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중국 강소성 신도시화의 질적향상과 녹색경제효율성의 연계 발전에 관한 연구

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The Coordinated Development of New Urbanization Quality and Green Economy Efficiency in Jiangsu Province

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요 약 본 논문은 2007년부터 2021 년까지 강소성 13개 현급 도시의 패널 데이터를 사용하여 엔트로피 방법, SBM 모델 및 결합조정정도 모델을 채택하여 강소성의 신도시화의 질적향상과 녹색경제효율성의 연계발전관계를 실증분석하였다. 연구결과 연계발전관계는 2008년과 2009년에는 낮은 수준으로 나타났으나, 2010년 이후에는 꾸준히 개선되었으며, 2018년부터 2021년까지는 큰 폭으로 증가하였다. 이후 2021년에 높은 발전을 보여 강소성의 도시화와 녹색경제효율성 간의 연계발전수준이 꾸준히 개선되고 있는 것으로 나타났다. 강소지역의 발전은 전반적으로 건전하고, 상당한 속도로 조정되고 있지만, 지역 간에는 여전히 차이가 있었다.

주제어 신도시화, 녹색경제효율성, SBM 모델, 엔트로피 방법, 연계조정정도

Abstract This article uses panel data of thirteen prefecture-level cities in Jiangsu Province from 2007 to 2021, and adopts entropy method, SBM model, and coupling coordination degree model to empirically study the development level of new model of urbanization and green economic efficiency in Jiangsu Province and the coupling coordination relationship between them. The results show that: the coupling coordination was in a moderate disorder and on the verge of disorder in 2008 and 2009. However, it steadily improved after 2010, and even witnessed a significant increase from 2018 to 2021. After that, it shows a high-quality coordination in 2021, indicating that the level of coordination between urbanization and green economic efficiency in Jiangsu province is steadily improving. Analyzed from a spatial perspective, the overall development of the regions in the province is sound and the coordination is growing at a significant rate, but there are still certain gaps in the coordinated development between the regions.

Key Words New urbanization, Green economy efficiency, SBM model, Entropy method, Coupling coordination degree

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1. Introduction

Since the reform and opening-up, China's urbanization has experienced a period of high growth in pursuit of speed and quantity. Statistics show that by 2022, China's urbanization rate has reached 65.22%, an increase of 47.3% since the reform and opening-up, which shows significant improvement in the level of urbanization. However, the development of traditional urbanization relies mainly on the consumption of resources and energy and attracting a large number of rural people to gather in towns and cities, so the rapid development of urbanization has also generated a series of derivative problems, such as environmental damage and waste of resources, which restrict the sustainable development of cities [1]. The new model of urbanization was first proposed in China in 2002, and gradually became a research hot spot after the Party's 18th National Congress report put forward the four transformations [2]. Decision of the Central Committee of the Communist Party of China on Some Major Issues Concerning Comprehensively Deepening the Reform points out that we should adhere to the new type of urbanization with Chinese characteristics and promote urbanization with people at its core" [3]. It can be seen that urbanization is transforming from the traditional focus on outward expansion to intensive development with improved connotation, and from a simple focus on the speed of development to a focus on the quality of urban development.

The concept of green economy was first proposed by Pearce, a British environmental economist, in 1989. He stated that economic development should not be at the expense of the environment and blind consumption of resources [4]. In the context of the new normal, the green economy, as a new driving force for the overall green transformation of the social economy. emphasizes the core concept of green development and correctly handles the relationship between resource elements, ecological environment and economic development [5]. In the new era, it has become an inevitable trend to reshape traditional industries and economic systems with the concept of green economic development, which is conducive to improving regional environmental quality while injecting new vitality into the construction of new model of urbanization [6,7].

The essence of new model of urbanization is to promote urbanization with scientific development methods and provide a practical carrier for green economic development. Green economy efficiency is the intrinsic driving force of new urbanization. Therefore, the two are interdependent [8]. As a large economic province and one of the first provinces in China to start exploring the new urbanization path, it is to be studied and proven whether its accelerated urbanization process brings waste of resources and damage to the environment in Jiangsu province. The basic principle of "green and low-carbon, intensive and efficient" was put forward in the Fourteenth Five-Year Plan for New Model of Urbanization of Jiangsu Province released in 2021, emphasizing the concept of ecological health in a more prominent position in urbanization development, and comprehensively establishing a balanced matching mechanism between urban construction and development and resources and environment. This principle reinforces the importance of the coordinated development of new model of urbanization and green economy efficiency. However, the evolutionary relationship between the two involves many factors and complex mechanisms. Thus, it has also become a hot spot and a difficult area of research at present.

