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Synergetic Development of Port Logistics and Regional Economy in Jiangxi Province

Ting Liu

School of Management, Jiujiang University, China
Email: cream4.24@163.com

Abstract

Based on the entropy weight method and a synergy model of the composite system, the researcher investigated the synergetic development of port logistics and regional economy in Jiangxi Province, China. The results show that the evolution trend of order degree of port logistics and regional economy is rather consistent in falling first and then rising. From 2005 to 2010, the order degree of regional economy in Jiangxi Province was almost all higher than that of port logistics. Then both order degrees began to rebound after 2010, and the development degree of port logistics was higher than that of regional economy from 2012 to 2017. In the adjacent base period, the weak synergy degree of the composite system occurred in three years during 2006-2017, and was in a non-synergy state in the rest of the years, indicating that the connection and impact between port logistics and regional economy were relatively low and the synergy status greatly fluctuated. In the fixed base period, the synergy degree of the composite system of port logistics and regional economy carried a non-synergy status, and lacked a good synergetic development mechanism. On the basis of these findings, the author has some suggestions to strengthen infrastructure construction, promote the coordinated development of port groups, and accelerate upgrading of the industrial structure.

Keywords: *Entropy weight method, synergy model of composite system, port logistics, regional economy, order degree, development degree*

1. Introduction

1.1 Synergy of Port Logistics and Regional Economy

Synergy between port logistics and regional economy refers to the degree of organic combination, mutual promotion and synergetic development of the two. Port logistics, as a tertiary industry, has an impact on various aspects of regional economic development, such as promoting upgrading of the industrial structure, increasing talent cohesion, attracting capital, and accelerating infrastructure construction. On the other hand, regional economic development can also increase the demand for port logistics. The two complement and rely on each other. So far, the research on port logistics and regional economy has become a hot issue, and the application scope of synergetic has expanded from the original field of physics to those of economics and sociology. The main research of international scholars focuses on various issues. DRP authority of Philadelphia (1953) was the first to study the influence of ports on regional economic development. Slack (1990, 1996) studied the relationship between the port and the port hinterland under the change of transportation mode, and discussed the coordinated development between the two. Pollock (1981) and Seabrooke et al. (2003) demonstrated the interactive relationship between port logistics and hinterland economy based on theoretical analysis and empirical research. Kisperska-Moron (1994) proposed that port logistics is an effective support for the rapid development of regional economy, an important factor affecting regional economic development, and it is also a content that should be fully considered when formulating long-term plans and planning strategies. Hillier (1999) used relevant fitting equations to evaluate the degree of coordinated development between the port system and the city system on the basis of the ideal city model, so as to further analyze the relationship between the port and the city. Omiunu (2002) and Fernández et al. (2004) studied the relationship between the Nile and Seville regions and their ports. Haken (2004) believes that the synergy of the overall system can reflect the coordination of internal subsystems.

The research of Chinese scholars mainly includes the following. Ming et al. (2011) used the entropy weight method to determine the weight of the index system and established the general synergic model of Dalian port and urban economy. The result shows that the synergic degree between the two is relatively high. Guan (2020) took six cities in the coastal economic belt of Liaoning Province as the research objects, and made a quantitative analysis by using synergy degree model of the composite system. She believed that the synergy degree of the economic composite system is low on the whole and the level of economic synergy among all cities is poor, and put forward relevant suggestions. Jie (2019) built a collaborative development model of water environment management system from the aspect of the four elements, analyzed the coordination state of the composite system from two aspects of the adjacent base period and fixed base period, and thought that the system coordination state is unstable under adjacent base level, so that synergy degree needs further ascension, and under the same base period, the system coordination degree is rising year by year, but the coordination level is low and slowly grows, and thus shows a future outlook. Chen et al. (2019) used entropy weight method to determine the weight of the index system, established the coordination degree model of the composite system of Jingzhou port logistics capacity and industrial structure upgrading, measured the order degree of each subsystem, and found that the order degree shows a downward trend. Chang (2019) believed that the port scale should be included in the index system, which can be measured by the length of the wharf, the number of berths and the number of 10,000-ton berths. Therefore, the synergetic model of port logistics and hinterland economy in Beijing-Tianjin-Hebei region was established, and the system has a high degree of coupling. Feng et al. (2019) studied the synergies between Ningbo port logistics and a port economic circle, and the results show that there are regional differences in the synergies, which could be divided into three echelons. Jing et al. (2020) used the entropy weight method to determine the weight of the index system and evaluated the carrying capacity through TOPSIS method. The research on port logistics and regional economy mostly focuses on the relevance and collaboration, as well as the division of hinterland economic regions. The main research methods include the regression method, grey correlation, a coordination model, the general synergic model, a system dynamics model and the VAR model, to name but the major ones, but these quantitative methods also have some limitations, for example, they are singular and cannot reflect the existing problem comprehensively, the indexes are few, and the judgment on the weight of the index system is rather simple. Most researchers concentrated on the economically developed areas of China, such as Jiangsu, Zhejiang, and Beijing-Tianjin-Hebei. There is a lack of relevant research on economically backward provinces, particularly Jiangxi Province.

