columns (2), (4), and (6)), the interaction terms *ACORR* × *FT* and *SUSTAIN* are only significantly positively correlated in the eastern region. In this case, the moderating effect of fiscal transparency exists, meaning that in the eastern region, higher fiscal transparency enhances the impact of anti-corruption efforts on government debt sustainability. However, in the central and western regions, the moderating effect is not observed. Notably, in the western region, the coefficients for *ACORR* × *FT* and *SUSTAIN* are negative. This indicates that the moderating effect of fiscal transparency gradually increases from the western and central regions to the eastern region.

These results may be attributed to economic development disparities among the three regions. Per capita GDP data for the sample period reveal that the eastern region has the highest level of economic development, followed by the central region, while the western region lags behind (Following Deng et al. (2020), GDP per capita is used to measure the economic development level of the region; in the sample period of 2010–2017, the average per capita GDP was CNY 68,918.11 in eastern China, CNY 39,652.24 in the central region, and CNY 34,398.33 in the western region. The data come from National Bureau of Statistics of China.). In economically prosperous regions, governments possess ample resources—human, financial, and material—to support policy implementation effectively, including anti-corruption and government information disclosure policies. As a result, policy implementation in the eastern region is more robust, and the effect of anti-corruption policies on government debt sustainability is more pronounced. Simultaneously, fiscal transparency is higher, and its moderating effect is easier to achieve. In contrast, although the central region offers some support for anti-corruption efforts, its effectiveness is reduced compared to the eastern region due to relatively lower economic development. Thus, the impact of anti-corruption on government debt sustainability in the central region remains significant, it is weaker than that in the eastern region, and fiscal transparency is also lower. Consequently, the moderating effect is absent. In the western region, the least economically developed region, anti-corruption policies are less effective due to resource constraints, and fiscal transparency is low. Consequently, anti-corruption efforts' impact on government debt sustainability and the moderating effect of fiscal transparency do not manifest. In summary, the findings indicate that, as economic development improves, the influence of anti-corruption efforts on government debt sustainability strengthens, and the positive moderating effect of fiscal transparency becomes more significant.

5.4. Robustness Tests

To ensure the reliability of the empirical test results, this paper conducts robustness tests to examine the validity of the direct impact of anti-corruption efforts on local govern-

ment debt sustainability and the moderating effect of fiscal transparency. Specifically, the following methods are employed:

(1) The lag test model (LT) is used to address potential endogenous issues, that is, whether there is a reverse causal relationship between anti-corruption efforts and local government debt sustainability. This could imply that improved debt sustainability leads to stronger anti-corruption efforts. A lag period for anti-corruption efforts is introduced to test for this possibility.

(2) The replacement of the independent variable (DEBT) is performed. Drawing on the research of Ghosh et al. [33], the debt-to-GDP ratio can also reflect the sustainability of government debt to a certain extent. However, this indicator, used to measure the sustainability of government debt, is an inverse indicator, that is, a higher debt-to-GDP ratio reflects lower debt sustainability. Therefore, to facilitate the comparability of empirical results, the opposite of the variable is factored the model to obtain the *DEBT_R*, meaning that the smaller the *DEBT_R*, the higher the debt-to-GDP ratio, that is, the lower the debt sustainability.

(3) It is necessary to change the empirical model and adopt a mixed-effects model (POLS). Without considering the individual or cross-section, examining any positive correlation between anti-corruption efforts, local government debt sustainability, and the enhancing effect of fiscal transparency remains a valid approach.

(4) Th replacement of the moderating variable (FT) is required. It is necessary to replace the moderating variable *FT* with the dummy variable *FT_R*. In this model, values greater than the median were set to 1, and values less than the median were set to 0. It is necessary to introduce an interaction term (*ACORR* × *FT_R*) to test whether the positive moderating effect of fiscal transparency is valid.

The results of all the robustness tests are summarized in Table 5.

The robustness test results in Table 5 demonstrate that, in column (1) of the lag test model, L.*ACORR* and *SUSTAIN* are significantly positively correlated ($\alpha_1 = 0.00452$, $p < 0.01$), indicating that anti-corruption efforts, with a lag of one period, enhance government debt sustainability without endogeneity issues.

Columns (2) and (3) reflect the outcome of changing the independent variable, where *ACORR* exhibits a significant positive correlation with *DEBT_R* ($\alpha_1 = 0.00575$, $p < 0.01$), and ACORR × *FT* and *DEBT_R* also show a significant positive effect ($\beta_1 = 0.000153$, $p < 0.01$). This signifies that anti-corruption efforts enhance government debt sustainability, with fiscal transparency positively moderating this relationship.

Columns (4) and (5), which involve a mixed-effects model, show a significant positive correlation between *ACORR* and *SUSTAIN* ($\alpha_1 = 0.00556$, $p < 0.01$). Additionally, ACORR × *FT* and *SUSTAIN* also demonstrate a significant positive effect ($\beta_1 = 0.000332$, $p < 0.05$), reaffirming the role of anti-corruption efforts in promoting government debt sustainability and the positive moderating effect of fiscal transparency.

Column (6) displays results from changing the measurement of the moderating variable, where *ACORR* × *FT_R* significantly positively correlates with *SUSTAIN* ($\beta_1 = 0.00970$, $p < 0.05$), confirming the positive moderating effect of fiscal transparency.

All the results from these robustness tests corroborate the initial research conclusion that enhancing anti-corruption efforts can improve local government debt sustainability. Furthermore, fiscal transparency reinforces the positive relationship between them, signifying that higher fiscal transparency is more likely to promote the enhancement of government debt sustainability. Therefore, the direct impact of anti-corruption efforts on local government debt sustainability and the moderating effect of fiscal transparency are robust.

Table 5. Robustness test results.

