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Land Finance, Local Government Debt and Economic Green Transformation

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Abstract: As economic development continues to advance globally, countries are increasingly focused on the green transformation of their economies. This paper employs a data envelopment analysis (DEA) model and entropy weighting methodology to construct and assess an indicator system for economic green transformation, taking into account environmental pollution. The analysis is based on panel data from 215 prefecture-level cities in China between 2015 and 2019. The two-way fixed effects model and moderating effect model are employed to investigate the influence of land finance on economic green transformation and to ascertain the moderating effect mechanism of local government debt. The study's conclusions are as follows: (1) Land finance impedes the transition to a green economy. (2) Local government debt is a major factor that restricts the influence of land finance on the transition to a green economy; as local government debt levels rise, land finance's role in impeding the transition to a green economy rises, and a positive moderating effect occurs. (3) Depending on the urban geographic location, the size of the economy and other factors, the impact of local government debt and land finance on the economic green transition varies. This empirical study demonstrates that the more local government debt there is in an eastern region or city with a bigger economic output scale, the more of an inhibitory influence land finance has on the economic transition to a green economy. In light of this, the paper suggests that the land finance policy be updated at the appropriate time, that the land market be regulated, that the government's reliance on land finance be gradually decreased, that the nature and amount of public debt be actively optimised, that the industrial infrastructure be enhanced to facilitate the transition towards a more environmentally sustainable economy, and that other suggestions be made.

Keywords: land finance; local government debt; green economy transition; moderating effect

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1. Introduction

From the inception of the United Nations Framework Convention on Climate Change to the ratification of the Kyoto Protocol and the Copenhagen Climate Conference, environmental concerns, particularly those related to global warming caused by carbon emissions and particulate matter emissions, have garnered increasing global attention. In 2009, the United Nations Environment Programme published the Global Green New Deal Policy Brief, which advocated a transition to a green economy within the global economy. In 2011, Resolution 236 of the 64th United Nations General Assembly proposed that the concept of a "green economy in the context of sustainable development and poverty eradication" be included as one of the themes of the 2012 United Nations Conference on Sustainable Development. In 2012, on the 20th anniversary of the Rio Conference on Environment and Development, the "Rio+20" United Nations Conference on Sustainable Development proposed a new concept of green economy, which can be understood as a call for a paradigm shift in the economy. It can be observed that the transition to a green economy is becoming increasingly serious for governments. Since the "reform and opening-up" of China, i.e., its

economic reform, the country has experienced rapid economic growth and has become the world's second largest economy. However, it faces some challenges. Certain industries with high energy consumption, high emissions and high pollution have a significant impact on the ecological environment and also produce certain negative externalities on a global scale. In September 2020, China announced to the world at the United Nations General Assembly that it would achieve the goal of "carbon peaking" by 2030 and "carbon neutrality" by 2060. Local governments in China have promoted economic growth and social development through land finance and massive borrowing, which has also affected climate change and environmental pollution. The Chinese government is actively exploring the adoption of green economic policies to improve environmental issues. In this context, it is crucial to examine the interrelationships among land finance, local government debt and the green transformation of the economy.

Land finance represents a significant source of revenue for local governments, deriving from the transfer of land use rights. In the short term, land finance can facilitate the green transformation of the local economy, stimulate economic growth, enhance production efficiency and optimise the urban environment. However, as the reliance on land finance increases, its long-term negative effects begin to emerge, including the sacrifice of environmental quality, the distortion of the allocation of land resources, the hindrance of the rationalisation of the industrial structure and the crowding out of social resources, thereby inhibiting the green transformation of the regional economy. In addition, the specific areas in which local governments invest the funds raised through debt, as well as the methods of repayment guarantees, will all have an impact on the manner in which land finance affects the green transformation of the regional economy. The expansion of local government debt has resulted in accelerated urbanisation, a bias towards non-environmental infrastructure investment, and increased environmental pollution. It has also promoted the reliance on land finance, hindered the upgrading of the industrial structure and squeezed social resources, affecting the green innovation of enterprises and inhibiting the green transformation of the economy. Consequently, a more profound comprehension of the influence of local government debt on the ecological transformation of the economy through land finance can assist in a more comprehensive understanding of the economic policies of local governments in China in the context of the sustainable development goals.

The objective of this paper is to examine the influence of land finance on the green transformation of the economy, as well as the role of local government debt as a highly correlated variable with land finance in the mechanism between land finance and the green transformation of the economy. Empirical research indicates that land finance has impeded the advancement of the green transformation of the economy at this juncture. Furthermore, the use of local government debt as a moderating variable in empirical research indicates that local government debt plays an important role in the relationship between land finance and the green transformation of the economy. This conclusion is also valid in the context of heterogeneity in geographical regions and economic output. In addition to giving local governments experience in formulating land policies and resolving local government debt policies, the research given in this paper enhances our comprehension of the logical connection among land finance, local government debt and economic green transformation. It also provides a theoretical foundation for promoting the region's economic green transformation in order to achieve sustainable development. The primary contribution of this study to the field of research it belongs to can be summed up in the following three aspects.

Research perspective: Firstly, the green transformation of the economy is currently a hot topic in academia, and many papers have studied the factors influencing the green transformation of the economy. Some scholars have begun to study and discuss the impact of land finance on green economic growth or environmental pollution, but there has been very little research on the mechanism of the interaction among land finance, local government debt and the green transformation of the economy. This paper introduces the variable of local government debt into the framework of the impact of land finance on the

green transformation of the economy, enriching the research perspective on land use policy and the green transformation of the economy.

Theoretical and empirical analysis: Secondly, this paper constructs a theoretical framework among land finance, local government debt and economic green transformation earlier than the current literature and empirically examines the moderating effect of local government debt on the impact of land finance on economic green transformation, enriching research on land use policy and economic green transformation.

Practice: Finally, this paper provides practical suggestions for government decision makers on how to promote green economic development through the formulation of land finance policies and local government debt policies. It can help the government better reduce its dependence on land finance; effectively resolve local government debt; maintain a balance between local financial sustainability and environmental sustainability; reduce environmental pollution, natural resource depletion and ecosystem damage; and better achieve high-quality economic development.

2. Literature Review

2.1. Land Finance

Since the reform of China's tax system, land finance has greatly promoted local economic growth. There are two main views in academia on the causes of local government land finance [1]. First, local financial pressures. After China's tax system reform, local governments faced the mismatch between financial and administrative powers, which led to pressure on expenditure. They compensate for the financial gap by developing land finance [2]. Second, the incentive for officials to be promoted and competition among governments. China's GDP-oriented and short-term-oriented official assessment mechanism has led to local officials' political incentives to quickly obtain financial revenue by selling land and accelerating land finance [3]. Competition among governments also promotes land finance and drives the continuous expansion of land finance [4].

Local governments can monopolise the primary market for land supply, and they are both operators and managers. Land, as a factor of production, can bring land transfer fees and related taxes, becoming the "second finance". In terms of the economic role of land finance, the impact of land finance on economic development is complex and diverse. It is generally believed that land finance has a short-term effect on economic development, but it is not sustainable in the long term. For example, Mo (2018) used a land finance model to study the long-term and short-term effects of land finance on the Chinese economy, and land policy plays a special role in stimulating the economy [5]. Zheng (2014) empirically demonstrated that land resources have a significant positive impact on economic growth [6]. Su (2024) used Hangzhou as an example and studied the pros and cons of TOD projects implemented by local governments in China. The results of the study show that TOD under land financing leads to high housing prices and the expansion and development of cities. The model of promoting economic growth through land finance has obvious drawbacks and can lead to many hidden risks in the economic operation process. Therefore, reducing the degree of dependence on land finance and transforming the development model are the only effective ways to overcome the obstacles to high-quality economic development in China [7]. Regional coordinated development policies can be an effective tool to reduce the reliance on land finance [8].

2.2. Local Government Debt

With regard to local government debt, a great deal of research and discussion have been conducted by academics, who have developed a number of views and theoretical frameworks on the causes of local government debt and its economic impact. From the perspective of the causes of local government debt, Yang highlight that since the 1994 tax-sharing reform, local governments have been granted greater financial autonomy and diminished accountability, yet their financial expenditure responsibilities have not been reduced, placing pressure on local government finances. This, in conjunction with the

intensifying economic competition among local governments, has resulted in a mounting demand for local government financing, which has consequently led to an escalation in local government debt [9]. Chen (2020) also highlight that local governments have incurred hidden deficits through local government financing platforms in order to stimulate the economy, which has also led to an increase in local debt [10].

The economic impact of local government debt includes its impact on economic growth and its impact on systemic risk. There are three different views in academia on whether local government debt can promote economic growth. On the one hand, some scholars argue that local government debt can promote local economic growth by financing public infrastructure investment through debt [11]. Xu (2016) conducted an empirical analysis of panel data on local government debt in cities at the prefecture level and above in China from 2006 to 2013 and found that local government debt has a positive correlation with regional economic development, but this effect is less effective in economically relatively underdeveloped regions [12]. Conversely, while some scholars maintain that local government debt within a certain size can have a beneficial impact on economic growth, others have begun to discuss the adverse effects of excessive indebtedness. Long-term, large-scale debt increase can have a detrimental impact on investment [13], economic growth [14,15] and the stability of the financial system [16,17]. K. Tsui (2011) noted that China's local debt concerns mostly stem from local governments' inclination towards long-term debt-financed infrastructure investment [18]. Moreover, the presence of substantial amounts of local debt hinders efforts to rectify the structural imbalance of the economy. In addition, some scholars believe that there is no non-linear relationship between local government debt and economic growth. When the scale of government debt exceeds a certain threshold, the economic burden it brings will reduce the government budget, reduce the public investment rate and thus have a negative impact on economic growth [19,20].