1.2 Jiangxi Province

As one of the nine provinces and two cities along the Yangtze River Economic Belt, Jiangxi Province is an inland open economic pilot zone established by China. It is located in the central region of China, with 152 km of golden coastline along the river and convenient transportation, so it has a unique location advantage. Under the strategic background of the country's key implementation of the Yangtze River Economic Belt, Jiangxi Province has issued a series of policies and measures, actively participated in the Yangtze River Economic Belt development, and established a regional network of the channel system. The Province has built Jiujiang port and Nanchang port as the cores of the regional logistics center to accelerate the inland waterway transport modernization with intensification of ports, large-scale and standardized ships, and advanced information platform. In order to realize its strategic goal, the Province has carried out research into synergetic development of port logistics and regional economy to promote its further prosperity.

1.3 Research Method

Based on the selection principles of the index system and the availability of data, the researcher established a multi-index system that can fully reflect the characteristics of the two subsystems of port logistics and regional economy. The entropy method was used to determine the weight of the index system, which effectively eliminated human interference factors, made the research results objective and fair, and then created a synergy model of the composite system of port logistics and regional economy in Jiangxi Province. Two synergy measurement methods of adjacent base period and fixed base period were adopted instead of a single method of synergy measurement, the synergetic development degree and evolution trend of port logistics and regional economy in Jiangxi Province were analyzed to obtain suggestions for Jiangxi Province in achieving the synergetic development of the two was put forward.

2. Synergy Model of Composite System

2.1 Order Degree Model of Subsystem

Suppose there are several subsystems in the composite system S, so S can be expressed as $S = \{S_1, S_2, S_3,.., S_i\}$, where $i \in [1, m]$, $m \geq 2$, is a positive integer, $i = 1, 2, 3,..., m$. The order parameter of subsystem S_i is $S_i = \{x_{i1}, x_{i2}, x_{i3},.., x_{ij}\}$, where $j \in (1, n)$, $n \geq 2$, is a positive integer, $j = 1, 2, 3,..., n$. The order degree X_{ij} of the order parameter component x_{ij} of subsystem S_i is calculated as follows:

$$X_{ij} = \begin{cases} \dfrac{x_{ij} - \beta_{ij}}{\alpha_{ij} - \beta_{ij}}, & x_{ij} \text{ is a positive index} \\ \dfrac{\alpha_{ij} - x_{ij}}{\alpha_{ij} - \beta_{ij}}, & x_{ij} \text{ is a negative index} \end{cases} \quad (1)$$

Where, $X_{ij} \in [0, 1]$; α_{ij} and β_{ij} are respectively the upper and lower limits of subsystem's order parameter component x_{ij}, namely $\beta_{ij} \leq x_{ij} \leq \alpha_{ij}$. If x_{i1}, x_{i2}, x_{i3}..., and x_{ij} are positive indexes, the greater the value is, the better is. It means that the greater the contribution of the order parameter component x_{ij} to the subsystem S_i is, the higher the degree of order will be. If x_{i1}, x_{i2}, x_{i3}... and x_{ij} are negative indexes, the larger the value is, the smaller the contribution to the subsystem S_i is, and the lower the order degree is. The sum of the order degree of each order parameter component of the subsystem is the order degree of the subsystem. In this paper, the linear weighted sum method is adopted to calculate the order degree X_i of the subsystem S_i:

$$X_i = \sum_{j=1}^{n} w_{ij} \cdot X_{ij}\ ,\ 0 \le w_{ij} \le 1\ ,\ \sum_{j=1}^{n} w_{ij} = 1 \quad (2)$$

Where, w_{ij} is expressed as the weight of the order parameter component x_{ij}.