	LT	DEBT		POLS		FT
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Variable	*SUSTAIN*	*DEBT_R*	*DEBT_R*	*SUSTAIN*	*SUSTAIN*	*SUSTAIN*
L.*ACORR*	0.00452 ***					
	(2.91)					
ACORR		0.00575 ***	0.00488 ***	0.00556 ***	0.00454 **	−0.000923
		(5.19)	(6.22)	(2.67)	(2.09)	(−0.03)
ACORR × *FT*			0.000153 ***		0.000332 **	
			(4.26)		(2.38)	
FT			−0.00113 ***		−0.000169	
			(−3.99)		(−0.16)	
ACORR × *FT_R*						0.00970 **
						(2.33)
FT_R						−0.231 **
						(−2.34)
GGDP	2.703 ***	0.136	0.0863	2.685 ***	2.754 ***	2.744 ***
	(10.83)	(0.93)	(1.23)	(7.72)	(7.79)	(8.50)
FD	−0.149	0.434 ***	0.340 ***	0.166	0.147	0.105
	(−0.76)	(4.01)	(3.80)	(0.78)	(0.69)	(0.46)
PGDP	0.00929	−0.0301 ***	−0.0379 ***	0.00401	0.00567	0.00807
	(0.83)	(−4.88)	(−6.59)	(0.33)	(0.46)	(0.65)
GFIX	0.653 ***	0.453 ***	0.240 ***	0.643 ***	0.630 ***	0.613 ***
	(4.96)	(5.35)	(6.12)	(3.70)	(3.61)	(3.65)
Cons	−0.405 ***	−0.411 ***	−0.154 ***	−0.534 ***	−0.411 ***	−0.506 ***
	(−4.72)	(−7.77)	(−4.73)	(−5.21)	(−5.08)	(−5.29)
Year	Control	Control	Control			Control
N	210	240	240	210	210	210
R2				0.493 ***	0.504 ***	
Wald	378.4 ***	169.0 ***	314.5 ***			215.6 ***

Note: *z* statistics in parentheses in Model (1), (2), (3) and (6); *t* statistics in parentheses in Model (4) and (5), ** $p < 0.05$, *** $p < 0.01$.

6. Discussion

Through the empirical process outlined in the previous section, this paper tested its hypothesis and further analyzed the heterogeneity of regional economic development. This section mainly discusses the empirical results based on existing research.

First, this paper identifies that anti-corruption efforts can improve local government debt sustainability, supporting hypothesis H1. Previous research suggests that debt sustainability is contingent on the solvency and debt levels of local governments. Moreover, corruption leads to increased public debt [6] and reduced solvency (higher fiscal deficits) [43]. The findings support these two views from the perspective of anti-corruption, link them, and expand upon them. This research posits that strengthened anti-corruption measures can enhance government solvency by boosting government revenue and reducing expenditure and can reduce debt levels by optimizing debt management. Consequently, it contributes to the improved sustainability of local government debt.

Second, this paper verifies hypothesis H2, that is, fiscal transparency can positively regulate the role of anti-corruption in promoting local government debt sustainability. Previous research has demonstrated that fiscal transparency promotes anti-corruption [21] and contributes to debt sustainability [22]. The result of this paper supports and extends these conclusions. In delving further into the interaction between fiscal transparency and these factors, this paper observes that enhanced fiscal transparency facilitates anti-corruption in fiscal and debt-related domains. Consequently, this strengthens anti-corruption's impact on government debt solvency and debt levels, thereby significantly enhancing its role in promoting government debt sustainability.

Thirdly, further regional heterogeneity analysis reveals that, under China's political and economic system, in regions with better development levels, anti-corruption has a more significant effect on debt sustainability, and the moderating effect of fiscal transparency is amplified. The finding supports hypotheses H1 and H2 again, providing proof of their robustness. This study also supplements existing research on the relationship between corruption and debt in different economic development regions [3]. This pattern is primarily attributed to the fact that regions with higher economic development offer more support for anti-corruption initiatives, making them easier to implement. Additionally, these regions tend to exhibit greater fiscal transparency, allowing the role of anti-corruption in promoting debt sustainability to flourish better, and providing a more ideal environment for the moderating effects of fiscal transparency to be felt.

7. Conclusions

Against the backdrop of China's debt risk prevention and control and its anti-corruption campaign targeting officials, this paper focuses on 30 provincial-level administrative regions in China. It employs panel data from 2010 to 2017 to examine the impact of anti-corruption on local government debt sustainability, while introducing fiscal transparency as a moderating variable to further analyze its influence on their relationship. The primary findings of this study are as follows: (1) Increased anti-corruption efforts can effectively enhance the sustainability of local government debt. (2) In regions characterized by high fiscal transparency, the effectiveness of anti-corruption efforts in promoting local government debt sustainability is bolstered, highlighting a positive moderating role for fiscal transparency. (3) Regional heterogeneity analysis reveals a progressive increase in the influence of anti-corruption efforts on local government debt sustainability and the moderating effect of fiscal transparency from the western to the central and eastern regions of China.

7.1. Theoretical Contributions

The main theoretical contributions of this paper are as follows:

(1) In the context of China's anti-corruption campaign targeting officials, this paper provides empirical evidence for the promoting effect of anti-corruption efforts on local government debt sustainability. Existing research on the effects of anti-corruption primarily examines its impact on government performance and credibility from a governmental viewpoint [15,16]. This paper extends this inquiry to encompass government debt sustainability. In addition, while research on the prevailing determinants influencing debt sustainability has focused on numerous external policy shocks [19,39], China's anti-corruption campaign targeting officials, though overlooked, is examined within this article as a policy shock affecting debt sustainability in order to investigate the impact of anti-corruption efforts on local government debt sustainability.

(2) Fiscal transparency was introduced as a moderating variable to analyze its moderating effect on the relationship between anti-corruption and local government debt sustainability. This promotes relevant research on the influence of financial transparency on anti-corruption and debt sustainability. Existing studies have demonstrated that fiscal transparency has an impact on anti-corruption and government debt sustainability, respectively [20,22]. However, there is no research exploring its influence on the relationship between these two factors. This paper employs fiscal transparency as an external moderator to investigate how varying degrees of fiscal transparency affect the relationship between anti-corruption and the sustainability of local government debt. It is a deepening of the relationship between them.

(3) This paper examines variations in the impact of anti-corruption on local government debt sustainability across regions with different levels of economic development in China and the distinctions in the moderating effect of fiscal transparency. Existing research suggests that there are regional disparities in the impact of corruption on debt [3,43]. This paper expands the investigation of the link between anti-corruption efforts and debt sustainability to diverse regions and scrutinizes the heterogeneous

effects induced by varying economic development levels within China's economic system, thus contributing a valuable dimension to existing research.

