

Research Progress on Urban Land Use Efficiency in China from the Perspective of Green Finance in the New Era

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Abstract: Urban land green utilization efficiency is an important indicator of the transition in land resource utilization and high-quality land use in China, accompanying the background of carbon peaking and carbon neutrality. As a new macroeconomic regulation tool for achieving the smooth operation of the green economy, green finance and taxation policies have become a frontier issue in China's ecological quality construction and coordinated economic development. This paper selects a large number of domestic and foreign literature to comprehensively summarize and analyze the connotation and role of green finance policies and the development of land use efficiency measurement. Existing literature indicates that: (1) Despite the current lack of mechanisms and unclear incentive measures, green finance policies are still an inevitable trend in the development of China's fiscal and tax systems in the new era. Achieving scientific and green financial management requires more government investment and practical improvements. (2) Research on land use efficiency is mainly divided into measurement system research and influencing factors research. The former focuses on the efficiency evaluation of input-output and has evolved from comparing efficiency differences in a single region over time to studying regional differentiation and interregional land spillover effects. The latter focuses on the construction of indicators and theoretical transmission pathways that affect land use efficiency. (3) Under environmental regulation, most studies on urban land use efficiency focus on government control, environmental negative effects output, and other measures as new standards for measuring green low-carbon development. However, there is limited literature that points out the role of green finance from the perspective of fiscal incentives and tax impacts. This direction of research is insufficient and deserves sustained attention.

Keywords: Green Finance Policy; Land Green Utilization Efficiency; Green Input-output Measurement Evaluation.

1. Introduction

In recent years, with the rapid development of industrialization and urbanization in China, the country's economic level has been significantly improved. However, this progress has often led to environmental pollution and wastage of resources. The uncontrolled expansion of construction land has resulted in severe ecological space shrinkage and fragmentation, especially in coastal cities, putting increasing pressure on environmental management for land use. This has also adversely affected the normal production and livelihood of residents, as well as the socio-economic development. In response to the pressure of energy conservation, emission reduction, and resource optimization, the Chinese government first included the target of reducing energy intensity as a binding indicator in the 11th Five-Year Plan. In the 12th Five-Year Plan, the government further added the target of reducing carbon emission intensity as a binding indicator, setting the goals of a 16% reduction in energy consumption per unit and a 17% reduction in carbon emissions per unit of GDP by 2015 compared to the levels in 2010. To successfully achieve the targets of energy consumption and carbon intensity reduction, the Ministry of Finance and the National Development and Reform Commission selected 30 cities in three batches to carry out comprehensive demonstration work on fiscal policies for energy conservation and emission reduction starting from 2011. In June 2011, the two ministries jointly issued the "Notice on Carrying out Comprehensive Demonstration Work on Fiscal Policies for Energy Conservation and Emission

Reduction," identifying Beijing, Shenzhen, Chongqing, Hangzhou, Changsha, Guiyang, Jilin, Xinyu, and other eight cities as the first batch of demonstration cities. In October 2013, the second batch of demonstration cities was determined, including Shijiazhuang, Tangshan, Tieling, Qiqihar, Tongling, Nanping, Jingmen, Shaoguan, Dongguan, and Tongchuan. In 2014, the two ministries added Tianjin, Linfen, Baotou, Xuzhou, Liaocheng, Hebi, Meizhou, Nanning, Deyang, Lanzhou, Haidong, and Urumqi as 12 additional demonstration cities. These cities vary significantly in terms of size and economic development level, but they have strong representativeness, typicality, and demonstration effects. The construction of demonstration cities influences their carbon emissions through a combination of fiscal incentives and target constraints. On the one hand, the construction of demonstration cities promotes energy conservation and emission reduction through financial incentives. The demonstration period of the cities is three years, during which the central government will provide funding rewards for typical demonstration projects filed by the demonstration cities. The scale of the reward funds is determined based on the classification of demonstration cities, with direct-administered municipalities and city clusters, planned single-city directly administered municipalities and provincial capitals, and other cities being rewarded 600 million yuan, 500 million yuan, and 400 million yuan per year, respectively. Subsequently, in the 14th Five-Year Plan Outline, China explicitly stated its intention to promote high-quality development and efficiently utilize existing resource elements through the cultivation of urban clusters, leading regional

