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Research Article

Utilization of Rural Resource Assets: Time-Space Estimate on the Total Factor Productivity

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The utilization efficiency of China's rural collective resource assets has always been at a low level, and excessive energy consumption and input have become the main limiting factor, which seriously affects the overall improvement of agricultural modernization and rural people's livelihood. In this paper, time measure and space measurement are adopted alternatively, and spatiotemporal vertical-horizontal progressive deduction is built with the improved model, so as to set up a perfect spatiotemporal dynamic effect evaluation system: First of all, improve the U-HDM-GML index model, study on the improvement strategy for input redundancy and unexpected output redundancy in the utilization efficiency of rural collective resources assets in various provinces of China, as well as the equilibrium rupture relation between the two from the perspective of global space and time, and at the same time of fulfilment of time measurement and estimation, provide support for better expressing the spatial effect in terms of improving approach and strategy; secondly, measure the improvement strategy of the total factor productivity of research samples with the spatial expletory ESDA test method, and it is also applicable to global spatial effect evaluation system; finally, apply FE-SDM to further analyze the difference of spatial effect of total factor productivity in rural resource asset utilization. Through analysis of the significant difference characteristics of the research samples with different geographical and spatial characteristics, the strategy deficiency in terms of difference discrimination is made up. *Conclusions*. This paper carries out the time and spatial effect measurement of total factor productivity for the performance of pilot strategies in various provinces of China in the last ten years and puts forward a more beneficial improved strategy and mechanism, preferentially selected according to the direction indicated by good research indicators, gets the redevelopment strategy for improving the utilization efficiency of areas at a low level of resources utilization currently, and indicates the direction for tapping the full potential of existing rural resources according to the practical conditions at local places, in the hope of establishing the trans-provincial cooperation supply and demand system based on the new rural collective economic organizations (cooperatives) after the reform experimentation and optimizing the spatial spillovers of rural resources assets, so as to make a breakthrough in the barrier due to growth of technical efficiency.

1. Introduction

Since the 19th China national Congress of the CPC, the development of China's rural collective economy has created a new historic achievement for the all-round construction of a modern socialist country. As the prosperous rural industries are rooted in the promotion of collective resource utilization efficiency, the vital basis for the development of rural collective economy in the next century lies in the innovation in the ways of rural collective resources utilization, the establishment of cross-provincial rural resources benefit coupling, the exploration into the coordination between resource ecology and resource-based economy, and green sharing and balance-broken relation (boundary-limiting relationship between balance and imbalance). Especially China's rural collective resources assets have gone through extensive development for a very long time, which has caused the problems of insufficient vitality of production factors, short chain of cross-provincial resource utilization, multiple financial dilemmas of agriculture, rural areas, and rural residents [1]. Therefore, how to effectively utilize the characteristics of rural spatial patterns and improve the utilization efficiency, quality, and economic results in the society of rural collective resources by improving the influencing factors of spatial effect is extremely urgent.

Utilization efficiency of resource assets is an important indicator to measure the improvement of total factor productivity (hereinafter TFP) under the interaction of multiple systems, such as rural collective asset ownership confirmation, resource utilization management, and ecological civilization construction. It comprehensively reflects the transfer and transformation of matter energy and the acting forces between internal elements of urban and rural economies and between internal elements and the external environment [2].

There are many gaps in the existing studies literature. Such as, the studies focus on the multiple dimensions of the effectiveness of land reform, resources utilization, and bioenvironment balance. However, there is a lack of innovation in the selection of research samples, with the average data of cities being chosen as most of the research samples, while it was impossible for the original administrative regions to reform rapidly to achieve the research objectives. For example, the studies conducted the quantitative evaluation of the security of rural collective land use from the perspectives of five asset types for households' livelihood [3], of which the results lack universal practical significance because such analysis has a requirement for the research sample, requiring the research sample to have typical research characteristics. The studies analyzed the shortcomings of the profit-making strategy of resource management of independent members exit from the collective at the structural level of the secondary market of rural collective land from the perspective of land management [4, 5], but they neglected that there lacks a clear legal relationship protection mechanism between the rural collective organizations and members, the long-term livelihood guarantee for peasants with high mobility as provided by a dynamic management and income distribution, and a perfect design for people at the bottom of the society.

Given our objectives, we draw on the existing studies and summarize the gaps in existing literature, and then present innovations as follows: Firstly, study the innovation of the samples selected. Take the China National Development New Area in provinces that have successfully completed the integrated use of urban and rural land and have the obvious advantage of the joint office system of various functional institutions as examples to study on the rapid urbanization; secondly, combined with the resource endowment and spatial differences of geographical information of each province, provide data support for effectively realizing the development and interindustry aggregation on supply chain of idle resource assets in rural areas, so as to improve the current situation of rural population migration; Thirdly, enhance the promotion of the construction of interprovincial Internet of Things platform for rural collective to provide services for the secondary and tertiary industries, and further improve the current situation of hollow villages, providing the policy basis and theoretical data support for improving the level of economical and intensive utilization of urban and rural resources in China.

2. Literature Review

Drawing on a comprehensive review of prior literature on empirical model analysis, for example, the Naive Bayes-based distance classification approach is applied to the Online HDM in the existing literature [6], which is stable, contributes through combining known algorithms, and offers satisfactory accuracy while carrying out the classification tasks including distance, effective in terms of time and memory complexity. In the literature, a distance measurement approach based on HDM combined with a dimension reduction is proposed [7], which follows a similar deformation and allows a clustering into local structures over time. This study focuses on breaking the general constraints of traditional DEA models limited by radial and nonradial distance function models.

Although the characteristics and differences of urban construction land use efficiency within each province were measured based on DDF-GML improved index model, the improved scheme was based on the assumption of constantly expanding desirable output and constantly decreasing undesirable output [8]. As a result, the changes in land use efficiency in high efficiency areas and extensive areas are very similar, which shows the limitations of the method requiring specific control assumptions, so we must consider the efficiency reform and improvement scheme under the condition of undesirable output in this study.

