

# Research on the Synergy Between Kaohsiung Port Logistics and Taiwan Province's Economic

Hui Zhang

Shanghai Maritime University, Shanghai 201306, China.

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## Abstract

The coordinated development of port logistics and regional economy is an important guarantee for enhancing regional economy and port logistics competitiveness. As the province of Taiwan with an export-oriented economy as its main body, Kaohsiung Port, as the largest port in Taiwan, plays a pivotal role. It is of great practical significance to study the relationship between the two. This article collects the data of Taiwan Province's economy and Kaohsiung port from 2009 to 2018, and uses the synergy idea to establish a corresponding synergy model. It comprehensively and objectively analyzes the coordinated relationship and trend of Taiwan's economic development and development.

## Keywords

Economic development in the Gulf Province; Economic development in the Gulf Province; Collaboration Model.

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## 1. Introduction

"Prospering cities with ports and cities with ports". Since ancient times, the prosperity and prosperity of many cities have been closely related to their coastal geographic locations and the opening and construction of ports. Nowadays, with the rapid development of navigation technology and the acceleration of globalization, more countries have shifted their economic focus to port cities, and the level of port development has become the key to the further improvement of the economic strength of a city and even a country. The analysis and research on the development of the interactive relationship between Hong Kong and the city has become a focus of more and more scholars.

The relationship between port logistics and urban economic development has accumulated a rich academic foundation. In view of the different influencing factors contained in the two, scholars mainly use various quantitative methods to analyze the relationship between the two. Wang [1] used the RCI model to analyze the relationship between the port and the city by analyzing the port throughput and the organizational relationship between local residents. Guo et al [2] used gray correlation to measure the degree of correlation between ports and cities in the Beijing-Tianjin-Hebei region. Wang [3] and Fan [4] used the entropy method to confirm the weight of the two influencing factors, and then used the synergy model to obtain the cooperative development relationship between the port and city. Lan [5] uses Bayesian networks to test the factors affecting the coordinated development of the port and city, and to provide a scientific reference for actual logistics builders. Guo [6] proposed the DCI model based on the RCI model, which dynamically reflects the relationship between port logistics and urban economy by measuring the impact of port transportation growth on urban economic growth. In summary, each quantitative analysis method has its own advantages and disadvantages, which can reflect the relationship between the port and the city, but compared with other models, the synergy model can better reflect the relationship between port logistics and urban economy. Therefore, this paper adopts a coordination degree model based on the coupling idea to

develop the cooperative relationship between the economy of Taiwan Province and the port logistics of Kaohsiung Port.

## **2. Background and significance of the topic**

### **2.1 Background of the topic**

Nearly 90% of China's import and export trade is completed by sea. The economic level of the top ten cities in container throughput is also among the best in the country. It can be seen that ports, as a special city function, are crucial to the promotion and development of the city's economy. The development of port logistics and urban economy are interrelated and mutually promote each other. Port logistics can attract more import and export of goods by virtue of its superior geographic location, hydrological conditions, collection and distribution efficiency, and comprehensive services, and open up urban transportation. System, increase employment positions, further integrate the city and the global network, optimize the allocation and sharing of resources, and improve the economic level of the city. As the city's economic level improves, it will also increase investment in ports, strengthen its hardware and software facilities, and improve port logistics.

Taiwan Province is located in the southeastern waters of mainland China. It faces the Taiwan Strait to the west and Fujian Province, the Bashi Strait to the south, and the endless Pacific Ocean to the east. Due to its special geographical location surrounded by the sea, Taiwan Province's import and export trade is mainly completed by sea, and the importance of its port is self-evident. The largest port in Taiwan Province is Kaohsiung Port. It is located at the intersection of the Taiwan Strait and the Bashi Strait. It has superior hydrological conditions. There are more than 130 routes covering five continents, and it bears nearly two-thirds of Taiwan Province's trade traffic. Kaohsiung Port plays an important role in the economic development of Taiwan Province, and Taiwan Province also attaches great importance to the construction and development of Kaohsiung Port.

