Membrane Technology
ISSN (online): 1873-4049

Assessment of Compensatory Gain on Land Resource Utilization: Insights for Engineering and Environmental Sustainability from China

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Abstract:

Since China's economic reform in 1978, the utilization of land resources has significantly contributed to material and environmental support for economic growth and industrial progress. However, the distributional effects of compensatory gains from land resources have shown disparities, particularly between urban and rural populations, with rural residents benefiting less from land appreciation. Despite its critical role in engineering sustainable development and environmental management, limited research has focused on the economic and environmental implications of these compensatory gains and their distribution.

This study integrates the Marxian theory of land rent to define the economic and environmental attributes of compensatory gains from land resources, emphasizing their distributional impacts across 29 Chinese provinces from 2007 to 2021. Additionally, land development intensity is introduced as a moderating variable to explore its influence on the equitable use of land for industrial and environmental purposes.

The findings indicate that compensatory gains from land resources exacerbate distributional inequities, with significant implications for sustainable land resource management and regional development. The moderating effect of land development intensity highlights that higher levels of land openness mitigate the widening inequities caused by compensatory gains. These insights are critical for policymakers to enhance land resource utilization in a manner that supports industrial engineering, environmental sustainability, and socioeconomic equity.

Keywords: Land resources; Compensatory revenues; Land development intensity; Moderating effects

1. INTRODUCTION

From the classical economics perspective, land has been a key element of socioeconomic development. As a distinct natural resource asset, land encompasses factors such as production, property rights, power, and capital. The intricate dynamics between institutions and markets, coupled with the unbalanced distribution of costs and benefits generated by land resources, markedly affect satisfactory distribution. According to Marx's doctrine of property rights, "ground rent" is the economic expression of the landowner's realization of ownership. In this context, "rent" refers to the revenue on property rights, which is a material revenue to the landowner for renting out land and is essentially an income of a compensatory nature. Ricardo also emphasized that the objective productivity and fertility of the land bring benefits to the user, whereas the landowner receives compensation in the form of ground rent. In his elaboration of the utility-value theory, Say suggested that ground rent is a cost to the user of land occupation and compensation for the landowner's property rights. Since China's economic reform, land resources have provided substantial material and environmental support for progress in social and economic development. Because of the special characteristics of China's ownership system of the production means, the revenue and distribution system of land resources have continuously been under exploration, playing a unique role in fostering efficiency changes in economic development and equitable changes in social development. Particularly in recent decades, land resources have acted as a central character in China's "economic miracle." Although there have been many studies on the various elements of the land resource management system, this study takes an academic research approach, providing a logical starting point for exploring the benefits of land resources. It traces their economic attributes and offers a comprehensive understanding of strategies to rationalize the distribution of land resource benefits in China.

Revenues from land resources are property rights transactions, which are reflected in land prices and, in turn, affect the owner's income [1,2]. The benefits derived from land resources have been used in several ways. For example, in a growth-oriented way, land has been used as a profitable commodity to promote urban growth via a coalition of local interest groups that comprise economic and political elites [3]; via urbanization of capital, land tends to become strictly fiscal property [4,5], becoming the

chief way of increasing funds for urban growth in most developing nations [6]. After the establishment of the People's Republic of China in 1949, the constitution explicitly stipulated that all land in cities belonged to the state, and all land in the countryside collectively belonged to peasants, which was a key aspect of socialism. In the following 30 years of planned economy, sale and purchase of urban state-owned land was strictly prohibited, and thus only local governments, on behalf of the state, used urban land free of charge. In other words, by distributing the right to use land to certain entities, the local government produced a series of effects [7]. In 1978, the Chinese government boldly implemented a reform and opening-up strategy, converting the planned economy into a market economy in which production's primary factor, represented by urban land resources, played a critical role. Under the premise of retaining the state's ultimate ownership of urban land, the urban land market was established gradually in the 1980s, and the 1986 Land Management Law formally protected, for the first time, the right to use land that is owned by individuals or private enterprises, and explicitly permitted entities or individuals to pay for the right to use land [8]. An important turning point was China's constitutional amendment of 1988, which formally allowed market trading practices for land resources. In the subsequent Property Law of 2007 and the Civil Code of 2020, property rights were formally recognized as one of the core property rights protected under Chinese law. This series of reforms formalized urban land ownership's separation from urban residents [9]. As shown in Figure 1, although China's central government still holds the ultimate ownership of urban land, local governments can transfer, mortgage, or sell land resources as packaged property rights for profit [10]. Many western scholars argue that China's land transfer proceeds are similar to the use rights embodied in the country's rental properties [11].