7.2. Policy Recommendations

Based on the research findings of this paper and in consideration of China's economic development, this paper asserts that the conundrum of local government debt sustainability can be ameliorated by focusing on the following three dimensions:

(1) The research in this paper confirms that anti-corruption contributes to the enhancement of local government debt sustainability. Therefore, it is imperative to continue promoting the anti-corruption campaign targeting officials and embrace the concept of the "normalization of anti-corruption", maintaining a relentless crackdown on corrupt government officials. This entails the following actions: first, the strict enforcement of fiscal revenue and expenditure budget management, alongside the approval processes for fiscal fund allocation, can mitigate corruption in fiscal operations and enhance the government's capacity to service debts. Second, it is necessary to optimize the debt management system, encompassing measures such as bond issuance approval and continuous fund usage monitoring, to eliminate corruption opportunities in debt issuance and management. This approach will lead to a reduction in government debt levels and improve the plight of government debt sustainability.

(2) The conclusion of the study on the moderating effect shows that elevating fiscal transparency strengthens the positive impact of anti-corruption efforts on government debt sustainability. To achieve this, pertinent government information should be disclosed to heighten fiscal transparency. This involves two key facets: firstly, publicly divulging information related to fiscal revenue, expenditure, and debt management to leverage public oversight in promoting anti-corruption in these domains. Secondly, revealing government affairs pertaining to the populace's well-being can enhance the government's credibility. This, in turn, boosts public confidence in economic development, raises public expectations, attracts capital inflow to stimulate the economy, garners public support and engagement in anti-corruption endeavors, and reinforces the path for anti-corruption to influence government debt sustainability.

(3) Heterogeneity analysis found that, in regions with good economic development level, the promoting effect of anti-corruption on debt sustainability and the positive moderating effect of financial transparency is enhanced. Therefore, the implementation of policies on anti-corruption and financial transparency should be reinforced in economically underdeveloped regions. This comprises two primary contents. Firstly, intensifying the implementation of anti-corruption policies in economically backward areas, where the resources required for effective anti-corruption measures are often limited. Thus, increasing anti-corruption investments in economically disadvantaged regions and fortifying anti-corruption efforts becomes crucial to enhancing government debt sustainability. Secondly, the government should mandate the disclosure of information about public affairs in strict compliance with relevant regulations and systems to enhance fiscal transparency. This will strengthen the moderating effect of fiscal transparency on the enhancement of anti-corruption efforts in government debt sustainability. Ultimately, this approach not only improves government debt sustainability but also fosters economic development in less developed areas.

7.3. Limitations and Future Directions

This paper explores the impact of anti-corruption on local government debt sustainability and the moderating influence of fiscal transparency on their relationship. It offers theoretical insights and policy recommendations to address the sustainability challenges of local government debt in China. Nonetheless, several limitations necessitate future research. First, the data from the sample period spanning 2010 to 2017 are utilized in this paper to validate the hypothesis. However, it should be acknowledged that the sample period does not extend to the present time. This is due to the challenges related to data

consistency and availability. As research progresses, more comprehensive data can be accessed to further substantiate this paper's conclusions. Second, this paper delves into China's anti-corruption campaign as an external shock on debt sustainability. The findings hold substantial value for comprehending debt sustainability within China or regions with similar policy framework. Nonetheless, it remains to be ascertained through further validation whether these conclusions can be extrapolated to nations characterized by different policy framework and political systems, such as in territories devoid of anti-corruption measures or those operating under alternative political regimes. This will serve to ascertain the generalizability of the conclusions. Third, the heterogeneity analysis revealed that variations in regional economic development levels also exert an impact on how anti-corruption efforts influence the government debt sustainability, as well as the moderating effect of fiscal transparency. While this conclusion has been substantiated within China, this limited verification inherently confines our comprehension of the phenomenon. Thus, future research should broaden the investigative lens by examining this issue across national boundaries or within diverse regional contexts of multiple countries in order to deepen the research.

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

Funding: This research was funded by the National Natural Science Foundation of China (NSFC), grant number 71971169.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: The data supporting the report results are mentioned in the text and primarily come from the Wind database and publicly released data from the National Bureau of Statistics of China (https://data.stats.gov.cn/easyquery.htm?cn=E0103) and official statistical publications.

Acknowledgments: We thank editors for excellent editorial guidance and anonymous reviewers for their helpful comments.

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

Appendix A

Drawing on Xia et al. [69], Ghosh et al. [33] and Li and Du [36], this paper utilizes available fiscal space to gauge the sustainability of local government debt. The calculation method is outlined below:

$$SUSTAIN_{i,t} = \frac{d^*_{i,t} - d_{i,t}}{1/fe_{i,t}} \quad \text{(A1)}$$

where, i denotes the province, t denotes the time. $d_{i,t}$ represents the real government debt ratio ($d = \frac{debt}{GDP}$) of province i in year t. $d^*_{i,t}$ is a sustainable government debt ratio, which can also be understood as the ratio of debt limit to GDP, that is $d^* = \frac{debt\ \text{limit}}{GDP}$, calculated through a nonlinear fiscal response function. fe represents the efficiency of government fiscal expenditure, derived from the DEA model.

Firstly, the nonlinear fiscal response function is applied to compute d^*.

(1) Set the nonlinear fiscal response function

Ghosh et al. [33] introduced the nonlinear fiscal response function, building upon Bohn's [70] fiscal response function rooted in the concept of fiscal fatigue, to assess the response of the primary balance to lagged debt. Expanding on this, inspired by Li and

Du [36], this paper incorporates the lagged primary balance to formulate the nonlinear fiscal response function as follows:

$$pb_{i,t} = \rho pb_{i,t-1} + \lambda f(d_{i,t-1}) + \varphi X_{i,t} + \mu_{i,t} \quad \text{(A2)}$$

where $pb_{i,t}$ denotes the fiscal primary balance ratio of province i in year t. $pb_{i,t-1}$ signifies the fiscal primary balance ratio of the lagging period. $d_{i,t-1}$ represents the government debt ratio of the lagging period, that is, the government debt ratio of province i in year $t-1$. $f(d_{i,t-1})$ signifies the cubic function of the government debt ratio, as depicted in the following equation. $X_{i,t}$ encapsulates a set of vectors, including factors influencing the fiscal primary balance ratio. $\mu_{i,t}$ denotes the residual term of the model.