2. Previous Studies

The current research on the new type of urbanization mainly focus on three aspects. The first aspect is the interpretation of connotations. It focuses on the connotation enhancement of culture, service and spirit, and emphasizes the synergistic development of

urban and rural areas [9]. In this way, the new model of urbanization is people-oriented, pursues intensive, intelligent, green and low-carbon development, and is embedded with Chinese characteristics [10]. The second aspect is the construction of its evaluation system. The single indicator analysis method and the comprehensive indicator analysis method are usually used. The single indicator analysis method is highly characterized and data are easily available, but it is difficult to reflect connotations comprehensively, such as the proportion of urban population [11]. The comprehensive indicator analysis method is a comprehensive evaluation from multiple dimensions, which can more effectively reflect the true level. Although the understanding of intrinsic laws has been deepened and the indicator system has been improved, whether the new model of urbanization can be measured comprehensively and scientifically has become an urgent research issue because its development is a complex system process. Some scholars have defined the connotations of the new model of urbanization and constructed the indicator system. For example, Wang (2020), Zhang (2020), and Li (2022) used the entropy method to calculate the development level of new model of urbanization by objectively assigning weights [12-14]. Liu et al. (2020) selected characteristic indicators from multiple dimensions such as development, population, resources and environment to measure the development level of the new model of urbanization with the help of hierarchical analysis (AHP) and Delphi method [15]. The third aspect is the dynamic mechanism and development model of the new urbanization. The development model of new urbanization is structured in qualitative dimensions such as policies, paths, and countermeasure suggestions [16,17].

The green economy efficiency is a common indicator to evaluate the performance of economic development, which will be based on resources, environment, inputs, outputs and other factors related to the assessment of green economy, which is suitable for the concept of sustainable development [18] and is conducive to promote the green economic development in China. For quantitative research on green economy efficiency, Ramanathan (2006) and Song (2022) measured it by constructing an evaluation system of input-output indicators with the help of data envelopment analysis method (DEA) [19,20]. Wang (2015) analyzed the green economy efficiency using Malmquist index to compare the effect of environmental constraints [21]. Wu (2022) set input and output indicators separately and measured green total factor productivity using C-D production function and stochastic frontier model [22].

On the theoretical basis of new urbanization and green economy, some scholars have turned their attention to the research on the combination of new urbanization and green economic development. For example, Shang (2021) and others examined the impact of new urbanization on green total factor productivity using a systematic GMM model. The results showed that new urbanization can significantly promote green total factor productivity, but negatively affect green technical efficiency [23]. Wang (2018) used the coupled coordination degree model to quantitatively study the level of new urbanization and green economic development in each province in China, analyzing the gap between provinces and making an evaluation [24]. Weng (2021) applied the coordination degree model, a spatial econometric approach and a restricted dependent variable panel Tobit model to study the coupled coordination degree of new urbanization and green economy efficiency and its influencing factors in a sample of 11 prefecture-level cities in Zhejiang Province [25]. To sum up, the respective studies on new urbanization and green economy efficiency have yielded some results, but the current studies on whether and what characteristics of the coordination between new urbanization level and green economy development in time and space are still

immature and need to be further explored.

3. Research Design

3.1 Indicator System and Data Source

This article draws on the experience of Wang (2020) [26] to comprehensively measure the development level of China's new urbanization at six systemic levels: demographic, economic, social, ecological, spatial, and urban-rural integration, and further refines the indicators with reference to Wang (2013) [12] and others. In addition, two indicators of local financial revenue per capita and public library collection per 100 people in the city were added. Then, the entropy method was used to calculate the weight of the information carried by each indicator, so as to minimize the influence brought by subjective factors and provide a basis for comprehensive evaluation of multiple indicators. The traditional measurement of economic efficiency is mostly based on input and output indicators, while in the context of green economy theory, output indicators should not only include the desired economic benefits, but also bear the ecological damage caused by non-desired outputs. Therefore, the author refers to the study of Weng (2021) [25] to take into account non-desired output indicators such as industrial wastewater emissions, industrial smoke (dust) emissions, and industrial sulfur dioxide emissions in addition to input indicators (total social fixed asset investment and the number of employees in the whole society at the end of the year) and desired output indicators (regional GDP). Traditional data envelopment analysis (DEA) methods assess green economy efficiency under the assumption of a monotonic linear relationship between inputs and outputs, and are unable to portray non-desired output terms. So, this article adopts the non-expectation DEA (SBM) model for measurement, which not only avoids the bias caused by radial and angular measures, but also takes into account the influence of non-expectation

〈Table 1〉 Description of New Urbanization and Green Economy Efficiency Indicators