2.3. Economic Green Transformation

The green transformation of the economy is derived from green development. This reflects a gradual shift from static "green development" to dynamic "green transformation". It emphasises the dynamic evolution of the economy from a "black" or "brown" economy to a green economy. In order to assess the economic green transformation, some scholars have proposed the construction of different evaluation index systems in different dimensions for analysis. These systems are constructed by using weighted subjective assignment methods, such as the entropy-OWA operator method and grey correlation improved TOPSIS model [21–23]. Additionally, scholars have developed models such as the SBM model and the Luenberger index to assess the advancement of China's economic green transformation based on the efficiency of this transformation [24,25]. With regard to the dimension of economic green transformation, a number of scholars have sought to measure the level of economic green transformation from different perspectives. These include the green transformation of resource cities, the green transformation of industries, the green transformation of enterprises and the green low-carbon and recycling development of the economy [26–29].

In terms of influencing factors, the green transformation of the economy is affected by the industrial structure, the level of openness to the outside world, the level of finance and innovation factors. The upgrading and transformation of the industrial structure can promote green economic growth [30], and there is significant regional heterogeneity [31]. The main reason is that the rationalisation and upgrading of the industrial structure is conducive to improving labour and capital output efficiency, enhancing the level of resource allocation and thus promoting green economic growth [32]. Foreign direct investment (FDI) is an important indicator of the level of openness to the outside world. Many scholars have found that FDI is closely related to environmental pollution, forming two views: the "pollution refuge" and "pollution halo" hypotheses. The "pollution refuge" hypothesis holds that in order to reduce the cost of pollution discharge, enterprises in developed countries with higher environmental standards often transfer polluting or sunset industries

to host countries with lower environmental protection requirements [33]. The "pollution halo" hypothesis holds that foreign-invested enterprises usually have more advanced environmental protection technology, pollution control funds and effective management systems, which are conducive to the introduction of environmentally friendly technologies, the realisation of energy conservation and emission reduction and green economic growth [34]. The impact of finance on the green transformation of the economy is that a high quality level of financial development is conducive to economic transformation and upgrading, quality improvement and efficiency enhancement, and pollution reduction and emission reduction [35]; the impact of innovation factors is mainly achieved through green scale efficiency and green pure technical efficiency [36]. In addition, some scholars have also found that the economic development level, education level, fiscal decentralisation and financial level all have an impact on green economic efficiency.

2.4. Land Finance, Local Government Debt and Economic Green Transformation

The existing literature contains a limited number of studies that analyse the development of land finance, local government debt and the green transition of the economy in a unified framework. Furthermore, the majority of these studies discuss the impacts of land finance and local government debt on the green transition of the economy separately.

Current academic research on land finance and economic green transition is focused on the economic growth effect and environmental effect of land finance. In terms of economic growth, under the framework of the promotion tournament theory, the scale of land finance is closely related to the promotion of officials. In order to obtain promotion, local officials are keen to sell land and win economic performance evaluations, which has a significant negative effect on economic growth [37,38]. The reason why land finance causes environmental pollution is inseparable from China's pursuit of rapid economic growth. Some scholars have studied the environmental effects of land finance from the perspective of carbon emissions. Wang (2020) studied the relationship between land finance and carbon emissions based on fiscal decentralisation and environmental federalism. The empirical results show that the overall impact of land finance on carbon emissions is non-linear and depends on the level of per capita GDP [39]. Xu (2016) also verified the bidirectional causal relationship between the quality of land urbanisation and carbon emissions in China [40]. Further, when land financing becomes the main driving force for urban development, the construction of infrastructure will accelerate the process of urbanisation, which will in turn cause ecological and environmental pollution. Wang (2019) found that there is an environmental Kuznets inverted U-shaped curve between urbanisation and environmental pollution [41].

Additionally, there is a paucity of research on the direct impact of local debt and economic green transformation. Currently, scholars are concentrating their efforts on the influence of local government debt on economic growth and economic development. Nevertheless, as China has initiated the implementation of a green development strategy, some scholars have begun to examine the relationship between local government debt and the development of a green economic transition. Firstly, government debt investment has an investment crowding-out effect [42] and cannot effectively improve the investment environment for environmentally friendly firms [43], thus hindering private investment and the potential for long-term green development of the economy. Secondly, local governments, confronted with the necessity of achieving GDP-based performance appraisals and competing with other regions, will lower environmental pollution enforcement standards and relax restrictions on highly polluting firms in exchange for economic growth [44–47], thereby increasing government revenues to alleviate fiscal pressures.

2.5. Literature Gap

In summary, existing research has discussed land finance, local government debt and economic green transformation, providing a rich theoretical framework and empirical testing methods for further research on the relationship among the three. Most of the

existing literature focuses on land finance and economic green transformation, and few scholars have studied the impact of local government debt on economic green transformation. Some scholars have also begun to study and discuss the unilateral impact of land finance on economic growth or environmental pollution, but there are relatively few studies that incorporate land finance, local government debt, and economic green development into a unified framework. Research at the level of the impact mechanism also needs to be supplemented and improved. Although some scholars, such as Hou (2021) [48], have used spatial effect models to study the spatial spillover effects of land finance on green economic growth, the mechanisms and pathways of the effects of land finance and economic green transformation are not very clear. In particular, there is very little research on the effects of land finance and economic green transformation from the perspective of local government debt. Therefore, this paper will incorporate land finance, local government debt and economic green transformation into a unified research framework to more comprehensively explore the relationship among land finance, local debt and economic green development, as well as the impact mechanisms, which is an innovative contribution of certain practical significance.

3. Theoretical Analysis and Research Hypotheses

3.1. The Influence of Land Finance on the Green Transition of the Economy

Land finance is a form of revenue for local governments to meet financial needs and maintain financial expenditure by relying on the transfer of land use rights to obtain land transfer fees. It is undeniable that the economic development model based on land has brought positive economic development to China since the beginning of the new century. Therefore, in the early stages of development, land finance can temporarily promote the green transformation of the local economy in the short term. On the one hand, local governments choose to sell land to ensure that financial expenditure needs are met, which stimulates investment growth and economic expansion; promotes industrial agglomeration and thus forms economies of scale; improves factor production efficiency, including green total factor productivity; and drives the green transformation of the local economy. On the other hand, after local governments sell land, they have more funds to control local pollution. Urban environmental optimisation will promote the healthy development of local green industries and promote the green transformation of the economy.

However, as local governments' dependence on land finance continues to increase, its long-term negative impact is gradually becoming apparent. Because of its unsustainable and predatory nature, land finance will inevitably hinder economic development [49]. The same is true for the green transformation of the urban economy. As local governments' financial pressures continue to increase and the scale of land finance continues to expand, the "original intention" of land sales has gradually "deteriorated", leading to a distortion of land resource mismatches and a shift from promoting to inhibiting the green transformation of the urban economy.

First, land finance has become a financing tool for urban expansion at the expense of environmental quality, inhibiting the green transformation of the regional economy. Land finance has strengthened the power of local governments in the allocation of land resources. The original intention was to increase investment in regional environmental governance and alleviate the pressure on green fiscal expenditure. However, the land finance development model is not sustainable. With the rapid expansion of cities and the expansion of resource-intensive industries, local governments face greater challenges in balancing urban expansion and environmental governance. In addition, the fiscal decentralisation system has weakened local financial power, and the local official assessment system emphasises GDP over environmental performance. Local governments have chosen to invest a large amount of capital in heavy industry in order to pursue rapid economic growth. However, the price is the accelerated depletion of resources, a significant increase in the discharge of three waste types and a continuous decline in environmental quality. The failure of various green transition power indicators inhibits the green transformation of the local economy.

In addition, the continuous expansion of cities will also lead to the rapid urbanisation of land. While high-rise buildings are being built, the area of urban green space is being reduced, leading to a decline in the ecological environment conservation and restoration functions and a deterioration of the urban green ecosystem, further hindering the green transformation of the regional economy.

Second, land finance may lead to distortions in the allocation of land resources and hinder the rationalisation of the industrial structure, thereby inhibiting the green transformation of the local economy. The government's over-reliance on land transfer fees may lead to the irrational allocation of land resources, raising the price of residential land while lowering the price of industrial land. On the one hand, the mismatch of land resources may increase the incentive for industrial enterprises to seek rent from land, making the transformation and upgrading process insufficient and blocking the industrial upgrading process. Enterprises attempt to achieve the goal of reducing costs and increasing profits by increasing investment in low-priced industrial land. Since land investment is less complex than industrial restructuring and the business objectives can be achieved more quickly, the existence of this potential path will significantly reduce the subjective willingness of industrial enterprises to carry out technological innovation, the upgrading of production and the optimisation and adjustment of industrial structure [50], hindering the process of green industrial development and thus having a negative impact on the green transformation of the entire regional economy. On the other hand, land resource mismatch will also lead to the distortion of the price signals faced by enterprises. Industrial enterprises with lagging production efficiency can easily obtain land at low cost, while enterprises with higher production efficiency cannot obtain land at ideal prices due to initial land mismatches and poor redistribution channels. The prominent land use conflicts between enterprises and uneven resource allocation among industries hinder the transformation and upgrading of enterprises in other industries and the optimisation of the industry, making industrial agglomeration and economies of scale fail to play a driving role, and ultimately may cause the green transformation of the regional economy to stagnate.