$$f(d_{i,t-1}) = \lambda_1 d_{i,t-1} + \lambda_2 d_{i,t-1}^2 + \lambda_3 d_{i,t-1}^3 \quad \text{(A3)}$$

Subsequently, there is: $pb_{i,t} = \rho pb_{i,t-1} + \lambda_1 d_{t-1} + \lambda_2 d_{t-1}^2 + \lambda_3 d_{t-1}^3 + \varphi X_{i,t} + \mu_{i,t}$

(2) Data collection and parameter estimation

Based on the above fiscal response function, the dependent variable is Primary Balance Ratio (PB), which is expressed by the ratio of fiscal revenue, transfer payment income minus non-interest fiscal expenditure to GDP, referencing the research of Li and Du [36]. Independent variables include Primary Balance Ratio with one-period lag and Debt Ratio with one, two, three-period lag. The control variables refer to Ghosh et al. [33] and Li and Du [36], and considering data availability, the paper selects fiscal expenditure gap, output gap, GDP growth rate, trade openness, fixed-asset investment growth rate, and fiscal decentralization as the control variables (denoted as $X_{i,t}$) in the fiscal response function. Fiscal expenditure gap and output gap refer to the ratio of difference between the real value and the potential value to the potential value. The calculation of the potential value follows the study by Li and Du [36], using HP filtering to eliminate the trend of the actual value. Trade openness is expressed by exports and imports as a share of GDP. Fiscal decentralization is expressed as a proportion of the per capita local fiscal revenue and the sum of the per capita local and central fiscal revenue.

The samples used for calculating the fiscal response function are consistent with those used for hypothesis testing in this paper, which include 30 provincial administrative regions in China from 2010 to 2017. The data sources of all variables are primarily derived from the China Statistical Yearbook, China Fiscal Yearbook, and Wind database. Descriptive statistical analysis was conducted to understand the preliminary characteristics of the data. The definitions and descriptive statistics of all variables are presented in Table A1.

According to the descriptive statistics in Table A1, the maximum value of the primary balance ratio is 0.0164, the minimum value is −0.126, and the standard deviation is 0.016. This indicates that there is little difference in the fiscal status of different regions. However, the mean value of −0.00907 suggests that the fiscal status of most regions is not optimistic due to fiscal deficits. The maximum and minimum values of the Debt ratio are 0.673 and 0.0011, respectively. This indicates that all regions have significant debt, with some regions reaching up to 67.3%. The average value of 0.117 further highlights the severity of the debt situation. The statistical characteristics of the control variables are consistent with existing studies, making them suitable for the next step in solving the financial response function.

In line with the fiscal response function setup, the model incorporates the one-stage lag of the primary balance ratio as an independent variable, endowing it with dynamic explanatory capability. Simultaneously, given that the number of provinces in the sample surpasses the length of the year, resulting in short panel data, a dynamic short panel data model is suitable. To effectively address issues of heteroscedasticity and endogeneity, this paper, following del Castillo et al. [74], employs the two-step system GMM (Generalized Method of Moments) for estimation. The specific results for all coefficients are detailed in Table A2.

Table A1. Definition and descriptive statistics of variables in the fiscal response function.

Variable	Abbreviation	Definition	Mean	Std. Dev.	Max	Min
Primary balance ratio	*PB*	(Fiscal revenue + transfer payments—non-interest fiscal expenditure)/GDP	−0.00907	0.0166	0.0164	−0.126
Debt ratio	*DEBT*	Government debt balance/GDP	0.117	0.135	0.673	0.0011
Fiscal expenditure gap	*FGAP*	(Actual government spending—potential government spending)/potential government spending	−0.000570	0.0453	0.173	−0.166
Output gap	*OGAP*	(Actual real GDP—potential real GDP)/potential real GDP	0.0000328	0.00968	0.0395	−0.0441
GDP growth rate	*GGDP*	Year-on-year growth rate of GDP	0.118	0.0596	0.265	−0.0395
Trade openness	*TO*	Share of import and export/GDP	0.295	0.322	1.464	0.0180
Fixed-asset investment growth rate	*GFIX*	Year-on-year growth rate of fixed-asset investment	0.150	0.125	0.412	−0.626
Fiscal decentralization	*FD*	Per capita local government fiscal revenue/(per capita local government fiscal revenue + per capita central government fiscal revenue)	0.856	0.0404	0.937	0.753

Table A2. GMM estimation results of the fiscal response function.

Variable	*PB*	*t*/*p*
L.*PB*	0.418 ***	(14.22)
$DEBT_{t-1}$	−0.0809 ***	(−4.44)
$DEBT_{t-1}^2$	0.363 ***	(3.88)
$DEBT_{t-1}^3$	−0.495 ***	(−3.83)
FGAP	−0.162 ***	(−14.00)
OGAP	0.310 ***	(14.57)
GGDP	0.106 ***	(26.52)
TO	0.0132 ***	(7.96)
GFIX	0.0339 ***	(7.19)
FD	−0.0508 ***	(−3.95)
Cons	0.0213 *	(1.98)
N	210	
AR(1) test	−2.020 **	[0.0434]
AR(2) test	−0.154	[0.877]
Hansen test	23.13	[0.678]

Note: *t* statistics in parentheses and *p*-value in brackets. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

In Table A2, the results of the AR(1) test show rejection of the null hypothesis ($p < 0.05$), while the AR(2) test accepts the null hypothesis ($p > 0.1$). This implies first-order autocorrelation in the model's random perturbation term, with no second-order autocorrelation. The Hansen test results also accept the null hypothesis ($p > 0.1$), indicating the absence of tool variable over-recognition issues in the model. This affirms the validity of the GMM estimate. Substituting the parameters into the fiscal response function yields:

$$\begin{aligned} pb_{i,t} &= 0.418 \times pb_{i,t-1} - 0.0809 \times d_{t-1} + 0.363 \times d_{t-1}^2 - 0.495 \times d_{t-1}^3 - 0.162 \times FGAP_{i,t} + 0.310 \times OGAP_{i,t} \\ &+0.106 \times GGDP_{i,t} + 0.0132 \times TO_{i,t} + 0.0339 \times GFIX_{i,t} - 0.0508 \times FD_{i,t} + 0.0213 \end{aligned} \quad \text{(A4)}$$