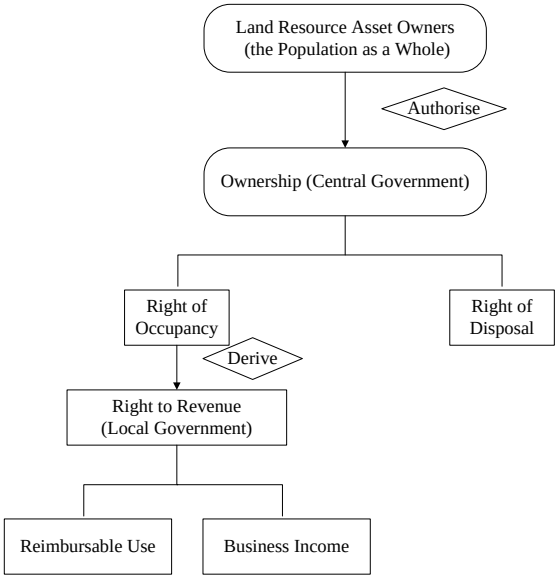

Figure 1 Institutional Revenue Framework for Land Resource Management in China

Furthermore, the distributional effects generated by land resource revenue have gradually become a primary concern [12]. According to the study, the distributional destination of local governments' land resource revenues is primarily reflected in several aspects. First, land resources act as an important macroeconomic tool [9] and provide urban economic development with adequate development space, leading to faster wage growth for urban residents [13]. Second, the expanding development of secondary and tertiary industries in cities is causing in-creased employment to drive rural labor's transfer and increase non-farm income [14]. However, a lack of skills and education has caused the wage earnings of rural residents that work in cities to grow slower than that of urban residents [15,16]. Third, most of the land revenue is used for infrastructure construction in urban and rural areas [17]. Land development policies favor cities, and the one-time compensation gains from land expropriation and high-priced concessions that are obtained by local governments flow to urban residents primarily via improved public services. Even if rural residents receive a certain amount of compensation, they receive far less social welfare than urban residents [18]. As shown in Figure 2, the local government, in its capacity as agent of state-owned land property rights, directly participates in land market transactions as a market subject, It also participates in the initial distribution of land value-added gains in the form of obtaining land premiums (essentially ground rent gains), and occupies a dominant position in the distribution of land value-added gains by monopolizing the supply of land, and in the process of pre-land preparation and real estate development, the local government, as a land manager, participates in the secondary distribution of land value-added income in the form of land tax (fee) collection. Therefore, the land premium is a non-tax government fund paid by land users to the government to obtain the right to use the

land, which is income from land rent for a certain year. Previous studies have reached the consensus that the revenue distribution effect of land resources is not equitable. As research continues to deepen, it can be found that local governments tend to prioritize making decisions on land development to maximize the revenue from land resources; however, this is not consistent with meeting local spatial needs [19,20]. Therefore, this land development behavior may lead to a mismatch between land resource benefits and their distributional effects. From a quantitative perspective, local governments tend to develop more land when they have higher financial needs [21]. This intensity of land development may lead to various negative consequences such as excessive rural land being converted to urban land; furthermore, compensation for land acquisition usually deviates from the market price. The large gap between the price of land compensation price and the high land grant premium is one of the sources of the inequitable distributional effects of land resource benefits in China [22]; Cao et al. [15], Lin and Yi [23], and Lin [24] emphasize this point.

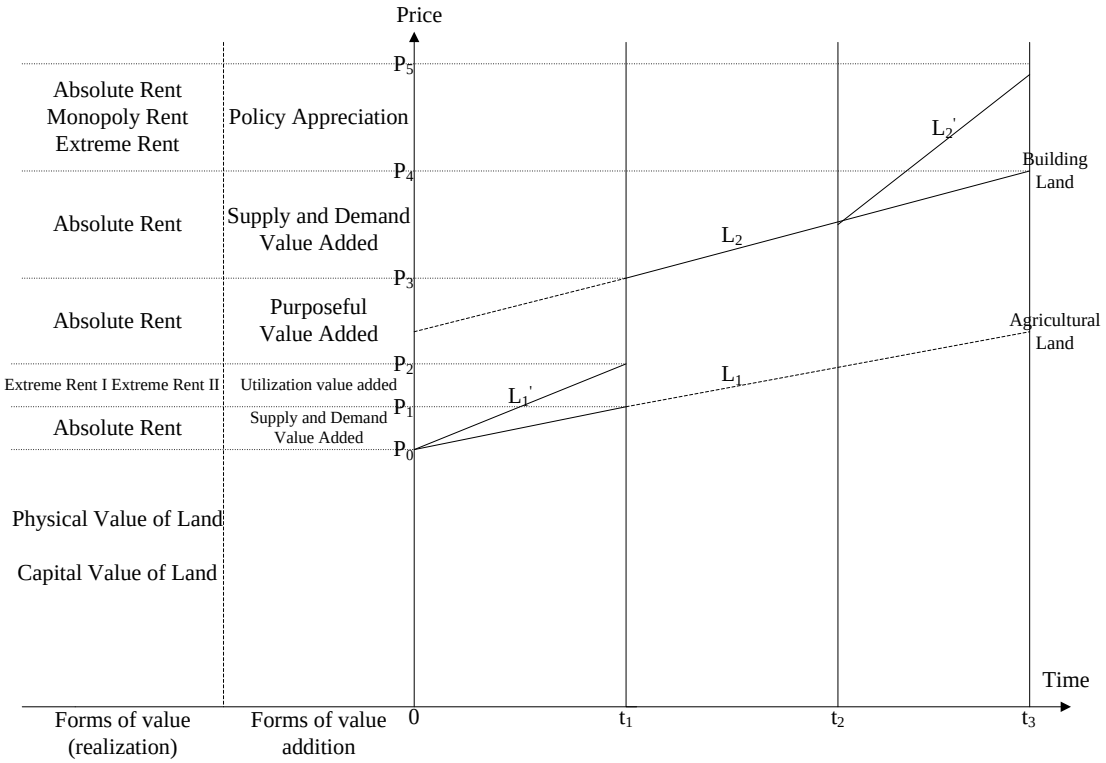

Figure 2 Analysis of the Formation Mechanism of Land Value-Added Revenue

In summary, the process of land resource revenue and distribution is closely related to residents' quality of life, and the distribution and redistribution of revenues on land resources should ultimately be reflected in the improvement of the standard and quality of life of residents, with the wealth of resources being shared between current and future generation of residents. The government will need to use the revenues from land resources to provide more high-quality ecological products to meet the people's growing need for a beautiful ecological environment, to form a spatial pattern that conserves resources and protects the environment, and to return tranquility and beauty to nature and the people. Therefore, the satisfactory distribution of benefits from land resources is to allow for a rational and orderly distribution of land resources and their added value among the people. This study innovatively applies the Marxian theory of land rent to define the nature of local government land revenue in China and on this basis measures the distributional effects of that revenue in terms of its satisfactory nature. Additionally, this study adds the variable of land development intensity to measure its moderating effect, which helps to further understand the multifaceted role of land in China's socioeconomic development.