In the paper, a model that is adaptable to the special features of unconventional output is defined [9]. To seek robustness, the author used an enhanced version of the Malmquist-Luenberger productivity index to overcome some of the drawbacks suffered from the original approach. Due to the technical regression experienced during my study, this regression method was cited here for improving the limitations of the single Malmquist index model, exploring the ways and strategies to improve the utilization efficiency of rural collective resources assets in each province of China, and discussing whether the spatial effect can be better expressed.

[10, 11] are intended to provide an overview of the developments that have taken place in the field of ESDA, with emphasis on tools that are now available for spatial data exploration [10, 11]. The former's point is an introduction to ESDA (including the temporal dimension as ESTDA), presents the web-based tools that are currently available for the early developments in ESDA/ESTDA, and reflects on the future. The latter's point aims to study urban planners and require an understanding of the composition as well as the spatial distribution and the spatial dependency to design policies for various wards of a city. His result owns to the statistics used (i.e., global Moran index), which is an average statistic that captures the overall spatial autocorrelation of the data and does not capture variability on a local scale.

[12] used the superundesirable-SBM to thoroughly measure and evaluate the dynamic characteristics of environmental space of TFP and improvement conditions of

environmental regulation under the comprehensive consideration of undesirable output [12]. However, there is a lack of the equilibrium rupture relation evaluation for slack variables' redundancy rates of input and undesirable output, respectively, under the premise of maximizing the desirable output, so it is impossible for the research to obtain the optimal evaluation of the strategy.

Based on the research results of existing literature, possible innovations in this study include the adoption of improved models. Comprehensively use the advantages of U-HDM with a global time-space perspective and Malmquist index model with global technology to complete the measurement in the dimension of time and then use FE-SDM to complete the evaluation system of spatial dynamic effect, thus better evaluating the performance at different stages of resource assets regulation reform strategy in China in the past decade, so as to provide a strategic basis for the next stage of revitalizing the management strategy of provincial rural collective resource assets, constructing the dynamic management system of time-space effects, and improving the average technical efficiency per capita and per land area.

3. Conditional Hypothesis and Improved Models Development

3.1. Measurement Method of Improved U-HDM. The Hybrid Distance model is selected in this study, which integrates the advantages of the radial BCC model and nonradial SBM distance function models together, and effectively avoids the problem of losing the original proportion information of factors in the efficiency frontier in traditional performance model studies [13]. It improved the single evaluation target of economic benefits in the past and assumed the ideal state of taking the improvement strategy of purely relying on the infinite decrease in input and increase in desirable output. During socioeconomic development, the destruction of resource assets is nonrevertible. Therefore, the researches based on the improved equilibrium rupture relation of undesirable output redundancy and input redundancy have practical significance. Therefore, the U-HDM with undesirable hybrid distance function including slack variables was adopted, and the objective function and constraint conditions are designed as follows:

$$\begin{aligned}
&\mathrm{Min}\rho = \frac{\theta - \varepsilon 1/\sum_{i=1}^{m} w_i^- \sum_{i=1}^{m} w_i^- s_i^- / x_o}{\varphi + \varepsilon 1/\sum_{r=1}^{s} w_r^+ \sum_{r=1}^{s} w_r^+ s_r^+ / y_o},\\
&\text{subject to} \sum_{\substack{j=1\\ j\neq o}}^{n} x_{ij}\lambda_j + s_i^- = \theta x_{io}, \quad i = 1,\ldots,m,\\
&\sum_{\substack{j=1\\ j\neq o}}^{n} y_{rj}^{g}\lambda_j - s_r^{g+} = \varphi y_{ro}^{g}, \quad r = 1,\ldots,s,\\
&\sum_{\substack{j=1\\ j\neq o}}^{n} y_{rj}^{b}\lambda_j + s_r^{b-} = \varphi y_{ro}^{b},\ r = 1,\ldots,s, \lambda_j, s_i^-, s_r^{g+}, s_r^{b-} \geq 0,
\end{aligned} \tag{1}$$

where ρ is the evaluation index of resources assets efficiency, x_o is the input vector, yg/o and yb/o are, respectively, desirable output vector and undesirable output vector. The slack variables $s_i^-, s_r^{g+}, s_r^{b-}$ represent input redundancy, desirable output redundancy, and undesirable output redundancy. DUM weight in each designed area is set as λ, and $\varepsilon \in [0, 1]$ is the key parameter.

3.2. Calculation of TFP Change Index Based on Global Technology. Based on the research results of U-HDM of the previous stage, Global Malmquist Luenberger (GML) index was used for the measuring and calculating method of TFP change of global technology, which solved the problem of no solution to nontransitivity and no feasible solution to linear programming in the circularly cumulative data statistics. The direction vector was set as $g = (-g_x, g_y)$, where g_y includes desirable output and undesirable output. Import in the hybrid direction distance function to get $\overrightarrow{D}(x, y; g_y) = \sup\{\beta\colon (y + \beta g_y) \in P(x)\}$, so the expression of U HDM-GML (2) is as follows:

$$GML_{HDM} = \frac{1 + D^G\left(x^t, y^t; y^t\right)}{1 + D^G\left(x^{t+1}, y^{t+1}; y^{t+1}\right)}. \tag{2}$$

According to its influencing factors, the HDM-GML index can be decomposed into two indexes: EFFCH and TECH, which can measure the differential treatment for technical progress and technical efficiency in TFP change, where the technical progress is used to measure the moving characteristics of efficiency frontier during two periods, and technical efficiency change is used to measure whether the land utilization efficiency in sampling areas is more approximate to the efficiency frontier [14].