Third, land finance may lead to the crowding out of social resources, lowering the efficiency of production and resource utilisation and thus inhibiting the green transformation of the regional economy. In the market economy system, excessive local government dependence on land finance will distort land prices and cause a waste of resources. On the one hand, the current sharp reduction in the price of industrial land and bullish expectations for the future will increase the investment of industrial enterprises in non-development land, resulting in more land not being fully utilised or even being left idle. This will not only reduce the resource utilisation and production efficiency of the enterprises themselves but also reduce the possibility of other industries using the land, which will have a negative impact on regional development. The lack of overall economic development momentum will inevitably affect the ability and willingness of cities to transform greenly, thereby inhibiting the green transformation of the economy. On the other hand, local governments under greater financial pressure are more motivated to obtain funding income through land finance. Real estate is also favoured by local governments due to its high rate of return on investment, forming a closed-loop development of "land finance–real estate development". The tendency and preference of local governments to sell land for real estate development also means that resources that should have flowed into industries other than real estate are being squeezed out, the operating costs of the real economy are rising and the innovation and industrial upgrading of real enterprises are being hindered. In addition to being transmitted among enterprises, the negative effects of cost and resource allocation are also spread among regions, which in turn inhibits the green transformation of the urban economy.

Therefore, based on the above theoretical analysis, Hypothesis 1 is proposed.

H1. *The expansion of land finance will inhibit the green transformation of the economy.*

3.2. The Impact of Local Government Debt on Land Finance and Economic Green Transformation

Under the guidance of the "4 trillion" economic stimulus policy, local governments have begun to choose new debt financing models to raise funds for infrastructure construction, including issuing local government bonds and raising funds through financing platforms. While meeting the government's financial needs, these financing methods have also created a large scale of local government debt. The investment areas and repayment guarantee methods of funds raised by local governments through debt will have an impact on the way land finance affects the green transformation of the regional economy. The specific impact mechanisms include the following three points.

First, the impact of land finance on the degree of environmental pollution and its role in inhibiting the green transformation of the economy is affected by local government debt. The scale of local government debt reflects the amount of funds currently available to local governments. Therefore, the larger the scale of local government debt, the greater the potential motivation and financial support for local governments to accelerate urbanisation and achieve scale expansion under the "GDP-only" official assessment system. In this context, local governments will also be more inclined to use funds for infrastructure projects in non-environmental protection areas. Infrastructure investment projects are often medium-sized or large-scale projects with long time cycles and high resource consumption, which inevitably has a negative impact on the urban ecological environment and atmospheric environment during the construction process. In addition, during the rapid expansion of the city, local governments and officials have weak awareness of environmental protection, and they fail to take effective measures to curb environmental pollution during the construction period, which will further expand the degree of environmental pollution under the land finance system and further increase the inhibitory effect on the green transformation of the urban economy. Therefore, the larger the scale of local government debt, the stronger the motivation for local governments to urbanise land use, the higher the probability that land finance will increase the degree of environmental pollution, and the greater the inhibiting effect on the green transformation of the regional economy.

Second, the impact of land finance on the green transformation of the regional economy is mediated by local government debt. The interactive effect of local government debt and the scale of land finance will further promote the formation of land finance dependence and push up the scale of land finance. On the one hand, the expansion of the scale of local government debt issuance will encourage the government to conduct land sales more frequently to serve as collateral for debt or to repay the principal, thereby deepening its dependence on land finance policies. On the other hand, the expansion of the scale of local government debt will increase government investment in infrastructure. In the short term, infrastructure investment can be significantly capitalised into land prices, and rising land prices can alleviate the budget constraints faced by local governments through two channels: land mortgage borrowing and land transfer income. This will lead to more land mortgage loans and increase local government debt. The expansion of the scale of land finance will further increase the distortion of land resource allocation, further slowing down the process of industrial restructuring and upgrading, and the efficiency of resource allocation and utilisation among industries will continue to be low, ultimately inhibiting the green transformation of the urban economy. Therefore, the larger the scale of local government debt, the higher the dependence of local governments on land sales for revenue, the stronger the role of land finance in hindering industrial restructuring and the greater the inhibition of the green transformation of the regional economy.

Third, the impact of land finance on the green transformation of the regional economy is affected by local government debt. There are a positive interaction and interest coupling between local government debt and land finance, which makes local economic growth driven by local government debt unsustainable [51]. Local governments issue local government debt with land transfer income in the future as collateral. Due to the existence of a positive feedback mechanism between real estate prices and public investment, it will cause price fluctuations in the real estate market [52]. The uncertainty of income caused

by housing price fluctuations will further expand the resource crowding-out effect of real estate development on other industries and increase the inhibitory effect of land finance on the green transformation of the regional economy. In addition, financial institutions prefer to provide credit to local governments with higher credit ratings and lower default risks. When the financing needs of local governments increase and the scale of their debt expands, it will also crowd out the financial resources of enterprises and individuals, which is not conducive to the development of green innovation projects by enterprises, and will further inhibit the green transformation of the urban economy. Therefore, the larger the scale of local government debt, the higher the degree of crowding out of social resources by land finance, and the more obvious the inhibiting effect on the green transformation of the urban economy.

Therefore, based on the above theoretical analysis, the following hypothesis is proposed.

H2. *Local government debt has a positive effect on the suppression of the green transformation of the economy by land finance.*

The theoretical analysis logical framework diagram is shown in Figure 1.

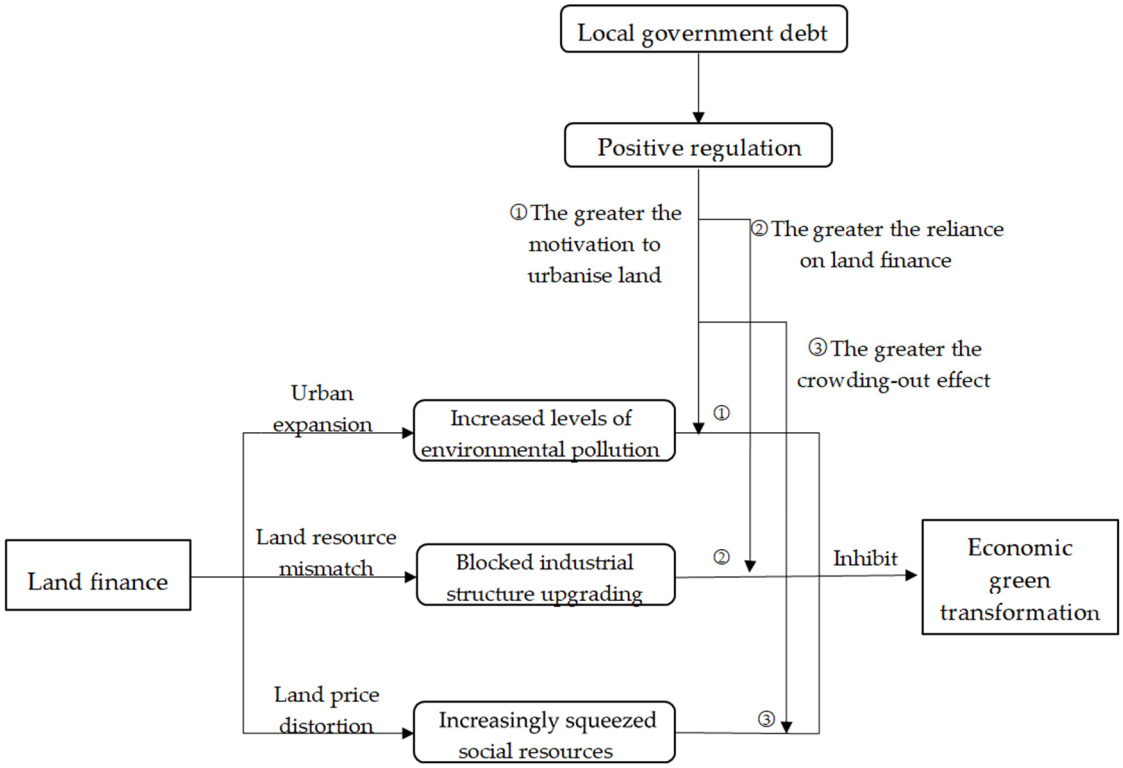

Figure 1. The conceptual framework for the impact of land finance and local government debt on the green transformation of the economy.

4. Empirical Design

4.1. Sample Selection and Data Sources

In this paper, the data sources for constructing the green GDP index are *China City Statistical Yearbook* and *China Science and Technology Statistical Yearbook*; the data for land transfer income are from *China Land & Resources Almanac*; the data for local government debt are from the Wind database; and the remaining control variables are from *China City Statistical Yearbook* and *China Science and Technology Statistical Yearbook*.

This paper takes all 293 prefecture-level cities in China into consideration, but due to the availability and accuracy of the data, the prefecture-level city samples in Xinjiang and Tibet are excluded, and the prefecture-level city samples with more missing data

are also excluded. Finally, the extreme values are trimmed, and some missing data are supplemented by interpolation.

4.2. Variable Definition

4.2.1. Explained Variable

Green economic transformation. The measurement of economic green transformation adopts the methodology proposed by Wang (2014) [53], employing the DEA model to assess green economic efficiency. The process involves several steps: Initially, the entropy weight method is utilised to select industrial waste data, constructing a comprehensive environmental pollution index. Subsequently, this index is used to establish green GDP output indicators. Inputs including labour (L), capital (K) and technological development (T) are paired with the green GDP indicator as outputs. DEAP2.1 software is then employed to compute the green economic efficiency (TFP), which serves as the primary explanatory variable. The green GDP defined in this paper is the GDP/environmental pollution index, where GDP is the real GDP after removing the impact of local price indices, and the data come from *China Statistical Yearbook*. Industrial waste refers to the three main pollutants: industrial wastewater discharge, industrial sulphur dioxide emissions and industrial smoke emissions; the data come from *China City Statistical Yearbook*. The input indicator labour (L) is defined as the number of employees at the end of each region, and the data source is *China City Statistical Yearbook*; the technology input indicator is defined as the number of patent applications and authorisations at the end of each region as a substitute, and the data source is *China Science and Technology Statistical Yearbook*; the capital stock data are estimated based on the relevant research methods and research results of Wang (2017) [54], using the perpetual inventory method for estimation, and the fixed asset investment data are sourced from *China City Statistical Yearbook*, while the data required for calculating the price index and depreciation rate are sourced from *China Statistical Yearbook*.