economic development. Meanwhile, ecological civilization construction requires the optimization of the spatial development and protection pattern of the national land, as well as the rational allocation of resources and improved utilization efficiency. Since 2015, the country has successively introduced several city cluster plans, providing strategic planning and institutional guarantees for the construction of highly urbanized city clusters to promote stable and sustainable economic development. Against the backdrop of the Party and the state's commitment to green and sustainable development and the goal of building a beautiful China, exploring the improvement approaches for land use in city cluster regions from the perspective of green fiscal policies based on the development path of energy conservation and emission reduction demonstration cities can help optimize resource allocation between regions and achieve harmonious development and virtuous cycles among society, economy, and ecological systems.

2. The Meaning and Development of Green Fiscal Policies

Green fiscal and taxation policy refers to tax policies that are proposed to promote the development of a green economy and maximize the quality of resource utilization. It is an important policy support for macroeconomic regulation in our country. It is not only the inevitable result of economic development but also an important guarantee for achieving healthy and sustainable development. As an important tool for promoting energy conservation, emission reduction, and climate change response, green fiscal policy has received increasing attention as global climate continues to deteriorate, and it has gradually become a hot research issue in the field of environmental economics and public economics in various countries. In theory, fiscal incentives, as the main policy tool for government resource allocation, are an important carrier for coordinating the relationship between the central and local governments, maintaining the orderly operation of the system, and exerting the governance capacity of stability and development while meeting the local government's pursuit of maximizing fiscal revenue at its own level, and also effectively compatible with the central government's economic development goals. Special transfer payments can guide local governments to complete central tasks and achieve established macro goals. Existing research has fully demonstrated that the financial support and policy integration brought about by fiscal incentives can accelerate corporate transformation and upgrading by adjusting the scale, structure, and preferences of fiscal expenditure, affecting the pattern and efficiency of regional resource allocation from the perspectives of financing constraints, innovation incentives, signal effects, etc. Based on the macro-effect of fiscal incentives, green fiscal policy can use "revenue orientation" punitive environmental taxes and fees to correct enterprises' pollution costs and internalize the external costs of pollution units; In addition, the government can use "expenditure orientation" environmental governance direct investment to restrict corporate pollution behavior, stimulate enterprises to improve green production technology, and promote energy conservation and emission reduction. In recent years, a large number of literatures have used fiscal pilot projects and demonstration policies and causal inference methods to investigate the environmental effects of environmental fiscal policies. For example, used a difference-in-differences

method to investigate the air pollution control effect of the "coal-to-gas, electricity" policy and found that with the support of central finance, the "coal-to-gas, electricity" policy can effectively reduce air pollution in pilot cities. Lin and Zhu (2019) evaluated the pollution reduction effect and sustainable development effect of energy conservation and emission reduction fiscal policies, and found that the implementation of energy conservation and emission reduction fiscal policies not only reduced pollution emissions in pilot cities but also improved ecological efficiency [8]. However, some scholars hold the opposite view and believe that environmental tax policies have not played an effective incentive role in practice. Especially in some developing countries, the uneven economic development, local protectionism, and imperfect environmental fiscal systems have raised widespread questions about the practical effects of green fiscal policies.

From the perspective of the origin of green fiscal and taxation policies, it originated from developed Western countries. After years of development and practice, it has finally formed a relatively complete fiscal and taxation policy system. China's green fiscal and taxation policies started relatively late and require a long time from formation to maturity. Although China's green fiscal and taxation policies are still imperfect, they play a positive role in promoting the transformation towards intensification and coordinating social and economic development. From the perspective of the government, changing and optimizing fiscal policies through macroeconomic regulation can encourage and stimulate more enterprises and individuals to invest in green ecological construction activities, driving national ecological and environmental construction. The implementation of fiscal and taxation policies depends on two fundamental elements: the government and policies. The government plays a leading role in economic regulation, social construction, etc., especially in the process of environmental construction, which requires comprehensive consideration of different situations. As an important part of the national economic system, tax, formulated from the government's perspective, can ensure the scientific and rationality of tax policies. In the policy design, it needs to be focused on energy conservation, green production, environmental protection, etc., so as to encourage enterprises and individuals to actively engage in environmental construction and achieve the transformation and development of green economy. In addition, the implementation of green fiscal and taxation policies also aims to promote the sound development of the economy, continuously optimize the economic system, and promote the implementation of the new normal work. Green fiscal and taxation policies can also to some extent alleviate resource and environmental issues. Therefore, the implementation of green fiscal and taxation policies is an inevitable trend, and the scientific use of green fiscal and taxation policies is necessary.