2.2 Order Parameter Weights of Subsystem

The order parameter weights of subsystem are an important factor affecting the order degree of subsystem. The weight is determined by the entropy weight method, which is an objective weighting method. The basic idea of determining the objective weight is based on the dispersion degree of the index. The greater the entropy value is, the greater the dispersion degree of the index is, and the greater the weight in the system is.

2.2.1. Calculation of the Contribution Degree of Order Parametric Component

The contribution degree P_{ijy} of the order parameter component x_{ijy} in a certain year can be expressed as:

$$P_{ijy} = \frac{x_{ijy}}{\sum_{y=1}^{r} x_{ijy}} \quad (3)$$

Where, y represents different years, and $y \in [1, r]$, $r \ge 2$, is a positive integer, $y = 1, 2, 3,...$

2.2.2. Calculation of Entropy of Each Order Parameter Component

Entropy E_{ij} is the total contribution of all years to the order parametric component x_{ijy} , and the calculation formula is:

$$E_{ij} = -k \cdot \sum_{y=1}^{r} \ln(P_{ijy}) \cdot P_{ijy} \quad (4)$$

Where, $k = 1 / \ln(r)$, k is constant.

2.2.3. Calculation of Entropy Weight

According to the entropy value of the order parameter component x_{ij}, the degree of dispersion is determined, namely $(1- E_{ij})$. The greater the degree of dispersion is, the greater the weight is. The weight calculation formula is as follows:

$$w_{ij} = \frac{(1 - E_{ij})}{\sum_{j=1}^{n} (1 - E_{ij})} \quad (5)$$

Where, w_{ij} is the weight of the order parameter component x_{ij} in the subsystem S_i.

2.3 Synergy Model of Composite System

There are two methods to calculate the synergy degree of the composite system. One is to calculate the synergetic state and evolution trend of the system based on the fixed base period. The other is based on adjacent base period to analyze whether the synergetic status between the subsystems is stable. Assuming that at the initial time t_1, the order degree of each subsystem is X_i^1, $i \in [1, m]$, and when the system develops to time t_2, the order degree of each subsystem is X_i^2, then the synergy degree of the composite system S is calculated as follows:

$$C = \eta \cdot \sqrt[m]{\prod_{i=1}^{m} \left| X_i^2 - X_i^1 \right|} \tag{6}$$

Where $\eta = \begin{cases} 1, & X_i^2 - X_i^1 \geq 0 \\ -1, & \text{others} \end{cases}$, $C \in$ [-1,1], the greater the C value is, the better the synergetic status between the two subsystems in the composite system is, the system will tend to generate a new ordered structure. The smaller the C value is, the more disordered the system is. The criteria for judging the composite system state are shown in Table 1.

Table 1: The Criterion for Determining the Degree of Synergy

C value	$-1 \leq C \leq 0$	$0 \prec C \leq 0.3$	$0.3 \prec C \leq 0.7$	$0.7 \prec C \leq 1$
System state	non-synergy	weak synergy	general synergy	strong synergy

3. Establishment of Synergy Model of Jiangxi Province's Port Logistics and Regional Economic Composite System

3.1 Index Selection and Data Sources

3.1.1. Index Selection

The index selection should not only reflect the characteristics of the two subsystems, but also follow the selection principle of the index system. *The port logistics subsystem* can be considered from two aspects of port construction and port operation; its indexes mainly include port cargo throughput, container throughput, the total number of ports, wharves, berths, loading and unloading machineries, the total length of wharves and berths, the number of one-thousand tonnage level berths and ten-thousand tonnage level ports and port operating revenue. *The regional economic subsystem* can be considered from the aspects of economic scale, people's quality of life, social development and employment. The indexes mainly include GDP, per capita GDP, urban per capita disposable income, total retail sales of social consumer goods and the number of social employees. In addition to the selection principle of indexes, the availability of data should also be considered, and the indexes should be determined by the Delphi method, as shown in Table 2.