The specific decomposition is shown as follows:

$$\begin{aligned} GML_{HDM} &= \left(\frac{1 + D^t\left(x^t, y^t; y^t\right)}{1 + D_v^{t+1}\left(x^{t+1}, y^{t+1}; y^{t+1}\right)} \times \frac{1 + D_C^G\left(x^t, y^t; y^t\right)/1 + D_v^G\left(x^t, y^t; y^t\right)}{1 + D_C^G\left(x^{t+1}, y^{t+1}; y^{t+1}\right)/1 + D_v^G\left(x^{t+1}, y^{t+1}; y^{t+1}\right)} \right) \\ &\times \frac{1 + D_v^G\left(x^t, y^t; y^t\right)/1 + D_v^t\left(x^t, y^t; y^t\right)}{1 + D_v^G\left(x^{t+1}, y^{t+1}; y^{t+1}\right)/1 + D_v^{t+1}\left(x^{t+1}, y^{t+1}; y^{t+1}\right)} \\ &= \text{EFFCH} \times \text{TECH}. \end{aligned} \tag{3}$$

3.3. Exploratory ESDA Test Method. According to the results of time measurement, select the global Moran index in ESDA so as to further identify whether the spatial measurement was more suitable to be applied for the research samples and be used to measure the autocorrelation and aggregated effect of the improved strategy of TFP in global spatial analysis.

The global Moran index is calculated as follows:

$$I = \frac{\sum_{i=1}^{n} \sum_{j\neq 1}^{n} \omega ij \left(x_i - \overline{x}\right)\left(x_j - \overline{x}\right)}{S^2 \sum_{i=1}^{n} \sum_{j=1}^{n} \omega ij}. \tag{4}$$

According to the design, n is the total number of areas researched; ω_{ij} is the spatial weight matrix, x_i and x_j are, respectively, the total factor productivities of area i and area j, where $\overline{x} = 1/n \sum_{i=1}^{n} x_i$, $s^2 = 1/n \sum_i \left(x_i - \overline{x}\right)^2$; first Rook contiguity is adopted for calculation, and the value range of the index is set as [−1, 1], and the absolute values could explain the strong or weak relationship of spatial correlation [10].

3.4. Fixed Effects-Spatial Durbin Model. Rural collective resource assets at different geographic locations in China boast prominent differences. The improved models combine FE-SDM with fixed effect, which could be helpful to make up for the shortcomings of spatial calculation and measurement method in terms of spatial measurement and differentiation discrimination, and thus better solve the problem of improving the TFP of rural resource assets in terms of spatial effect.

First Rook contiguity matrix method is used for model calculation. According to the design, ω_{ij} is the spatial weight matrix; the explained variable GML_{it} represents the logarithm of total productivity efficiency of the province i during the period of the explained variables, respectively: economic development level (GDP_{it}), the level of the secondary industrial structure (IND_{it}), the level of border economic cooperation $(BECit)$, urbanization level (URB_{it}), and financing level $(FINit)$. The FE-SDM is expressed as follows:

$$\begin{aligned} \ln GML_{it} &= \beta_0 + \rho \sum_{j=1}^{n} \omega_{ij} \ln GML_{it} + \alpha \ln GDP_{it} + \beta \ln IND_{it} + \\ &\psi \ln BEC_{it} + \tau \ln URB_{it} + \varphi \ln FIN_{it} + \alpha' \sum_{j=1}^{n} \omega_{ij} \ln GDP_{it} + \beta' \sum_{j=1}^{n} \omega_{ij} \ln IND_{it} + \psi' \sum_{j=1}^{n} \omega_{ij} \ln BEC_{it} + \\ &\tau' \sum_{j=1}^{n} \omega_{ij} \ln URB_{it} + \varphi' \sum_{j=1}^{n} \omega_{ij} \ln FIN_{it} + \mu_i + \varepsilon_{it}. \end{aligned} \tag{5}$$

4. Research Methodology

This study is to improve the conceptual framework of sampling and develop the measures. We began the scale development process by investigating the relevant existing literature as far as possible for validated scales that could be used in this study. Although we did not find the complete direct sample scales that were suitable for this study, we were able to identify several time or spatial measurement models and scale fragments to find an excellent selection of sample indicators since insufficient coverage of the technical barriers was deemed an issue. Based on the research objectives, the data and indicators in this study were selected in two stages: The first stage of the study is that the majority of the governance system transformation was adopted from the rural collective resource assets management project but modified slightly for the time measure models context. The second stage of the study is that the majority of the global spatial autocorrelation was adopted from the China National Economic and Technological Development New Area. Some new indicators were self-developed based on the definitions provided by making innovations for the spatial measure models in context.

4.1. Sampling Administration of Time Measurement Models. The first stage: time measurement and analysis, the data of 30 provincial areas of China (except Tibet) from 2009 to 2019 were selected, mainly from the China Statistical Yearbook, the annual statistics of each province, city and county, and each department, China Energy Statistical Yearbook, China Rural Statistical Yearbook, and China Agricultural Statistics Yearbook. Selection of input indicators: The capital stock of collective economic organizations, the number of available workers in rural areas except for the primary industry, energy consumption, and the capital, labor, and energy input used as rural collective resource assets, and the capital stock is estimated by the perpetual inventory method [15]. Selection of desirable output indicators: Rural GDP, the added value of the rural secondary industry, the proportion of newly developed land area and newly cultivated land area; selection of undesirable output indicators: Negative externalities measured by urban and rural sewage discharge. Go into the input and undesirable output redundancy in resource utilization of each provincial areas, analyze the true characteristics of the tendencies and changes, and explore whether it is more effective to use space to improve the analysis path.

4.2. Measurement Indicators Development of Spatial Measure Models. The second stage: spatial measurement and analysis. Based on the research results from the first stage, derived from building spatial measurement and analysis for strategy system evaluation by performance. According to the structure and layout of the leading industry, land use structure and ecological endowment, and future potential factors in rural areas of China, it can position the successful research samples for the accelerated urbanization process more accurately [16]. In the spatial benefit model, the China national economic and technological Development New Area in each province were selected as the research samples. The indicators of social and economic levels, secondary industry structure adjustment level, border economic cooperation level, urbanization level, and financing level were selected to decompose the influencing factors of TFP. The logarithm of per capita GDP, the proportion of the added value of the secondary industry in GDP, trade of agricultural and forestry products and the total amount of border tourism, urbanization rate, and increase of loans guaranteed by financing for agriculture, rural areas, and farmers were used in measuring, respectively. Data are from China Rural Statistical Yearbook, China Land and Resources Statistical Yearbook, the Report on Development of State-level Economic and Technological Development New Area, Notification on the Evaluation about Intensive Land Use of State-level Economic and Technological Development New Area, The Third national Agricultural Census of China, and so on. The spillover effect of TFP was analyzed by spatial measurement method in order to provide data support and strategy reference for China's rural revitalization strategy research.