(3) Debt sustainability assessment

According to Ghosh et al. [33] and Debrun et al. [49], the debt and fiscal primary balances must align with the government's fiscal budget constraints. In other words, the total expenditure of the government (the sum of non-interest fiscal expenditure and interest expenditure) should equal the sum of newly issued debt and total revenue:

$$S_t + (1 + r_t)D_{t-1} = R_t + D_t \tag{A5}$$

where, D_t and D_{t-1} denote the debt balances of year t and $t-1$, respectively. r_t represents the real interest rate of all debts (the average interest rate of all debt balances in year t). S_t represents government non-interest fiscal expenditure, and R_t represents government fiscal revenue (excluding central transfer payments). Consequently, the fiscal primary balance is calculated as government fiscal revenue minus government non-interest fiscal expenditure: $PB_t = R_t - S_t$. This results in:

$$D_t = (1 + r_t)D_{t-1} + S_t - R_t = (1 + r_t)D_{t-1} - (R_t - S_t) = (1 + r_t)D_{t-1} - PB_t \tag{A6}$$

where PB_t denotes the fiscal primary balance for period t. To facilitate the examination of the relationship between the government debt ratio and the fiscal primary balance ratio, divide both sides of the equation by GDP to obtain:

$$\frac{D_t}{GDP_t} = \frac{(1 + r_t)D_{t-1}}{GDP_t} - \frac{PB_t}{GDP_t} = \frac{(1 + r_t)D_{t-1}}{(1 + g_t)GDP_{t-1}} - \frac{PB_t}{GDP_t} = \frac{(1 + r_t)}{(1 + g_t)}\frac{D_{t-1}}{GDP_{t-1}} - \frac{PB_t}{GDP_t} \tag{A7}$$

where g_t represents the real GDP growth rate. According to the concept and measurement of the government debt ratio and the fiscal primary balance ratio, in the above formula, there is $\frac{D_t}{GDP_t} = d_t$, $\frac{D_{t-1}}{GDP_{t-1}} = d_{t-1}$, $\frac{PB_t}{GDP_t} = pb_t$.

As $\frac{(1+r_t)}{(1+g_t)} \approx 1 + r_t - g_t$, the above equation can be transformed to:

$$d_t = (1 + r_t - g_t)d_{t-1} - pb_t \tag{A8}$$

This implies: $d_t - d_{t-1} = (r_t - g_t)d_{t-1} - pb_t$

where, d is the government debt ratio, pb is the fiscal primary surplus ratio, g is the real GDP growth rate, and r is the real interest rate on all debt balances.

If and only if the difference between the current debt ratio and the previous period's debt ratio is 0, the government debt ratio reaches a maximum value, that is:

$$d_t - d_{t-1} = (r_t - g_t)d_{t-1} - pb_t = 0 \tag{A9}$$

This can be expressed as: $pb_t = (r_t - g_t)d_{t-1}$

The simultaneous fiscal reaction function can be derived as follows:

$$\rho pb_{t-1} + \lambda_1 d_{t-1} + \lambda_2 d_{t-1}^2 + \lambda_3 d_{t-1}^3 + \varphi X_i + \mu = (r_t - g_t)d_{t-1} \tag{A10}$$

That is: $\rho(r_{t-1} - g_{t-1})d_{t-1} + \lambda_1 d_{t-1} + \lambda_2 d_{t-1}^2 + \lambda_3 d_{t-1}^3 + \varphi X_i + \mu = (r_t - g_t)d_{t-1}$

Merge homogeneous items:$[\rho(r_{t-1} - g_{t-1}) - (r_t - g_t) + \lambda_1]d_{t-1} + \lambda_2 d_{t-1}^2 + \lambda_3 d_{t-1}^3 + \varphi X_i + \mu = 0$

Substituting the corresponding parameters from the financial response function into the above equation yields:

$$\begin{aligned}&[0.418 \times (r_{t-1} - g_{t-1}) - (r_t - g_t) - 0.0809] \times d_{t-1} + 0.363 \times d_{t-1}^2 - 0.495 \times d_{t-1}^3 - 0.162 \times FGAP_{i,t} + 0.310 \\ &\times OGAP_{i,t} + 0.106 \times GGDP_{i,t} + 0.0132 \times TO_{i,t} + 0.0339 \times GFIX_{i,t} - 0.0508 \times FD_{i,t} + 0.0213 = 0\end{aligned} \tag{A11}$$

Substituting the observed values of each variable in the year t for province i into the above formula, the univariate cubic equation of $d_{i,t-1}$ can be obtained. Solving this

equation yields the maximum value of the government debt ratio. The largest real solution from the cubic function represents the corresponding upper limit of the debt ratio d^*.

Secondly, drawing on Li et al. [3], the DEA model is employed to compute the fe (efficiency of government fiscal expenditure). The input–output indicators are categorized into economic and social input–output, with specific definitions and data sources detailed in Table A3.

Table A3. Indicators for computing government fiscal expenditure efficiency through the DEA model.

Items	Indicators	Description	Unit	Sources
Economic investment	Per capita investment in fixed assets		CNY	China Statistical Yearbook
Social investment	Per capita Expenditure for General Public Services		CNY	China Statistical Yearbook
	Per capita expenditure for education		CNY	China Statistical Yearbook
	Per capita expenditure for science and technology		CNY	China Statistical Yearbook
	Per capita expenditure for Health care		CNY	China Statistical Yearbook
	Per capita expenditure for Social Security and Employment		CNY	China Statistical Yearbook
	Per capita expenditure for Energy Conservation and Environment Protection		CNY	China Statistical Yearbook
Economic output	Intensity of economic development	Per capita GDP	CNY	China Statistical Yearbook
	Strength of economic development	Fiscal revenue/GDP		China Statistical Yearbook
	Stability of economic development	Reciprocal of the coefficient of variation of GDP growth rate		China Statistical Yearbook
	Rationality of economic development	Industrial Structure Theil Index		China Statistical Yearbook
	Extension of economic development	by location of total imports and exports/GDP		China Statistical Yearbook
Social output	General public services output	Road network density	km/100 sq·km	China Statistical Yearbook
		Per capita area of paved roads	sq.m	China Statistical Yearbook
		Number of public buses and trolley buses per 10,000 persons	Unit	National Bureau of Statistics of China
		Length of city sewage pipes	10,000 km	China Statistical Yearbook
		Per capita electricity consumption	kW·h	China Statistical Yearbook
	Education output	Per capita education years	Year	China Statistical Yearbook Population Census
		Average school enrolment per 100,000 population of higher education	Person	China Statistical Yearbook

