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Research on the Coordinated Development of Xiamen Port and Xiamen City Economy

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Abstract

The coordinated development between port logistics and the urban economy is an objective reality. The two rely on each other and support each other. This article takes Xiamen Port and Xiamen City as an example. By citing the synergy theory, a synergy evaluation model of the two is built, and a quantitative analysis of the synergy between the two is made. It is found that in the process of continuous improvement of the synergy between the two The improvement of logistics service capacity has a stimulating effect on the development of urban economy, and the development of urban economy also provides a strong resource support for port logistics, which can objectively improve the development level of port logistics. Therefore, the coordinated development between port logistics and urban economy deserves attention.

Keywords

Port logistics; Urban economy; Order parameters; Synergy.

1. Introduction

The port is an important transportation hub and commodity trade distribution center. Port logistics strengthens the commercial and trade links between the port city and domestic and foreign countries. It is an important port for achieving domestic and international commodity distribution, accelerating the flow of various commodities, and promoting the economic development of the port city. The development of port logistics drives the flow and collection of talents and information, enhances the port city's ability to radiate and drive the surrounding areas, is conducive to the formation of related industrial clusters, and becomes the growth pole of port city economic development. The development of the port city economy can provide capital, technology and talent support for the development of port logistics, promote the continuous upgrading of port infrastructure, enhance the comprehensive service level and attractiveness of the port, and promote the continuous development of the port in the direction of modernization . Today, the port logistics and the port city economy have formed an interdependent and mutually supporting development pattern, and the coordinated development of the two has also become an effective means to promote the rapid development of the port city economy and the surrounding regional economy.

As the largest port on the west coast of the Taiwan Strait, Xiamen Port has become an important trade hub port connecting inland and overseas due to Xiamen's strong economic strength and the developed distribution network system inside and outside the port. Nowadays, with the increasingly sophisticated port logistics infrastructure and increasingly powerful comprehensive logistics service capabilities of Xiamen Port, the strong radiation capability and industrial agglomeration capability of Xiamen City are constantly being highlighted. An important foundation for development. Based on the application of the synergy theory and the selection of relevant order parameters, this paper will

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build an evaluation model of Xiamen Port Logistics and Xiamen City's coordinated economic development, and conduct an empirical study on the change trend of the synergy between the two.

2. Introduction to Xiamen Port

Xiamen Port is one of the main coastal ports in China, an important hub of China's comprehensive transportation system, a container trunk port, a cruise port, a main carrier of Xiamen Southeast International Shipping Center, and an important port for cross-strait exchanges. It is the four major nationally determined ports. One of the international shipping centers and four pilot cruise port demonstration ports. Xiamen was selected as a port-type national logistics hub construction list, highlighting the important position of Xiamen Port in the national economic development. For three consecutive years, the container throughput exceeded 10 million TEUs, surpassing Kaohsiung Port, ranking 14th in the world and setting the best record in history.

Xiamen Port is located in Xiamen City, Fujian Province. It is an important central city, port and scenic tourist city on the southeast coast. The city vigorously develops various service industries such as headquarters economy, brand economy, cruise business, information service industry and port business logistics. Promote the economic development of the province. The gross domestic product (GDP) of Xiamen in 2019 is 599.504 billion yuan.