Target layer	System layer	Indicator layer	Unit	Direction
New model of urbanization	Population urbanization	• Share of urban population (V1) • Size of urban population (V2)	% ten thousand	+ +
	Economic urbanization	• GDP per capita (V3) • Ratio of secondary and tertiary industries to GDP (V4) • Local fiscal revenue per capita (V5)	yuan % yuan	+ + +
	Social urbanization	• Share of education expenditure in fiscal expenditure (V6) • Number of beds in medical and health institutions per 1,000 population (V7) • Number of Internet users per 100 people in the city (V8) • Citywide public library collections per 100 people (V9) • Gas penetration rate (V10)	% / % / %	+ + + + +
	Ecological urbanization	• Greening coverage rate of built-up areas (V11) • Park green area per capita (V12) • Pollution-free treatment rate of urban domestic waste(V13) • Urban domestic sewage treatment rate (V14)	% m^2 % %	+ + + +
	Spatial urbanization	• Road area per capita (V15) • Share of built-up areas in urban area (V16)	m^2 %	+ +
	Urban-rural integration	• Comparison of urban and rural residents' consumption (V17) • Ratio of urban residents' per capita disposable income (V18)	/ /	− −
Green economy efficiency	Input	• Total social fixed asset investment (P1) • Employment (P2)	0.1 billion yuan ten thousand people	+ +
	Desired outputs	• Gross regional product (P3)	0.1 billion yuan	+
	Non-desired outputs	• Industrial wastewater emissions (P4) • Sulfur dioxide emissions (P5) • Industrial solid waste generation (P6)	ten thousand tons tons	− − −

output factors in the production process, and better reflect the essence of efficiency evaluation. The data are mainly from public information sources including the Jiangsu Statistical Yearbook (2007-2021) and Jiangsu Statistical Yearbook on Environment (2007-2021).

3.2 Research Design

3.2.1 Measurement of the Development Level of New Urbanization

$$\rho=\min\frac{1-\frac{1}{q}\sum_{i=1}^{q}\frac{s_i^-}{x_{i0}}}{1+\frac{1}{u1+u2}\left(\sum_{r=1}^{u1}\frac{s_r^g}{y_{r0}^g}+\sum_{i=1}^{u2}\frac{s_i^b}{y_{i0}^b}\right)},\quad \begin{cases} x_0=X\lambda+s^- \\ y_0^g=Y^g\lambda-s^g \\ y_0^b=Y^b\lambda+s^b \\ \sum_{i=1}^{n}\lambda_i=1, s^-\geq 0 \end{cases} \quad (3\text{-}2\text{-}2)$$

The study first assumes that the region is i and the indicator is j. Then, P_{ij} denotes the value of the indicator j in the i region. The data is dimensionless and the proportion of sample i under indicator j was calculated. The formula is $P_{ij}''=\frac{P'_{ij}}{\sum_{i=1}^{n}P'_{ij}}$. The entropy value of indicator j was calculated and represented by e_j. The formula is $e_j=-K*\sum_{i=1}^{n}(P''_{ij}*\ln(P_{ij}''))$ $K=\frac{1}{\ln(n)}$ and $0 \leq e_j \leq 1$. The coefficient of variation of the indicator j was defined as C_j, and the formula is $C_j = 1 - e_j$. The larger the coefficient of variation, the greater the weight ω assigned to the indicator in the composite rating. According to $\omega_j=\frac{C_j}{\sum_{j=1}^{m}C_j}$, the development level of new urbanization was calculated by $N_i=\sum_{j=1}^{m}\omega_j P_{ij}$

3.2.2 Measurement of the Level of Green Economy Efficiency

This article draws on the experience of Li (2014) [27], using the SBM model to measure the green economy efficiency of cities. The larger the efficiency value, the higher the green economy efficiency development in China. The author then assumes a production system with n DMUs, each with three factors: inputs, desired outputs and undesired outputs (environmental pollution factors). In the following equation, x, y^g, and y^b represent the inputs, the desired outputs and the undesired outputs of the decision unit. s^-, s^g, and s^b stand for slack vectors for inputs, desired outputs and undesired outputs. λ is the weight vector, and the subscript "0" in the model is the evaluated unit. The objective function value ρ is green economy efficiency, which is strictly monotonically decreasing with respect to s^-, s^g, and s^b. Its value range is between 0 and 1.