2. THEORETICAL ANALYSIS AND RESEARCH HYPOTHESES

2.1 Income Attributes of Land Resources and Allocation Processes

In his elaboration on the theory of the total social product, Marx argued that the value of the total social product is composed of three parts: the compensation fund, the value of necessary labor, and the value of surplus labor. In the case of natural resource assets, the compensation fund covers two aspects: the value of the consumed natural means of production of natural origin and stable retention (i.e., natural resource assets), that is, compensatory revenues, and the value of the consumed artificial means of

production. The value of surplus labor is the return on investment (i.e., cumulative income) received by the owner, who enjoys ownership of natural resource assets. Owing to the nature of China's socialist state, the roles of landowners and sovereignty are merged. By its sovereignty, the state collects the excess profits obtained from all types of economic entities via the possession and use of natural resource assets in the form of taxes and uses them to fulfill the state's functions after nationalizing them. This not only implies fairness of the tax burden but also ultimately safeguards the rights and interests of the state's owners [25]. Under the conditions of China's socialist market economy, owners of different means of production obtain the benefits generated by inputting into the production of materials under their corresponding property rights. Therefore, various forms of income from natural resources such as land are an objective necessity. In the process of high-quality economic development, the unity of reproduction of material resources, labor, and production relations should be realized. The reproduction of material resources requires that the natural means of production consumed by society in a certain period be replaced in physical form and compensated in value form to ensure that more natural resource assets can be transformed into factors of production and put into a new round of the production process. According to the theory of compensation for means of production, a country or region should follow the specific principle of compensating consumed natural resource assets individually. Xia [10] proposed that natural resource assets represented by land resources should first be compensated to obtain compensatory revenues, and the corresponding economic benefits should then be obtained via material reproduction. As shown in Figure 3, the existing income from natural resource assets is primarily in the form of rent, tax, profit, fee, and gold, and the "rent" here originates from land ownership; moreover, land as a material entity of ownership generates rent (land premium) and as a material entity of national sovereignty generates tax. Thus, land rent becomes the original form of tax and is the most primitive form of taxation [25].

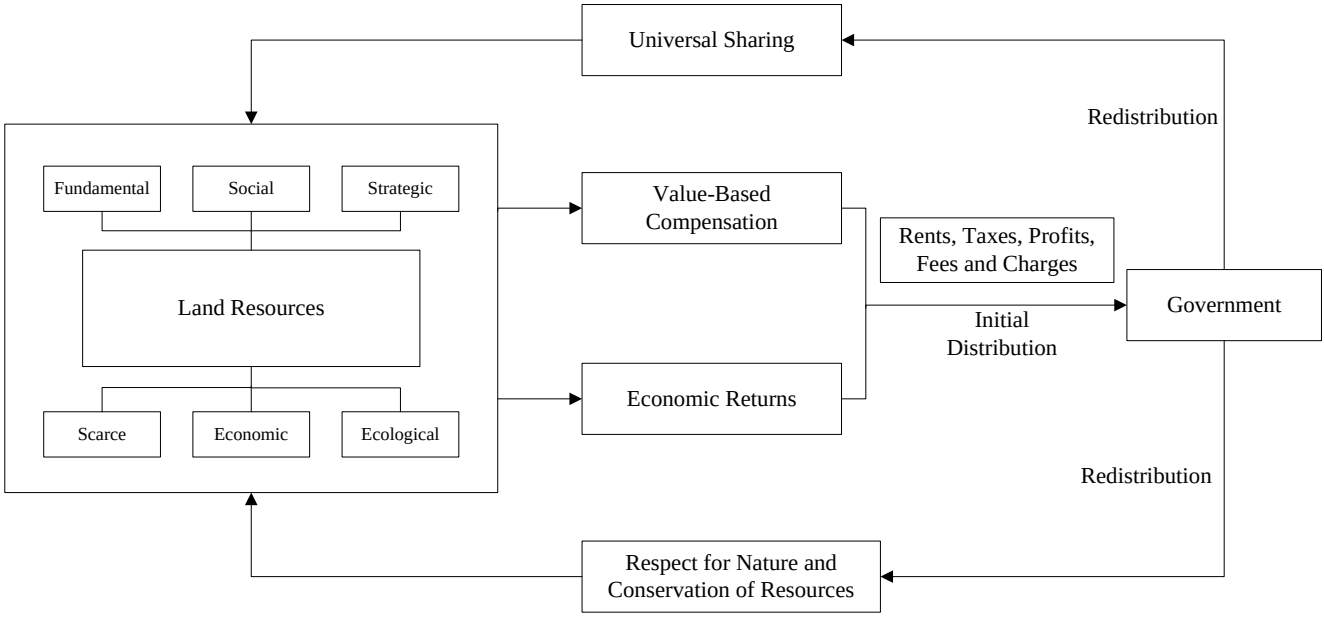

Figure 3 Flowchart for Compensation of Land Resource Value

China's fiscal system around land resources is a complex income distribution system dominated by local governments and consists of many links with self-reinforcing characteristics, especially because local governments can achieve promotions and regional economic growth via compensatory revenues from land resources and continue to carry out land development, cyclically driving up urban land and housing prices [7]. This mechanism further contributes to the fact that local government's land grant revenues are primarily invested in urban infrastructure construction, and the proportion of expenditure on basic public services for rural areas and farmers is severely low [26]. With the monopoly of land supply in their hands, local governments have an incentive to increase infrastructure investment directly linked to spatial urbanization while lacking incentives to provide public services and human capital investment related to population urbanization, thus promoting the rapid expansion of spatial urbanization [27]. Cheng et al. [28] suggested that unbalanced urbanization development makes rural residents unable to effectively migrate and settle in cities and cannot equally share land appreciation gains from urban development, which ultimately leads to the widening of the unsatisfactory distribution. Based on the above theoretical assumptions, Hypothesis 1 was proposed.

Hypothesis 1: 'Compensatory revenue's distribution effects on land resources are unsatisfactory distribution.'