4.2.2. Key Explanatory Variable

Land financial scale (LF). Drawing upon the research conducted by Zou (2015) [55], land finance is gauged by using local land transfer revenue (LF) as a proxy variable. This metric aptly mirrors the resource endowment and financial capability of local governments, playing a pivotal role as a primary explanatory variable.

4.2.3. Moderating Effect Variable

Local government debt. Local governments predominantly procure funding by issuing urban investment bonds through local financing platforms and other instruments. Moreover, the transparency regarding local government debt in China remains limited, resulting in the absence of precise data on its scale. Therefore, given the availability of data, this paper uses the total amount of municipal investment bonds as a proxy variable for the size of local government debt (LGD).

4.2.4. Control Variables

Since the green transformation of the economy is also affected by factors such as the level of economic development, industrial structure, technological innovation and environmental policy, in order to eliminate the interference of other factors on the model and control the factors that may affect the green transformation of the economy, the following control variables are selected in this paper: per capita real output, degree of openness to the outside world, industrial structure, per capita expenditure on science and technology education, fiscal decentralisation, environmental regulation and financial level. The principal variables are delineated in exhaustive detail and presented in Table 1.

Per capita real output. The level of regional economic development is an important factor affecting the green transformation of the economy. In this study, the level of economic development is used as a control variable, and only the impact of its first-order term on green development efficiency is considered.

Table 1. Variable names and definitions.

Category	Variable Name	Symbol	Definition
Explained variable	Green economic efficiency	TFP	Green economic efficiency measured by data envelopment method
Explanatory variable	Land finance	LF	Local land transfer income in the current year
Moderating effect variable	Local government debt	LGD	Estimating the scale of urban investment bond stock
Control variables	Real output per capita	pgdp	GDP/population
	Foreign direct investment accounts for GDP share	fdi	Foreign direct investment/GDP
	Proportion of tertiary industry	pti	Gross output value of tertiary industry/GDP
	Financial institution loan balance at end of year Share of GDP	ptlf	Financial institution loan balance/GDP
	Per capita expenditure on science and technology education	pse	Total expenditure on science and technology education/population
	Environmental regulation	er	The entropy weight method is used for the calculation
	Degree of fiscal decentralisation	fis	Fiscal revenue/fiscal expenditure

Degree of openness. The degree of openness of a region also affects its green economic efficiency. The main reasons include the technology diffusion effect [56] and the "pollution haven" hypothesis [57]. This paper selects the actual amount of foreign direct investment in each province and converts it into CNY units according to the intermediate exchange rate announced by the National Bureau of Statistics. The ratio of the converted FDI to the GDP of each region in the same year is used to measure the degree of openness of each prefecture-level city.

Industrial structure. Pender (2003) believes that the flow of factor resources from low-productivity sectors or low-growth sectors to high-productivity sectors or high-growth sectors will bring about a "structural dividend" effect. In addition, according to the law of Pareto–Clark, resources such as labour will first flow from agriculture to the secondary industry and then from the secondary industry to the service industry. This process will bring about a structural dividend. Therefore, the increase in the proportion of the tertiary industry in the city will promote green economic efficiency [58]. This paper uses the proportion of the tertiary industry in GDP as an important control variable.

Per capita expenditure on science and technology education. The level of scientific and technological innovation is also an important control variable. According to the endogenous economic growth theory, the higher the R&D investment of enterprises, the more conducive it is to promoting technological innovation and technological progress [59], accordingly improving enterprise production efficiency and green economic efficiency. This paper uses per capita expenditure on science and technology education to measure the level of scientific and technological innovation.

Fiscal decentralisation. Fiscal decentralisation can promote local governments to optimise resource allocation and engage in healthy competition, thereby laying the foundation for industrial upgrading and improving the soft environment for industrial upgrading, which is conducive to promoting industrial upgrading and thus promoting the green transformation of the economy [60]. This paper uses the fiscal autonomy index to measure fiscal decentralisation, expressed as budgeted fiscal revenue/budgeted fiscal expenditure [61].

Environmental regulation. The Porter hypothesis holds that appropriate environmental regulation will encourage enterprises to carry out innovative activities, thereby

enhancing product competitiveness and thus promoting the efficiency of green development. However, some studies have found that environmental regulation will increase production costs and reduce R&D investment, which is not conducive to the efficiency of green development [62]. This paper draws on research by scholars such as Lin [63] to first standardise industrial wastewater discharge, industrial SO_2 emissions and industrial smoke (dust) emissions per unit of economic output. It then employs the entropy method to obtain weights, which are used to calculate the environmental regulation intensity index.

The level of financial development is also an important factor affecting the green transformation of the economy in various regions. In this paper, the proportion of the balance of loans from financial institutions at the end of the year to GDP is used to measure the level of financial development in various prefecture-level cities. In addition, environmental policies are also among the factors affecting the green transformation of the economy. As an important environmental policy in China, the low-carbon city pilot has been carried out in three batches, with 81 pilots. This paper adds the low-carbon city pilot as a control variable; however, as it has little impact on the empirical analysis and the results of this paper, it is not considered.

4.3. Model Setting

This paper is based on relevant economic panel data of 215 prefecture-level cities from 2015 to 2019. It selects the land transfer income of each prefecture-level city as the core explanatory variable and multiple control variables on a theoretical basis. Since the research sample contains short panel data of multiple prefecture-level cities, there are individual characteristics such as urban area and population that do not change or change little over time in each prefecture-level city. Individual effects are added to the model to control the omitted variable problem caused by individual changes in cities. At the same time, under the requirements of high-quality economic development, the process of green transformation of the economy in each city also has a trend of continuous change over time, which is controlled by adding a time fixed effect. For example, China's annual macroeconomic conditions and monetary policy also have an impact on the local economy. Through a two-way fixed effects model, the impact of the explanatory variable on the dependent variable can be more accurately identified, and unobserved individual heterogeneity and time heterogeneity can be controlled. The following benchmark model is established to test the impact of land finance on the green transformation of the economy:

$$TFP_{it} = \beta_0 + \beta_1 LF_{it} + \beta \sum controls + \mu_{it} + \delta_{it} + \varepsilon_{it} \quad (1)$$

In order to better understand how local government debt affects the hindrance of economic green transformation through land financing, a regulatory effect mechanism model, shown in (2) and (3), is constructed for future investigation. The empirical testing process involving moderating effects entails several steps: Initially, a baseline regression, based on model (2), examines the inhibitory impact of land finance on economic green transformation. Subsequently, if the regression coefficient of the core explanatory variable, β_1, proves significant, the analysis proceeds to test model (3). In the event that the regression coefficient, β_3, related to its interaction term displays significance, it establishes the presence of a moderating effect, signifying that local government debt moderates the influence of land finance on economic green transformation.

The specific model is as follows:

$$TFP_{it} = \beta_{01} + \beta_1 LF_{it} + \beta \sum controls + \mu_{it} + \delta_{it} + \varepsilon_{it} \quad (2)$$

$$TFP_{it} = \beta_{02} + \beta_1 LF_{it} + \beta_2 LGD_{it} + \beta_3 LF_{it} \times LGD_{it} + \beta \sum controls + \mu_{it} + \delta_{it} + \varepsilon_{it}. \quad (3)$$

Above, TFP_{it} is the measured green economic efficiency of city i in year t, LF_{it} is the land transfer income of city i in year t, LGD_{it} is the adjusting variable local government debt, $LF_{it} \times LGD_{it}$ is the interaction term between the explanatory variable land finance

LF_{it} and local government debt LGD_{it}, controls is the control variable, μ_{it} and δ_{it} are time fixed effects and individual fixed effects and ε_{it} is the random interference error term.

5. Empirical Analysis

5.1. Descriptive Statistical Analysis

The table (Table 2) displays the mean, standard deviation, maximum and minimum values of the selected variables. All statistical values pertaining to the data indicate a reasonable level, and there are no outliers observed for the subsequent empirical analysis.

Table 2. Descriptive statistics.

Variable	N	Mean	sd	Min	Max
TFP	1046	1.017	0.062	0.617	1.492
LF	1046	0.017	0.027	0.001	0.193
LGD	1046	0.199	0.467	0.004	4.730
pgdp	1046	1.677	0.517	0.411	6.465
fdi	1046	200.973	262.512	0.024	1978.282
pse	1046	7.054	0.822	2.843	10.151
fis	1046	0.487	0.214	0.071	1.413
pti	1046	0.534	1.815	0.174	59.090
ptlf	1046	1.377	0.998	0.247	9.012
er	1046	0.0094	0.0274	0.0003	0.7725

The correlation analysis conducted on the research variables revealed Pearson coefficients at a reasonable level, indicating a low likelihood of covariance issues among the selected variables. In order to further investigate multicollinearity, the Variance Inflation Factor (VIF) test was utilised. The results indicate that the explanatory variable possesses VIF coefficients below 5 in all cases, suggesting the absence of multicollinearity among the chosen variables. This validation substantiates the earlier assertion.

5.2. Basic Regression Analysis

A panel regression model was used to conduct a multiple regression analysis on the sample data to verify the impact of land finance on the green transformation of the economy. By using Stata 18.0, the F-test *p*-value was 0, rejecting the null hypothesis and concluding that the fixed effects model was superior to the mixed effects model. The LM test and Hausman test were then conducted, and the *p*-value was 0, indicating that the random effects model was not selected for analysis and did not conform to the characteristics of the data. Based on the above test steps and results, the panel fixed effects model was finally selected as the benchmark regression model to verify the impact of land finance on the green transformation of the economy.