### **2.2 Significance of the topic**

In 2018, Kaohsiung Port ranked 18th in the Lloyd's List of global container ports, and it is an important container hub port in the Asia-Pacific region. The container throughput of Kaohsiung Port accounts for 70% of the container throughput of Taiwan Province, and the cargo throughput accounts for 60% of the total. It can be seen that Kaohsiung Port has undertaken the main task of Taiwan Province's import and export trade and is an important part of promoting Taiwan's economy. Every year, it also invests material and financial resources to help the further construction of Kaohsiung Port. However, the complementary relationship between the two is relatively rough and it is difficult to objectively describe the degree of their coordinated development. Therefore, this paper adopts the synergy model to collect the evaluation indicators of each subsystem in the ten years from 2009 to 2018, and calculate the synergy value to qualitatively and quantitatively Analyze the degree of coordinated development and provide corresponding suggestions.

## **3. Mathematical model**

### **3.1 Order parameter selection**

According to the synergy theory, the order parameter refers to the parameter that characterizes the order of the system at the macro level, and it reflects the final structure and order of the system [7]. The selection of order parameters is based on the subjective judgment of the researcher, but should follow the principles of comprehensiveness, objectivity, and the combination of dynamic and static. Combining the relevant literature of Liu [8], Feng [9], and Xun [10] and the availability of relevant data, this paper selects 9 sequence parameters that can represent the economic development level of Taiwan and the development level of Kaohsiung Port 6 order parameters, see Table 1.

Table1 Port logistics and urban economic order parameters

	Order parameter
Port Logistics	Container throughput
	Cargo throughput
	Cargo handling capacity
	Number of passengers
	Number of import and export ships
	Free trade zone trade value
Cite economy	GDP
	Industrial output
	Disposable income per capita
	Household consumption
	Total import and export
	Government revenue
	Foreign investment
	Total output value of agriculture, forestry and fish husbandry

### 3.2 Order parameter contribution

The order parameter contribution degree indicates the contribution degree of the order parameter to the subsystem, which can be expressed by the power function. The calculation formula is as follows:

$$X_{ij} = \begin{cases} \frac{x_{ij}-b_{ij}}{a_{ij}-b_{ij}}, x_{ij} \text{ positive effect} \\ \frac{a_{ij}-x_{ij}}{a_{ij}-b_{ij}}, x_{ij} \text{ negative effect} \end{cases} \quad (1)$$

In this case,  $X_{ij}$  represents the contribution degree of the order parameter  $x_{ij}$ ,  $X_{ij} \in (0,1)$ ,  $i=1,2,\dots,n$ ;  $j=1,2,\dots,m$ ;  $n$  is the number of samples, and  $m$  is the number of sequence parameters of the subsystem. According to the synergy theory, the value of  $X_{ij}$  is between 0-1, and since port logistics and urban economy are generally complementary to each other, the default here is a positive effect, and the value of  $X_{ij}$  is positively related to the degree of contribution of the order parameter to the subsystem.  $a_{ij}$  and  $b_{ij}$  respectively represent the upper and lower limits of each sequence parameter. In order to avoid zero values, the upper and lower limits are enlarged and reduced by 1%.

### 3.3 Order parameter weight

The order parameter  $x_{ij}$  of each subsystem can generate the total contribution degree. Here we use the linear weighting method, and the calculation formula is as follows:

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

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

Among them,  $S_i$  represents the total contribution of sample  $i$  to the subsystem;  $u_{ij}$  is the weight of each order parameter contribution  $X_{ij}$ . For the weight  $u_{ij}$ , this paper adopts the entropy method to get the value.

$$U_{ij} = \frac{x_{ij}}{\sum_{i=1}^n x_{ij}} \quad (4)$$

$$e_j = -k \sum_{i=1}^n U_{ij} \ln U_{ij} \quad (5)$$

$$P_j = 1 - e_j \quad (6)$$

$$u_j = \frac{P_j}{\sum_{j=1}^m P_j} \quad (7)$$

Among them, (5) represents the specific gravity transformation of  $X_{ij}$ ; in (6)  $e_j$  represents the  $j$ -th order parameter entropy value, and  $k$  generally takes  $1/\ln(n)$ ; in (7),  $P_j$  represents the  $j$ th Order

parameter difference value; in (8),  $u_j$  represents the order parameter weight.  $i=1,2,\dots,n$ ;  $j=1,2,\dots,m$ ;  $n$  is the number of samples, and  $m$  is the number of sequence parameters of the subsystem.