Table A3. *Cont.*

Items	Indicators	Description	Unit	Sources
Social output	Science and technology output	Number of patent applications	Pieces	China Statistical Yearbook
		Full-time equivalent of R&D personnel	Man-year	China Statistical Yearbook on Science and Technology
	Health care output	Number of beds in health care institutions per 1000 persons	Bed	National Bureau of Statistics of China
		Health technical personnel in health care institutions per 1000 persons	Person	National Bureau of Statistics of China
	Social security output	Number of employed persons in urban units	10,000 persons	China Statistical Yearbook
		Urban–rural income gap		China Statistical Yearbook
	Ecological environment output	Per capita area of parks and green land	sq.m	China Statistical Yearbook
		Common industrial solid waste Integrate reused rate	%	China Statistical Yearbook
		GDP output per sulfur dioxide emissions	10,000 yuan/kg	China Statistical Yearbook

To ensure the validity of the calculation results for fiscal expenditure efficiency, this paper standardizes all index data to eliminate the difference in indicator dimensions. Additionally, for the social output indicators, equal weight is assigned to third-level indicators, amalgamating them into corresponding second-level indicators. The fiscal expenditure efficiency fe for each region is then determined by solving all input–output index data using the DEA model.

Finally, plug d^* and fe into the initial equation to find *SUSTAIN*, representing the local government debt sustainability.

References

1. Napo, S. Assessing public debt sustainability under COVID-19 uncertainty: Evidence from Côte d'Ivoire. *Afr. Dev. Rev.* **2022**, *34* (Suppl. S1), S141–S160. [CrossRef] [PubMed]
2. Klutse, S.K.; Sági, J.; Kiss, G.D. The role of COVID-19 in worsening the debt sustainability in developing economies—The case of Ghana and Kenya. *Reg. Sci. Policy Pract.* **2023**, *15*, 1259–1275. [CrossRef]
3. Li, Y.; WenXiu, H.; ZhenXing, S. Impact of Local Official Corruption on Local Government Debt in China: The Mediating Role of Government Investment Efficiency. *SAGE Open* **2023**, *13*, 21582440231184976. [CrossRef]
4. E. Warren, M. What Does Corruption Mean in a Democracy? *Am. J. Political Sci.* **2004**, *48*, 328–343. [CrossRef]
5. Yohou, H.D. Corruption, tax reform and fiscal space in emerging and developing economies. *World Econ.* **2023**, *46*, 1082–1118. [CrossRef]
6. Baklouti, N.; Boujelbene, Y. Corruption, Democracy, and Public Debt: A Case of the Arab Countries. *J. Knowl. Econ.* **2022**, *13*, 574–586. [CrossRef]
7. Tang, N.; Ding, Z.; Xu, Y. Corruption and Anti-Corruption Research in China: A Critical Review of Chinese Top Journal Publications (1989–2017). *Chin. Public Adm. Rev.* **2018**, *9*, 79–98. [CrossRef]
8. Yuan, S.; Pan, X.; Li, M. The nonlinear influence of innovation efficiency on carbon and haze co-control: The threshold effect of environmental decentralization. *Environ. Dev. Sustain.* **2023**, *25*, 14283–14307. [CrossRef]
9. Zhu, Q.; Zou, X.; Zhong, J.; Gao, F.; Wei, Z.; Shi, X. Promotion incentives, economic growth targets and industrial land supply: Evidence from China. *Appl. Econ.* **2024**, 1–14. [CrossRef]
10. Zhang, M.; Chen, W.; Kou, A.; Wu, Y. Promotion incentives, tenure uncertainty, and local government debt risk. *Financ. Res. Lett.* **2023**, *56*, 104136. [CrossRef]
11. Gan, W.; Xu, X. Does anti-corruption campaign promote corporate R&D investment? Evidence from China. *Financ. Res. Lett.* **2019**, *30*, 292–296. [CrossRef]