3.2.3 Coupling Degree of the Coordination Development of New Urbanization Quality and Green Economy Efficiency

The coupling degree refers to the dynamic correlation between the interaction and influence of the systems to achieve coordinated development, which can reflect the degree of interdependence and mutual constraints between the systems. The index values involved in the model are coupling degree C value, coordination index T value, and coupling coordination degree D value. The equations are listed as follows:

$$C=2\left[\frac{U_1U_2}{(U_1+U_2)^2}\right]^{\frac{1}{2}},(0\leq C\leq 1)\quad \text{Coupling Coordination Degree } D=\sqrt{CT},\ T=\alpha U1+\beta U2 \quad (3\text{-}2\text{-}3)$$

U1 and U2 denote the combined evaluation value of new urbanization and green economy efficiency, respectively. The larger the value of C, the higher the coupling degree, and vice versa. T is the combined development level. This article considers that new urbanization and green economy efficiency interact with each other and have the same status. Therefore, it takes α=β=0.5, so as to further classify the coordination degree level.

4. Empirical Analysis

4.1 Results and Analysis of New Urbanization

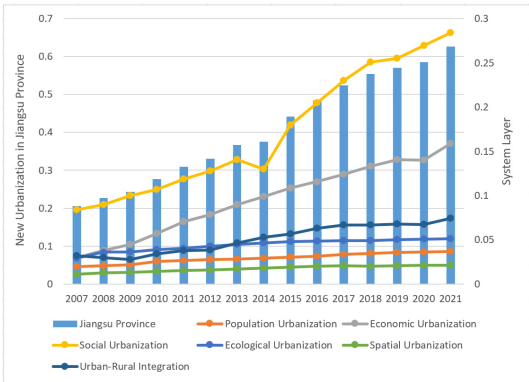
Analyzing at the provincial level, the weights and

rankings of the indicators of new urbanization in Jiangsu province were calculated by the entropy method as shown in Table 2. The top three indicators with the highest ω values were the number of Internet users per 100 people, public library collection per 100 people, and GDP per capita, accounting for 20.78%, 15.05%, and 13.88%, respectively. The bottom three were the ratio of secondary and tertiary industries to GDP, the share of education expenditure in fiscal expenditure, and the gas penetration rate, accounting for 0.09%, 0.1%, and 0.16%, respectively.

Figure 1 shows the comprehensive evaluation value and target system evaluation analysis of new urbanization in Jiangsu Province from 2007 to 2021. The results show that during this 15-year period, the overall development level of new urbanization in Jiangsu Province is positive, demonstrating a general trend of steady increase, with only a short slowdown in 2014. Among them, the rising trend of social urbanization is the most obvious, with the fastest growth rate. But in 2014, there was an inflection point, showing a V-shaped growth, indicating that Jiangsu Province has continuously increased investment in people's livelihood, expanded the supply of basic public services in recent years, and significantly improved the quality of urban functions. Then, the economic urbanization, with an average annual growth rate of 31.06% over 15 years, has been maintaining a steady growth, reflecting the serious implementation of national macroeconomic policies in Jiangsu Province to maintain a balance between stable growth and structural adjustment and achieve speed adjustment without reducing the trend. Urban-rural integration is fluctuating, and the institutional mechanism of urban-rural development integration needs to be improved and perfected. The development speed of spatial urbanization, population urbanization and ecological urbanization is increasing at a smaller rate but the development is slow, which should be further strengthened.

〈Table 2〉 Weighting and Ranking of Indicators of New Urbanization in Jiangsu Province

System layer	Indicator layer	Information entropy value e	Information utility value d	Weighting factor w (%)	Rank
Population urbanization	V1	0.9911	0.0089	3.12	8
	V2	0.9962	0.0038	1.32	13
Economic urbanization	V3	0.9602	0.0398	13.88	3
	V4	0.9997	0.0003	0.09	18
	V5	0.9696	0.0304	10.61	5
Social urbanization	V6	0.9997	0.0003	0.10	17
	V7	0.9633	0.0367	12.80	4
	V8	0.9405	0.0595	20.78	1
	V9	0.9569	0.0431	15.05	2
	V10	0.9996	0.0004	0.16	16
Ecological urbanization	V11	0.9968	0.0032	1.11	15
	V12	0.9959	0.0041	1.44	12
	V13	0.9946	0.0054	1.90	10
	V14	0.9956	0.0044	1.52	11
Spatial urbanization	V15	0.9916	0.0084	2.93	9
	V16	0.9966	0.0034	1.18	14
Urban-rural integration	V17	0.9777	0.0223	7.79	6
	V18	0.9879	0.0121	4.22	7



〈Figure 1〉 Comprehensive Evaluation Value and Target System Evaluation Value of New Urbanization in Jiangsu Province