5. Data Analysis and Results

5.1. Slack Variables Analysis with U-HDM. As the completion year of China's resource assets management project and the year of rural collective economic governance system transformation, 2016 plays a historic role in comprehensively initiating the task of deepening supply-side reform for the 13^{th} Five-Year Plan. This study takes the data of 2016 as a typical example and uses U-HDM to measure the slack variables of provincial input index and undesirable output index under the assumption of constant returns to scale. Take the redundancy rate of each province when it realizes validity for measurement, the input redundancy rate when output remains unchanged represents that invalid provinces become valid, and how much the proportion of investment that can be decreased should be. The undesirable output's redundancy rate when input remains unchanged represents how much the proportional share that can be reduced from the current level under the premise of ensuring validity may possibly be, as shown in Table 1.

From the analysis of each area, the utilization efficiency of China's rural collective resource assets is still at a medium and low level, and the undesirable output of sewage discharge has reduced the resource utilization efficiency by more than 20%. In terms of the geographical spatial location of each area and each province, the utilization efficiency gradually decreases from the eastern provinces to the western provinces. In the process of adjusting and optimizing the distribution of resource structure and improving the comprehensive carrying capacity of the land, the redundancy rate of energy consumption throughout China exceeds 25%, and the redundancy rate of sewage discharge exceeds 34%. However, as seen from the differences of each province classified by region, there are still 4 provinces in eastern China—Hebei, Fujian, Guangxi, and Hainan—with a redundancy rate higher than the national average. Because of the particularity of geographical distribution and industrial distribution, the redundancy rate in northeast China is the most unbalanced. The stock redundancy of collective economic organizations in Henan Province in central China, which obviously lags behind other provinces in implementing the reform strategy of the rural collective property rights system, is more than twice the local and national average level. Qinghai Province in western China has the highest redundancy rate among other provinces in China, especially in energy waste.

Eastern regions are economically developed on the whole and are more mature with respect to resources assets utilization, especially the utilization of land resources. There

Table 1: Input and undesired output redundancy rates of rural collective resource assets in China in 2016.

Area		Input redundancy			Undesirable output redundancy
		Collective economic organization capital stock (%)	Employable persons in rural areas except primary industry (%)	Energy consumption (%)	Sewage discharge (%)
East	Beijing	0.00	0.00	0.00	0.00
	Tianjin	4.73	9.73	17.14	22.32
	Hebei	19.51	35.78	46.49	50.06
	Shanghai	0.00	0.00	0.00	0.00
	Jiangsu	6.50	12.34	2.42	17.69
	Zhejiang	5.62	31.38	2.60	9.94
	Fujian	15.75	30.22	5.68	16.38
	Shandong	9.82	11.07	19.97	53.33
	Guangdong	0.00	0.00	0.00	0.00
	Guangxi	19.23	19.23	19.23	31.79
	Hainan	20.32	38.34	19.29	50.89
	East area	9.23	17.10	12.07	22.95
North east	Inner Mongolia	45.32	1.36	58.74	76.09
	Liaoning	0.36	0.42	11.76	31.24
	Jilin	29.85	7.25	22.54	62.70
	Heilongjiang	1.37	1.74	23.31	46.21
	North east area	19.23	2.69	29.09	54.06
Central	Shanxi	14.03	14.03	64.23	83.21
	Anhui	0.00	39.89	13.16	39.79
	Jiangxi	0.00	4.73	2.60	17.69
	Henan	32.60	49.58	21.69	36.09
	Hubei	9.73	9.73	21.14	24.72
	Hunan	14.03	39.59	23.33	19.90
	Central area	11.73	26.26	24.36	36.90
West	Chongqing	7.21	22.55	24.72	7.21
	Sichuan	0.23	30.16	33.59	4.23
	Guizhou	14.17	14.17	44.98	60.07
	Yunnan	29.48	29.48	35.88	33.88
	Shaanxi	27.03	8.93	32.32	63.31
	Gansu	2.83	13.69	47.86	58.79
	Qinghai	56.91	36.57	68.33	41.28
	Ningxia	6.50	13.49	20.86	28.79
	Xinjiang	9.28	0.00	49.68	56.00
	West area	17.07	18.78	39.80	39.28
National		13.41	17.52	25.12	34.65

are significant effects of the general checkup on the collective fixed assets in rural areas and relatively reasonable layout of industrial structure. In particular, Beijing, Shanghai, Guangdong, Tianjin, and Jiangsu have effectively reduced energy consumption and improved the sewage treatment effect when they steadily pushed forward the process of integration in urban and rural areas; however, in Shandong, Hebei, Hainan, and Guangxi, energies are utilized extensively, and at the same time, the policies, measures, and hardware support for pollution control lag far behind the process of industrial structure layout. Northeast China shows the characteristics of uneven industrial structure, the dominance of heavy industry in the early stage, good resource endowment, and a complex natural environment. The rural collective economic organization has a certain foundation, but it still needs to introduce advanced technology in energy consumption reduction and wastewater and biomass treatment to explore a path of substantial improvement. The utilization rate of input factors in the central region is on the rise, but there is too much personnel redundancy, so it is encouraged to transfer the labor force to the central and western regions.

In western regions, the rural collective economy is backward. Generally, there are more mountainous and deserts which cannot be developed, the villages are dispersed, not concentrated and, more importantly, in the core areas of ecological restoration, there are backward supporting infrastructures, insufficient innovation mechanism, less emerging industries and technology industry layout, prevailing labor-intensive industries, and serious hollow village phenomenon, the labor forces go out for work for more than 6 months in a year, property rights system reform is not implemented effectively and has poor performance, energy utilization is extensive, as manifested by the high input, high consumption, high emission and low output. In recent years, with the policy support of the state, western regions have increased the investment in large-scale fixed assets; however, the effective layout of industrial structure and the policies on technology and talent introduction are still lacking, and the conversion rate of investment assets is not high. It should accelerate to improve the rural collective organization system, stabilize the membership of economic organizations, better the general checkup on the fixed assets, rationally plan the development paths, and strengthen land consolidation and intensive use.