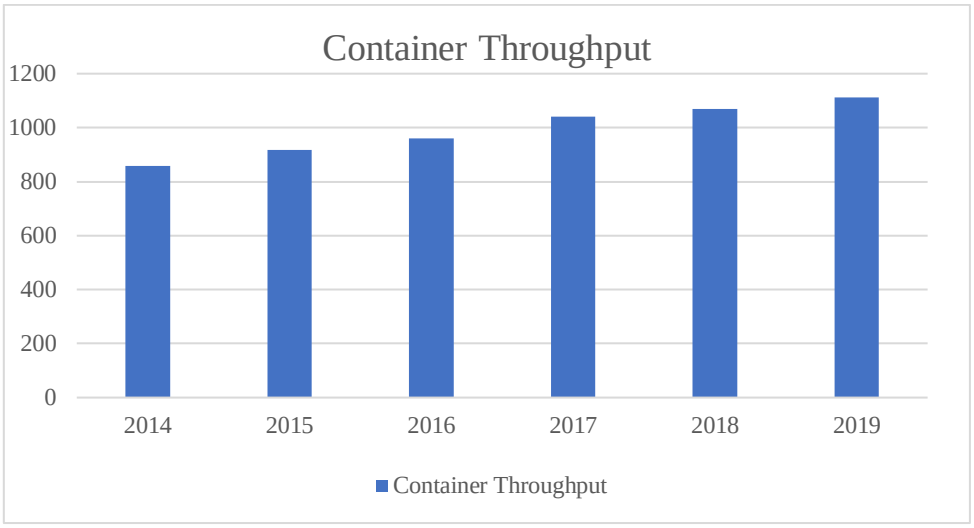

Figure 1. Xiamen Port Container Throughput (2014-2019) (Unit: Ten Thousand TEU)

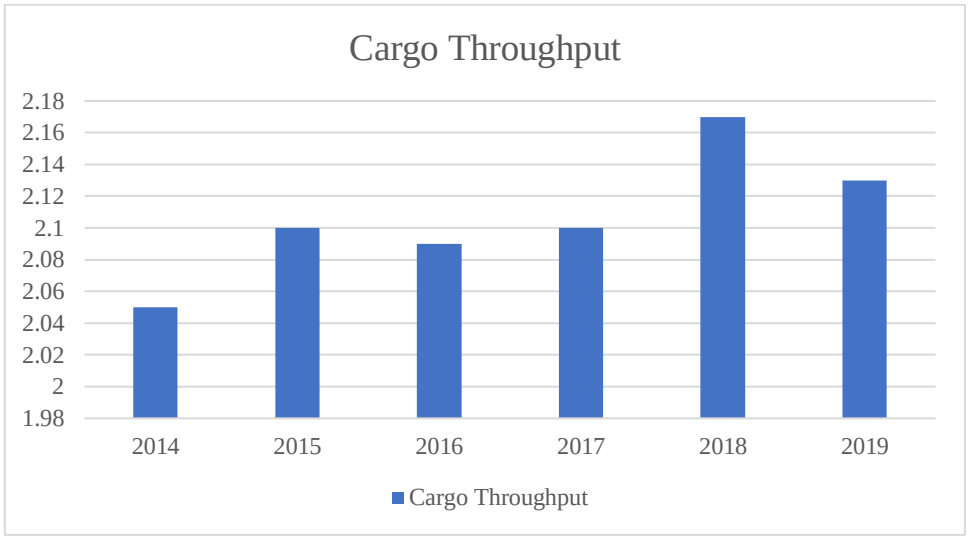

Figure 2. Xiamen Port Cargo Throughput (2014-2019) (Unit: 100 million tons)

ISSN: 2414-1895 DOI: 10.6919/ICJE.202009_6(9).0033

3. Determine the evaluation index system of synergy

3.1 Brief introduction to the theory of synergetic

The synergy theory was proposed by the German physics professor Haken in 1969. The core idea of the theory refers to a system composed of multiple subsystems. Under certain conditions, the subsystems influence and cooperate with each other to achieve the best overall effect. The synergy theory mainly studies the dynamic development law among the order parameters in the system. Synergy theory believes that the evolution of each system is affected by the order parameters, and the degree of order and the final result of the system evolution depends on the order parameters. As the external conditions change, the order parameters corresponding to the system will also change. When the value of the order parameter reaches the critical point, the value of the order parameter of the system increases to the limit, and the organizational structure of the system will change from the macro It becomes absolutely orderly.

3.2 Constructing the evaluation index system of synergy

The relevant statistical data selected in this model are all from the "Statistical Bulletin of Xiamen's National Economic and Social Development" from 2011 to 2019. This paper selects two first-level indicators of port logistics indicators and urban economic indicators as subsystems by referring to the research model of relevant literature, and selects four port cargo throughput, container throughput, operating income level, 10,000-ton berths for production, etc. The indicators are used as the sequence parameters of the port logistics subsystem, and six indicators, such as regional GDP, local general public budget revenue, total retail sales of social consumer goods, total imports and exports of the city, total investment in fixed assets of the whole society, and disposable income of urban residents, are selected as indicators The order parameters of the urban economic subsystem. The specific synergy evaluation indicators are shown in Table 1.