4.2 Results and Analysis of Green Economy Growth

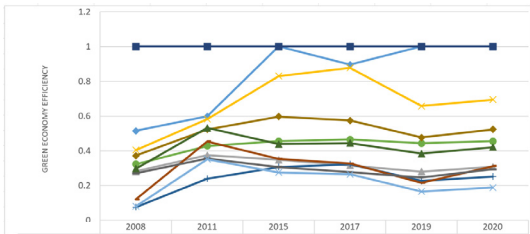
As shown in Table 2, during the period 2007-2021, the average value of green economy efficiency in

Jiangsu Province is 0.91, which is a high average, showing the well development of green economy. The years in which ρ is 1 are: 2019, 2010, 2011, 2014, 2015, 2021, accounting for 42.9%, indicating that the overall input of the province in the above years can be effectively converted into regional GDP, and at the same time can achieve effective control of industrial wastewater, industrial emissions of sulfur dioxide and industrial dust, thus reducing the damage caused to the environment. The year of 2016 has the lowest efficiency value. According to the values of slack variables corresponding to each analysis item listed in the table, it can be analyzed that the efficiency of transforming the inputs of labor and capital indicators into regional GDP in the province in 2016-2020 is low, and the input-output does not reach the most appropriate ratio. Moreover, the emissions of industrial pollutants (industrial wastewater, sulfur dioxide and industrial dust) are excessive, which is not conducive to the sustainable development of the economy and becomes a resistance to the development of the green economy.

〈Table 3〉 Results of Green Economy Growth Efficiency in Jiangsu Province

Year	ρ	s^- P1	s^- P2	s^g P3	s^b P4	s^b P5	s^b P6
2007	1	0	0	0	0	0	0
2008	0.8531	0	0	0	0.0103	0.03	0.0575
2009	1	0	0	0	0	0	0
2010	1	0	0	0	0	0	0
2011	1	0	0	0	0	0	0
2012	0.915	0.0096	0	0	0	0.0113	0.1224
2013	0.901	0	0	0	0	0.0001	0.1662
2014	1	0	0	0	0	0	0
2015	1	0	0	0	0	0	0
2016	0.7919	0.0643	0	0	0.0283	0.1286	0.2222
2017	0.8122	0.129	0.1705	0	0.045	0.0241	0
2018	0.8357	0.1267	0.1295	0	0.0409	0.0445	0
2019	0.8676	0.1236	0.0949	0	0.0256	0.0377	0
2020	0.8315	0.0626	0.1235	0	0.0926	0.0909	0.08
2021	1	0	0	0	0	0	0

In order to better understand the green economy efficiency values among cities in Jiangsu Province, the green economy efficiency values of 13 cities in the province were calculated, and the detailed values of some years were intercepted as shown in Figure 2. The first echelon is Wuxi, Suzhou, and Zhenjiang, and the green economic efficiency value is 1 in 2007, 2008, 2011, 2015, 2017, 2019, and 2021, which represents that the inputs of labor and fixed asset investment can meet the sustainable economic development of these regions in that year, and can efficiently transform these input factors into regional GDP, while conforming to the core concept of green development. The second echelon is Nanjing, Changzhou and Yangzhou, with the average value of efficiency above 0.5, but there is a certain gap with the green economic efficiency of the first echelon. The development concept of the first echelon should be borrowed to adjust the industrial structure and reasonably allocate resources, so that the green economic efficiency can reach the optimal solution. The third echelon is Xuzhou, Nantong, Lianyungang, Taizhou, Suqian, Yancheng, and Huaian, with efficiency values hovering below 0.5 and persistently at a lower level, indicating a certain redundancy of inputs



	2008	2011	2015	2017	2019	2020
NanJing	0.5149	0.5982	1	0.8948	1	1
WuXi	1	1	1	1	1	1
XuZhou	0.2815	0.3739	0.3484	0.3164	0.2802	0.3081
ChangZhou	0.4043	0.583	0.8304	0.8774	0.6577	0.6947
SuZhou	1	1	1	1	1	1
NanTong	0.3229	0.4274	0.4554	0.4643	0.4433	0.4553
LianYunGang	0.0762	0.2396	0.3067	0.3234	0.2265	0.2522
HuaiAn	0.1195	0.4542	0.3523	0.3267	0.2144	0.3114
YanCheng	0.2701	0.3558	0.3069	0.2773	0.2475	0.2938
YangZhou	0.3725	0.5235	0.5964	0.5744	0.4766	0.5228
ZhenJiang	1	1	1	1	1	1
TaiZhou	0.2966	0.5309	0.4384	0.4441	0.3833	0.4203
SuQian	0.0808	0.3521	0.2753	0.2649	0.1662	0.1894

〈Figure 2〉 Green Economy Efficiency Values of 13 Cities in Jiangsu Province (data for selected years during 2007-2021)

in capital, labor, and energy. These cities need to pay attention to transforming development models, vigorously developing new industries, rationalizing resource allocation, and continuously promoting environment-friendly economic development.