### 3.4 Coupling coordination degree model

The degree of coordination indicates the degree of mutual coordination of the Taiwan Province economy in the port logistics of Kaohsiung Port in a certain period. Here we introduce the coupling function [11] in physics to solve the problem. The calculation formula is as follows:

$$S1_i \text{ or } S2_i = \sum_{j=1}^m u_j X_{ij} \quad (8)$$

$$C_i = \frac{2\sqrt{S1_i S2_i}}{S1_i + S2_i} \quad (9)$$

Among them,  $C_i$  represents the degree of coordination between port logistics and urban economy under sample  $i$ ,  $S1_i$  represents the total contribution of the urban economic order parameter to its economic development under sample  $i$ , and  $S2_i$  represents the port order parameter of sample  $i$  to its port Total contribution of logistics development. Coupling coordination degree value  $C_i \in (0,1)$ , the closer  $C_i$  is to 1, the higher the coordination degree of port logistics and urban economy.

This paper combines the degree of coupling coordination with port logistics and urban economic contribution to calculate the degree of synergy ( $D_i$ ). The calculation formula is as follows:

$$D_i = \sqrt{C_i \times F} \quad (10)$$

$$\begin{cases} F = \alpha S1_i + \beta S2_i \\ \alpha + \beta = 1 \end{cases} \quad (11)$$

Among them,  $\alpha$  and  $\beta$  are the contribution coefficients of the two subsystems. Combined with the research of Li [12], the importance of port logistics and urban economy is the same, and each takes 0.5. The degree of synergy  $D_i \in (0,1)$ . When  $D_i$  tends to 1, it means that the two subsystems of port logistics and urban economy have a higher degree of synergy, and the components develop coordinately and promote each other; when  $D_i$  tends to 0, it represents There is no connection between the two subsystems, which has the effect of mutual promotion. This paper divides the degree of coordination of the system into four parts according to the value of the degree of coordination. When  $D_i \in (0,0.3]$  the two subsystems are in a low coordination stage, and the development of the two subsystems is relatively isolated, and the city's economic development level is relatively low. The logistics demand is small, and at the same time, the role of port logistics in promoting the urban economy is limited; When  $D_i \in (0.3,0.6]$ , the system is in a moderate coordination stage, and the urban economy begins to shift from self-sufficiency to an export-oriented economy. Trade with the whole country and even the world increases, and it begins to focus on port construction and development. At the same time, with port efficiency The increase in scale and scale has driven the city's economic development; when  $D_i \in (0.6,0.9]$ , the system is in a highly coordinated state, and the two subsystems form a "logistics follow-up mode". The port logistics industry brings greater economic benefits to the city. Promote industrial upgrading and transformation, while the city's economy is at a relatively prosperous level. Urban planners focus on port development and continue to invest in the scale of port construction. When  $D_i \in (0.9,1]$  the system is in an extremely coordinated state, and the city is export-oriented. Develop the core, vigorously develop the port economy, and form an interdependent and inseparable connection between the city and the port. The development of the urban economy promotes the increase in the "volume" of port logistics, but also begins to pursue the optimization of its services and industrial structure. The highly prosperous logistics has also added vitality to the urban economy and guaranteed stable development.

## 4. Case Analysis

### 4.1 Data collection

The data collected in this article about the port logistics of Kaohsiung Port and the economic order parameters of Taiwan Province are derived from the "Taiwan Statistical Yearbook" (2009-2018) and

the official website of Kaohsiung Port Corporation. The summary data is shown in Table 2 and Table 3.