Table 3 lists the estimated results under different model settings. Column (1) is the baseline model in the research design without control variables, controlling for individual fixed effects, and the results are not significant. Column (2) adds the control variable of per capita real output and controls for individual fixed effects. It was found that when other conditions are constant, the explanatory variable LF is significantly negative, indicating that when other conditions are constant, the larger the scale of land finance, the stronger the inhibitory effect on the green transformation of the economy. Column (3) adds other control variables to (2), and the explanatory variable LF is still significantly negative, with the absolute value reduced. Finally, column (4) adds all control variables and controls for individual and time fixed effects. The results show that the impact coefficient of land finance on the green transformation of the economy is −2.184 from the perspective of the entire sample, which is significant at the 5% level, proving that land finance has an inhibiting effect on the green transformation of the economy as a whole, which is consistent with research hypothesis H1 in this paper.

Table 3. Land finance and economic green transition: panel fixed effects regression.

	(1)	(2)	(3)	(4)
LF	−0.850	−1.710 **	−1.668 **	−2.184 **
	(−1.20)	(−2.22)	(−1.99)	(−2.50)
Constant	1.089 ***	1.037 ***	1.249 ***	1.406 ***
	(78.09)	(44.41)	(4.50)	(3.84)
Controls	N	Y	Y	Y
Time	N	N	N	Y
Individual	Y	Y	Y	Y
Observations	1045	1045	1045	1045
R-squared	0.134	0.142	0.143	0.174

Notes: The t-value is presented in parentheses. Y for Yes, N for No. *** $p < 0.01$, ** $p < 0.05$.

5.3. Heterogeneity Analysis

5.3.1. Consideration of Regional Differences

Considering the disparities in economic development across China, regional financial disparities and varying reliance on and sensitivity to land finance are evident. Geographically, China's economic landscape broadly delineates stronger economic development in eastern cities compared with those in central and western regions. To analyse this, the sample was partitioned into three distinct geographic zones: the eastern, central, and western areas, comprising 85, 68, and 62 cities, respectively.

In Table 4, columns (5)–(7) report the regional heterogeneity. The coefficient of the impact of urban land finance on the green transformation of the economy in the eastern region is −3.583, and the result is significant at the 1% level. Conversely, in central and western cities, while the land finance coefficient shows negativity in relation to the environmental aspects, the significance level is less pronounced. The results show that the inhibiting effect of land finance on the green transformation of the economy is mainly found in cities in economically developed regions, and the inhibiting effect of land finance on the green transformation of the economy is not obvious in cities in central and western regions. Moreover, the spatial characteristics of regional debt scales reveal higher debt levels in China's eastern cities than in the central and western counterparts, proportional to the city's economic size. The reason for this is that the more economically advanced cities and regions have the capacity to service their debt in a way that matches the size of their debt. Consequently, the average government debt in eastern cities surpasses that of central and western regions. The significant inhibitory influence of land finance on economic transformation in the eastern region indicates a regulatory correlation between the adverse effects of land finance and the magnitude of government debt.

Table 4. Heterogeneity analysis.

	(5)	(6)	(7)	(8)	(9)	(10)	(11)
	Eastern Cities	**Central Cities**	**Western Cities**	**Tier 1 Cities**	**Tier 2 Cities**	**Tier 3 Cities**	**Tier 4 Cities**
LF	−3.583 ***	−0.618	−1.766	−2.132 **	−0.174	−0.463	0.425
	(−2.60)	(−0.36)	(−0.94)	(−2.02)	(−0.66)	(−0.62)	(0.56)
Constant	1.860 **	1.076	1.267 ***	2.281 *	1.453 ***	1.208 ***	0.989 ***
	(2.55)	(1.46)	(3.09)	(1.79)	(4.76)	(4.86)	(8.30)
Controls	Y	Y	Y	Y	Y	Y	Y
Time	Y	Y	Y	Y	Y	Y	Y
Individual	Y	Y	Y	Y	Y	Y	Y
Observations	419	330	297	73	125	215	632
R-squared	0.083	0.039	0.076	0.345	0.315	0.176	0.179

Notes: The t-value is presented in parentheses. Y for Yes. *** $p < 0.01$, ** $p < 0.05$ and * $p < 0.1$.

5.3.2. Consideration of Differences in Economic Output

To further corroborate these findings on the influence of land finance restraining environmental conservation and low-carbon economic transformation, particularly in

economically prosperous cities, the sample was categorised based on the 2019 national city economic output rankings. The cities were classified into Tier 1, Tier 2, Tier 3 and Tier 4 groups, where Tier 1 comprises the top 20 cities in GDP ranking, Tier 2 spans from the 21st to the 50th, Tier 3 from the 51st to the 100th and the remaining cities fall into Tier 4.

In Table 4, columns (8)–(11) report the heterogeneity of the differences in economic output. As shown in Table 4 column (8), the main regression coefficient for the first-tier sample is −2.132, which is significant at the 5% level, indicating that land finance has a more significant negative effect on the green transformation of the economy in economically strong cities. Columns (9) to (11) show that the main regression coefficients for the second-, third- and fourth-tier city samples are not significant. The regression coefficients for the second- and third-tier cities are still negative. The findings indicate that for cities with a relatively middle ranking in terms of economic development and economic scale, the inhibiting effect of land finance on the green transformation of the economy is not yet apparent. However, there is a discernible trend of negative effects. In contrast, the coefficient for the fourth tier of cities is positive, suggesting that for regions and cities with lagging economic development, land finance has not yet demonstrated an inhibiting effect on economic development. Consequently, there is still the possibility of promoting economic development.

This heterogeneity results from the considerable geographical variations in China's economic development as well as the various economic development levels found in different parts of the country. Regional variation exists with regard to the consequences of local government debt on land financing to impede the green transformation of the economy due to differences in the efficiency of using debt funds, the investment of funds, the ability to bear debt and the ability to repay debt.

5.4. The Role of Local Government Debt as a Constraint on the Impact of Land Finance on the Green Transformation of the Economy

5.4.1. Examination of Local Government Debt's Moderating Effect

In order to further investigate the impact mechanism of local government debt and land finance on the green transformation of the economy, the regulatory effect of local government debt is studied. So, the interaction term of local government debt and land finance is introduced in order to study the moderating effect of local government debt.

In Table 5, columns (12) and (13) present the findings of the moderation test for the full sample. As illustrated in Table 5 (13), the coefficient of the interaction term $LF_{it} \times LGD_{it}$ is −1.338, which is statistically significant at the 0.05 level. The results of the moderation test indicate that an increase in the scale of local government debt is associated with a stronger inhibiting effect of land finance on the green transformation of the economy. The results of the moderation test indicate that local government debt exerts a moderating effect on the impact of land finance on the green transformation of the economy. This finding is consistent with research hypothesis H2 presented in this paper.

In Table 5, columns (14) and (15) and columns (16) and (17) report the moderating effect test for the eastern region urban sample and the first-tier urban sample, respectively, and indicate that there is land finance inhibition of the green transition of the economy in the sample of eastern cities and first-tier cities and that there is a moderating role for the land finance inhibition of economic green transition in local government debt.

The aforementioned analysis results are consistent with earlier theoretical hypotheses: public investment will crowd out private investment and lower overall investment efficiency; additionally, local government debt has a risk aggregation effect and interacts with land finance to further inhibit economic green transition. The aforementioned variables collectively contribute to the local government debt playing a reinforcing role in the utilisation of land financing for the purpose of promoting the green transformation of the economy.

Table 5. Moderating effect test.

	(12)	(13)	(14)	(15)	(16)	(17)
	Full Sample		**Eastern Cities**		**Tier 1 Cities**	
LF	−2.184 **	−2.362 ***	−1.249 ***	−0.947 *	−2.132 **	−1.328 *
	(−2.50)	(−2.66)	(−2.81)	(−1.79)	(−2.02)	(−1.66)
LGD		0.265 **		0.170 **		0.444 **
		(2.00)		(1.98)		(2.52)
LF× LGD		−1.338 **		−0.735 **		−1.630 **
		(2.30)		(−2.12)		(−2.24)
Constant	1.279 ***	1.139 ***	1.029 ***	0.958 ***	2.281 *	2.395
	(3.28)	(4.04)	(4.17)	(3.86)	(1.79)	(1.47)
Controls	Y	Y	Y	Y	Y	Y
Time	Y	Y	Y	Y	Y	Y
Individual	Y	Y	Y	Y	Y	Y
Observations	1045	1045	419	419	73	73
R-squared	0.175	0.167	0.189	0.201	0.345	0.488

Notes: The t-value is presented in parentheses. Y for Yes, N for No. *** $p < 0.01$, ** $p < 0.05$ and * $p < 0.1$.

5.4.2. Group Regression by Size of Local Government Debt

The government debt ratio is a measure of the overall government debt level of prefecture-level cities, calculated by comparing the scale of local government debt to the scale of local economic activity. The chosen samples were further categorised into high and low groups, with the median being used as the benchmark for regression analysis. This was performed to enhance the presentation of the cause-and-effect link between land finance and economic green transformation, as well as the impact of local government debt adjustments. We examined the differences in the impact of land finance on the green transition of the economy when the size of government debt varies through the above methodology. The results are shown in Table 6.

Table 6. Regression with sample grouping.

	(18)	(19)	(20)	(21)	(22)	(23)
	Full Sample, High Debt	**Full Sample, Low Debt**	**Eastern Cities, High Debt**	**Eastern Cities, Low Debt**	**Tier 1 Cities, High Debt**	**Tier 1 Cities, Low Debt**
LF	−2.014 **	−0.285	−4.649 ***	−8.608	−6.154 *	−1.247
	(−2.39)	(−0.94)	(−3.56)	(−1.63)	(−2.02)	(−0.14)
Constant	1.946 ***	1.045 ***	1.787 *	1.188	2.053	0.810 ***
	(3.21)	(21.58)	(1.75)	(0.99)	(0.47)	(5.16)
Controls	Y	Y	Y	Y	Y	Y
Time	Y	Y	Y	Y	Y	Y
Individual	Y	Y	Y	Y	Y	Y
Observations	459	523	227	192	50	23
R-squared	0.245	0.062	0.175	0.088	0.487	0.708

Notes: The t-value is presented in parentheses. Y for Yes.*** $p < 0.01$, ** $p < 0.05$ and * $p < 0.1$.