4.3 Spatial and Temporal Coupling Analysis of New Urbanization and Green Economy Efficiency

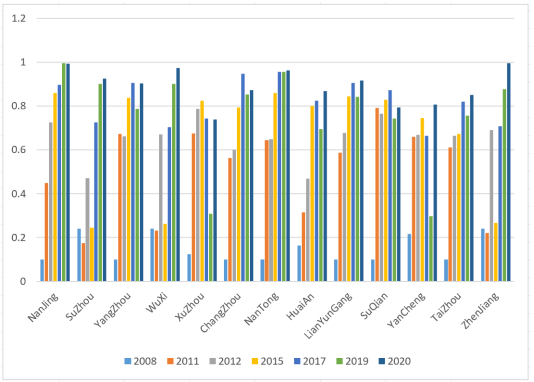
The coupled coordination model is used to evaluate the level of coordinated development between new urbanization and green economy efficiency, which can reflect the strength of interaction and coordination between new urbanization and green economy efficiency in Jiangsu Province. The indicators related to the coupling degree and coupling coordination degree of new urbanization and green economy efficiency in Jiangsu Province from 2007 to 2021 are shown in Table 4. A larger value of the coupling degree C indicates a greater interaction between the two systems. In terms of the coupling degree of the two systems, the new urbanization and green economy efficiency in Jiangsu province have been at a high coupling stage except in 2008, 2009, and 2016. The coupling coordination degree D value is between 0 and 1. The larger the D value, the higher the coordination degree between systems. In terms of coupling coordination, the coupling coordination was in a moderate disorder and on the verge of disorder in 2008 and 2009. However, it steadily improved after 2010, and even witnessed a significant increase from 2018 to 2021. After that, it shows a high-quality coordination in 2021, indicating that the level of coordination between urbanization and green economic efficiency in Jiangsu province is steadily improving. From the spatial perspective, the analysis of the coupled coordination degree of new urbanization and green economy efficiency of 13 prefecture-level cities in Jiangsu was intercepted for some years, as shown in Figure 3. It can be seen that the overall

〈Table 4〉 Analysis of the Coupling Coordination between New Urbanization and Green Economy Efficiency in Jiangsu Province, 2007–2021

Year	Coupling degree C value	Coordination index T value	Coupling coordination degree D value	Degree of coupling coordination
2007	0.199	0.5	0.315	Mild disorder
2008	0.354	0.154	0.234	Moderate disorder
2009	0.463	0.525	0.493	On the verge of disorder
2010	0.627	0.557	0.591	Barely coordinated
2011	0.763	0.601	0.677	Basically coordinated
2012	0.883	0.401	0.595	Barely coordinated
2013	0.963	0.412	0.63	Basically coordinated
2014	0.693	0.575	0.631	Basically coordinated
2015	0.943	0.743	0.837	Well coordinated
2016	0.257	0.298	0.277	Moderate Disorder
2017	0.671	0.409	0.524	Barely coordinated
2018	0.804	0.533	0.655	Basically coordinated
2019	0.926	0.588	0.738	Mildly coordinated
2020	0.774	0.535	0.644	Basically coordinated
2021	1	0.99	0.995	Excellently coordinated

development of the municipalities is improving, and the coordination is growing at a significant rate, but there is still a certain gap between the coordinated development of the cities in the province. The five cities of Nanjing, Suzhou, Nantong, Wuxi, and Zhenjiang show a high and stable upward trend of coupling new urbanization and green economy efficiency in 2017, 2019, and 2020, while Xuzhou, Huai'an, Yancheng have low Well-coordinated degrees of coordination. The volatility is great and the coordination has not yet reached a stable state. In terms of geographical distribution, there is a high level of coupled development in the southern cities and a low level of coupled development in the northern cities. Therefore, the northern cities should develop strategies according to their own characteristics and adhere to economic growth transformation and industrial structure adjustment. Southern cities with a relatively strong economy should strengthen ecological and environmental management and improve sustainability,

so as to have a higher level of coupled and coordinated development.



〈Figure 3〉 Analysis of the Coupling and Coordination of New Urbanization and Green Economy Efficiency in 13 Prefecture-level Cities in Jiangsu Province

5. Conclusion

By constructing the index system of new urbanization and green economy efficiency, the entropy method, non-expectation DEA model and coupled coordination model are applied to measure the comprehensive development index and coordinated development level of new urbanization and green economy efficiency in Jiangsu Province from 2007 to 2021. Then, their spatial and temporal distribution characteristics are analyzed. It should be noted that the evaluation of the degree of coordination is a dynamic and comprehensive process, and there are many factors influencing the design. The conclusions of this article are only indicative based on currently available economic and social data.