2.2 Compensatory Revenues from Land Resources and Intensity of Land Development and Distribution

Urban land development intensity is the spatial mapping of urban modernization degrees, which are caused by the integrated result of the overall urban land use and urban development strategy [29]. Pan et al. [21] proposed that the intensity level of regional land development is a key factor in ensuring order in a city's operations as a whole and is closely connected to the efficiency of urban land use and the supply of urban public goods, which directly leads to inequality in basic public services; the influence of the transmission pathway from disadvantaged groups and farmers is more evident. In general, the higher the land development's intensity, the higher the land use's economic efficiency, and the corresponding rise in local governments' compensatory revenues from land resources. In contrast, if the intensity of land development is insufficient, that is, if the land is not fully utilized, or if the intensity of development is insufficient because of improperly determined land use, it will weaken the value of the use of the land and reduce the compensatory revenues from land resources. However, some studies have suggested that different degrees of land development intensity affect urban land use efficiency and urban public goods provision and are important factors affecting the level of regional infrastructure provision [30]. It should be noted that the Earth is vast, and each country and region's land resource endowment, socioeconomic development level, land use management policies, and utilization efficiency show distinct non-equilibrium, leading to the heterogeneity of urban land demand, supply capacity, and the overall evolution path of land use systems in different regions [31]. In reality, local governments are subjectively willing to continuously increase the level of land supply to maximize the compensatory revenues from land resources as well as the promotion and economic growth effects brought about by it; however, the supply and demand of land are inextricably linked, and the distributional effects of compensatory revenues from land resources will be weakened after the intensity of land development reaches a certain threshold [32]. Based on the above theoretical assumptions, as shown in Figure 4, Hypothesis 2 was proposed.

Hypothesis 2: 'Land development intensity has a negative moderating effect on the distribution process of compensatory revenues from land resources.'

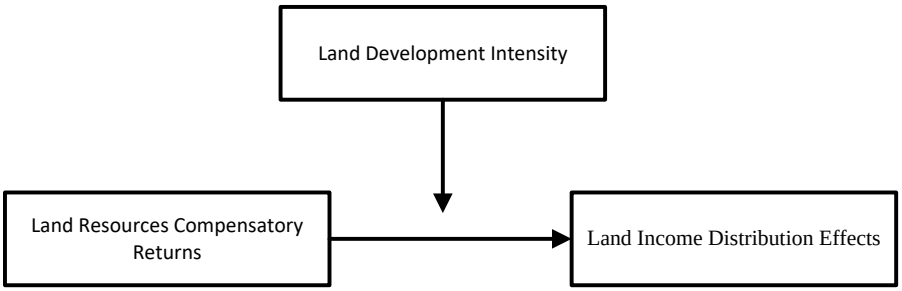

Figure 4 Analysis of Income Distribution from Land Resources

3. MATERIALS AND METHODS

3.1 Data Sources

From the viewpoint of China's land finance practice, provincial governments are in an important position among the four levels of government, and the successive reforms of the fiscal system, the provinces have assumed the important responsibility of negotiating with the central government on the distribution ratios upward and dominating the distribution ratios of revenues of the sub-provincial levels downward. Provincial governments are the pivotal point of research on the fiscal relationship between governments. Therefore, all data used in this study were from 2007-2021 for 29 provincial levels (excluding Shanghai, Tibet, Taiwan, Hong Kong, and Macau). The data came from the China Urban Statistical Yearbook, China Land and Resources Statistical Yearbook, China Regional Economic Statistical Yearbook, provincial budget tables, and data platforms, such as the National Bureau of Statistics, EPS, and Land Market Network. To minimize the effects of heteroscedasticity and skewness on the empirical results, this study used the logarithm of the ratio of compensatory revenues from local government land, per capita disposable income of urban residents, and per capita net income of rural residents. To eliminate the influence of prices, variables involving amounts were recalculated and excluded using the provincial consumer price index with 2007 as the base period. In addition, we tailed each variable to avoid outliers that could interfere with the empirical results.

3.2 Selection of Variables

3.2.1 Explained variables

Explained variables selected for the study included the distribution of compensatory benefits from land resources Effectiveness (Inequality).

The ratio of the per capita disposable income of urban residents to the per capita net income of rural residents was used as a proxy variable to measure the distributional effects of compensatory revenues from land resources [33].

3.2.2 Explanatory variables

Explanatory variables selected for this study included local government compensatory revenues for land revenue (Landrev) which include land premiums, land idling fees, compensation fees for soil and water conservation, land reclamation fees, reclamation fees for cultivated land, compensation fees for the temporary use of land, compensatory land use fees for newly constructed land, and land revenue payments. In 2020, the ratio of land premiums to revenue from the local land resources of local governments in China was 80.77% [7]. Owing to data availability, this study measures the proxy variable for local government land compensatory revenues by land transfer fees.

3.2.3 Control variables

Control variables selected for this study included the level of industrial structure (industry) and degree of industrialization (industry). In this study, the ratio of secondary and tertiary industries to gross domestic product (GDP) was used to measure industrial structure. A higher ratio of industrial structure represents a higher level of industrialization and urbanization of the region, which may also have a greater demand for land resource financing and affect the intensity of land development [33].

(1) Urbanization rate (urban).

A higher urbanization rate indicates that regional agglomeration affects economic development efficacy and is more likely to produce scale utility [14,34].

(2) Human capital (Humcap).

The level of a worker's human capital can be measured in terms of both its quantity and quality, the latter depending on the worker's level of education, skills acquired through training, and experience gained from “learning by doing.” Research has shown that human capital, such as education level, professional skills training, work experience, and other labor skills, is critical to the economic success of workers [35]. Human capital reflects the degree of regional emphasis on human resources. To increase the effective labor productivity of society and thus improve the efficiency of resource allocation, it is primarily measured using the average number of years of education of residents in each province. Theoretically, the longer the years of education per capita, the smaller the unsatisfactory distribution.