Regression of Full-Sample Subgroups by Local Government Debt Size

In Table 6, columns (18) and (19) report the results of the regression analysis for the full sample. Due to disparities in economic development among various provinces and municipalities across regions, assessing each locality's debt scale solely through the local debt balance stock indicator lacks comparability. Therefore, a more justifiable approach involves comparing it against comprehensive financial strength to derive the local government debt ratio. This ratio signifies the regional economy's growth capacity relative to the magnitude of local government debt and serves as a measure for each locality's debt scale. Column (18) shows that in the high-scale group of local government debt, land finance has a significant inhibitory effect on the green transformation of the economy, with a coefficient of −2.014, which is significant at the 5% level. Column (19) shows that in the low-scale group of local government debt, although the coefficient of land finance on the green transformation of the economy is still negative, indicating an inhibitory effect, it is

not statistically significant. The regression findings within this subgroup highlight that the inhibitory impact of real estate finance on the economic green transformation is more pronounced in prefecture-level cities grappling with higher local government debt.

Regressions Grouped by Size of Local Government Debt in Eastern Cities

In Table 6, columns (20) and (21) show the regression results for the subgroup of eastern cities. In order to further explore the aforementioned conclusions and examine the moderating influence of local government debt, the magnitude of local government debt in the central and eastern cities of the sample was divided into high and low groups by using the median as a dividing threshold. Cities exceeding the median local government debt size were classified as the high-debt group (assigned a value of 1), while those below the median form the low-debt group (assigned a value of 0).

As shown in Table 6 (20), the substantial debt burden in eastern cities poses a significant obstacle to the progress of the green transformation of the economy, with a coefficient of −4.649, which is statistically significant at the 1% level. Simultaneously, land finance in the low-debt group in eastern cities has a consistent direction of the effect of the green transition of the economy, with a coefficient that is still negative but not statistically significant. The aforementioned group regression results demonstrate how the intensity of the land finance-induced economic green transition inhibitory effect is influenced by both high and low levels of government debt; in other words, local government debt amplifies this effect, thereby supporting research hypothesis H2.

Regressions Grouped by Size of Local Government Debt in First-Tier Cities

In Table 6, columns (22) and (23) report the regression results by the size of local government debt in first-tier cities. The local government debt burden ratio of the first-tier cities was divided into high and low groups for group regression based on the median, and the cities with local government debt size larger than the median were defined as the high-debt group and assigned the value of 1, while the cities with local government debt size smaller than the median were defined as the low-debt group and assigned the value of 0.

As shown in columns (22) and (23), with a coefficient of −6.154, which is significant at the 10% level, land finance has a substantial inhibiting impact on the green transition of the economy in major cities with large levels of debt; in the low-debt group, the coefficient of land finance's effect on the economy's green transition is still negative, indicating that it has an inhibitory effect but is not statistically significant.

The group regression results presented above indicate that local government debt plays a moderating role in the relationship between land finance and economic green transition, confirming hypothesis H2. Furthermore, the results suggest that as local government debt increases, the inhibitory effect of land finance on economic green transition becomes stronger.

5.5. Robustness Testing

The analysis in this paper employs various grouping regressions to examine the impact mechanism. These analyses consistently highlight the amplified moderating effect of local government debt on the relationship between land finance and the transition to a greener economy. Following this, a benchmark regression was conducted to further scrutinise the robustness of these findings. The results are shown in Table 7.

Table 7. Base regression robustness analysis.

	(24)	(25)	(26)	(27)	(28)
	TFP-SBM	**TFP-SBM**	**TFP-SBM**	**TFP**	**TFP**
LF	−0.278	−0.597 **	−0.582 **	−1.781 **	−3.774 ***
	(−1.12)	(−2.27)	(−2.19)	(−1.99)	(−3.43)
Constant	1.022 ***	0.995 ***	1.040 ***	1.354 ***	1.245 ***
	(214.24)	(110.27)	(9.36)	(3.80)	(2.73)
Controls	N	Y	Y	Y	Y
Time	N	N	Y	Y	Y
Individual	Y	Y	Y	Y	Y
Observations	1045	1045	1045	1032	839
R-squared	0.145	0.158	0.164	0.169	0.241

Notes: The t-value is presented in parentheses. Y for Yes, N for No. *** $p < 0.01$, ** $p < 0.05$.

5.5.1. Robustness Analysis with Replacement of Explanatory Variable

In Table 7, columns (24)–(26) report the results of the robustness analysis for the replacement of the explained variables. To assess the continued suppressive impact of land finance on environmental protection and low-carbon economic transformation, alongside the moderating role of local government debt, the primary explanatory variable undergoes substitution in the robustness test section. The actual analysis using the DEA method might introduce measurement bias due to potential random errors, making it challenging to authentically evaluate the impact of random errors and internal management variables. To address this, the super-efficient SBM model proposed by Tone (2001) [64] was adopted to recalibrate the economic efficiency of the green sector. Following the methodology outlined by Yuan (2020) [65], non-expected outputs were integrated into the super-efficient SBM model to gauge the new green economic efficiency, termed TFP-SBM. Subsequently, the model undergoes re-regression for further analysis. The findings demonstrate that the suppressive impact of land financing on the economic green transformation is robust.

5.5.2. Robustness Analysis with Partial Sample Exclusion

Table 7 (27) reports the results of a robustness analysis that excludes some of the samples. This study focuses on data of prefecture-level cities, a dataset notably comparable to provincial data and significantly larger than that of ordinary prefectures and cities. Consequently, the data from the four municipalities and certain samples from western Chinese provinces, where efforts are concentrated on developing their capital cities, like Chengdu and Xi'an, were excluded for robustness analysis. And the key explanatory variable continued to be statistically significant.

Furthermore, this paper examines the impact of local government debt reform. As illustrated in Table 7 (28), due to the 2015 local government debt reform, local government debt is subject to quota management and classified into budget management. The data on local government debt fluctuate greatly, so the 2015 sample was excluded. After excluding some samples, the impact of land finance on the green transformation of the economy is still significantly negative. The conclusions are consistent with the benchmark regression, indicating that the inhibiting effect of land finance on the green transformation of the economy is robust.

5.5.3. Robustness Analysis of Moderating Role of Local Government Debt

In Table 8, columns (29) to (34) report the results of the robustness analysis of the local government debt reconciliation. In columns (29) and (30), the moderating effect model replaces the dependent variable with TFP-SBM and uses a subsample after exclusion to conduct a robustness test of the moderating effect. The results show that the interaction term is still significantly negative, indicating that local government debt, as a moderating variable, has a robust moderating effect on the positive effect of land finance on the green transformation of the economy. In columns (31) to (34) of Table 8, the moderating

effect of local government debt on the green transformation of the economy is robust to the replacement of the dependent variable in the moderating effect model for eastern cities and first-tier cities. The moderating effect is still significant after replacing the dependent variable with TFP-SBM, which once again confirms the robustness of the positive moderating effect of local government debt as a moderating variable on the impact of land finance on the green transformation of the economy.

Table 8. Robustness analysis of moderating effects.

	(29)	(30)	(31)	(32)	(33)	(34)
	Full Sample		**Eastern Cities**		**Tier 1 Cities**	
LF	−0.582 **	−0.612 **	−3.825 ***	−3.570 **	−6.938 **	−4.230 *
	(−2.19)	(−2.33)	(−2.69)	(−2.11)	(−2.29)	(−1.92)
LGD		0.093 *		0.604 **		1.453 ***
		(1.93)		(2.20)		(3.10)
LF × LGD		−0.579 **		−1.965*		−5.211 **
		(−2.57)		(−1.77)		(−2.69)
Constant	1.040 ***	1.056 ***	1.539 *	1.336 *	2.949	4.593
	(9.36)	(10.17)	(1.95)	(1.68)	(0.63)	(1.06)
Controls	Y	Y	Y	Y	Y	Y
Time	Y	Y	Y	Y	Y	Y
Individual	Y	Y	Y	Y	Y	Y
Observations	839	839	410	410	65	65
R-squared	0.164	0.162	0.205	0.217	0.437	0.553

Notes: The t-value is presented in parentheses. Y for Yes.*** $p < 0.01$, ** $p < 0.05$ and * $p < 0.1$.

5.5.4. Robustness Analysis of Regressions Grouped by Local Government Debt Size

In Table 9, columns (36)–(39) present the results of the robustness analysis of the regression, which was grouped according to the size of local government debt. The explanatory variable TFP-SBM was still utilised, and a robustness test was conducted by performing a grouped regression on the excluded sample. This was performed to verify the robustness of the grouped regression results on the size of local government debt. The regression results show that in both first-tier and eastern region cities, the impact of land financing on impeding the green transition of the economy becomes more pronounced as the level of local government debt increases, demonstrating the robustness of the grouping regression results.

Table 9. Subgroup regression robustness analysis.