Table 1. Evaluation index system of synergy between port logistics and urban economy

Subsystem	Order parameter	Contribution of system sequence parameters
Port logistics indicators	Port cargo throughput/100 million tons X_{11}	X_{11}
	Container throughput/10,000 TEU X_{12}	X_{12}
	Operating income level X_{13}	X_{13}
	Number of 10,000-ton berths per production X_{14}	X_{14}
Urban economic index	Regional GDP/100 million RMB X_{21}	X_{21}
	Local general public budget revenue/100 million RMB X_{22}	X_{22}
	Total retail sales of social consumer goods/100 million RMB X_{23}	X_{23}
	The city's total imports and exports / 100 million RMB X_{24}	X_{24}
	Total social fixed asset investment/100 million RMB X_{25}	X_{25}
	Disposable income of urban residents/RMB X_{26}	X_{26}

4. Constructing the cooperative evaluation model of port logistics and city economy

4.1 Order parameter contribution model

The power function collaborative model is used to indicate the contribution of the order parameter to its corresponding subsystem, and the calculation formula is as follows:

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$$X_{ij} = \begin{cases} \frac{x_{ij}-\beta_{ij}}{\alpha_{ij}-\beta_{ij}} \\ \frac{\alpha_{ij}-x_{ij}}{\alpha_{ij}-\beta_{ij}} \end{cases} \quad (1)$$

In the formula, x_{ij} is the order parameter, i is the number of subsystems (i=1, 2), j is the number of order parameters of each subsystem (j=1,2,3,...,m); X_{ij} is the order parameter pair The contribution degree of the system, $X_{ij} \in$ (0,1), whenX_{ij}approaches 1, the greater the contribution of the sequence parameter to the subsystem, and conversely, when X_{ij}approaches 0, the smaller the contribution of the timing parameter to the subsystem. α_{ij} and β_{ij} are the maximum and minimum values of each order parameter, namely $\alpha_{ij} \leq x_{ij} \leq \beta_{ij}$. In the specific calculation process, in order to avoid the occurrence of 0 and 1 values, the maximum value of each order parameter value is enlarged by 1%. The minimum value is reduced by 1%.

The order degree of the subsystem is formed by assembling the order degree of each order parameter component. The linear weighting method is adopted here, and the mathematical expression is:

$$X_i = \sum_{j=1}^{m} \omega_{ij} X_{ij} \quad (2)$$

$$\sum_{j=1}^{m} \omega_{ij} = 1 \quad (3)$$

In the formula, X_i represents the order degree of the subsystem, ω_{ij} X_{ij} represents the order degree of the order parameter component, X_{ij} represents the contribution degree of the order parameter to the subsystem, and ω_{ij} is the weight.

4.2 Entropy method to determine weight

The entropy method is an objective weighting method. It determines the weight of each index through the calculation of "entropy" according to the degree of difference of each state parameter value. This method avoids the deviation caused by human factors. The specific calculation steps As follows:

(1) Because the measurement units of various indicators are not uniform, they must be standardized before using them to calculate comprehensive indicators. The positive indicators indicate that the higher the value, the better, and the negative indicators indicate the lower the value. Well, the specific standardized processing formula is as follows:

$$\text{Positive indicators: } x'_{ij} = \frac{x_{ij} - min(x_{1j} \cdots x_{nj})}{max(x_{1j} \cdots x_{nj}) - min(x_{1j} \cdots x_{nj})} \quad (4)$$

$$\text{Negative indicators: } x'_{ij} = \frac{\max(x_{1j} \cdots x_{nj}) - x_{ij}}{\max(x_{1j} \cdots x_{nj}) - \min(x_{1j} \cdots x_{nj})} \quad (5)$$

In the formula, i represents the year, j represents the order parameter in each subsystem, i=1,2,...,n; j=1,2,...,m. For convenience, the normalized data is still recorded as x_{ij}

(2) Calculate the proportion of the i sample value under the jth indicator to the indicator

$$P_{ij} = \frac{x_{ij}}{\Sigma_{i=1}^{n} x_{ij}} \quad (6)$$

(3) Calculate the entropy value of the jth index:

$$e_j = -k \sum_{i=1}^{n} P_{ij} \, ln(P_{ij}) \quad (7)$$

ISSN: 2414-1895 DOI: 10.6919/ICJE.202009_6(9).0033

Where $k=1/ln(n)$, and satisfy $e_j \geq 0$.

