Coupling Coordination Degree Between Financial Ecological Environment and New Urbanization in Jiangsu Province with an Approach to AI Quantization

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Abstract—The coupling coordination of the financial ecological environment and new urbanization moves through the following stages. Firstly, new urbanization needs financial support to promote infrastructure construction. Traditional financial tools need to be innovated with new urbanization development to promote the new urbanization process. The two systems are being advanced through continuous promotion together. In 2014, Jiangsu Province was awarded a pilot for new urbanization in China by exploring standardized and innovative methods to develop new urbanization.
This paper constructs index systems for Jiangsu Province's new urbanization and financial ecological environment and calculates the comprehensive index, coupling degree, coordination degree, and coupling coordination degree from 2011 to 2020. The results indicate that the coupling degree grew rapidly from 2011 to 2013 and fluctuated at a high level, while the coordination degree rose steadily. By the end of 2020, the coupling coordination degree reached a high-level stage.

Keywords-component; Jiangsu province; new urbanization; financial ecological environment; coupling coordination

1 INTRODUCTION

China's rapid urbanization has achieved remarkable results in the past three decades. At the end of 2014, China's urbanization rate was about 54.77%, if measured by the percentage of the non-agricultural population of the total population. However, the urbanization quality in some areas was poor. Public services cannot keep up with population urbanization, leading to some people cannot take advantage of urbanization. To solve these, Premier Keqiang Li proposed a new type of urbanization before issuing the "National New Urbanization Plan (2014-2020)" in 2014. And Jiangsu Province has become a pilot in new urbanization since 2015.

The financial ecological environment introduces the ecosystem into traditional financial theory. Most scholars agree that the financial ecological system includes financial subjects and their ecological environment, with the environment representing external conditions affecting financial subjects. In terms of evaluation, researchers mainly construct index systems from the four aspects, including the economy, law, credit, and government services.

Many scholars have investigated how financial development supports urbanization. Wellman K and Pretorius F (2012) emphasized the importance of financing and empirically analyzed the efficiency of different financing forms in urbanization [1]. Buckley M and Hanieh A (2014)

FFIT 2022, October 28-30, Shenzhen, People's Republic of China

DOI 10.4108/eai.28-10-2022.2328442

explored the relationship between urbanization and the bank credit system in Arab regions, concluding that they are mutually reinforcing [2]. Financial agglomeration is also an essential factor in urbanization (C.Ye & C.Sun, 2018)[3]. In this research, the coupling coordination model is used to measure how two or more systems interact (J. Wang, Y. Lin, A. Glendinning & Y. Xu, 2018)[4].

2 MATERIALS AND METHODS

2.1 Indexes System of financial ecological environment

Table 2 shows 4 primary and 12 secondary indicators in the financial ecological environment index system.

A high-quality economy can facilitate financial development, and a higher GDP represents more opportunities. The proportion of primary and tertiary industries reflects the condition of a region's industrial structure and economic potential. The tertiary industry is considered a positive indicator with a higher investment return, while the primary industry is a negative indicator. The aggregate trade value is also a positive indicator measuring the openness of the regional economy. As the driving force for economic growth, consumer demand makes the total retail sales of consumer goods a positive indicator. The loan balance of financial institutions/ GDP and insurance penetration measure the relative scale of the financial industry, and capital raising from the stock market/ GDP reflects the efficiency. The bad-loan ratio measures the legal environment, representing the lack of a credit system and related policies; the illiterate population as a percentage of the people aged 15 and above shows the educational level; the tax revenue as a proportion of the fiscal revenue and Fiscal expenditure/ GDP represents the government involvement. They are all negative indicators.

2.2 Indexes System of new urbanization

There are 4 primary indicators and 13 secondary indicators in the financial ecological environment index system, shown in Table 3.

GDP per capita and urban disposable income per capita are positive indicators chosen to measure a region's comprehensive economic development. The Engel coefficient, considered a reverse indicator examines residents' consumption levels. A Higher Engel coefficient always leads to more food consumption and lower other consumption. Permanent urban residential proportion indicates population urbanization; the employee ratio in the tertiary industry examines the amount of rural surplus labor. They are positive indicators. But the urban unemployment rate is a negative indicator related to the unemployment situation.

The urban built-up area is the non-agricultural production; urban population density and urban road area per capita are chosen to measure urban density. They are all positive indicators.