First, during the period 2007-2021, the overall development level of new urbanization in Jiangsu Province was positive, showing a general trend of steady increase, with only a short slowdown in 2014. Among them, social urbanization has the highest contribution rate and the most obvious upward trend. This is followed by economic urbanization, which has been maintaining a steady growth. Urban-rural integration takes 2016 as the node, and the development rate gradually slows down. While spatial urbanization, population urbanization, and ecological urbanization develop at a smaller growth rate and develop slowly.

Second, from 2007 to 2021, the average value of green economy efficiency in Jiangsu Province is 0.91, which is a high average value, showing the well developed green economy. However, the province's input and output did not reach the most appropriate ratio in 2016-2020, and the excessive emissions of industrial pollutants became a resistance to the development of green economy. There are also some differences in the development of green economy among cities. The three cities with better development are Wuxi, Suzhou and Zhenjiang, followed by Nanjing, Changzhou and Yangzhou. Cities with the lower level of development are Xuzhou, Nantong, Lianyungang, Taizhou, Suqian, Yancheng, and Huaian, with efficiency values hovering below 0.5 and continuing at a lower level.

Third, except for 2008, 2009 and 2016, the efficiency of new urbanization and green economy in Jiangsu Province has been in a high coupling stage. The coupling coordination was in a moderate disorder and on the verge of disorder in 2008 and 2009. However, it steadily improved after 2010, and even witnessed a significant increase from 2018 to 2021. After that, it shows a high-quality coordination in 2021, indicating that the level of coordination between urbanization and green economic efficiency in Jiangsu province is steadily improving. In terms of geographical distribution, there is a high level of coupled development in the southern cities and a low level of coupled development in the northern cities.

In this paper, the coupled coordination degree model is adopted to analyze the two systems of new urbanization and green economy efficiency in time and space. However, this paper only analyzes it from a

macroscopic point of view, without further exploring its internal mechanism. On the basis of this paper, the driving forces affecting the coordinated development of new urbanization and green economy efficiency in Jiangsu will be further explored from the perspective of econometric analysis, which will also be an important content of future research.

References

[1] Cai Ning et al. Green development and new urbanization in China - a two-dimensional study based on SBM-DDF model [J]. Journal of Beijing Normal University (Social Science Edition), 2014, No. 245 (05): 130-139.
DOI:10.3760/cma.j.issn.1674-2907.2014.02.021

[2] Li Chenghua. New urbanization strategy under the guidance of scientific development concept [J]. The Truth Monthly, 2012 (14): 35-37.
DOI: CNKI:SUN:QUSI.0.2012-14-013

[3] Decision of the Central Committee of the Communist Party of China on Some Major Issues Concerning Comprehensively Deepening the Reform: http://www.gov.cn/jrzg/2013-11/15/content_2528179.htm

[4] Prieels Anne-Marie. Blueprint for a green economy: David Pearce, Anil Markandya and Ed. B. Barbier 185 pages, Â£6.95 (London, Earthscan, 1989)[J]. Futures, 1990, 22(4) : 436-439.
DOI : 10.1016/0016-3287(90)90055-M

[5] Liu Ru et al. Local government competition, industrial agglomeration and regional green development efficiency: an analysis based on spatial correlation and spillover perspective [J]. Inquiry into Economic Issues, 2022(01): 79-91.

[6] Ma Jun, Zhou Panchao. Study on the spatial effect of industrial upgrading on enhancing ecological efficiency of Yangtze River Economic Belt [J]. Journal of Nanjing University of Technology (Social Science Edition), 2020, 19(02): 73-88+112.
DOI:10.3969/j.issn.1671-7287.2020.02.009.

[7] Xi Jinping. Secure a Decisive Victory in Building a Moderately Prosperous Society in All Respects and Strive for the Great Success of Socialism with Chinese Characteristics in the New Era - A Report at the 19th National Congress of the Communist Party of China [J]. China Human Resources and Social Security, 2017 (11): 6-23.