12. Huang, C.; Jin, Z.; Tian, S.; Wu, E. The real effects of corruption on M&A flows: Evidence from China's anti-corruption campaign. *J. Bank. Financ.* **2023**, *150*, 106815. [CrossRef]
13. Zhou, M.; Wang, B.; Chen, Z. Has the anti-corruption campaign decreased air pollution in China? *Energy Econ.* **2020**, *91*, 104878. [CrossRef]
14. Mouna, A.; Nedra, B.; Khaireddine, M. International comparative evidence of e-government success and economic growth: Technology adoption as an anti-corruption tool. *Transform. Gov. People Process Policy* **2020**, *14*, 713–736. [CrossRef]
15. Funk, K.D.; Owen, E. Consequences of an Anti-Corruption Experiment for Local Government Performance in Brazil. *J. Policy Anal. Manag.* **2020**, *39*, 444–468. [CrossRef]
16. Zhang, H.; Song, Y.; Tan, S.; Xia, S.; Zhang, H.; Jiang, C.; Xiong, D.; Cheng, G.; Zhang, L.; Lv, Y. Anti-corruption efforts, public perception of corruption, and government credibility in the field of real estate: An empirical analysis based on twelve provinces in China. *Cities* **2019**, *90*, 64–73. [CrossRef]
17. Masaya, S.; Yukie, S. Government fiscal projection and debt sustainability. *Jpn. World Econ.* **2020**, *54*, 101010. [CrossRef]
18. Maureen, W.; Lekinyi, M. *Public Debt Sustainability and Debt Dynamics: The Case of Tanzania*; WIDER Research Report 20/5; World Institute for Development Economic Research (UNU-WIDER): Helsinki, Finland, 2020. [CrossRef]
19. Enrique, A.-I.; Gong, C.; Andrea, C.; Stavros, A.Z. *Debt Sustainability and Monetary Policy: The Case of ECB Asset Purchases*; BIS Working Paper No. 1034; Bank for International Settlements: Basel, Switzerland, 2022. [CrossRef]
20. Kohler, J.C.; Dimancesco, D. The risk of corruption in public pharmaceutical procurement: How anti-corruption, transparency and accountability measures may reduce this risk. *Glob. Health Action* **2020**, *13* (Suppl. S1), 1694745. [CrossRef]
21. Adam, I.; Fazekas, M. Are emerging technologies helping win the fight against corruption? A review of the state of evidence. *Inf. Econ. Policy* **2021**, *57*, 100950. [CrossRef]
22. Maslen, S.; Aslan, C. *Enhancing Debt Transparency by Strengthening Public Debt Transaction Disclosure Practices*; World Bank: Washington, DC, USA, 2022.
23. Zhou, A.; Li, J. Impact of anti-corruption and environmental regulation on the green development of China's manufacturing industry. *Sustain. Prod. Consum.* **2021**, *27*, 1944–1960. [CrossRef]
24. Chen, X.; Chen, G.; Lin, M.; Tang, K.; Ye, B. How does anti-corruption affect enterprise green innovation in China's energy-intensive industries? *Environ. Geochem. Health* **2022**, *44*, 2919–2942. [CrossRef] [PubMed]
25. Wang, X.; Chu, X.; Lee, C.-C. How does anti-corruption policy affect the sensitivity of green innovation to executive incentives? *Econ. Chang. Restruct.* **2023**, *56*, 79–109. [CrossRef]
26. Wei, Y.; He, W. Can anti-corruption improve the quality of environmental information disclosure? *Environ. Sci. Pollut. Res.* **2022**, *29*, 5345–5359. [CrossRef] [PubMed]
27. Hope, O.-K.; Yue, H.; Zhong, Q. China's Anti-Corruption Campaign and Financial Reporting Quality. *Contemp. Account. Res.* **2020**, *37*, 1015–1043. [CrossRef]
28. Alonso, M.; Palma, N.; Simon-Yarza, B. The value of political connections: Evidence from China's anti-corruption campaign. *J. Institutional Econ.* **2022**, *18*, 785–805. [CrossRef]
29. Zhang, H.; An, R.; Zhong, Q. Anti-corruption, government subsidies, and investment efficiency. *China J. Account. Res.* **2019**, *12*, 113–133. [CrossRef]
30. Han, L.; Li, X.; Xu, G. Anti-corruption and poverty alleviation: Evidence from China. *J. Econ. Behav. Organ.* **2022**, *203*, 150–172. [CrossRef]
31. Wu, Y.; Zhu, J. Corruption, anti-corruption, and inter-county income disparity in China. *Soc. Sci. J.* **2011**, *48*, 435–448. [CrossRef]
32. Shi, X. Anti-corruption campaign and economic growth in Chinese cities: The dichotomous mechanism of network-based political competition. *Eur. J. Political Econ.* **2024**, *83*, 102549. [CrossRef]
33. Ghosh, A.R.; Kim, J.I.; Mendoza, E.G.; Ostry, J.D.; Qureshi, M.S. Fiscal Fatigue, Fiscal Space and Debt Sustainability in Advanced Economies. *Econ. J.* **2013**, *123*, F4–F30. [CrossRef]
34. Abindaw Nabieu, G.A.; Minlah, M.; Mensah, D. Public debts, fiscal balance and sustainability: What can African governments learn from debt sustainability models? *Cogent Econ. Financ.* **2023**, *11*, 2235827. [CrossRef]
35. Oyadeyi, O.O.; Agboola, O.W.; Okunade, S.O.; Osinubi, T.T. The debt-growth nexus and debt sustainability in Nigeria: Are there reasons to be concerned? *J. Policy Model.* **2024**, *46*, 129–152. [CrossRef]
36. Li, T.; Du, T. Vertical fiscal imbalance, transfer payments, and fiscal sustainability of local governments in China. *Int. Rev. Econ. Financ.* **2021**, *74*, 392–404. [CrossRef]
37. Bonizzi, B.; Laskaridis, C.; Toporowski, J. Global Liquidity, the Private Sector and Debt Sustainability in Sub-Saharan Africa. *Dev. Chang.* **2019**, *50*, 1430–1454. [CrossRef]
38. Beetsma, R. The Economics of Fiscal Rules and Debt Sustainability. *Inter Econ* **2022**, *57*, 11–15. [CrossRef]
39. Alberola, E.; Cheng, G.; Consiglio, A.; Zenios, S.A. Unconventional monetary policy and debt sustainability in Japan. *J. Jpn. Int. Econ.* **2023**, *69*, 101274. [CrossRef]
40. Fournier, J.-M.; Bétin, M. *Limits to Government Debt Sustainability in Middle-Income Countries*; OECD Economics Department Working Papers, No. 1493; OECD Publishing: Paris, France, 2018. [CrossRef]
41. Owusu-Nantwi, V.; Owusu-Nantwi, G. Public debt, corruption and shadow economy in Africa: An empirical analysis. *J. Econ. Adm. Sci.* **2023**, *39*, 184–202. [CrossRef]