As an important country with significant carbon dioxide emissions and energy consumption in the world, China has achieved remarkable economic achievements while facing enormous international pressure to reduce carbon emissions. In recent years, the national economic system has been undergoing transformation, and production modes have gradually shifted from extensive to intensive. In the past development process, the lack of awareness of environmental pollution issues in agriculture and industry, coupled with high energy consumption, has posed great threats to the natural

environment. With the development of economic transformation, the emergence and implementation of intensive models and energy-saving requirements require controls in various aspects such as industry and agriculture. Taking agriculture as an example, the number of chemical fertilizers and pesticides needs to be reduced to ensure soil fertility and reduce pollution. This can not only improve the quality of agricultural products but also enhance the economic benefits of agriculture. In addition, promoting mechanized operations, creating medium- and low-yield fields, and innovatively applying new agricultural technologies, and implementing physical, biological, and other plant protection techniques. The corresponding green fiscal and taxation policies revolve around the above contents, such as exempting value-added tax for related companies when carrying out business training activities for farmers on agricultural machinery cultivation, ecological plant protection technologies, etc. Under this tax incentive policy, more and more agricultural businesses will actively invest in training activities. With the improvement of farmers' technical skills, corresponding agricultural ecological development and construction work will be further implemented. The same applies to industrial development. Therefore, it can be seen that the implementation of green fiscal and taxation policies has a certain role and value in improving the environment, constructing an ecological society, achieving sustainable development, and enhancing economic benefits. Distinguishing itself from general environmental policy tools, fiscal policies aimed at green and low-carbon transformation can not only correct the pollution behavior of social entities through environmental taxes and fees, internalizing the external costs of environmental pollution, but also reshape the pattern of resource allocation through fiscal subsidies, investments, and policy support, achieving the internalization of positive externalities in environmental governance to achieve established goals such as energy conservation and emission reduction. When properly designed, it can effectively balance environmental, economic, and social benefits. It is an effective measure for coordinating ecological environment protection and economic and social development, as well as an important means for the central government to reverse the local governments' bias, curb the "free-riding" and "short-sighted" strategies of local governments, in the context of fiscal decentralization system. Furthermore, the fundamental value of the tax policies in green fiscal policies lies in promoting and incentivizing enterprises and individuals to fully leverage their own value and contribute to the national ecological construction. In the future, it is necessary to optimize and adjust green fiscal and taxation policies according to the actual development needs of different industries to ensure the maximization of policy effects.

3. Development of Land Use Efficiency Measurement

3.1. Research Status of Land Use Efficiency

Land use efficiency refers to the social, economic, ecological, and environmental benefits directly generated by a unit area of land in a certain time and region during the land use process. It essentially measures the material output or effective results of the input and consumption of land per unit area in the social, economic, ecological, and environmental aspects of regional development. It has been a widely studied