(4) Calculate information entropy redundancy (difference)

$$d_j = 1 - e_j \tag{8}$$

(5) Calculate the weight of each indicator:

$$\omega_j = \frac{d_j}{\sum_{j=1}^{m} d_j} \tag{9}$$

Since the true number of the logarithm in equation (7) must be greater than zero, the normalized items are shifted to the right by 0.0001 units. So far, by applying the above formula, the order parameter weights of the two subsystems of Shanghai Port Logistics and Shanghai Urban Economy from 2011 to 2019 are shown in Table 2:

Table 2. Port logistics and urban economic order parameter weights

Port logistics indicators Order parameter	Weights	Urban economic index Order parameter	Weights
Port cargo throughput/100 million tons X_{11}	0.1779	Regional GDP/100 million RMB X_{21}	0.1726
Container throughput/10,000 TEU X_{12}	0.2389	Local general public budget revenue/100 million RMB X_{22}	0.1761
Operating income level X_{13}	0.3360	Total retail sales of social consumer goods/100 million RMB X_{23}	0.1550
Number of 10,000-ton berths per production X_{14}	0.2472	The city's total imports and exports / 100 million RMB X_{24}	0.0979
		Total social fixed asset investment/100 million RMB X_{25}	0.2289
		Disposable income of urban residents/RMB X_{26}	0.1696

4.3 Calculation of the order of each subsystem

Table 3. Order and degree of component and order of port logistics order parameters

	Order parameter component order degree $\omega_{ij}X_{ij}$				Order degree of port logistics subsystem
Years	Port cargo throughput/100 million tons	Container throughput/10,000 TEU	Operating income level	Number of 10,000-ton berths per production	
2011	0.0055	0.0032	0.0007	0.0061	0.0155
2012	0.0493	0.0396	0.0169	0.0484	0.1542
2013	0.1013	0.0794	0.0673	0.059	0.307
2014	0.1396	0.1074	0.1442	0.1119	0.503
2015	0.1533	0.1375	0.1492	0.1436	0.5836
2016	0.1779	0.2389	0.336	0.2472	0.6816
2017	0.156	0.1968	0.3196	0.1965	0.8688
2018	0.1724	0.2126	0.3105	0.1891	0.8846
2019	0.1615	0.2334	0.332	0.2387	0.9656

ISSN: 2414-1895 DOI: 10.6919/ICJE.202009_6(9).0033

By applying formula (1) to obtain the contribution of each order parameter, and according to the weight of the order parameter of each subsystem in Table 2, applying formula (2) can obtain the order degree of each subsystem and the order degree of order parameter components, specific values are as follows: Tables 3 and 4 show:

Table 4. City economic order parameter component order degree and subsystem order degree table

Years	Order parameter component order degree $\omega_{ij}x_{ij}$						Order degree of port logistics subsystem
	Regional GDP/100 million RMB	Local general public budget revenue/100 million RMB	Total retail sales of social consumer goods/100 million	The city's total imports and exports / 100 million RMB	Total social fixed asset investment/100 million RMB	Disposable income of urban residents/RMB	
2011	0.0012	0.0017	0.0013	0.0017	0.0014	0.0022	0.0095
2012	0.0149	0.0238	0.0130	0.0120	0.0277	0.0193	0.1107
2013	0.0247	0.0454	0.0281	0.0349	0.0296	0.0218	0.1846
2014	0.0372	0.0667	0.0443	0.0337	0.0582	0.0411	0.2812
2015	0.0465	0.0901	0.0599	0.0351	0.0994	0.0603	0.3913
2016	0.6250	0.1107	0.0787	0.0321	0.1329	0.0837	0.5007
2017	0.0896	0.1370	0.1055	0.0602	0.1611	0.1079	0.6613
2018	0.1110	0.1613	0.1211	0.0676	0.1917	0.1361	0.7888
2019	0.1697	0.1727	0.1521	0.0837	0.2217	0.1658	0.9657