Table 2: The Index System of Jiangxi Port Logistics and Regional Economic Subsystem

Subsystem	Symbol	Order parameter	Index sign	Index point
Port logistics	S_1	Port cargo throughout ($\times 10^9$ t)	x_{11}	Forward
		Port container throughout ($\times 10^4$ TEU)	x_{12}	Forward
		Investment in transport infrastructure ($\times 10^9$ Yuan)	x_{13}	Forward
		Number of ports	x_{14}	Forward
		Number of production berths	x_{15}	Forward
		Wharf length (m)	x_{16}	Forward
		Number of loading and unloading chineries	x_{17}	Forward
Regional economy	S_2	GDP ($\times 10^9$ Yuan)	x_{21}	Forward
		Total import and export value ($\times 10^9$ USD)	x_{22}	Forward
		Fixed asset investment ($\times 10^9$ Yuan)	x_{23}	Forward
		Number of social employees ($\times 10^4$)	x_{24}	Forward
		Per capita GDP (Yuan)	x_{25}	Forward
		Urban per capita disposable income (Yuan)	x_{26}	Forward
		Total retail sales of social consumer goods ($\times 10^9$ Yuan)	x_{27}	Forward

3.1.2. Data Sources

In this paper, the relevant data of Jiangxi Province from 2005 to 2017 for empirical study was selected from Jiangxi Statistical Yearbook, Jiangxi Traffic Yearbook, Jiangxi Statistical Bulletin, Yangtze River Yearbook and China Port Yearbook.

3.2 Calculation and Evaluation of Synergy Degree of Composite System

3.2.1. Data Standardization

In order to eliminate the influence of different dimensions on the original data of order parametric component, SPSS (Statistic Package for Social Science) was used to conduct 0-1 standardized processing on the original data, that is, after dimensionless, the mean value and standard deviation of each order parametric component data are respectively 0 and 1.

3.2.2. Weight Calculation

Entropy value and dispersion degree of order parameters of each subsystem were calculated according to the entropy weight method, and their weights were computed accordingly, as shown in Table 3.

Table 3: The Weight of Order Parameters of Each Subsystem

Subsystem	Symbol	Order parameter	Weight of index symbol	Entropy	Dispersion	Weight
Port logistics	S_1	Port cargo throughout ($\times 10^9$ t)	w_{11}	0.9783	0.0217	0.1788
		Port container throughout ($\times 10^4$ TEU)	w_{12}	0.947	0.0530	0.4363
		Investment in transport infrastructure ($\times 10^9$ Yuan)	w_{13}	0.9574	0.0426	0.3504
		Number of ports	w_{14}	0.9999	0.0001	0.0012
		Number of production berths	w_{15}	0.9997	0.0003	0.0023
		Wharf length (m)	w_{16}	0.9986	0.0014	0.0112
		Number of loading and unloading machineries	w_{17}	0.9976	0.0024	0.0199
Regional economy	S_2	GDP ($\times 10^9$ Yuan)	w_{21}	0.9552	0.0448	0.1388
		Total import and export value ($\times 10^9$ USD)	w_{22}	0.9299	0.0701	0.2174
		Fixed asset investment ($\times 10^9$ Yuan)	w_{23}	0.9261	0.0739	0.2293
		Number of social employees ($\times 10^4$)	w_{24}	0.9995	0.0005	0.0014
		Per capita GDP (Yuan)	w_{25}	0.953	0.0470	0.1456
		Urban per capita disposable income (Yuan)	w_{26}	0.9687	0.0313	0.0970
		Total retail sales of social consumer goods (×109 Yuan)	w_{27}	0.945	0.0550	0.1705