hot topic. Measuring the efficiency of construction land use is of great significance for optimizing regional resource allocation and guiding the sustainable development of regional economy. As a production factor, urban land often undergoes frequent exchanges and drastic transformations during the urbanization process of a country. Urban land use efficiency directly impacts the social and economic development and human living environment of a region. From 1990 to 2014, the built-up area in China increased from 13,148 square kilometers to 49,882.7 square kilometers (National Bureau of Statistics of China, 2015). However, the continuous expansion of urban areas has caused various negative impacts. In the coastal areas of eastern China, the scarcity of available land resources severely limits their growth. In particular, the overvaluation of real estate has led to irrational expansion in urban areas. Additionally, almost all Chinese cities have large areas of land that are underutilized or not optimally utilized. Therefore, a key issue in China's urbanization is how to improve the efficiency of urban land use and maximize its fundamental role in urban development. Urban land use has been investigated from various perspectives, especially in terms of evaluating the efficiency of urban land use. Overall, most scholars examine ULUE from the perspective of economic output, such as "urban economic output per unit of land" and the ratio of the total output value of the secondary and tertiary industries to the urban land area. use "average economic output per square kilometer of urban construction land" as a measure of ULUE. In recent years, scholars at home and abroad have achieved rich academic results in the exploration of land use efficiency, including comprehensive empirical studies based on input-output relationships and analyses of intensive use and optimal allocation of construction land using multi-index evaluation models. Generally, land, labor, and capital are common input indicators in the Cobb-Douglas production function model, and outputs gradually expand from economic benefits and social benefits to ecological benefits and other dimensions. In addition, the calculation methods for construction land use efficiency are determined based on the evaluation indicator system, roughly divided into two types: parametric methods, mainly stochastic frontier production function methods, and non-parametric methods, mainly including traditional DEA models, super-efficiency DEA models, and SBM models. Liu and Ge (2021), based on empirical research on 11 prefecture-level cities in Shanxi Province, developed indicators for land use efficiency and land productivity. Bootstrap-DEA and Bootstrap-Malmquist methods were used to calculate the efficiency of urban land use under the government-supported transition of resource-based economy [5]. Yao and Zhang (2021) studied 32 cities in Sichuan Province using data from 2003 to 2018[3]. Based on the measurement results and spatiotemporal characteristics of urban land use efficiency in Sichuan Province, the SDM model was used to verify that the efficiency of urban land use in Sichuan Province can be optimized from three aspects: innovation, industrial structure, and economic connections. Factors influencing the efficiency of urban land use and their distribution characteristics were explored.

On the other hand, many scholars have used Tobit models, econometric models, and other methods to study the factors influencing the efficiency of construction land use and found that urbanization of land, industrial structure, human-land relationship, and smart city construction have driven the changes in land use efficiency to a certain extent. Wang et al.

(2021) constructed a difference-in-differences (DID) model to examine the impact of smart city construction on the green land use efficiency of cities and its transmission mechanism [1]. The results show that the effectiveness of smart city construction in improving urban land green utilization efficiency is more significant in cities with higher levels of human capital, financial development, and information infrastructure. In cities with higher levels of financial development, the effects of urban policies are more favorable.

The scope of research has shifted from single spatial-temporal comparative analysis at the national, regional, and city-county levels to the spatial spillover effect of land use between regions. For example, Lu et al. (2018) included environmental pollution indicators in the ULUE evaluation indicator system and used the non-radial, non-angular slack-based measure (SBM) model to calculate the ULUE of 31 provinces in mainland China from 2001 to 2014 [7]. The results show that the ULUE in mainland China generally showed an upward trend during the same period, and regional differences were the main cause of overall differences. Liu et al. (2020) used a one-stage stochastic frontier analysis (SFA) to test the impact of negative outputs (such as industrial pollutant emissions) on ULUE and revealed the spatiotemporal differences in ULUE of Chinese provinces and cities [4]. Zhou et al. (2021) utilized municipal panel data on urban land use from 2009 to 2017 and constructed a slack-based super-efficiency model (SE-SBM) from the perspective of municipal governance to evaluate the spatiotemporal differentiation characteristics of construction land use efficiency in 41 cities in the Yangtze River Delta region [10]. Peng et al. used an analytic hierarchy process to construct an evaluation model for the coordination degree of social, economic, ecological, and environmental aspects and found that the overall land use efficiency in Jiangning District, Nanjing City was moderate. They also analyzed the spatial differentiation characteristics of seven types of land use efficiency districts. Yang et al. examined 11 cities in Zhejiang Province and concluded that the economic benefits of land use in Zhejiang Province are at a high level and exhibit significant spatial clustering. These studies generally use comprehensive evaluation indicator systems, focus on the spatial differences within micro-administrative regions, provide relevant policy recommendations based on land use efficiency itself, but the subjective nature of comprehensive evaluation indicator systems may limit the analysis of variable correlations and the effectiveness and practicality of the proposed recommendations are limited.