5.2. Evolution Tendency and Characteristic Analysis. Based on the longitudinal evolution trend analysis on the time scale, the TFP of rural resources asset utilization in 30 provinces of China from 2009 to 2019 was decomposed. Taking 1 as the critical point, the TFP of resource utilization and its decomposition value were divided into three types: Increase (index >1), stagnation (index = 1), and regression (index <1). The number of provinces under various results is shown in Table 2:

The growth of the TFP change index of the rural collective resources assets mainly depends on the improvement of the technical level. From the analysis of Table 2, it can be known that, from the overall average of 10 years, there are 11 provinces that can basically realize the constant increase of TFP utilization rate of collective resources asset with the average increase rate of about 36%, and 19 provinces regressed with the average regression rate of about 64%; during the investigation period, Beijing, Shanghai, Guangdong, and other first-tier provinces have the technical efficiency value of 1, which have reached the efficiency frontier and the change index stagnates. Among the provinces that have achieved technological progress, 40% have sustained growth, 13% have stagnated, and 47% have regressed. On average, 13 provinces can achieve a technological efficiency increase, accounting for 43% of the total, and the regression rate is 57%, which is high. It can be seen from the comprehensive analysis that the TFP utilization rate of rural collective resources assets in most provinces of China is in a state of regression, but the regression speed is in a downward trend, indicating that there is still a large space for resource planning and improvement and technological level improvement, especially since 2016. The number of provinces gradually shows a rising trend with the strengthening of the national reform of the rural collective property rights system during the "13th Five-Year Plan" period. The overall utilization efficiency trend is getting better, but it still needs to be reinforced and increase improvement planning during the "14th Five-year Plan" period.

Horizontal analysis by spatial scale differences is shown in Table 3:

From Table 3, through the spatial horizontal analysis from the TFP of rural resource asset utilization in various regions on the same time axis, it can be seen that the overall national average is still less than 1 after over 10 years of reform and rectification, while all indicators showed varying degrees of increase; in terms of technical indicators, the EFFCH change index and the TECH progress index showed the opposite situation in different regions as a whole. The global GML index can be divided into two stages. The first stage is before 2015, and the overall growth rate is slow and below 0.98. The change difference among technical indicators is small, and the growth rate of technical efficiency is relatively higher than the technological progress. In the second stage, from 2015 to 2019, the growth rate of the GML index is accelerated, increased to more than 0.99 on the whole, and is greater than 1 in 2018-2019 (the growth rate reached 0.9%). The growth rate of technical efficiency was significantly accelerated, and the performance was greater than 1 in three periods, while the change of technological progress showed an opposite trend, showing a large regression from 2015 to 2017 (by 4.8% and 7.4%, respectively).

From the regional differences in total factor productivity (hereinafter TFP), the average TFP of the eastern, northeast, central, and western regions were 1.004, 0.981, 0.972, and 0.981, respectively. The eastern region has seen faster growth of its TFP and achieved positive growth in 2012–2019 (GML index >1), but the growth rate slowed down gradually after 2016; the central region has seen slower growth and increase in its TFP, indicating the lack of effective improvement measures and technologies; the western region showed a strong fluctuation before 2015, while the overall improvement was relatively average after 2015 but still showed an overall growth trend. The EFFCH index of the four regions is larger than its TECH index, and the effectiveness of technical efficiency improvement is obvious, which shows that there is still much room for improving the TFP of resource utilization in each region in terms of TECH index. Different regions show different growth, which is obviously influenced by regional differences. The profound economic basis and superior geographical location of the eastern region make the public infrastructure form a linkage system as a whole, which can supply internal and internal and external circulation demand. The rational industrial distribution in the eastern region has been able to achieve the agglomeration effect of advantageous industries. Besides, the first and second stages of relatively complete land remediation projects in the eastern region have been fully completed, and the implementation rules of various natural resources management and environmental ecological restoration and management systems have been built, which has formed a more reasonable and complete overall mode in the strategic layout of rural collective resource assets. The northeast region has complex resource attributes and the initial completion of the rural collective economic organization. Compared with other provinces in China, the northeast region has the largest floating population base and is difficult to manage, and the basic facilities in the vast territory still need greater improvement. It is necessary to take the idea of continuing to introduce new technology industries, attracting and retaining talents as the core of structural layout transformation. Rural collective organizations in the central and western regions have a relatively disorganized system, weak overall strength, poor collective economic foundation, and supporting

Table 2: Decomposition value and evolution trend of total factor productivity of rural resource assets utilization.

Particular year	UHDM-GML			UHDM-EFFCH			UHDM-TECH		
	Increase	Stagnate	Backwards	Increase	Stagnate	Backwards	Increase	Stagnate	Backwards
2009-2010	8	0	22	9	5	16	8	0	22
2010-2011	8	0	22	12	5	13	8	0	22
2011-2012	5	0	25	3	5	22	19	0	11
2012-2013	13	0	17	18	4	8	5	0	25
2013-2014	12	0	18	4	3	23	20	0	10
2014-2015	16	0	14	14	3	13	17	0	13
2015-2016	10	0	20	23	4	3	6	0	24
2016-2017	15	0	15	12	6	12	13	0	17
2017-2018	12	0	18	12	6	12	13	0	17
2018-2019	19	0	11	14	3	13	17	0	13
Mean	11	0	19	12	4	14	13	0	17

infrastructure, which needs to be improved. Due to the lack of attractiveness of financing, long-term "credit dilemma," low level of industrial structure, and waste of resources, it is difficult to achieve a strong industrial agglomeration effect. Moreover, the slow progress of technology is not enough to significantly curb pollution discharge, resulting in the overall resources being idle or exploited at will, as well as the relatively extensive and low-level resource management. However, with the "Belt and Road Initiative," the development speed of the western region has been greatly improved since 2012 with strong potential. The western region should strive to tap the superiority of geographical resources, develop characteristic industries according to local conditions, adjust the transformation and allocation of economic structure in a timely manner, and enhance the cross-provincial and cross-border cooperation mode, especially in northwest mountainous areas and minority areas. In addition, it should accelerate the establishment of the IoT (Internet of Things) service platform to more effectively improve the TFP of rural collective resource assets utilization, retain organization members to work and start businesses in rural areas, and vigorously support rural micro and small enterprises, and complete the last step of financial services such as collective organizations and local governments jointly guarantee and exploitable resources mortgage loans.