There are four secondary indicators under social urbanization. The urban-rural per capita disposable income ratio is a negative indicator, measuring whether the development of urban and rural areas is harmonic. The number of public transport vehicles reflects the infrastructure condition; the number of health technicians reflects the convenience of medical services; the urban green space per capita reflects whether the city is livable. These three are positive indicators.

2.3 Coupling coordination degree model

The data used to calculate the weights are collected from the wind database, Jiangsu financial operation report, Jiangsu national economic report, Jiangsu Statistics bureau, and Jiangsu statistical Yearbook.

Step 1. To render the results comparable and eliminate the impact of dimension, we standardize the indicators:

For positive indicators:

$$X_{ij}\text{'}=\frac{\mathrm{X_{ij}}-\min(\mathrm{X_{ij}})}{\max(\mathrm{X_{ij}})-\min(\mathrm{X_{ij}})} \quad (1)$$

For negative indicators:

$$X_{ij}\text{'}=\frac{max(X_{ij})-X_{ij}}{max(X_{ij})-min(X_{ij})} \quad (2)$$

Step 2. The entropy method is used to calculate the weights of indicators. It was first introduced by Shannon (1948) to describe the uncertainty of an information source. Indicators providing useful information will have a high weight (He, S, Yu, S, Li, G, and Zhang, J)[5]. We calculate the weights as follows:

Proportion (P_{ij}) of X_{ij}:

$$Pij=\frac{X_{ij}}{\sum_{i=1}^{n} X_{ij}} \quad (3)$$

Entropy (e_{ij}) of indicator j:

$$e_{ij}= -k * \sum_{i=1}^{n} P_{ij} log \ \ (P_{ij}) \quad (4)$$

Entropy redundancy (g_j) of indicator j:

$$g_j=i\text{-}e_j \quad (5)$$

Weight (W_{ij}) of indicator j :

$$W_{ij}=\frac{g_i}{\sum_{j=1}^{m} g_i}, \text{ j=1, 2, …m} \quad (6)$$

Step 3. Comprehensive index (U) of the subsystem in the year i:

$$U=\sum_{j=1}^{m} W_{ij} * P_{ij} \ (i=1,2,...n) \quad (7)$$

The comprehensive index of new urbanization is U_1, and the comprehensive index of the financial ecological environment is U_2.

Step 4. The coupling degree, coordination degree, coupling coordination degree are calculated as follows:

The formula of coupling degree is $C = (U_1 * U_2 \dots \dots U_n)/\left[\prod(U_i + U_j)\right]^{1/n}$. We assume that each subsystem is equally important, so $\alpha = \beta = 0.5$.

The formula of coupling degree:

$$C = 2[(U_1 * U_2)/[(U_1 + U_2)^2]^{1/2} \quad (8)$$

The formula of coordination degree:

$$T = \alpha U_1 + \beta U_2, \ \alpha = \beta = 0.5 \quad (9)$$

The formula of coupling coordination degree

$$D = (C \times T)^{1/2} \quad (10)$$

3 ANALYSIS

3.1 Research framework

The study takes the interaction between new urbanization and financial ecological system as the objects, focusing on three main problems: (1) Indexes System of financial ecological environment and new urbanization (2) Coupling degree, coordination degree, and coupling coordination degree between two systems (3) Key influencing aspects on the interaction between two systems. First, the paper constructs index systems and provides detailed indicators for the two systems. Second, the coupling coordination model is used to calculate the coupling coordination degree. Third, by analyzing the model results, The paper reveals the interaction between the two systems in Jiangsu province.

3.2 Model result

Weights of different indicators are calculated by the formula (1) - (6) and are shown in Table 1 and 2. The comprehensive index of new urbanization and financial ecological environment, coupling degree, coordination degree, and coupling coordination degree are calculated by the formula (7) - (10) and are shown in Table 3.