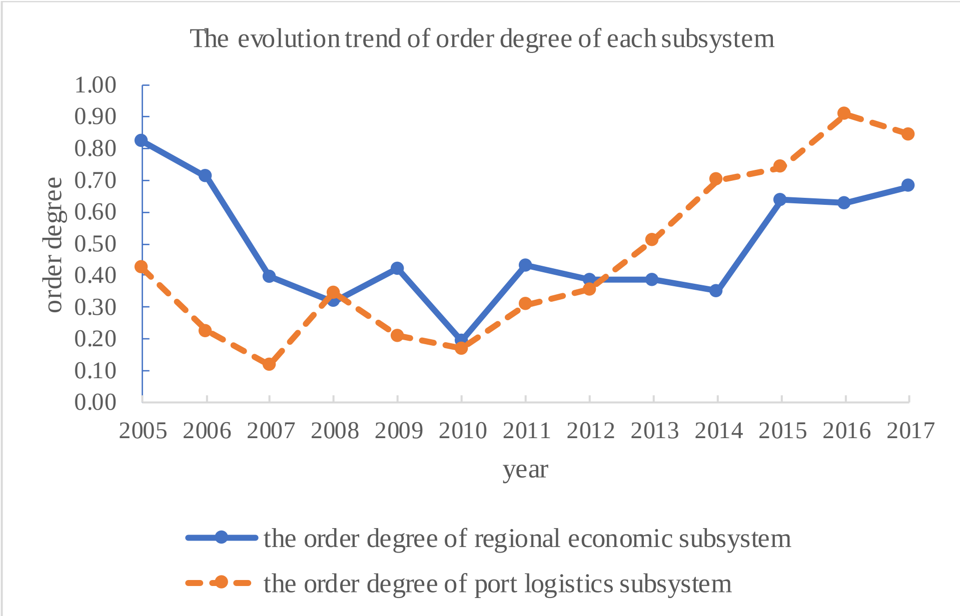
3.2.3. The Order Degree Calculation of Each Subsystem

According to Equation (1), the order degree of the order parameter component of each subsystem was calculated. On this basis, the order degree of each subsystem in Jiangxi Province from 2005 to 2017 was counted according to Equation (2), and shown in Table 4 and Figure 1.

Table 4: The Order Degree of Each Subsystem in Jiangxi Province from 2005 to 2017

Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Port logistics	0.4224	0.2246	0.1178	0.3457	0.2102	0.1698	0.3067	0.3553	0.5125	0.7003	0.7414	0.9076	0.8444
Regional economy	0.8231	0.7101	0.3971	0.3188	0.4218	0.1941	0.4302	0.3847	0.3857	0.3508	0.6381	0.6269	0.6803

Figure 1: The Evolution Trend of Order Degree of Each Subsystem from 2005 to 2017



As seen in Table 4 and Figure 1, the evolution trend of the order degree of port logistics subsystem and regional economic subsystem in Jiangxi Province presented a high consistency. The order degree of two subsystems in 2005-2010 showed the declining trend, but the order degree of the regional economy subsystems was almost higher than that of the port logistics subsystems during this period. After 2010, the order degree began to rebound, and then the order degree of port logistics was higher than that of the regional economy in 2012-2017. Since 2010, Jiangxi Province has introduced a number of policies, actively responded to the country's strategy of developing the Yangtze River Economic Belt, and speeded up modernization construction of waterway transportation in Jiangxi Province. In 2010, Jiangxi Province issued "Several opinions on supporting the golden waterway construction of the Yangtze River and improving the level of waterway transport development," increased investment in infrastructure, and built three one-thousand tonnage level berths. In 2011, the three-level channel increased by 92 km and the four-level channel by 87 km. At the same time, the Province has promoted the development of "large-scale and standardization" transport vessels, and the average deadweight cargo tonnage of vessels has increased from 208 t in 2005 to 504 t in 2011. In 2012, Jiangxi Province issued " Opinions of the People's Government of Jiangxi Province on further promoting the opening and development of Jiujiang along Yangtze River," Jiujiang Port, that is as the only transportation hub port of Yangtze River in Jiangxi Province, highlighted its importance by putting forward to exploit shoreline and construct port as the key point, promoting large-scale opening, exploitation and development along the river, and building a strategic port structure of "one leader, three linkages." The construction of ports and wharves was dominated by large-scale, intensification and specialization, and began to make full use of the advantages of the Golden waterway, port shoreline, waterway transport resources and comprehensive traffic location of

Yangtze River. The effect of these policies has been verified over time, and yielded the phased results since 2012. The port logistics subsystem began to develop rapidly, and its orderly development degree was higher than that of the regional economic subsystem.