(3) Degree of economic openness (Open).

Relevant studies have shown that the opening of China's economy has promoted the development of manufacturing and trade-related industries, which are concentrated in urban areas and contribute to increasing the income of urban residents [20]. The increase in economic openness reflects the increased interaction effect of the labor force between urban and rural areas, which is an important contributor to narrowing the unsatisfactory distribution [33].

(4) Government public expenditure structure (government).

Given that China has entered a new stage of steadily promoting common prosperity, the structure of public expenditure maps local governments’ inclinations toward livelihoods. Therefore, this study selected livelihood expenditures, including science and education, social security and employment, and healthcare expenditures, and used the sum of these three expenditures as a percentage to measure the government's public expenditure bias. Government public expenditure is essentially a type of resource redistribution, and if its proportion increases, it implies that local governments pay more attention to the redistribution of resources between urban and rural areas, which will help to narrow the unsatisfactory distribution; on the contrary, it will widen it.

(5) Population size (Hrp).

The urban–rural population agglomeration effect has an impact on land development intensity [6].

(6) Tax burden (Tb).

The tax burden can be a barometer of the economic policies implemented by the state and can also affect the unsatisfactory distribution, specifically the local government's tax revenue to GDP ratio [9].

3.2.4 Moderating variables

The moderating variable selected for this study was land development intensity (CLD-urban land development intensity).

Urban land is a spatial carrier facilitating a variety of human activities, supporting and constraining industrial development and urban construction, determining environmental capacity and regional re-source potential, and providing turban economic growth with the basic conditions it needs [29,36]. Land development's intensity is a reflection of the prevailing state of land use, a beginning aim for future sustainable use, and an indicator characterizing the width of urban land development, the ability to carry out population agglomeration, and the level of socioeconomic development in a regional context, which is a centralized reflection of the scale, level, and characteristics of land production of the local government.

3.3 Modeling

3.3.1. Baseline regression model

Baseline regression model followed the formula:

$$\mathrm{Lninequality}_{it} = \alpha_0 + \alpha_1 \mathrm{Lnlandrev}_{it} + \gamma \mathrm{Control}_{it} + \mu_t + \vartheta_t + \tau_t \quad (1)$$

In Equation (1), i denotes the city, t denotes the year, $\mathrm{Lninequality}_{it}$ is a measure of the distributional effect of compensatory revenues from land resources, $\mathrm{Lnlandrev}_{it}$ represents the logarithm of the compensatory revenues of local governments for land revenue, $\mathrm{Control}_{it}$ represents the set of all other control variables, μ_t and ϑ_t denote the fixed effects of province, city, and the fixed effects of time, and τ_t is the random error. Descriptive statistics for each variable are given in Table 1.

Table 1 Summary statistics

VarName	Obs	Mean	SD	Min.	Median	Max.
ln_inequality	435	2.6810	0.436	1.84	2.61	4.21
ln_landrev	435	6.3220	1.483	0.12	6.54	9.25
Industrials	435	1.1645	0.679	0.50	0.96	5.30
Urban	435	0.5626	0.142	0.21	0.55	0.90
Humcap	435	0.0192	0.006	0.01	0.02	0.04
Open	435	0.2758	0.330	0.01	0.14	1.72
Goverex	435	0.2669	0.196	0.09	0.22	1.33
Hrp	435	5.2652	1.519	0.86	5.62	8.28
Tb	435	0.0784	0.030	0.03	0.07	0.20
Industrialization	435	0.3246	0.097	0.07	0.34	0.56

3.3.2 Moderating effects model

The above analysis shows that the intensity of land development regulates the distributional effect of the compensatory revenues from local governments' land resources. To explore the moderating role of land development intensity on the distributional effect of compensatory revenues on land resources, the following model was established:

$$\mathrm{Lninequality}_{it} = \alpha_0 + \alpha_1 \mathrm{Lnlandrev}_{it} + \beta_0 \mathrm{Lnlandrev}_{it} * \mathrm{Cld}_{it} + \beta_1 \mathrm{Cld}_{it} + \gamma \mathrm{Control}_{it} + \mu_t + \vartheta_t + \tau_t \quad (2)$$

Equation (2) measures the moderating effect of the intensity of land openness (Cld) on the distributional effect of compensatory revenues to local government land by introducing a regression of the interaction term ($\mathrm{Lnlandrev}_{it} * \mathrm{Cld}_{it}$) between the intensity of land openness (Cld) and the compensatory revenues to local government land (Lnlandrev), and the extent of the moderating effect is measured by looking at the sign of α_1, β_0, and β_1.

4. RESULTS

4.1. Basic Regression Results

As shown in Table 2, the distributional effects arising from compensatory revenues on local government land were examined using stepwise regression, taking into account other economic and social factors. The gradual addition of variables in Columns (1)–(6) gradually increases the explanatory strength of the model. Human capital has a strong negative correlation with the distributional effects of compensatory revenues on land. Column (7), when population density (Hrp) is added, shows a positive correlation with the effect of compensatory revenues distribution on land resources, and shows significance at the 1% level. Column (8) considers the degree of industrialization (industrialization) and finds that it is positively associated with the unsatisfactory distribution and is significant at the 1% level. In the final model, all explanatory variables are considered, and the R-squared value is 0.875, indicating that the model has good explanatory power for the variation in the distributional effects of compensatory revenues to land resources. It is worth noting that the compensatory revenues from local government land, industrial structure, urbanization rate, human capital level, government public expenditure structure, population density, and tax burden level were all significant in the model.