Some scholars have recognized these limitations and extended their research beyond micro-administrative regions. For example, Zhu et al. (year) used the coefficient of variation method to determine weights and quantitatively evaluated land use efficiency in China based on the TOPSIS method. They identified the main characteristics of overall low utilization level and significant regional differences between eastern, central, and western regions. However, the number of such studies is relatively limited. Zhao et al. (2021) pointed out that in the era of regional economic integration, regional economic integration has a significant impact on urban land use and ULUE within a region [2]. To fill this gap, they classified 29 cities in the Yangtze River Delta region into two categories based on city size and discussed the impact of government integration strategies using a two-stage least squares (2SLS) method. The empirical results show that regional economic integration can significantly improve

ULUE. Gao et al. (2020) taking Wuhan as an example, examined the spatial spillover effects of regional economic integration on land use efficiency in both core development zones and restricted development zones during the period of 2001-2015 [6]. They used data envelopment analysis for quantification. They argue that in metropolitan areas, regional economic integration may lead to adjustments in the input-output structure of cities through the flow of market factors and the redistribution of industrial structure, ultimately affecting urban land use efficiency. In summary, existing literature on the evaluation of construction land use efficiency has primarily focused on the social and economic dimensions, while the emphasis on ecological benefits and environmental pollution needs further strengthening. There are more studies on efficiency measurement, but more empirical support is needed for exploring influencing factors. Additionally, there is limited attention to government environmental regulations.

3.2. Research on the Measurement of Urban Green Land Use Efficiency

With the continuous advancement of ecological civilization construction, more and more scholars have begun to focus on the environmental negative effects caused by pollution emissions on construction land. The "14th Five-Year Plan for National Economic and Social Development and the Outline of Vision for 2035" of the People's Republic of China emphasizes the need to achieve new progress in ecological civilization construction, accelerate green transformation and development, and comprehensively improve resource utilization efficiency. Therefore, under the dual constraints of scarce resources and ecological problems, it is gradually necessary to pay equal attention to both ecological benefits and socio-economic benefits in the study of urban land green utilization efficiency (ULGUE), in order to reduce ecological and environmental risks in urban land development and utilization, implement the goals of carbon peaking and carbon neutrality, and promote sustainable economic and social development. It is of great practical significance to achieve the unity of economic, social, and ecological benefits.

Based on the consideration of the ecological and environmental risks caused by land use, most scholars generally incorporate industrial pollutant emissions and energy consumption directly into the undesirable output indicators of the SBM model during the measurement of land use efficiency, or set expected outputs after comprehensive consideration of ecological and environmental benefits. Tang et al. (2021) took 26 cities in the Yangtze River Delta as an example and constructed an evaluation system for urban land use efficiency under the guidance of green development [9]. This evaluation system considers the inputs of land, capital, labor, and energy factors in the process of urban development. While emphasizing economic output, it also considers the social benefits and adverse outputs brought about by urban development. The super-efficiency SBM model was used to measure the efficiency of urban land use, and based on this, the spatio-temporal characteristics of urban land use efficiency were analyzed. The ULGUE of 285 prefecture-level and above cities in China from 2009 to 2018, and empirically analyzed the spatial heterogeneity characteristics of ULGUE driving factors based on the GTWR model and K-means clustering method. It was found that ULGUE showed a fluctuating upward trend overall, with significant spatial agglomeration characteristics and obvious inter-provincial and intra-provincial differences. However,

the overall efficiency was not high, and the spatio-temporal evolution of ULGUE was the result of the interaction of many factors, and each driving factor had obvious spatial heterogeneity characteristics, presenting a spatial strip or patch distribution pattern. Among them, the level of economic development, advanced industrial structure, ecological resource endowment, and environmental regulations mainly had a positive impact on ULGUE. From the perspective of environmental constraints, used the SFA model to calculate the land use efficiency of 16 cities in the Chengdu-Chongqing urban agglomeration from 2005 to 2017. Based on this, they analyzed the spatio-temporal characteristics and influencing factors of land use efficiency, and concluded that the overall land use efficiency of the Chengdu-Chongqing urban agglomeration has been steadily increasing, but the growth rate has been declining year by year, indicating that there is still room for improvement.