[8] Wang Yaping, Cheng Yu, Ren Jianlan. The impact of urbanization on the efficiency of green economy [J]. Urban Problems, 2017 (8): 59-66.
DOI : CNKI:SUN:CSWT.0.2017-08-008

[9] Sun Zhenhua. The dynamic mechanism of new urbanization development and its spatial effect [D]. Dalian: Northeast University of Finance and Economics, 2014.
DOI : CNKI:CDMD:1.1015.565832

[10] Zhang Zancang. Theoretical confusion and innovative directions of new urbanization in China [J]. Journal of Management, 2014, 27(01): 27-33.
DOI: 10.3969/j.issn.1674-6511.2014.01.005

[11] Wang Fang. A comparison of urbanization in China and other developing countries [J]. Population and Development,2021, 27(02): 29-38+64.

[12] Wang Fuxi et al. Measurements of urbanization quality and analysis of spatial differences in Shandong Province based on entropy value method [J]. Journal of Geographical Sciences, 2013, 33(11): 1323-1329.
DOI : CNKI:SUN:DLKX.0.2013-11-006

[13] Zhang Xiaohan et al. Analysis of the coordinated development of new urbanization and industrial structure in Jiangsu Province [J]. Journal of Nanjing Normal University (Natural Science Edition), 2020, 43(03): 91-98.
DOI: 10.3969/j.issn.1001-4616.2020.03.015

[14] Li Yali. Research on the mechanism and effect of new urbanization construction on carbon emission [D]. Jiangxi University of Finance and Economics, 2022.
DOI:10.27175/d.cnki.gjxcu.2022.000459.

[15] Liu Y, Zhang F, Zhang Y. Appraisal of typical rural

development models during rapid urbanization in the eastern coastal region of China [J]. Journal of Geographical Sciences, 2009, 19(5): 557-567.
DOI : 10.1007/s11442-009-0557-3

[16] Duan Longlong. Synergistic development path of new urbanization and rural revitalization: a reverse urbanization perspective [J]. Modern Economic Discussion, 2021 (5): 10-16.
DOI: 10.3969/j.issn.1009-2382.2021.05.003

[17] Gao Zhe et al. Implications of new infrastructure for industrial transformation in the scenarios of new urbanization and rural revitalization [J]. Economic Geography, 2021, 41(4): 8-14.
DOI: 10.15957/j.cnki.jjdl.2021.04.002

[18] Ding Yulong. A study on the influence of city size on green economic efficiency and its spatial effect - an empirical analysis based on data from 285 prefecture-level and above cities in China [J]. Urban Issues, 2021(12): 58-68.
DOI: 10.13239/j.bjsshkxy.cswt.211207

[19] Ramanathan R. A multi-factor efficiency perspective to the relationship among world GDP, energy consumption and carbon dioxide emissions. Technological Forecasting & Social Change, 2006, 73 (5): 483-494.
DOI : 10.1016/j.techfore.2005.06.012

[20] Song Jinzhao et al. A spatial and temporal coupling study of new urbanization, industrial structure upgrading and green economic efficiency in the Yellow River Basin [J]. Soft Science, 2022, 36(10): 101-108.
DOI: 10.13956/j.ss.1001-8409.2022.10.14

[21] Wang Xiaoyun et al. Measurement and decomposition of green economic efficiency under environmental constraints - a case study of prefecture-level cities in Gansu Province [J]. Productivity Research, 2015(05): 61-66.
DOI : CNKI:SUN:SCLY.0.2015-05-015

[22] Wu Yiqing et al. Evaluation of green development of China's provincial economy - based on the perspective of green total factor productivity [J]. Journal of Hebei University of Economics and Business, 2022, 43(01): 67-81.

[23] Shang Juan et al. The impact of new urbanization on green total factor productivity [J]. Statistics and Decision Making, 2021, 37(05): 116-119.
DOI:10.13546/j.cnki.tjyjc.2021.05.025.

[24] Wang Xiaobin. Measurement of the level of coupled and coordinated development of new urbanization and green economy [J]. Business and Economic Research, 2018, No.755(16): 182-184.
DOI: 10.3969/j.issn.1002-5863.2018.16.053

[25] Weng Yijing et al. A study on the coordination degree of new urbanization and green economy efficiency in Zhejiang Province - based on the perspective of Two Mountain Theory [J]. East China Economic Management, 2021, 35(06): 100-108.
DOI:10.19629/j.cnki.34-1014/f.201203011.

[26] Wang Fang, Tian Minghua, Qin Guowei. Coupling, coordination and optimization of new urbanization and industrial structure upgrading [J]. East China Economic Management, 2020, 34(03): 59-68.
DOI:10.19629/j.cnki.34-1014/f.190926005.

[27] Hong Li, Jin-feng Shi. Energy efficiency analysis on Chinese industrial sectors: an improved Super-SBM model with undesirable outputs [J]. Journal of Cleaner Production, 2014, 65.
DOI : 10.1016/j.jclepro.2013.09.035

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