Table 2 Basic Regression Results

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	a1	a2	a3	a4	a5	a6	a7	a8
VARIABLES	Inequality	Inequality	Inequality	Inequality	Inequality	Inequality	Inequality	Inequality
ln_landrev	0.0196*	0.0306***	0.0365***	0.0287**	0.0284**	0.0335***	0.0265**	0.0301***
	(1.7236)	(2.6659)	(3.2223)	(2.5296)	(2.4863)	(2.9119)	(2.2891)	(2.5984)
Industrials		0.0902***	0.0362	0.0428*	0.0422	0.0511**	0.0615**	0.0889***
		(3.9686)	(1.4037)	(1.6872)	(1.6473)	(1.9903)	(2.4067)	(3.2332)
Urban			−1.0935***	−0.4468	−0.4193	−0.4816	−0.7079**	−0.5896*
			(−4.1677)	(−1.4460)	(−1.2331)	(−1.4233)	(−2.0747)	(−1.7251)
Humcap				−12.0206***	−11.7675***	−11.1506***	−7.0817**	−5.9652*
				(−3.8037)	(−3.4395)	(−3.2752)	(−1.9767)	(−1.6649)
open					−0.0126	0.0047	0.0814	0.0616
					(−0.1945)	(0.0723)	(1.1967)	(0.9065)
Goverex						−0.3851***	−0.2877*	−0.3701**
						(−2.5942)	(−1.9236)	(−2.4372)
Hrp							0.4443***	0.4490***
							(3.2878)	(3.3467)
Industrialization								0.3670**
								(2.5802)
Constant	2.9072***	2.7693***	3.3089***	3.2172***	3.2068***	3.2648***	0.9755	0.7231
	(47.9008)	(40.1510)	(22.6580)	(22.0988)	(20.6522)	(20.9614)	(1.3679)	(1.0118)

Observations	435	435	435	435	435	435	435	435
R-squared	0.829	0.836	0.843	0.849	0.849	0.851	0.855	0.858
Number of id	29	29	29	29	29	29	29	29
Year	YES	YES	YES	YES	YES	YES	YES	YES
Province	YES	YES	YES	YES	YES	YES	YES	YES

t-statistics in parentheses

*** p<0.01, ** p<0.05, * p<0.1

4.2 Moderating Effects Model

To further test the moderating effect of land openness intensity (CLD) on the compensatory revenues distribution effect of local government land, the regression model was further regressed by introducing the interaction term of land openness intensity (CLD) and ln_landrev (Lnlandrev*CLD). Table 3 shows the results of the moderating effects model regression. Column (1) shows the result of the baseline regression in this study, considering all previous explanatory variables. The ln_landrev correlation with the compensatory revenue distribution of local government land resources is positive at the 1% level of significance. In addition, most control variables (e.g., Indust, Goverex, and Tb) are significantly related to the compensatory revenue allocation effect of local government land resources. The interaction term between ln_landrev and CLD (landrev_CLD), as well as CLD itself, is introduced in column (2). The results show that the coefficient of ln_landrev is significantly higher, whereas the coefficient of the interaction term landrev_CLD is −0.1523 and significant at the 1% level, indicating that there exists a significant relationship between the compensatory revenues on land openness intensity (CLD) and local government land (ln_landrev); the distributive effect of compensatory revenues on local government land resources (inequality) exerts a negative moderating effect on CLD. Specifically, as the intensity of land openness increased, the positive effect of inequality on the distributional effect of compensatory revenues on local government land diminished. In addition, the CLD has significant positive feedback on the unconscionability of the compensatory revenue allocation effect of local government land resources. This result provides strong evidence that the compensatory revenues allocation effect of local government land varies at different levels of land openness intensity. In particular, the widening effect of compensatory revenues from local government land on the unsatisfactory distribution may be dampened in regions with higher land openness intensity. The possible reasons for this are as follows: first, in regions with a higher intensity of land openness, land may be utilized more efficiently. This implies that local governments may be more inclined to encourage land projects that bring economic benefits to localities. This efficient land use may attract more investment and businesses to the area, thereby increasing employment opportunities and promoting an income balance between urban and rural areas. Second, when the intensity of land opening is high, it indicates that the market demand for land in the region is also high, which confirms the degree of development of the local economy. When the regional economy is sufficiently developed, the local government's reliance on compensatory revenues from land resources declines, and rich sources of fiscal revenue can help increase the extent to which urban and rural residents share the benefits of urban development. Third, high land-opening intensity may imply that land in rural areas is more rationally utilized and developed, such as into leisure agriculture and rural tourism, bringing more economic opportunities to residents and easing the economic gap between urban and rural areas. Fourth, high-intensity land opening may lead to more prudent consideration of the government’s urbanization process to prevent disorderly urban expansion. This may, to a certain extent, curb the overly rapid flow of the rural population to cities, thus maintaining the labor force in rural areas and enhancing their economic vitality.

Table 3 Moderating Effect Results

	(1)	(2)
VARIABLES	Inequality	Inequality
ln_landrev	0.0301***	0.0799***
	(2.5984)	(4.2796)
landrev_CLD		–0.1523***
		(–4.6034)
CLD		1.2227***

		(5.8088)
Industrials	0.0889***	0.1240***
	(3.2332)	(3.0572)
Urban	–0.5896*	–1.6809***
	(–1.7251)	(–2.9472)
Humcap	–5.9652*	7.8606
	(–1.6649)	(1.3985)
Open	0.0616	0.1387
	(0.9065)	(1.1472)
Goverex	–0.3701**	–0.2397
	(–2.4372)	(–1.1226)
Hrp	0.4490***	–0.1433
	(3.3467)	(–0.7169)
Constant	0.7231	3.2702***
	(1.0118)	(3.5309)
Observations	435	205
R-squared	0.858	0.908
Number of id	29	29
Year	YES	YES
Province	YES	YES

t-statistics in parentheses

*** p<0.01, ** p<0.05, * p<0.1

4.3 Robustness Tests

To ensure that the results of this study are not generated by chance or for any special reason, this study employs three robustness tests. As listed in columns 1–6 of Table 4, the results of these robustness tests enhance the confidence in the results of the original model. The coefficients and significance of ln_landrev, the core variable of this study, remained largely stable, whether by changing the measure of the income distribution effect, excluding years that may have been affected by the pandemic, or by introducing the control variable of the degree of marketization. This suggests that there is indeed a clear positive effect of the unsatisfactory distribution of compensatory revenues from local government land and that this effect is robust across all contexts.