4.4 Collaboration calculation

The coordinated development of port logistics and urban economy changes with time, and the corresponding two subsystems gradually develop from disorder to order under the interaction. Port logistics has various relationships with the urban economic subsystem. In order to reflect the overall synergy between the two, a synergy degree model of a composite system is built on the basis of time changes:

$$C = 2\sqrt{(x_1^t * x_2^t) / (x_1^t + x_2^t)^2} \tag{10}$$

$$F = (x_1^t + x_2^t) / 2 \tag{11}$$

$$Y_t = \sqrt{C * F} \tag{12}$$

Among them, x_i^t represents the order degree of the two subsystems of port logistics and urban economy at time t; C represents the level of combination and coordination of the development degree of the two subsystems; F represents the integrated level of the two subsystems at t; Y_t represents the port The coordination degree of the two subsystems of logistics and urban economy, $Y_t \in (0,1)$, the closer the value is to 1, indicating that the coordination between the two subsystems of port logistics and urban economy is higher; otherwise, the closer it is to 0 means the lower the degree of coordination. The sub-system coordination degree classification standard is shown in Table 5.

Table 5. Classification table of subsystem coordination degree

Y_t	(0,0.3]	(0.3,0.5]	(0.5,0.8]	(0.8,1.0)
Rank	Low degree of synergy	Moderate collaboration	Highly collaborative	Extreme synergy

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According to the order value of each subsystem in Table 3 and Table 4, using formula (10)-formula (12), and referring to Table 5, the coordination degree between the two subsystems of port logistics and urban economy is obtained The degree scale is shown in Table 6.

Table 6. Evaluation results of the coordination degree of Xiamen port logistics and urban economy

Years	2011	2012	2013	2014	2015
Economic coordination between Shanghai Port and Shanghai	0.1101	0.3615	0.4879	0.6133	0.6913
The level of economic coordination between Shanghai Port and Shanghai	Low degree of synergy	Moderate collaboration	Moderate collaboration	Highly collaborative	Highly collaborative
Years	2016	2017	2018	2019	
Economic coordination between Shanghai Port and Shanghai	0.7643	0.8706	0.9140	0.9827	
The level of economic coordination between Shanghai Port and Shanghai	Highly collaborative	Extreme synergy	Extreme synergy	Extreme synergy	

In order to intuitively see the order degree of the two subsystems of port logistics and urban economy and the change trend of the degree of coordination between the two, according to the data in Table 3, Table 4 and Table 6, draw the relevant line chart, as shown in Figure 3