Table 2 Taiwan Economic Order Parameter Data

Year	GDP	Industrial output	Disposable income per capita	Household consumption expenditure	Provincial asset investment
2018	5899.1	147889	339772	811359	37940
2017	5749	139101	331903	811670	35432
2016	5313.6	131456	323490	776811	35622
2015	5256	138029	311256	759647	35131
2014	5305.2	153649	303762	755169	35212
2013	5116	148041	293523	747922	33602
2012	4959.2	148496	285939	727693	33042
2011	4856.7	153162	275984	729010	33829
2010	4461.4	146808	273647	702292	35245
2009	3921.1	113298	265750	705680	25802

Data source: Taiwan Statistical Yearbook

Table 2 Taiwan Economic Order Parameter Data(Continued from the table above)

Year	Total import and export	Government revenue	Foreign investment	Total output value of agriculture, forestry and fish husbandry
2018	49.6	147889	339772	811359
2017	58	139101	331903	811670
2016	49.8	131456	323490	776811
2015	48.1	138029	311256	759647
2014	38.2	153649	303762	755169
2013	33.4	148041	293523	747922
2012	29.1	148496	285939	727693
2011	24.9	153162	275984	729010
2010	21.7	146808	273647	702292
2009	28.1	113298	265750	705680

Table 3 Kaohsiung Port Logistics Sequence Parameter Data

Year	Number of passengers	Container throughput	Cargo handling capacity	Cargo throughput	Number of import and export ships	Free trade zone trade value
2018	117130	1043	45893	11880	35513	80857358
2017	196616	1045	45004	11607	37546	81325570
2016	119521	1027	45638	11662	36525	69539638
2015	207443	1046	45038	11090	34456	59874512
2014	214416	1026	46781	12295	34593	41088083
2013	141119	1059	44145	11503	35256	28564398
2012	119374	978	44030	12076	34503	30014540
2011	125815	964	43764	12393	35733	20906616
2010	144233	918	42307	12495	35312	20453937
2009	117632	858	39720	11243	35024	20086534

Data source: <https://kh.twport.com.tw>

## 4.2 Synergy calculation

According to the data in Table 2 and Table 3, substituting formulas (1)-(7), the order parameter weights of Taiwan Province's economy and Kaohsiung Port logistics development are obtained, as shown in Table 4 and Table 5.

Table 4 Order Parameter Weight of Economic Development of Taiwan Province

Year	Weights
GDP	0.083677807
Industrial output	0.066766839
Disposable income per capita	0.142298842
Household consumption expenditure	0.132632552
Provincial asset investment	0.060151252
Total import and export	0.175032793
Government revenue	0.00025213
Foreign investment	0.244328048
Total output value of agriculture, forestry and fish husbandry	0.094859737

Table 5 Order Parameter Weight of Economic Development of Taiwan

Year	Weights
Number of passengers	0.35153979
Container throughput	0.071699
Cargo handling capacity	0.059514
Cargo throughput	0.096246178
Number of import and export ships	0.12736474
Free trade zone trade value	0.293637

According to equations (2) and (8), the contribution of the port logistics of Kaohsiung Port and the economy of Taiwan Province from 2009 to 2018 can be obtained, as shown in Figure 1.