Table 4 Robustness Test Results

	(1)	(2)	(3)	(4)	(5)	(6)
	Substitution of explanatory variables	Substitution of explanatory variables	Removing the effects of the epidemic	Removing the effects of the epidemic	Adding control variables	Adding control variables
VARIABLES	Thielindex	Thielindex	Inequality	Inequality	Inequality	Inequality
ln_landrev	0.0040***	0.0079***	0.0301**	0.0748***	0.0288**	0.0601***
	(3.5937)	(4.7964)	(2.5588)	(3.9513)	(2.4983)	(3.4578)
landrev_CLD		–0.0153***		–0.1506***		–0.1468***
		(–5.2287)		(–4.5159)		(–4.8863)

CLD		0.1170***		1.1395***		1.1486***
		(6.6420)		(5.7923)		(6.3390)
Industrials	0.0091***	0.0158***	0.0940***	0.1146***	0.0951***	0.1917***
	(3.4704)	(4.4047)	(3.1264)	(2.6978)	(3.4659)	(4.7783)
Urban	–0.1878***	–0.2578***	-0.6255*	–2.0276***	–0.7739**	–1.7281***
	(–5.7628)	(–5.1215)	(–1.7572)	(–3.4950)	(–2.2218)	(–3.2517)
Humcap	0.0982	1.6233***	-5.1400	3.7152	-5.3579	–1.9633
	(0.2874)	(3.2722)	(–1.3557)	(0.5939)	(-1.5008)	(–0.3478)
open	0.0000	0.0065	0.0819	0.2363*	0.0827	0.1353
	(0.0021)	(0.6124)	(1.1727)	(1.8890)	(1.2150)	(1.1861)
Goverex	–0.0465***	–0.0218	–0.3771**	–0.1861	–0.3543**	0.0806
	(–3.2083)	(–1.1542)	(–2.3722)	(–0.8366)	(–2.3448)	(0.3943)
Hrp	0.0601***	–0.0191	0.5314***	–0.1635	0.4649***	–0.4208**
	(4.6980)	(–1.0835)	(3.7648)	(–0.7923)	(3.4819)	(–2.2004)
Industrializa-tion	0.0361***		0.4113***	-0.2578	0.4378***	–0.2897*
	(2.6581)		(2.7112)	(–1.3807)	(3.0315)	(–1.6989)
Market					0.0218**	0.0629***
					(2.3928)	(5.5757)
Constant	–0.1227*	0.2164***	0.2819	3.8182***	0.5405	4.4871***
	(–1.7993)	(2.6463)	(0.3726)	(3.6364)	(0.7555)	(4.7083)
Observations	435	205	406	192	435	205
R-squared	0.891	0.943	0.854	0.910	0.860	0.925
Number of id	29	29	29	29	29	29
Year	YES	YES	YES	YES	YES	YES
Province	YES	YES	YES	YES	YES	YES

t-statistics in parentheses

*** p<0.01, ** p<0.05, * p<0.1

4.4 Endogeneity Test

This study uses two-stage least squares to further explore the effects of the distribution of compensatory revenues on local government land. First, we consider the lagged period of compensatory revenues on local government land (Lln_landrev) as an instrumental variable and conduct a regression analysis in the first stage. Second, we use the predicted value of compensatory revenues to local government land estimated in the first stage (Lln_landrev) in the second stage to estimate its agreeableness with the effect of revenue distribution (inequality). The endogeneity test results have been presented in Table 5. The coefficient of the instrumental variable Lln_landrev with ln_landrev is 0.819 and is highly significant, rejecting the original hypothesis at the 1% level and implying that this instrumental variable is strongly correlated with the endogenous explanatory variables in the study. In the second stage, the estimated coefficient of ln_landrev on the income distribution effect (inequality) is 0.056 with a t-value of 1.92. This implies that there is a positive correlation between compensatory revenues on local government land and the income distribution effect, which is statistically significant at the 10% level, in line with the results of the benchmark regression.

Table 5 Endogeneity Test Results

	(1)	(2)
	First	Second
VARIABLES	ln_landrev	Inequality
Lln_landrev	0.819***	
	(31.42)	
Industrials	–0.052	0.149***
	(–1.19)	(3.65)
Urban	–0.704**	1.123***
	(–2.17)	(3.70)
Humcap	–2.056	–22.690***
	(–0.45)	(–5.41)
Open	0.314**	–0.197
	(2.45)	(–1.63)
Goverex	–0.556***	–0.631***
	(–2.77)	(–3.29)
Hrp	0.067**	–0.215***
	(2.53)	(-8.48)
Industrialization	0.224	1.279***
	(0.74)	(4.57)
ln_landrev		0.056*
		(1.92)
Constant	0.829***	3.239***
	(3.05)	(12.41)
F-value	987.33	
Year	YES	YES
Observations	406	406
R-squared		0.451

t-statistics in parentheses

*** p<0.01, ** p<0.05, * p<0.1

4.5 Heterogeneity Analysis across East-Central-West Zones

To investigate the heterogeneous effects of the unsatisfactory nature of the distribution of compensatory revenues to local government land across different geographic regions, this study also selected three major economic zones in China–east, central, and west to conduct regression analyses. As shown in Table 6, in the eastern sample, compensatory revenues to local government land are positively correlated with the unsatisfactory distribution; however, the coefficient is not significant, indicating that compensatory revenues to local government land may not be the main factor driving the urban_rural gap in the relatively economically developed eastern part of the country. In the central sample, compensatory revenues to local government land are significantly and positively related to the unsatisfactory distribution nature of allocation, implying that in the central part of the country, where the economy is moderately developed, increased compensatory revenues to land resources may widen the urban–rural gap. In the western sample, compensatory revenues to local government land are negatively correlated with unsatisfactory

distribution allocation; however, the coefficients are also insignificant, suggesting that compensatory revenues to land resources do not exert a significant impact on urban–rural disparities in the economically backward western part of the country.