Table 1 Index system of financial ecological environment

System	Primary indicator	Secondary indicator	Indicator direction	Weights of secondary indicator	Weights of primary indicator
Financial ecological environment	Economy elements	GDP	positive	7.56%	0.38
		The percentage of the output value of the primary industry to GDP	negative	9.18%	
		The percentage of the output value of the tertiary industry to GDP	positive	5.95%	
		The aggregate trade value	positive	7.97%	
		The total retail sales of consumer goods	positive	6.86%	
	Finance elements	Loan balance of financial institution/ GDP	positive	8.60%	0.31
		Insurance penetration	positive	12.45%	
		Capital raising from	positive	10.25%	

		stock market/ GDP			
	Credit elements	Bad-loan ratio	negative	11.73%	
		Illiterate population as a proportion of the population aged 15 and above	negative	8.38%	0.20
	Government elements	Tax revenue as a proportion of the fiscal revenue	negative	6.36%	0.11
		Fiscal expenditure/ GDP	negative	4.70%	

Table 2 Index system of new urbanization

system	Primary indicator	Secondary indicator	Indicator direction	Weights of secondary indicator	Weights of primary indicator
new urbanization	Economic urbanization	GDP per capita	positive	8.08%	0.24
		Urban disposable income per capita	positive	7.16%	
		Engel coefficient of urban residents	negative	8.49%	
	Population urbanization	Proportion of permanent urban residents	positive	7.13%	0.23
		Proportion of tertiary industry employees	positive	9.35%	
		Urban unemployment rate	negative	6.35%	
	Spatial urbanization	Growth rate of urban built-up area	positive	6.62%	0.27
		Urban road area per capita	positive	5.94%	
		Urban population density	positive	14.68%	
	Social urbanization	Urban and rural per capita disposable income ratio	negative	4.84%	0.26
		Number of public transport / 10 thousand people	positive	7.75%	
		Number of health technicians / 10 thousand people	positive	7.45%	
		Urban green space per capita	positive	6.16%	

Table 3 Index system of new urbanization

	Comprehensive index of new urbanization	Comprehensive index of financial ecological environment	Coupling degree	Coordination degree	Coupling coordination degree
2011	0.05	0.27	0.74	0.16	0.35
2012	0.09	0.24	0.90	0.17	0.39

2013	0.23	0.25	1.00	0.24	0.49
2014	0.36	0.28	0.99	0.32	0.56
2015	0.48	0.33	0.98	0.41	0.63
2016	0.58	0.50	1.00	0.54	0.73
2017	0.70	0.63	1.00	0.66	0.81
2018	0.79	0.60	0.99	0.70	0.83
2019	0.86	0.65	0.99	0.75	0.86
2020	0.90	0.87	1.00	0.88	0.94

3.3 Stages of coupling, coordination and coupling coordination

Table 4 and 5 show the coupling and coordination degrees in different stages.

Table 4 Stages of coupling degree

Coupling degree C	Stages
$0<C\leq0.3$	Low coupling
$0.3<C\leq0.5$	Basic coupling
$0.5<C\leq0.8$	Moderate coupling
$0.8<C\leq1$	High coupling

Table 5 Stages of coupling coordination degree

Coupling coordination degree D	Stages
$0<D\leq0.3$	Serious imbalance
$0.3<D\leq0.5$	Basic coupling coordination
$0.5<D\leq0.8$	Moderate coupling coordination
$0.8<D\leq1$	High coupling coordination

3.4 Study area

Jiangsu is a provincial administrative region of the People's Republic of China, located on the eastern coast of mainland China. Jiangsu has a total area of 107,200 square kilometers and a resident population of 85,054,000 in 2021. The overall competitiveness of Jiangsu's provincial economy is among the highest in China, the scale of actual foreign investment is the highest in China, and the GDP per capita has been the highest in China since 2009. Therefore, Jiangsu was selected as one of the pilot cities for new urbanization.

3.5 Analysis

From figure 2, the coupling coordination between new urbanization and the financial ecological environment rose gradually from 2011 to 2020 and reached a high-level coupling coordination stage by 2020. Their coupling degree grew rapidly from 2011 to 2013 and fluctuated at a high level, while the coordination degree increased steadily.