	(35)	(36)	(37)	(38)	(39)
	Full Sample	**Eastern Cities, High Debt**	**Eastern Cities, Low Debt**	**Tier 1 Cities, High Debt**	**Tier 1 Cities, Low Debt**
LF	−3.774 ***	−2.863 ***	−0.076	−3.909 **	−3.774
	(−3.43)	(−2.96)	(−0.06)	(−2.20)	(−0.37)
Constant	1.245 ***	2.098 **	0.863 **	1.706 **	1.245 ***
	(2.73)	(2.35)	(2.13)	(2.41)	(2.73)
Controls	Y	Y	Y	Y	Y
Time	Y	Y	Y	Y	Y
Individual	Y	Y	Y	Y	Y
Observations	839	141	269	23	42
R-squared	0.241	0.315	0.054	0.496	0.241

Notes: The t-value is presented in parentheses. Y for Yes. *** $p < 0.01$and ** $p < 0.05$.

6. Conclusions and Discussion

6.1. Conclusions

This study utilises panel data from 215 prominent prefecture-level cities, covering the period from 2015 to 2019. Its aim is to empirically scrutinise the influence of land finance on

economic green transformation, exploring the role and impact direction of local government debt as a regulatory variable. The research outcomes reveal the findings reported below.

First, a larger scale of land finance correlates with lower green economic efficiency, suggesting that land finance hampers urban economic green transformation.

Second, the influence of local government debt on the effect of land finance on the green transformation of the economy is substantial. With the escalation of local government debt, land finance's inhibitory influence on the green metamorphosis of the economy becomes more pronounced, thereby demonstrating a positive moderating effect.

Third, the impact of land finance and local government debt on the green transformation of the economy varies across different economic output scales and urban geographic regions. Empirical research conducted on subgroups reveals that within the eastern region and in prefecture-level cities with a larger economic output scale, there exists a correlation wherein a greater scale of local government debt is associated with more pronounced inhibition of economic green transformation due to land finance policies.

6.2. Discussion

The above empirical results confirm that the more serious the dependence on land finance and the higher the scale of government debt, the stronger the inhibiting effect on the green transformation of the economy in cities and regions. This reflects the more urgent need for economically developed cities to transform their economies and upgrade their industrial structure, as well as the greater need for governments to break away from their dependence on land finance and debt financing and find new and stable sources of revenue.

This paper shows that land finance has a significant inhibitory effect on the green transformation of the economy, which is consistent with Wang (2021) [66] considering the environmental effects of land finance. Land finance has an impact on economic growth as well as other aspects, so incorporating land finance and the green transformation of the economy into a unified research framework can help to expand research on the impact of land finance. On this basis, this paper also introduces the local government debt variable and empirically examines the moderating effect of local government debt on the impact of land finance on the green transformation of the economy, enriching the research content and perspective of land use policy and the green transformation of the economy.

In the world, the green transformation of the economy and green growth are ideal models for developing countries to achieve sustainable development [67]. The green transformation of the economy can be seen as a synergistic effect of simultaneous economic and ecological development and is the result of the combined effects of many factors, such as fiscal decentralisation, digitalisation, green innovation, green finance, etc. In addition to the above factors, this paper incorporates land finance and local government debt into the theoretical framework of green economic transformation and finds that the behaviour of local governments in making up for the funding gap through land finance and local government debt has a significant inhibitory effect on green economic transformation. Therefore, when local governments use land and debt to develop the economy, they should rationally exercise their right to allocate land resources and limit local government debt to a reasonable level.

7. Policy Implications

In 2008, a global financial crisis occurred. In order to boost the economy, the Chinese government proposed the "4 trillion" plan to stimulate domestic demand and promote development, of which 2.8 trillion, accounting for 70% of the total, was to be provided by local governments. Restricted by the reform of the tax-sharing system and the budget law, local governments began to rely on land finance and local financing platforms to increase local government revenue and raise related investment funds. Land finance and local debt have become important ways and means to solve the difficulties of local government revenue and expenditure and raise related investment funds. However, with the rapid development of the Chinese economy and the increase in the total economic volume,

the effectiveness of land finance and local debt in promoting economic development has begun to weaken, and their negative effects have begun to appear, even showing signs of hindering economic development and inhibiting economic transformation.

Through an analysis of the interplay among land finance, local government debt and the green transition of the Chinese economy, this paper can provide valuable insights into the experiences of a wide range of developing countries around the world, which can help policymakers to better formulate more inclusive, equitable and sustainable development paths that utilise land resources and alleviate government debt in order to achieve a green transformation of the economy.

Combined with the above findings, this paper focuses on the following policy recommendations.

First, local governments should promote the transformation of land finance to reduce the dependence of local governments on land finance. This paper has shown that land finance has a significant inhibitory effect on the progress of the green transformation of the economy. Therefore, the government should accelerate land policy reform, improve the fiscal and taxation system and actively seek new sources of fiscal and taxation revenue, in addition to enhancing the sustainability of land-related fiscal revenue, thereby reducing the dependence on land finance. Secondly, according to the heterogeneous conclusions of the study, the current inhibitory effect of land finance on the green transformation of the economy is mainly reflected in the more economically developed regions. Therefore, according to the different economic development status of China's eastern, central and western regions, different land financing policies need to be implemented according to local conditions. While reducing the reliance on land financing in economically developed regions, it is necessary to strengthen supervision and intervention in land financing in economically underdeveloped regions to minimise the inhibiting effect of land finance on the green transformation of the economy.

Second, local government should optimise the structure and scale of debt and upgrade and adjust the industrial structure. Initially, by implementing legislation, rules and other appropriate high-level strategies, the government aims to regulate and limit its borrowing activities, ensuring that the amount of debt incurred by local governments remains within a reasonable and effective range. Secondly, we should optimise the debt structure, change the current financial dependence status quo and abandon the "financial expansion–economic development" inherent thinking, so that the scale and structure of government debt is at the best level to promote the development of economic green transformation. Finally, it is necessary to eliminate the traditional land finance development model and the development path of local government financing projects, increase investment in and support for basic research and promote the transformation of industries into high-technology and high-value-added industries with low-energy consumption and low-pollution areas, so as to promote the healthy development of the economy.

Thirdly, local governments should improve the efficiency of their debt capital allocation by adapting to local conditions and implementing policies that are appropriate for their cities. For the eastern region, local government debt should be invested in public services that effectively improve environmental quality and infrastructure that helps to innovate green development, so as to lead innovation and high-quality supply and create new demand. For the central and western regions, it is necessary to strengthen the performance evaluation of local government debt, pay attention to the long-term mechanism of debt-financed operations and actively expand effective social investment while avoiding crowding out private sector credit.

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References

1. Wu, Q.; Li, Y.; Siqi, Y. The incentives of China's urban land finance. *Land Use Policy* **2015**, *42*, 432–442.
2. Guo, Z.; Gu, N. Institutional Change, Land Finance and Extended Urban Expansion—A New Perspective to Explain the Phenomenon of Inflated Urbanization and Industrial Structure in China. *Soc. Sci. Res.* **2013**, 8–14. [CrossRef]
3. Zhang, L.; Wang, X.; Xu, X. Financial incentives, promotion incentives and land grant behavior of local officials. *China Ind. Econ.* **2011**, *129*, 35–43.
4. Wu, P.; Sun, C.; Zhao, B. Local government financial pressure, official promotion incentives and land finance behavior: Theoretical analysis and empirical test. *Mod. Financ. Econ.-J. Tianjin Univ. Financ. Econ.* **2019**, *39*, 95–113.
5. Mo, J. Land financing and economic growth: Evidence from Chinese counties. *China Econ. Rev.* **2018**, *50*, 218–239. [CrossRef]
6. Zheng, S.; Sun, W.; Wu, J.; Wu, Y. "Generating Wealth with Land, Nurturing Land with Wealth"—A Study on the Investment and Financing Model of Urban Construction with Chinese Characteristics. *Econ. Res. J.* **2014**, *49*, 14–27.
7. Su, Y.; Wu, Y.; Choguill, L.C.; Luo, J.; Yu, X. Reflections on TOD in China: From land finance to inclusive growth. *J. Urban Manag.* **2024**, *13*, 294–307. [CrossRef]
8. Chen, L.; Chen, S. Institutional rethinking and optimization of regional fiscal balance—With the background of the construction of functional zones in municipalities directly under the central government. *Mod. Econ. Res.* **2024**, 11–19. [CrossRef]
9. Yang, J.; Yang, Q.; Liu, K. Land-based financing and debt growth-an empirical study based on prefecture-level city panel data. *Financ. Trade Econ.* **2018**, *39*, 52–68+117. [CrossRef]
10. Chen, Z.; He, Z.; Liu, C. The financing of local government in China: Stimulus loan wanes and shadow banking waxes. *J. Financ. Econ.* **2020**, *137*, 42–71. [CrossRef]
11. Puente-Ajovín, M.; Sanso-Navarro, M. Granger causality between debt and growth: Evidence from OECD countries. *Int. Rev. Econ. Financ.* **2001**, *35*, 66–77. [CrossRef]
12. Xu, C.; Cheng, L.; Zhuang, J. The impact and mechanism of local debt on regional economic growth: An analysis based on panel quantile model. *Economist* **2016**, *5*, 77–86.
13. Guo, Y.; Sun, X.; He, Y. Research on the incentive mechanism, growth performance and adjustment orientation of local fiscal leverage. *Econ. Res. J.* **2017**, *52*, 169–182.
14. Lyu, J. Analysis of the impact of local debt on economic growth: A liquidity perspective. *China Ind. Econ.* **2015**, 16–31.
15. Yang, C.; Lu, Y. Research on the Current Situation, Causes and Prevention Measures of Local Government Debt Risk. *Public Financ. Res.* **2013**, *11*, 58–60.
16. Cheng, Y.; Jia, S.; Meng, H. Fiscal policy choices of local governments in China: Land finance or local government debt? *Int. Rev. Econ. Financ.* **2022**, *80*, 294–308. [CrossRef]
17. Mao, R.; Liu, N.; Liu, R. Trigger mechanism of local government debt expansion and systemic financial risk. *China Ind. Econ.* **2018**, *4*, 19–38.
18. Tsui, K. China's infrastructure investment boom and local debt crisis. *Eurasian Geogr. Econ.* **2011**, *52*, 686–711. [CrossRef]
19. Liu, H.; Yang, G.; Yin, L. Government debt, economic growth and nonlinear effects. *Stat. Res.* **2014**, *31*, 29–38.
20. Chen, J. Analysis of the threshold effect of local government debt on economic growth in China. *Contemp. Financ. Econ.* **2018**, *10*, 33–44.
21. Jiang, J. Sustainable digital era: High-quality integration and development of digital economy and green economy. *Enterp. Econ.* **2021**, *40*, 23–30+161. [CrossRef]
22. Zhao, A.; Wu, C. Systematic evaluation of China's economic green transformation posture-based on entropy-OWA operator and gray correlation improvement TOPSIS. *Tech. Econ.* **2018**, *37*, 99–106. [CrossRef]
23. Chen, T.; Chen, K.; Li, K. Research on evaluation index system of green transformation of regional economy. *Stat. Decis. Mak.* **2019**, *35*, 59–62. [CrossRef]
24. Wai, X.; Huang, S. The impact of FDI preference on the green transformation of China's regional economy. *J. Cap. Univ. Econ. Bus.* **2018**, *20*, 62–72. [CrossRef]
25. Gao, X.; He, H. Cleaner production, green transformation and product quality upgrading of enterprises. *Stat. Res.* **2021**, *38*, 64–75. [CrossRef]
26. Yu, L.; Bi, X.; Zhang, W. Construction of green transformation evaluation system for industrial enterprises. *Stat. Decis.* **2019**, *35*, 186–188.
27. Xie, X.; Han, Y. How do local manufacturing enterprises realize "magnificent transformation" in green innovation?—A multi-case study based on the attention-based view. *Manag. World* **2022**, *38*, 76–106.
28. Zhang, Y.; Do, R.; Bai, Y. Measurement of the construction level of China's green, low-carbon and recycling development economic system. *J. Quant. Tech. Econ.* **2020**, *37*, 83–102.