3.2.4 Synergy Degree Calculation of the Composite System

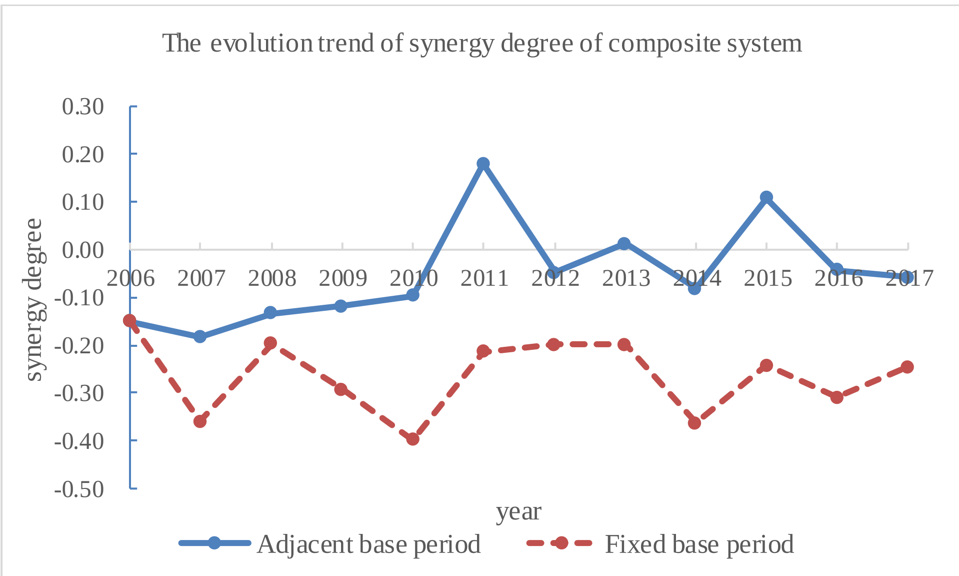
According to Equation (4), the synergy degree between port logistics and the regional economic subsystem in Jiangxi Province from 2005 to 2017, based on fixed base period and adjacent base period, was calculated respectively, as shown in Table 5 and Figure 2.

Table 5: The Coordination Degree between Port Logistics and Regional Economic System in Jiangxi Province from 2005 to 2017

Year		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Adjacent base period	**System synergy**	-0.1495	-0.1828	-0.1336	-0.1181	-0.0959	0.1798	-0.0470	0.0124	-0.0809	0.1086	-0.0432	-0.0581
	System status*	non	non	non	non	non	weak	non	weak	non	weak	non	non
Fixed base period	**System \synergy**	-0.1495	-0.3603	-0.1968	-0.2918	-0.3986	-0.2133	-0.1984	-0.1984	-0.3623	-0.2429	-0.3085	-0.2455
	System status*	non	non	non	non	non	non	non	non	non	non	non	non

*: non (non-synergy), weak (weak synergy).

Figure 2: The Evolution Trend of Synergy Degree between Port Logistics and Regional Economic System in Jiangxi Province from 2005 to 2017



Different synergy degrees between port logistics and regional economy in different periods reflect different dynamics and complexity (Ming et al., 2011). Table 5 and Figure 2 indicate that those based on system synergy of adjacent base period had only three years in weak synergy of two subsystems during 2006 - 2017, while the synergy value of other years was less than 0 and in a non-synergy state. The maximum synergy value was 0.1798 in 2011 and the minimum value was -0.1495 in 2006. During this period, it experienced more variation in a gradual rise, a surge, a sharp drop, or a steady and re-surge, which indicated that the synergy between port logistics and regional economy subsystem was unstable. From 2005 to 2010, the modernization level of waterway transport in Jiangxi Province was not enough, and waterway transport infrastructure conditions were poor, which failed to form an open, orderly, safe and efficient waterway transport market. At this period, the lower regional economic development level could not stimulate the logistics demand. The development of port logistics lagged behind, which was still manifested in the traditional cargo handling, storage and transfer functions. Port enterprises had too many operating subjects, small scale, low management level, weak competitiveness and feeble anti-risk ability.

Since 2010, Jiangxi Province issued the relevant policies to increase investment in inland waterway construction, and initiated Nanchang-Jiujiang integration development planning in 2014. The system synergy degree increased in 2010, 2013 and 2015, but the status was not stable and weak synergy appeared. It indicated under the impetus of policies: waterway transport developed rapidly, construction of supporting infrastructure accelerated, the loading and unloading capacity of port enhanced, and port logistics began to shift from traditional logistics to modern logistics mode. Regional economic development was faster too, but the order degree was lower than that of the port logistics; the logistics demand was increasing. After 2015, the synergy degree declined again. Although Jiangxi Province proposed to construct "two rivers and two ports" planning in 2015, the effect of policies and construction was lagging behind. In general, the relationship and influence between port logistics and regional economy in Jiangxi Province are still relatively low, and the synergy between the two subsystems is not stable and fluctuates greatly.