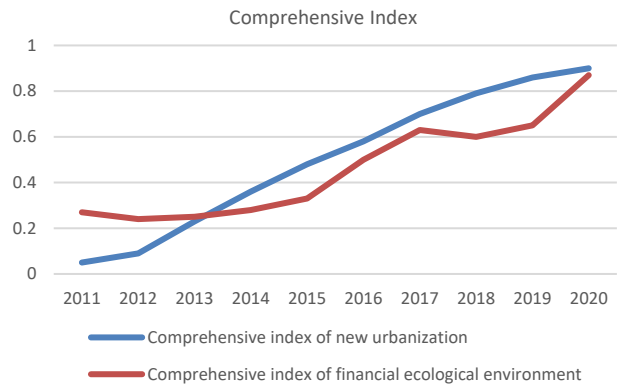

Figure 1. The comprehensive index of new urbanization and financial ecological environment

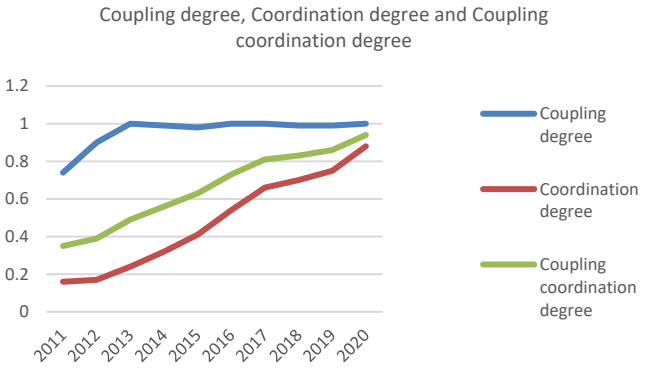

Figure 2. Coupling degree, Coordination degree, and Coupling coordination degree

From figure 1, the comprehensive index of the new urbanization grew steadily while that of the financial ecological environment fluctuated on the rise.

2011 to 2012 is a basic coupling coordination period, and indexes increase slightly. During this period, the index of the financial ecological environment in Jiangsu Province was higher than that of new urbanization, since it could support the new urbanization development. Also, illiteracy is relatively low among the population aged 15 and above, and the non-performing loan is infrequent.

From 2012 to 2013, the coordination degree between the two systems began to rise, the coupling degree slowed down, and the coupling coordination degree accelerated. In 2013, the comprehensive index of new urbanization caught up with that of the financial ecological environment. The financial ecosystem continued to support new urbanization, but its growth rate slowed down while new urbanization has entered a rapid development period. By 2013, their coupling coordination degree reached basic coupling coordination.

In 2013, the Jiangsu government proposed the construction of new urbanization, such as the developing of Yancheng, Nantong, and Lianyungang and strengthening ecological protection in coastal areas. They also generated financial support for urbanization development.

From 2014 to 2017, the coupling coordination degree of the two systems was moderate, and both the new urbanization and financial ecological environment developed rapidly.

At the end of 2014, the China government awarded Jiangsu Province as a pilot city for new urbanization. Jiangsu Province issued a series of documents to promote new urbanization, such as reducing the unemployment rate, providing schools for children, increasing health services, and improving social security. The government prepared to build a quick and convenient transportation network between cities and suburbs. There are also the blue sky project, the clean water project, and the green space project. The financial system was also advanced, such as improving the fiscal transfer payment system, financing for urban and rural construction, and developing a financial system that integrates urban and rural areas.

From 2017 to 2019, the development of the financial ecological environment became relatively slow. The bad-loan ratio increased, and the insurance penetration decreased. However, the new urbanization developed rapidly during this term.

At the end of 2019, the government gradually introduced a credit system to reward trustworthy behavior. Because of the Covid-19 epidemic, the unemployment rate rose, and economic growth slowed down. In 2020, the Nanjing Branch of the People's Bank of China announced ten measures to ensure the stable employment of enterprises.

In 2020, the development of new urbanization and the financial ecological environment started to increase; the coordination and coupling coordination between the two systems resume the growth rate of previous years.

4 CONCLUSION

The results indicated that the coupling degree grew rapidly from 2011 to 2013 and fluctuated at a high level. By 2020, the coupling coordination degree reached a high-level stage, meaning the financial ecological environment and new urbanization both positively affect each other. During this period, Jiangsu issued some policies to improve the coupling coordination degree between the two systems which provide valuable experience for the urbanization of other cities. Therefore, it is essential for the related government agencies to pay attention to the coupling coordination degree and the important influencing factors.

Further work is needed in at least two aspects. Firstly, the method of Jiangsu province to integrate new urbanization and financial ecological system is adjusted to Jiangsu province. So it is necessary to discuss which methods could be used in other provinces. Secondly, some cities with distinctive development models may be needed to be explored in the future.

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