42. Eyitayo Oyewunmi, O.; Ademola Obafemi, Y.; Rebecca Folake, B.-O. Revisiting the threshold effect of corruption in the link between public debt and economic growth in Nigeria. *Econ. J. Emerg. Mark.* **2022**, *14*, 151–161.
43. Ibrahim, C. Corruption, public debt and economic growth—Evidence from developing countries. *Int. J. Dev. Issues* **2021**, *20*, 24–37. [CrossRef]
44. Özekicioğlu, S.S.; Tülümce, S.Y. The impacts of corruption on budget balance and public debt in Turkey: An empirical analysis. *J. Manag. Econ. Res.* **2020**, *18*, 46–60. [CrossRef]
45. Togan Eğrican, A.; Caner, S.; Togan, S. Reforming public debt governance in Turkey to reach debt sustainability. *J. Policy Model.* **2022**, *44*, 1057–1076. [CrossRef]
46. Puron-Cid, G. The effects of corruption of public officials on the dimensions of financial sustainability of state governments in Mexico. *Public Budg. Financ.* **2021**, *41*, 65–88. [CrossRef]
47. Samuel, S. China's Resource-Backed Loans to Africa and Latin America: An Analysis of Corruption and Debt Distress. Senior Thesis, Princeton University, Princeton, NJ, USA, 2021. Available online: http://arks.princeton.edu/ark:/88435/dsp017p88ck63x (accessed on 4 July 2024).
48. Matthew Terry, R.; Ishmael, O.; Dooshima Jennifer, R. An Analysis of the Long-Run Relationship Between Corruption and Debt Sustainability in Nigeria. *RAIS J. Soc. Sci.* **2020**, *4*, 71–88.
49. Debrun, X.; Ostry, J.; Willems, T.; Wyplosz, C. Public Debt Sustainability. In *Sovereign Debt: A Guide for Economistsand Practitioners*; Abbas, S.A., Pienkowski, A., Rogoff, K., Eds.; Oxford University Press: Oxford, UK, 2019; Chapter 4, pp. 151–191.
50. Lambsdorff, J.G. Corruption and Rent-Seeking. *Public Choice* **2002**, *113*, 97–125. [CrossRef]
51. Chowdhury, F.; Audretsch, D.B.; Belitski, M. Does corruption matter for international entrepreneurship? *Int. Entrep. Manag. J.* **2015**, *11*, 959–980. [CrossRef]
52. Hutchinson, F. A review of donor agency approaches to anti-corruption. In *Policy and Governance Discussion*; Asia Pacific School of Economics and Government, The Australian National University: Canberra, Australia, 2005. [CrossRef]
53. Ferri, L.; Manes-Rossi, F.; Zampella, A. Readability versus obfuscation to fight corruption: Evidence from Italian local governments. *Public Money Manag.* **2023**, *43*, 659–668. [CrossRef]
54. Carstensen, K.; Toubal, F. Foreign direct investment in Central and Eastern European countries: A dynamic panel analysis. *J. Comp. Econ.* **2004**, *32*, 3–22. [CrossRef]
55. Mudalige, P.W.; De Silva, S.; Cooray, N.S. Fiscal decentralisation and provincial level service delivery in Sri Lanka: An econometric analysis. *Int. Soc. Sci. J.* **2023**, *73*, 753–769. [CrossRef]
56. Su, S.; Ni, X. Corruption in social relations: Bribe-taking, corruptibility, and corruption risks. *Public Adm.* **2023**, *101*, 481–499. [CrossRef]
57. Dvorak, J. Assessment of the Risks of Financial Crimes in Local Government. In *Management Strategies and Tools for Addressing Corruption in Public and Private Organizations*; Pérez-Uribe, R., Ramìrez-Garzòn, M., Muñoz-Maya, C., Diaz-Villamizar, O., Eds.; IGI Global: Hershey, PA, USA, 2023; Chapter 11, pp. 197–215. [CrossRef]
58. Li, H.; Zhou, L.-A. Political turnover and economic performance: The incentive role of personnel control in China. *J. Public Econ.* **2005**, *89*, 1743–1762. [CrossRef]
59. Salihu, H.A. Corruption: An impediment to good governance. *J. Financ. Crime* **2022**, *29*, 101–110. [CrossRef]
60. Deng, S.; Peng, J.U.N.; Wang, C. Fiscal transparency at the chinese provincial level. *Public Adm.* **2013**, *91*, 947–963. [CrossRef]
61. Amoah, A.; Asiama, R.K.; Korle, K.; Kwablah, E. Corruption: Is it a bane to renewable energy consumption in Africa? *Energy Policy* **2022**, *163*, 112854. [CrossRef]
62. Capasso, S.; Cicatiello, L.; De Simone, E.; Gaeta, G.L.; Mourão, P.R. Fiscal transparency and tax ethics: Does better information lead to greater compliance? *J. Policy Model.* **2021**, *43*, 1031–1050. [CrossRef]
63. Zvereva, T.; Taranov, P.; Musaelyan, A.; Krasnoplakhtich, M.; Pavlyukova, A. The impact of budget transparency on tax compliance. *E3S Web Conf.* **2021**, *284*, 07029. [CrossRef]
64. Sedmihradská, L.; Haas, J. Budget Transparency and Fiscal Performance: Do Open Budgets Matter? *Acta VŠFS* **2013**, *7*, 109–122. Available online: https://EconPapers.repec.org/RePEc:pra:mprapa:42260 (accessed on 11 August 2014).
65. Kazemikhasragh, A.; Buoni Pineda, M.V. Fiscal Space Policies for Sustainable Development and Debt Relief: Empirical Analysis in West African Countries. *New Glob. Stud.* **2023**, *17*, 1–16. [CrossRef]
66. Bastida, F.; Guillamón, M.-D.; Benito, B. Fiscal transparency and the cost of sovereign debt. *Int. Rev. Adm. Sci.* **2015**, *83*, 106–128. [CrossRef]
67. Yu, J.; Wei, W.; Butler, J.S. Fiscal Transparency and Government Credit Quality: Evidence from the U.S. States. *Public Perform. Manag. Rev.* **2021**, *44*, 378–403. [CrossRef]
68. Anderson, H.D.; Liao, J.; Yue, S. Financial expert CEOs, political intervention, and corporate investment decisions: Evidence from the anti-corruption campaign. *Int. J. Manag. Financ.* **2022**, *18*, 562–593. [CrossRef]
69. Xia, Y.; Hu, W.; Su, Z. Economic Policy Uncertainty, Social Financing Scale and Local Fiscal Sustainability: Evidence from Local Governments in China. *Sustainability* **2022**, *14*, 7343. [CrossRef]
70. Bohn, H. The Behavior of U. S. Public Debt and Deficits. *Q. J. Econ.* **1998**, *113*, 949–963. [CrossRef]
71. Wedeman, A. The Intensification of Corruption in China. *China Q.* **2004**, *180*, 895–921. [CrossRef]
72. Kopits, G.; Craig, J. *Transparency in Government Operations*; International Monetary Fund: Washington, DC, USA, 1998.

73. Hayes, A.F. *Introduction to Mediation, Moderation, and Conditional Process Analysis: A Regression-Based Approach*; Guilford Press: New York, NY, USA, 2013.
74. del Castillo, E.; Cabral, R.; Saucedo, E. The Sustainability of Mexican Municipal Public Debt. *Sustainability* **2022**, *14*, 6558. [CrossRef]

Disclaimer/Publisher's Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.