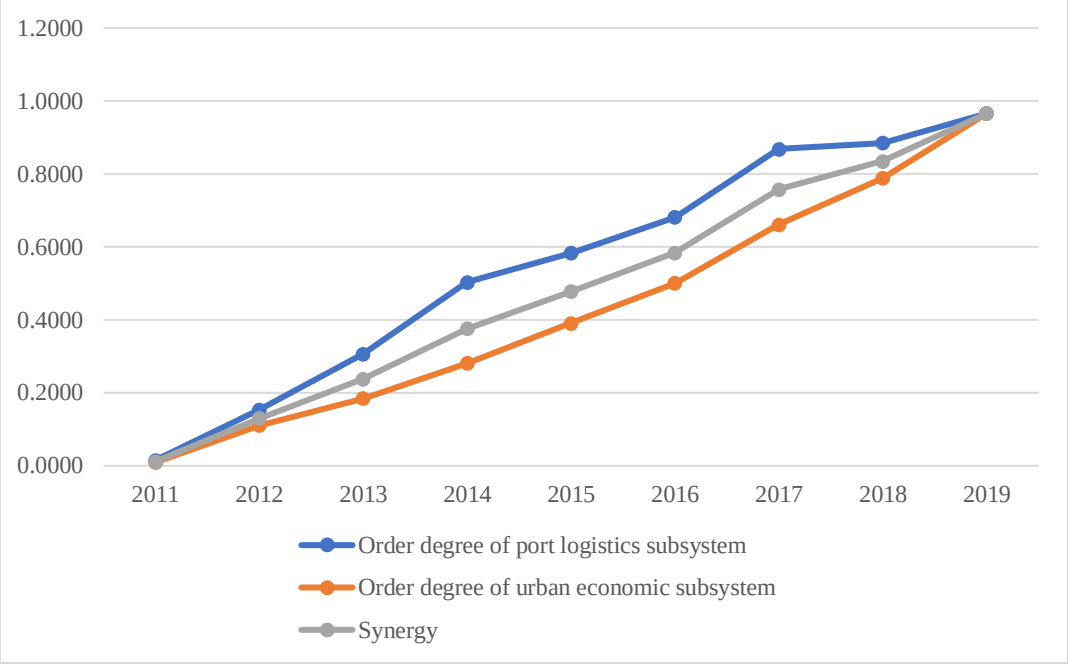

Figure 3. The trend of subsystem order and coordination degree from 2011 to 2019

It can be drawn from Figure 3 that the order degree of the Xiamen port logistics subsystem, the order degree of the urban economic subsystem, and the degree of coordination between the two are generally on an upward trend from 2011 to 2019. From a single point of view, the urban economic subsystem has relatively small fluctuations, and the overall trend is stable and rapid. The port logistics subsystem has relatively large fluctuations, but the overall development trend has also risen, and the

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degree of synergy with the changes of the two subsystems fluctuates. The change shows that there is a mutually dependent and mutually-promoting development relationship between Xiamen Port Logistics and Xiamen City Economy.

5. Result analysis and conclusion

5.1 Results analysis

According to the evaluation results table (Table 6) of Xiamen Port Logistics and Urban Economic Synergy, the overall synergy between Xiamen Port and Xiamen City from 2011 to 2019 shows an upward trend, of which the two are in a low degree of synergy in 2011. The degree value is 0.1101, indicating that the level of coordinated economic development between Xiamen Port and Xiamen City is relatively low this year, and Xiamen Port's pulling effect on the economic development of Xiamen City is relatively weak; , The synergy value is between 0.3615-0.4879. During this period, Xiamen's economy has achieved rapid development and improved the quality of development. At the same time, it has provided strong resource support for the development of Xiamen Port's port logistics. The service capacity has been rapidly improved; from 2014 to 2016, the port logistics and the city economy are in a highly coordinated state, and the synergy value of the two is between 0.6133-0.7643, which has increased year after year. During this period, the port infrastructure of Xiamen Port has been continuously improved. The continuous increase in container throughput has played a significant role in boosting the development of Xiamen's economy. The continuous improvement of the city's economy has also provided strong support for the development of port logistics, but the increase in the degree of coordination has slowed from 2014 to 2016. The main reason is that the cargo throughput of Xiamen Port has a downward trend during this period, and the order degree of the port logistics subsystem has shown a slow growth trend, but because the values of other order parameters are still in a rapid upward trend, the degree of coordination It is still in the ascending channel; from 2017 to 2019, the port logistics and the urban economy are in a state of extreme synergy. The synergy value of the two is between 0.8997-0.9827. During this period, the overall cargo throughput of Xiamen Port showed an upward trend. The annual revenue growth rate has increased, and the improvement of Xiamen Port's port logistics operations has brought more foreign trade opportunities to Xiamen City and promoted the development of the local economy. At this time, Xiamen Port and Xiamen City's urban economy have achieved mutual integration The situation of coordinated development.

5.2 Conclusion

Based on the data of Xiamen Port port logistics and Xiamen City economics from 2011 to 2019 as samples, this article draws the following conclusions from the perspective of quantitative analysis by building a subsystem order degree model and a subsystem coordination degree model. The city's economy as a whole is in coordinated development, and the level of coordinated development is constantly improving. Among them, coordinated development has experienced four different stages: low-level coordination, medium-level coordination, high-level coordination, and extreme-level coordination.

It can be seen from the empirical analysis that the logistics of Xiamen Port and the economy of Xiamen City promote each other and develop in a coordinated manner as a whole. The operational efficiency of Xiamen Port Logistics is one of the important factors to promote the development of Xiamen's economic system, and the coordinated development of the Xiamen Port and Xiamen City composite system requires the two systems to work together to develop together.

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