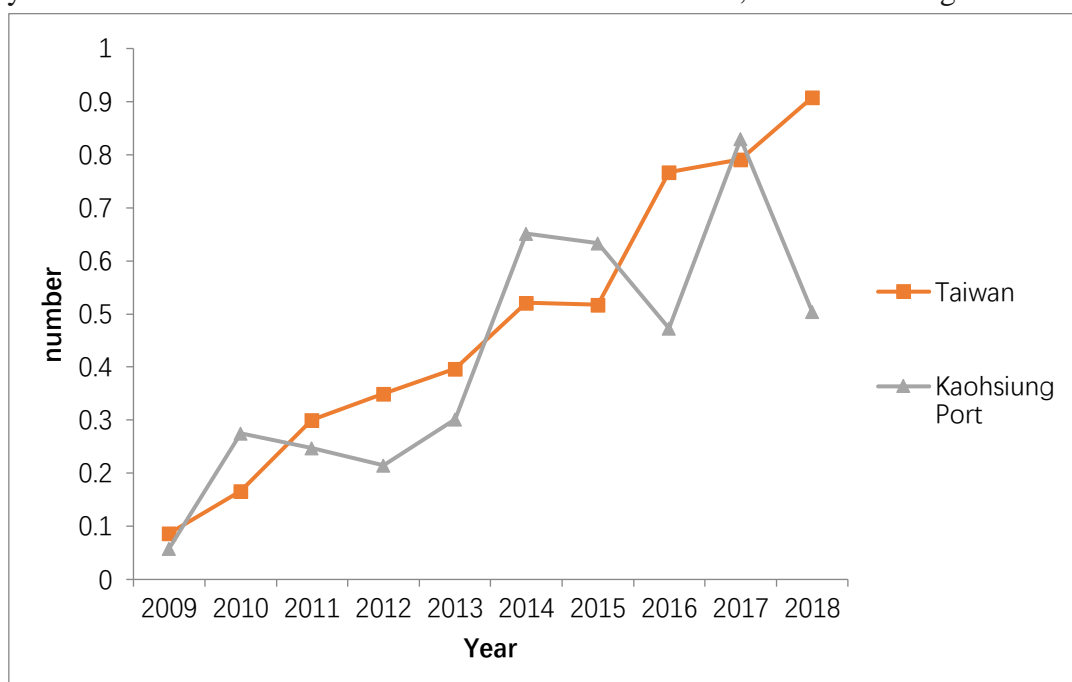


Figure 1. Change curve of contribution degree of Taiwan economy and port logistics development of Kaohsiung Port

It can be seen from Figure 2 that the contribution of economic development parameters of Taiwan Province from 2009 to 2018 showed an upward trend, which was in line with the law of social development, and the government continued to invest in the construction of Kaohsiung Port. The overall development parameters of the port logistics of Kaohsiung Port are also on the rise. However, there have been fluctuations from 2016 to 2018. Combined with the actual situation, it may be related to the Sino-US trade war, the deterioration of Sino-Taiwan relations in 2018, and the bottleneck of the port's own development. Kaohsiung Port's own development Frustrated and unstable contribution to Taiwan Province's economy.

According to formulas (8)-(11), the degree of coordination between the economic development of Taiwan Province and the port logistics development of Kaohsiung Port from 2009 to 2018 is obtained, and the changes are shown in Figure 2.