29. Nie, L.; Wang, Y.; Zhang, J. Evaluation of green transition performance of resource-based cities—A test from 114 prefecture-level cities in China. *Tech. Econ.* **2022**, *41*, 141–152. [CrossRef]
30. Chen, T.; Hu, Q.; Yan, H. Research on the impact of financial agglomeration on the efficiency of the green economy: An empirical analysis based on the Super-DEA model and the SGMM model. *J. Tech. Econ. Manag.* **2020**, *4*, 9–14.
31. Sun, J.; Liu, W.; Zhou, Y. China's opening up, industrial structure and green economic growth: An empirical test based on inter-provincial panel data. *Manag. World* **2014**, 172–173.
32. Wu, J.; Hu, J. Environmental regulation, industrial restructuring and green economic growth: An empirical test based on provincial panel data in China. *Inq. Econ. Issues* **2018**, 7–17.
33. Candau, F.; Dienesch, E. Pollution Haven and Corruption Paradise. *J. Environ. Econ. Manag.* **2017**, *85*, 171–192. [CrossRef]
34. Khachoo, Q.; Sharma, R. FDI and Innovation: An Investigation into Intra- and Inter-industry Effects. *Glob. Econ. Rev.* **2016**, *45*, 311–330. [CrossRef]
35. Zhang, Z.; Li, T.; Ma, Q. Threshold effect of financial agglomeration on the efficiency of urban green economy: Based on the statistical data of nine national central cities in China. *Res. Technol. Econ. Manag.* **2020**, *284*, 98–102.
36. Hu, A.; Guo, A.; Zhong, F. Can the agglomeration of high-tech industries improve the efficiency of the regional green economy? *China Popul. Resour. Environ.* **2018**, *28*, 93–101.
37. Li, X.; Hong, G.; Huang, L. The mystery of China's land finance growth: The strategic reform of the tax system and the growth of land finance. *China Econ. Q.* **2013**, *12*, 1141–1160.
38. Fan, Z. The root of land finance: Financial pressure or investment impulse. *China Ind. Econ.* **2015**, 18–31.
39. Wang, L.O.; Wu, H.; Hao, Y. How does China's land finance affect its carbon emissions? *Struct. Chang. Econ. Dyn.* **2020**, *54*, 267–281. [CrossRef]
40. Xu, R.; Wu, Y. Interaction of carbon emission, energy consumption and economic growth in the Yangtze River Delta urban agglomeration-Empirical evidence based on panel linkage equation model. *Ecol. Econ.* **2016**, *32*, 32–38. [CrossRef]
41. Wang, D.; Tang, M. How does land urbanization affect ecological environment quality?—An analysis based on dynamic optimization and spatially adaptive semiparametric model. *Econ. Res.* **2019**, *54*, 72–85.
42. Li, Q.; Wang, Y.; Lu, K. Local government debt, banking structure and green credit level. *Gansu Financ.* **2020**, *12*, 49–54.
43. Zhang, Z.; Deng, W. Research on the effect and path of local government debt affecting corporate ESG. *Mod. Econ. Res.* **2022**, 10–21.
44. Tang, Y.; Su, X.; Liu, Q. Local Fiscal Pressure and Weak Environmental Regulation-Empirical Evidence of Behavioral Choice of Environmental Opportunism. *Theory Pract. Financ. Econ.* **2023**, *44*, 82–91. [CrossRef]
45. Ma, E.; Yang, X. Fiscal Pressure, Energy-intensive Enterprises and Carbon Emissions-A Quasi-Natural Experiment Based on the Reform of Education Rights. *Financ. Trade Econ.* **2022**.
46. Guo, Y.; Xue, J. Research on the nonlinear environmental effects of local government debt. *Stat. Res.* **2021**, *38*, 105–117.
47. Xiong, H. Study on the economic growth effect of local government debt--Based on the dual perspective of quantity and quality. *J. Macro-Qual. Res.* **2021**, *9*, 113–128.
48. Hou, S.; Song, L.; Wang, J.; Ali, S. How Land Finance Affects Green Economic Growth in Chinese Cities. *Land* **2021**, *10*, 819. [CrossRef]
49. Tang, P.; Chen, Y.; Xiao, J. Research on the mechanism and spatial effect of land finance affecting economic growth. *Land Econ. Res.* **2019**, *2*, 17–31.
50. Wu, Y.; Li, L. Performance evaluation of China's development zone policies: Based on the perspective of enterprise innovation capabilities. *J. Financ. Res.* **2017**.
51. Wu, J. Local debt, land finance and economic growth—An empirical analysis based on the linkage equation model. *Bus. Res.* **2018**, *8*, 38–44. [CrossRef]
52. Gao, R.; Zhu, Z.; Chen, C. Local debt and China's economic fluctuations: Analysis of the financial accelerator mechanism. *Econ. Res. J.* **2022**, *57*, 83–100.
53. Wang, J.; Geng, J. Calculation and empirical analysis of China's green economic efficiency. *Econ. Probl.* **2014**, *4*, 52–55.
54. Wang, H. GDP data revision and capital stock estimation in China: 1952–2015. *Econ. Sci.* **2017**, *6*, 16–30.
55. Zou, W.; Liu, H. Is land finance "drinking poison to quench thirst"—A spatio-temporal dynamic space panel analysis based on prefecture-level cities in China. *Economist* **2015**, *9*, 21–32.
56. Taskin, F.; Zaim, O. The role of international trade on environmental efficiency: A DEA approach. *Econ. Model.* **2001**, *18*, 1–17. [CrossRef]
57. Zeng, D.; Zhao, L. Pollution havens and industrial agglomeration. *J. Environ. Econ. Manag.* **2008**, *58*, 141–153. [CrossRef]
58. Peneder, M. Industrial structure and aggregate growth. *Struct. Chang. Econ. Dyn.* **2003**, *14*, 427–448. [CrossRef]
59. Chen, G.; Lan, B. Research on R&D expenditure, competition and regional innovation capability in China: An empirical analysis based on domestic patent application data and R&D data from 1998 to 2004. *Economist* **2007**, *3*, 101–106.
60. Huang, Q.; Li, G. Does fiscal decentralisation promote industrial upgrading in China? *Reform Econ. Syst.* **2019**, *5*, 129–135.
61. Liao, G.; Qin, J. Can green technological innovation effectively improve environmental quality? Based on the perspective of fiscal decentralisation. *Technol. Econ.* **2022**, *41*, 17–29.
62. Ren, S.; Li, X.; Yuan, B.; Li, D.; Chen, X. The effects of three types of environmental regulation on eco-efficiency: A cross-region analysis in China. *J. Clean. Prod.* **2018**, *173*, 245–255. [CrossRef]

63. Lin, C.; Gong, X.; Kong, F. Environmental regulation and green technological progress: Promotion or inhibition—Based on the perspective of spatial effects. *Macroeconomics* **2019**, *11*, 131–142.
64. Tone, K. A slacks-based measure of efficiency in data envelopment analysis. *Eur. J. Oper. Res.* **2001**, *130*, 498–509. [CrossRef]
65. Yuan, X.; Wang, J.; Zhang, J. Evaluation of urban efficiency under high-quality development—Empirical research from 19 cities at the sub-provincial level and above. *Urban Dev. Stud.* **2020**, *27*, 62–70.
66. Wang, G.; Salman, M. Understanding the spatial spillover effect of land finance on China's green development: Does the moderating role of industrial structure matter? *Environ. Sci. Pollut. Res. Int.* **2023**, *30*, 95959–95974. [CrossRef]
67. Ferreira, J.J.; Lopes, J.M.; Gomes, S.; Dias, C. Diverging or converging to a green world? Impact of green growth measures on countries' economic performance. *Environ. Dev. Sustain.* **2023**, *1*, 1–19. [CrossRef] [PubMed]