The analysis reveals that based on system synergy of fixed base period (with 2005 data in the fixed base period), port logistics and regional economy were in a non-cooperative state. With the implementation of policies, port logistics has transformed from the traditional to the modern logistics model. Since 2010, port logistics has developed rapidly, and met the needs of regional economic development in support of export-oriented economy in Jiangxi Province. It should be noted that current port logistics cannot rapidly drive the development of regional economy, and the synergetic development mechanism has not been well established due to its vulnerability to interference factors.

4. Conclusion and Suggestions

4.1 Conclusion

Based on the entropy weight method and the synergy model of the composite system, a synergy model of the composite system of Jiangxi Province port logistics and regional economy was established, the weight of the order parameter components of each subsystem was determined with the entropy weight method, and both order degrees of Jiangxi port logistics and the regional economic subsystems and the system synergy degree from 2005 to 2017 were given. The research results show that the order degree evolution trend of port logistics and the regional economic subsystems continuously declined in 2005-2010, but with the order degree of the regional economy subsystem almost higher than that of the port logistics subsystem during this period. Then the trend began to rebound in 2010 and moved upward from 2012 to 2017. At this period, the orderly development degree of port logistics was higher than that of regional economy. In the case of adjacent base period, only system synergy in three years showed a weak synergy status from 2006 to 2017, while the remaining years in a non-synergy status. It indicated that the system synergy status was rather unstable and needed further improvement. Under the condition of fixed base period, the system synergy of all years was in a non-cooperative state, and the system did not form an effective synergetic development mechanism.

4.2 Suggestions

Based on the results of the study, the author would like to suggest three actions:

4.2.1. Strengthen Infrastructure Construction

According to the previous analysis of the entropy weight method, although the investment in transportation infrastructure accounts for an important proportion, it is difficult to meet the demand of rapid development. Jiangxi Province should increase investment in infrastructure construction persistently, further improve the channel level, speed up the construction process of "two rivers and two port," optimize the port function, strengthen the port capacity, promote the development of port transformation from traditional logistics to modern logistics, and realize the extension of integrated logistics services. To improve hardware configuration, the ports should also enhance their soft power, strive to achieve modernization, informatization, automation and intelligent development, and further promote regional economic development based on the development of port logistics. All these are to drive the optimization of the industrial structure and the establishment of a comprehensive transportation system for the aggregation of logistics enterprises.

4.2.2. Promote Coordinated Development of Port Groups

Besides Jiujiang Port on the main line of Yangtze River, there are also several ports on the tributaries of Yangtze River in Jiangxi Province. The ports should promote coordination among them, and take the advantage of the spanning area to build information platforms and open waterway transportation channels. On the one hand, the government can make a unified plan for the industries of each port to avoid vicious competition; on the other hand, it is conducive to accelerate the development and cooperation of regional economy and provide necessary logistics service support for regional economic development.

4.2.3. Promote Upgrading of the Industrial Structure

Since traditional industries account for 70% of the real economy of Jiangxi Province, it is necessary to accelerate the optimization and upgrading of the industrial structure, shift industries from low value-added to high value-added, and realize the transformation of industry from low to high additional value. The Province should consider implementing green manufacturing, innovative manufacturing, intelligent manufacturing, and fully integrating modern digital technologies in support of the industry development toward integration and intensification.

5. The Author

Ting Liu has B.S. in mechanical engineering and automation (2001), M.S. in industrial economics (2005) and Ph.D. in logistics management (2014) from Wuhan University of

Technology, Wuhan, China. She worked as an Assistant Engineer for Transport Planning and Research Institute, Ministry of Transport, Beijing, China in 2011. Since 2005, she has been an Assistant Professor at Jiujiang University, Jiangxi, China. Her research interests include transportation planning and management, regional economic development. Since 2015, she has presided over three provincial or ministry level projects, participated in two national projects and eight provincial and other projects. In 2019-2020, she was awarded a scholarship by China Scholarship Council (CSC) to pursue her study as a visiting scholar at The University of New South Wales, Sydney, Australia. Since 2008, she has earned four utility model patents in China and published more than 20 papers.

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