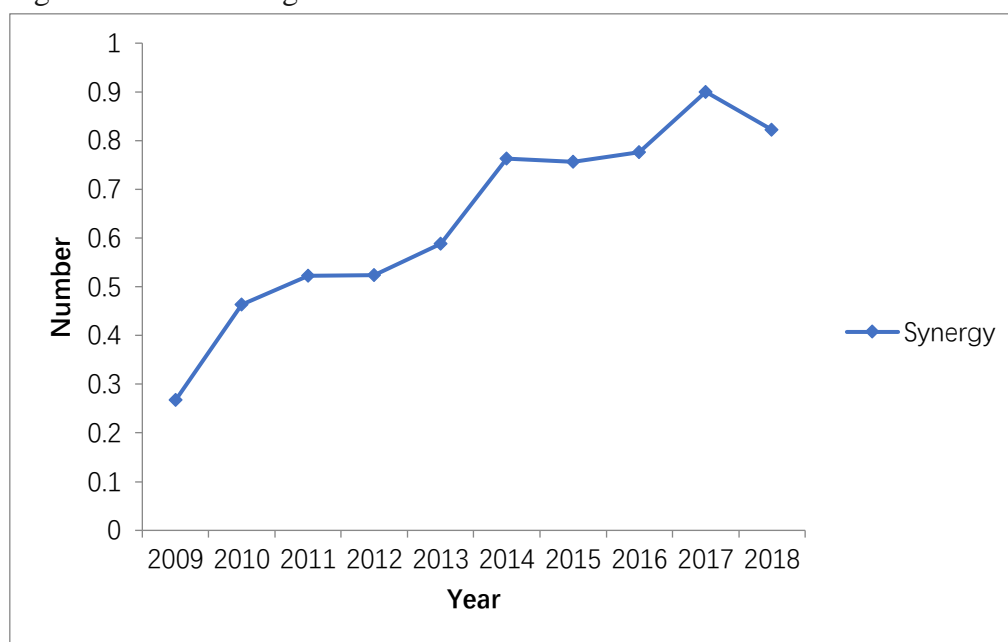


Figure 2. Change curve of coordination degree between Taiwan economy and Kaohsiung Port logistics development

From the analysis in Figure 2, we can see that in the past ten years, the cooperation between the economy of Taiwan Province and the port logistics development of Kaohsiung Port has gradually increased, and the relationship between the two has become closer. This shows that Kaohsiung Port has continued to feed back the economy of Taiwan Province while developing. Promote the further development of Taiwan Province's economy. In 2009, the port logistics of Kaohsiung Port and the economy of Taiwan Province were in a state of low coordination, and the relationship between the two was relatively fragmented. Due to the impact of the global economic crisis in 2008, Taiwan Province, which is an export-oriented economy as a development strategy, was greatly affected. , The economic development level is sluggish, and at the same time the global shipping market is undergoing a sharp decline. The port business has been greatly affected, and it is difficult for Taiwan Province to have a major role in promoting economic development. From 2010 to 2013, the global economy rebounded and foreign trade business gradually recovered. The economic development of Taiwan Province was slowly growing, and the demand for port logistics industry increased. Kaohsiung Port, the largest port in Taiwan Province, increased its revenue and actively promoted the economic development of Taiwan Province. From 2014 to 2017, the two entered a state of high coordination, and in 2017 they were in a state of extreme coordination. This shows that Taiwan Province's export-oriented economic strategy has gradually been achieved. The province's economy and Kaohsiung Port have established a complete mutual promotion system. Development is extremely dependent on the development of the port logistics industry in Kaohsiung Port, and at the same time



the ruling party has also increased investment in the construction of Kaohsiung Port. In 2018, there was a decline between the two. On the one hand, the Sino-US trade war has affected the global foreign trade market to a certain extent. On the other hand, the development of Taiwan Province has entered a bottleneck, and due to political factors, the relationship between the Taiwan Province authorities and the mainland has deteriorated. The trade and tourism exchanges have had an impact on Kaohsiung Port. At the same time, the rapid development of southern mainland ports has formed a competitive relationship with Kaohsiung Port, which has increased the pressure on the development of Kaohsiung Port's port logistics.

In view of the above analysis, on the one hand, Taiwan Province should increase investment in Kaohsiung Port, increase the port scale, develop port intelligence and unmannedness, improve service quality and comprehensiveness, and increase Kaohsiung Port's role as a cargo hub in the Asia-Pacific region. Competitiveness; on the other hand, Taiwan Province should clearly understand the inseparable and mutually reinforcing relationship between Taiwan Province and the mainland, improve cross-strait relations, increase cross-strait trade, and actively participate in the construction of China's One Belt and One Road. Only in this way can Taiwan Province break through the bottleneck of Taiwan's economic development , Adding new development momentum.

## 5. Conclusion

This paper establishes a corresponding synergy model by collecting data on the economic development of Taiwan Province and Kaohsiung Port from 2009 to 2018. This model comprehensively and objectively describes the degree and trend of cooperation between the economic development of Taiwan Province and the port logistics of Kaohsiung Port in the past ten years, and points out the gradual and inseparable relationship between the two. Analyze the reasons for fluctuations in the degree of coordination in combination with current affairs, and give relevant suggestions.

The port-city relationship is a complex geographical system and is subject to a greater degree of influence from the outside world. The order parameter index adopted in this article is relatively broad, so in the future we can further study the order parameter index system, improve the model structure, and analyze port logistics in a more in-depth and objective manner. The relationship with the urban economy.

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