5.3. Test by the Spatial Econometric Models

5.3.1. Establish the Spatial Weight Matrix. The model calculates the global Moran's I index of national development of the new area in each province from 2010 to 2019, as shown in Table 4, by using the global Rook first-order adjacency criterion to study the spatial aggregation degree and spatial dependence of global spatial autocorrelation for the TFP of integrated land use in Development New Area in each province.

The results showed that the global Moran's I index increased from 0.303 to 0.357 from 2010 to 2019, and all passed the significance test at the 1% level, indicating that the development of land use is linked to increase and decrease in each province in China has achieved initial results. Taking the data of China National Development New Area as a typical example, it can be found that the TFP of land utilization in the rapid urban-rural integration region has a significant spatial agglomeration and gradually increases as a whole.

5.3.2. Statistics and Inspection Management. In order to determine the applicability of the spatial econometric model, Wald statistics and LR statistics were used to test the performance of data in spatial lag and spatial error in the spatial model. The results show that statistical results all passed the significance test at the 1% level, and then the Hausman test was used and confirmed that the inspection result is 39.52, which also passed the significance test at the 1% level, indicating that SDM with fixed effect is most appropriate to achieve the research target. Import the statistical data to the FE-SDM to conduct econometric regression statistics on TFP of resource asset utilization in China National Development New Area in provinces, and the results are as shown in Table 5:

It can be seen from Table 5 that the value R^2 of the spatiotemporal two-way fixed effects is the maximum, reaching 0.883, and also passed the significance test at the 1% level, indicating that the model has the highest goodness of fit and good explanatory power. Using partial differential equations to decompose the SDM of time-space two-way fixed effects, the spatial effects of explanatory variables are manifested as direct spatial effects and indirect spatial effects. Among them, the indirect effect is manifested as a spatial spillover effect. That is, each explained variable is affected by the double influence effect of other explained variables and explanatory variables across provinces, as shown in Table 6.

From the analysis in Table 6, it can be seen that the direct effect and indirect effect of TFP on urban and rural resource utilization in each provincial, national development zone, based on the comprehensive analysis of five level indicators GDP_{it}, IND_{it}, $BECit$, URB_{it}, and $FINit$, are all positive numbers; except for the urbanization level indicator, all the others have passed the significance test at the 1% level, and there are significant spatial spillover effects among the indicators across provinces. The establishment and development of the China National Development New Area have

Table 3: Decomposition value and evolution trend of total factor productivity of resource assets in each region.

Year	GML					EFFCH					TECH				
	National	East	North east	Central	West	National	East	North east	Central	West	National	East	North east	Central	West
2009-2010	0.965	0.956	0.960	0.951	0.986	0.994	0.954	0.992	0.963	1.060	0.971	1.002	0.973	0.987	0.929
2010-2011	0.972	0.990	0.967	0.964	0.960	1.000	1.009	0.999	0.989	0.999	0.972	0.982	0.973	0.975	0.961
2011-2012	0.961	0.978	0.958	0.978	0.932	0.953	0.967	0.955	0.969	0.928	1.008	1.011	1.008	1.010	1.004
2012-2013	0.995	1.006	0.988	0.970	1.003	1.045	1.053	1.043	1.017	1.058	0.952	0.955	0.952	0.954	0.948
2013-2014	0.990	1.003	0.983	0.967	0.995	0.970	0.965	0.969	0.960	0.981	1.021	1.039	1.020	1.008	1.014
2014-2015	0.997	1.032	0.991	0.978	0.977	1.081	1.063	1.079	1.109	1.066	0.926	0.970	0.923	0.882	0.917
2015-2016	1.009	1.049	1.003	0.985	0.989	1.008	1.032	1.006	0.985	1.002	1.001	1.016	1.001	1.000	0.986
2016-2017	0.992	1.007	0.986	0.976	0.990	0.992	0.991	0.991	0.979	1.004	1.000	1.016	1.000	0.998	0.986
2017-2018	0.994	1.007	0.982	0.978	0.977	1.079	1.024	1.065	1.066	1.106	0.990	1.001	0.990	0.982	0.988
2018-2019	1.006	1.009	0.989	0.975	0.998	1.039	1.031	1.025	0.979	1.064	1.005	1.011	0.997	0.968	1.012
Mean	0.988	1.004	0.981	0.972	0.981	1.016	1.009	1.012	1.002	1.027	0.985	1.000	0.984	0.976	0.975

Table 4: Global Moran's I value of land use in China national development new area of China from 2010 to 2019.

Particular year	Moran's I index	Z-statistics	P value
2010	0.303	3.502	0.010
2011	0.340	3.583	0.005
2012	0.341	3.641	0.004
2013	0.343	3.784	0.001
2014	0.343	3.694	0.004
2015	0.368	5.473	0.000
2016	0.326	3.544	0.008
2017	0.337	3.570	0.005
2018	0.322	3.519	0.008
2019	0.357	4.589	0.000

Table 5: Estimation results of SDM.