Table 6 Heterogeneity Analysis Results across the Eastern, Central, Western Regions of China

	(1)	(2)	(3)
	the east	central section	western part
VARIABLES	Inequality	Inequality	Inequality
ln_landrev	0.0089	0.0404**	–0.0176
	(0.7009)	(2.0214)	(–1.2765)
Industrials	0.0821***	0.0957*	–0.0068
	(4.3165)	(1.7995)	(–0.1416)
Urban	0.0688	2.1875**	2.3661***
	(0.2220)	(2.4143)	(3.4732)
Humcap	–13.8930***	13.9903	1.2416
	(–4.8918)	(1.4291)	(0.1914)
Open	–0.0141	0.4309**	–0.4883***
	(–0.2686)	(2.1372)	(-2.6358)
Goverex	–0.0213	–0.2012	–0.6457***
	(–0.1459)	(–0.6081)	(–2.7477)
Hrp	–0.4279***	0.7128*	0.2725
	(–2.9535)	(1.8579)	(1.1498)
Tb	1.9835***	–0.8707	5.5963***
	(3.6403)	(–0.7530)	(4.7151)
Constant	5.0382***	–2.5166	1.2636
	(5.8922)	(–1.0558)	(1.3351)
Observations	150	90	165
R-squared	0.927	0.967	0.949
Number of id	10	6	11
Year	YES	YES	YES
Province	YES	YES	YES

t-statistics in parentheses

*** p<0.01, ** p<0.05, * p<0.1

5. CONCLUSIONS AND POLICY IMPLICATIONS

5.1 Conclusions

"Ground rent," represented by land concessions, is the basic form of initial distribution and redistribution of compensatory revenues from land in China, and land development is an important factor in the functioning of local government land finance systems. Although urban-biased policies are consistent with the global trend of aggressive urbanization and contribute to economic growth, they can considerably exacerbate the unsatisfactory nature of the distribution of compensatory revenues from local government land. Based on the analytical threads of the theoretical and empirical research, this study draws two conclusions. First, the compensatory revenues allocation effect of land resources is unsatisfactory distribution, a result that is

particularly significant in the central region. Second, in terms of the moderating effect of land development intensity, the distributional effect of compensatory revenues from local government land resources differs at different levels of land openness intensity. In particular, the unsatisfactory nature of the distributional effect of compensatory revenues on land resources may be suppressed in regions with a higher land openness intensity.

However, this study has the following limitations. Although our lagged variable regression model deals with the endogeneity issue, more theoretical configurations need to be done in exploring the compensatory revenues and allocation process of government land. In addition, although the land premium can measure the vast majority of local government land compensatory revenues, the inability to obtain data on land idling fees, soil and water conservation compensation fees, land reclamation fees, cultivated land reclamation fees, compensation fees for the temporary use of land, compensatory use fees for new construction land, and land revenue payments may partially affect the results.

5.2 Policy Implications

Efforts to build an integrated rural and urban land market should be persistently pursued over the long term, and the concept of urban bias should be completely discarded, including reducing the administrative power of local governments over the transfer of land in rural areas, recognizing the marketization of the status of rural residents as equal-rights subjects of land, and promoting the market mechanism to play a dominant role in the allocation, flow, and pricing of land elements. Currently, there is a serious problem of unfair income distribution in China's primary distribution areas. An imperfect market for production factors requires the government to formulate corresponding policies and systems to build a fair and reasonable, yet efficiency-compatible initial distribution system. In the area of redistribution, the weak regulation of taxation, the insufficient redistributive function of transfer payments, the variability of the social security system among different groups of people and different systems, and the low coverage and targeting of social welfare programs in impoverished areas have led to the government's redistributive policies not effectively regulating the unsatisfactory distribution. Therefore, for a long time, sharing the fruits of development and narrowing the unsatisfactory distribution will be the key to realizing the goal of common prosperity.

In contrast, the government is currently exploring revenue distribution patterns based on a sharing system supplemented by exclusive benefits. Presently, the government's secondary financial allocation of resource revenues is mostly based on compensatory revenues supplemented by cumulative revenues, and the distribution pattern is based on local exclusive revenues, supplemented by shared and centralized exclusive revenues. As the "nominal owners" and actual controllers of regional natural resource assets, local resource management departments have natural information and management advantages, and they maximize regional resource revenues under the premise of guaranteeing the standardized and rational development and utilization of natural resource assets. Therefore, when exploring and adjusting the distribution of natural resource revenue between the central and local governments, the pattern of a sharing system should be chosen as the main system, supplemented by exclusive benefits. Through the downward transfer of rights, the central government can not only provide a strong impetus for local economic development but also ensure its dominance and owners' rights and interests and always maintain a dynamic balance between the central and local governments.

AUTHOR CONTRIBUTIONS

Data curation, Huilin Xia and Yuchi Shen; Writing - original draft, Huilin Xia and Yiming Guan; Writing - review & editing, Huilin Xia and Yuchi Shen; Methodology, Yiming Guan; Project administration, Huilin Xia; Software, Yiming Guan; Formal analysis Huilin Xia and Yuchi Shen; Investigation Huilin Xia and Yuchi Shen; Funding acquisition, Huilin Xia; Resources, Huilin Xia; Conceptualization, Huilin Xia and Yuchi Shen; Supervision, Yuchi Shen; Validation, Huilin Xia and Yuchi Shen; Visualization, Yuchi Shen.

FUNDING

This research was supported by the National Social Science Fund of China (No. 19CJY057).

DATA AVAILABILITY STATEMENT

Not applicable.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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