In analyzing the influencing factors of construction land use efficiency, focused on the efficiency of land use in the context of environmental control, with a particular emphasis on considering the environmental negative effects such as the emissions of "three wastes" generated on construction land. Taking 17 prefecture-level cities in Shandong Province as the research unit, the super-efficiency SBM model was used to calculate the efficiency of land use under environmental control. The Tobit model was used to analyze the influencing factors of land use efficiency from four dimensions: "economic and social factors, policies, and spatial factors", providing theoretical basis for formulating policies to improve land use efficiency in the future. Combined theoretical analysis with empirical measurement using multiple linear and nonlinear regression methods. They first deduced theoretical results through logical deduction and mathematical modeling, and then obtained data from the government work reports through large-scale text mining, etc., to obtain provincial panel data from 2008 to 2017 in China. Based on this, they analyzed the relationship between urban land use efficiency and the level of government environmental regulations, and found that there is an "initial negative correlation, moderate positive correlation, and excessive negative correlation" relationship between them. In recent years, in the research on incorporating environmental regulatory indicators into the influencing mechanism, scholars have found a U-shaped relationship between them and ecological efficiency. In the short term, it may increase enterprise production costs, but in the long run, it can promote the improvement of efficiency by promoting technological and industrial upgrades, increasing economic output, reducing resource consumption, and pollutant emissions.

4. Conclusion

The current research in both domestic and international academic circles has made substantial progress in the fields of government environmental regulations and urban land use efficiency. However, there are relatively few studies that directly examine the impact of incentive-based environmental regulations, such as green fiscal policies, on urban land green utilization efficiency. Most studies focus on policy incentives, environmental control, and penalties for pollution output. The direct findings are limited and belong to a relatively new research field. Indirect findings include studies by Zhong Chenglin et al. using the super-efficiency SBM model and threshold panel regression model to classify environmental regulations into incentive-based and non-incentive-based

regulations. They found a significant institutional synergistic effect between the two types of regulations on ecological efficiency of urban construction land, with an overall inhibitory tendency. The fuzzy set qualitative comparative analysis method to explore the multiple pathways for improving urban land green utilization efficiency under the strategy of collaborative innovation in 284 cities in China. They found that collaborative technological innovation is an important means to improve urban land green utilization efficiency under the strategy of innovation-driven development. Wang Di et al. constructed a dynamic optimization model that showed that when the urbanization rate is high, the government tends to implement environmental regulation policies to control the degree of environmental pollution, which improves the per capita ecological environment quality of land. Although some studies have evaluated the implementation effects of comprehensive demonstration of energy-saving and emission-reduction fiscal policies, they have not directly focused on the impact of green fiscal policies in demonstration city construction on land use efficiency. Instead, they mainly examine the influence of carbon emissions mechanisms.

It is worth noting that compared to mature market economies, China's green fiscal and tax policies are relatively limited and lack comprehensive macroeconomic control measures. In the face of serious resource and environmental problems, the current green fiscal and tax policies cannot effectively promote energy conservation and emission reduction. The deficiencies and shortcomings of the current green fiscal and tax policies include an incomplete policy framework, inadequate punitive measures, insufficient government investment, and lack of rationality in fee policies. China has relatively limited funds for energy-saving development and invests less in the energy-saving and emission reduction industry, which fails to provide significant support for achieving energy-saving and emission reduction goals. Additionally, there is a lack of mechanisms for collecting and judging pollution fees, resulting in unclear and unreasonable fee procedures and difficulties in fee collection. The single factor charging also forces companies to evade high fees, leading to a distortion of priorities by reducing pollution control costs. Moreover, the content of tax policies is not comprehensive enough, lacking specific main tax types. Many tax types related to energy conservation and emission reduction exist, but they only indirectly save taxes for production activities. There is still a certain gap in transaction behavior, and the role of taxation in promoting resource conservation is small. Furthermore, there is no well-established green fiscal and tax system, which fails to drive the development of green enterprises during implementation and hinders the smooth development of the green and environmental protection era.

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