	No fixed effects		Period fixed		Space fixed		Space-time double fixation	
	Coefficient	T-value	Coefficient	T-value	Coefficient	T-value	Coefficient	T-value
$\ln GDP$	0.325^{***}	7.418	0.332^{***}	7.507	0.576^{**}	6.992	0.532^{***}	7.139
$\ln IND$	0.298^{**}	2.051	0.151^{**}	2.364	0.351^{**}	2.319	0.251^{**}	2.842
$\ln BEC$	0.243^{**}	4.109	0.208^{**}	4.357	-0.219^{**}	−4.083	0.119^{**}	4.039
$\ln URB$	0.176	0.851	0.196	0.673	0.153	0.837	0.028	0.984
$\ln FIN$	0.312^{**}	2.256	-0.293^{**}	−2.253	0.293^{**}	2.241	0.293^{***}	2.241
$\omega \times \ln GDP$	0.211	1.039	0.320^{**}	2.049	0.374^{*}	1.938	0.493	0.983
$\omega \times \ln IND$	0.412^{***}	2.983	0.438^{**}	2.382	0.527^{***}	6.938	-0.402^{**}	−2.038
$\omega \times \ln BEC$	−0.031	0.893	0.532	1.099	0.034^{***}	4.982	0.183^{***}	4.092
$\omega \times \ln URB$	0.209^{***}	3.984	0.201^{***}	3.083	0.184^{***}	3.948	0.302^{**}	2.093
$\omega \times \ln FIN$	-0.109^{***}	5.932	0.037^{***}	−4.983	-0.231^{**}	2.342	0.409^{***}	3.984
ρ	0.536^{***}	11.083	0.484^{***}	8.975	0.652^{***}	7.938	0.746^{***}	10.338
Cons	0.832^{***}	5.931	0.922^{***}	7.392	0.326^{***}	8.478	0.532^{***}	5.624
R^2	0.573		0.71		0.806		0.883	
Wald_spatial_lag	—		92.084^{***}		23.253^{***}		43.265^{***}	
LR_spatial_lag	—		—		—		55.643^{***}	
Wald_spatial_error	—		90.835^{***}		22.321^{***}		43.537^{***}	
LR_spatial_error	—		—		—		54.804^{***}	

EX: $^{*}p < 10\%$, $^{**}p < 5\%$, $^{***}p < 1\%$.

Table 6: Decomposition of spatial Dubin model based on temporal and spatial double fixed effects.

Variable	Direct effect		Indirect effect		Total effect	
	Coefficient	T-value	Coefficient	T-value	Coefficient	T-value
$\ln GDP$	0.504^{***}	7.507	0.319^{**}	5.732	0.826^{***}	4.932
$\ln IND$	0.237^{**}	2.064	0.163^{**}	1.998	0.401^{***}	3.023
$\ln BEC$	0.116^{***}	4.357	0.089^{***}	3.736	0.195^{***}	2.986
$\ln URB$	0.036	0.773	0.083	0.893	0.118	1.023
$\ln FIN$	0.289^{**}	2.753	0.092^{***}	3.062	0.381^{***}	3.248

EX: $^{*}p < 10\%$, $^{**}p < 5\%$, $^{***}p < 1\%$.

not only improved the TFP of resource asset utilization in the province but also have had a positive impact on the neighboring provinces.

6. Discussion and Practice

Based on the time axis, spatial evolution, and time-space effects, this study measures the TFP of resource asset utilization and its improvement and decomposition in provinces of China in the recent decade and draws the following conclusions: (1) There are ineffective improvements in the utilization of rural collective resource assets in all provinces and regions of China, and the unbalanced industrial layout leads to a low utilization intensity of resource assets on the whole, except that the first-tier provinces in eastern China have a higher overall level of intensive utilization of resources and the input redundancy rate is 0. The other ineffective provinces all have high redundancy of human resources, energy, and sewage discharge, and the effect of resource income stagnates and presents a declining trend. Since 2015, the regression speed in northeastern China and the western regions has decreased significantly year by year, whereas, under the impact of a large number of resource assets, authentic right and population migration, social problems, such as aging and hollow village, are still the relatively serious problems restricting the development of rural collective economy in the region. However, thanks to technological progress and larger improvement room for resource utilization efficiency, the advantages of population relocation in western China to develop the characteristic industries have made the TFP improve significantly and show a steady growth trend; the results of the comprehensive analysis of the central region are the least satisfactory. From the perspective of input-output benefits, the input intensity accounts for about 80% of that in the eastern region but with an output per land of only 40%, and the redundancy of sewage discharge is even1.6 times the average in the eastern region. The overall growth rate of all provinces is very slow and small, and it needs to be improved in all aspects of deepening the reform and implementation. (2) Dual management of spatial evaluation and time-space effect is a favorable evaluation system for the effectiveness of constructing strategies for improvement of TFP of rural collective resources asset utilization in China. There are natural attributes of resource utilization, including force majeure, inseparability, and unpredictable dynamics, so that enhancing monitoring its nonlinear dynamics and the emerging characteristic changes shall be considered as the core of spatial dynamic management evaluation. This study selected the state-level Development New Area as crack policy, financing, project implementation level, personnel, supplies, and other barriers to collaboration between the various functional departments, which is typical and practically significant. Statistical results confirmed in decomposition that the indicators of China National Development New Area in improving the TFP of rural collective resources asset utilization have a significant positive spatial correlation, and the spatial agglomeration and spatial spillover effects are increasing year by year; in terms of the improvement of urbanization migration defects, upstream and downstream industry service clusters that break geographical limitations can be built through the internal competition of the spatial benefits of the original rural collective resource assets, gathering and enhancing the strength of characteristic industries to guide collective organization members to relocate, and improving industrial technical efficiency and service level, so as to form a more optimized and complete improvement strategy.

6.1. Implications for Practice. The National Development New Area as a very special organization in China is bearing part of the government's economic and technical industry management functions. While being different from the administrative management functions of the traditional regional government, it focuses on solving the problem of the low spatial and temporal effect of TFP due to the unfair distribution of resource endowments in the original administrative division. Since 1986, various provinces have been successively establishing the China National Development Zones, which has laid a good foundation for the provinces to explore the development strategy of optimizing the layout of modern industrial structures dominated by emerging and high-tech. China National Development New Area is planned to be distributed in the transportation hub areas (a kind of connection) of various provinces, municipalities, and autonomous regions, undertaking important responsibilities such as urban-rural integrated development, opening-up layout, high-tech localization transformation, deepening supply-side reform pilots, and leading the rural revitalization strategies.

Analyzing the standard of economic development, the establishment of Development New Area has promoted the sharing of resources, information, and technology between urban and rural areas, especially increasing the Supporting infrastructure for ensuring people's wellbeing and the public service facilities. Some qualified Development New Area has begun to drive the surrounding villages and towns with conditions to transform into urban, comprehensive functional service areas and construct and improve the "satellite city" (medium and small cities around the big city) belt clusters with improved management mechanisms and development strategies. The improvement of the integration of the rural collective industrial structure in the original area has begun to take shape, which effectively intensifies the use efficiency of land for construction, with the supply volume reaching as high as 87%. At the same time, areas with higher index levels bring a positive spatial spillover effect to more surrounding areas through spatial agglomeration effect and realize the radiation, diffusion, and collaborative sharing level of capital, technology, and other factors.

Analyzing the industrial estate structure, Set 2016, for example, among the research targets, only the total revenue of the high-tech industry exceeded RMB 9.9 trillion. The optimization and upgrading of industrial structure effectively accelerated the optimal and reasonable allocation and flow of resource factors. Scientific and technological progress and the innovation of management mode of resource assets by TFP had a significantly positive influence, which has improved the land factor output level brought by mismatching of information chain and supply chain.

Analyzing economic cooperation, Taking Guangxi and Inner Mongolia as examples, border economies have become the development core of the industrial layout of the rural collective economy in this region, the improvement of trade in agricultural and forestry products and border tourism is conducive to the exchange and improvement of technology, which utilized characteristic business operation to have revitalized the transformation of idle, unused resource assets to useable operational assets.

6.2. Implications for Theory. Especially in the developed regions, the establishment of an integrated public supporting linkage system in the form of urban and rural opening has basically been completed. This "New Area" setup and the development have not only improved the TFP of resource asset utilization across provinces, but also have had a positive impact on the neighboring provinces.

Analyzing the Urbanization process, spatial effects were positive but have not passed the significance test, indicating that a surge of China National Development New Area can effectively promote the rapid urbanization rate, while the population migration and industrial agglomeration thus resulted have high mobility, instability, and unsustainability, and the real and stable agglomeration of manpower and capital cannot be immediately manifested in the early stage of urbanized transformation, which is mainly based on attracting people to migrate for short-term employment. In order to realize the agglomeration of industrial structure optimization with human capital and the positive correlation of it with energy consumption structure, the core of truly improving TFP of resource utilization lies in providing improving guarantee mechanisms. We will effectively solve the problem that the negative effects of energy consumption and pollution increase in the labor importing areas and the economic income dominating the consumption still remain in the original household registration place. The positive spatial spillover benefits can only be generated by simultaneously improving technological progress and technological efficiency.

Analyzing the loan openness of financing guarantee for agriculture, rural areas, and rural residents, in order to effectively avoid the risk of social capital encroachment on the contracted management rights of rural collective land, China's laws have clearly prohibited the establishment of right to mortgage the rural land since the mid-1990s, which has greatly restricted the development of agricultural land financialization and finance for agriculture, rural areas, and rural residents. Since the full implementation of rural collective property and capital verification and land rights confirmation in 2016, financial services have once again entered the countryside and farmland. The provincial finance departments all provided "agriculture, rural areas, and rural residents" with financing guarantee platforms and policy support for medium-small- microsized enterprises, solving the credit dilemma of rural areas and peasants gradually and orderly promoting the impact of farmer's credit access from farmland mortgages on regional economic structure adjustment and the scale expansion of farmland management, to improve the scale preference of rural industrial layout.

7. Improvement Strategies

Based on the analysis of the results of the study, the following improvement strategies are proposed: First, the Local governments should unite with the National Development New Area to build a strategic layout of urban-rural integration such as establishing living quarters along the traffic lines and integrating the layout of administrative villages and natural villages in axial clustering; giving preference to public infrastructure in rural land use; coordinating the development of equal access to public services in urban and rural areas so as to complete the last step of the intangible transformation; balancing the income between urban and rural areas; improving the utilization efficiency of newly added cultivated land and develop large-scale agricultural operations with distinctive features to increase farmers' incomes.

Second, strengthen the effectiveness of the dynamic evaluation system of time-space control and attract the clustering of cross-provincial industry chain service platforms. The government should provide preferential policies and encourage additional social capital investment opportunities for the intensive transformation of special industries. Revitalize the centralized management of industrial land index adjustment in contiguous villages and support the construction of scale-oriented credit systems that do not depend on traditional farmland collateral, such as farmland management credit scoring system, industrial cluster loans, financial supply chain, etc., so as to reduce the potential credit guarantee risk or compensation undertaken by local governments in the pilot reform of farmland mortgage and effectively alleviate the scale preference constraints of small-scale farmers in credit access.

Finally, the government should strengthen the differential control measures of border rural economy. Support the differentiated development of borderland use, make overall plans for policies supporting special use of land, and put an end to the one-size-fits-all border construction land supply policy. Besides, scientifically guide the improvement of socioeconomic supply implementation rules for border security and development according to the progress of local urban function, so that border farmers can participate in the operation and development of foreign cultural value-added services to drive the economic development of the nearby regions.

8. Limitations

Additionally, we should mention some limitations of our study. First, we have not taken into available data about the negative numerical value and zero numerical value into potential contextual factors affecting the units in our measures of performance; thus, a potential extension of the current research could entail the use of a particular model that works with particular data, not using alternative methodological approaches that allow us to include this information such as the Parallel system models proposed. Second, we cannot interpret our results in a single dimension way since it would entail neglecting the potential presence of interactivity in times and space measure (e.g., arising from the sample times selection bias, reversed space causality, or unobserved heterogeneity). It is worth mentioning that we have developed methods to address the issue of unobserved times-heterogeneity and space-endogeneity in our next studies. However, these possibilities exceed the scope of the present paper.

Data Availability

Data used in this study could be accessed by request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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