

## Research Article

### Grey Relational Analysis Based on the Joint Development of Regional Economy

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**Abstract:** Based on the scholars' research at home and abroad, This study take comprehensive application of gray correlation analysis model and location entropy to analysis the economic relevance and the linkage between regional economic of the cities in Shandong Peninsula. We obtain the results of the economic linkage in different industries and different cities by the gray relational analysis of data of the Shandong Peninsula cities in 2009 and show the corresponding evaluation and analysis of the economic management. This provide a method and draw upon ideas of new decision-making to the analysis of the regional economic development fully and effectively carried out in future, which has a good theoretical and practical value.

**Keywords:** Gray correlation analysis, joint development, location entropy, the regional economy

#### INTRODUCTION

The regional economy is an economic development concept which is in a certain area of economic development of the interaction of internal factors and external conditions; it is a comprehensive economic development of the geographical concept. In a certain period of time, regional economic development and finance, technology, labor quality, labor costs and many other factors related linkage. Therefore, the regional economic development within the region depends largely on the impact of the various members and relevancy, coordination, joint development, complementary. Joint development of its internal members, largely determines the overall regional efficiency, stable development, to promote each other and promote the effectiveness of regional development.

In view of this, scholars at home and abroad have done a number of fruitful researches on the co-development of regional economic. Zhengping Shen (Zhengping *et al.*, 2007) builds a healthy development directed towards the efficiency of the upgrade to the industrial sector. GU Chao-lin and others have done the research on the construction of space for the spatial layout confusion (Chaolin *et al.*, 2007). Feng Zongxian and others application location entropy and similarity coefficient method measures the similarities and differences between urban agglomeration of the industrial structure (Zongxian and Jianshan, 2005). These have done in-depth study on joint development of a range of economic (Yuanda, 2003; Jefferson *et al.*, 2000; Zhongbao *et al.*, 2011; Zheng and Zhong-Ying, 2011; Xi *et al.*, 2010; Maha *et al.*, 2010).

As a large province which has superiority on development level and scale of development in North

China and across the country, in the Twelfth Five-Year Plan period, Shandong will further promote the implementation of key regional strategies to support the development of special economic zone to speed up and speed up the process of regional integration, particularly, the Shandong Peninsula, which has a good condition on location, resources, with well-coordinated development of regional economic advantage. This study based on Shandong Peninsula, by the application of location entropy and gray relational analysis method, analysis and evaluation the Shandong Peninsula's regional economic linkage and made a corresponding analysis of economic management. And it provides a new analysis idea for the future work.

This study takes comprehensive application of gray correlation analysis model and location entropy to analysis the economic relevance and the linkage between regional economic of the cities in Shandong Peninsula. We obtain the results of the economic linkage in different industries and different cities by the gray relational analysis of data of the Shandong Peninsula cities in 2009 and show the corresponding evaluation and analysis of the economic management. This provide a method and draw upon ideas of new decision-making to the analysis of the regional economic development fully and effectively carried out in future, which has a good theoretical and practical value.

#### SIMILARITY ANALYSIS OF THE INDUSTRIAL STRUCTURE

Generally speaking, the cities in the same region, has a certain similarity in development , with a similar

proportion of tertiary industry, similar to the value and key development projects, Despite the similarity of regional economic development help to improve the regional economy in an industry's overall strength.

However, due to internal development projects and key advantages among its members is similar. There must be competition within the city. Therefore, how to evaluate and analysis the regional and internal similarity is particularly important.

This study with the method of similarity coefficient, Selection data of GDP proportion, analysis the representative cities' similarity of Shandong peninsula.

The similarity coefficient of two regions is:

$$S_{ij} = \frac{\sum (X_{ik} \cdot X_{jk})}{\sum X_{ik}^2 \cdot \sum X_{jk}^2} \quad (1)$$

$i, j = 1, 2, \dots, m, k = 1, 2, \dots, n$

where, i and j denote two different regions,  $X_{ik}$  and  $X_{jk}$  denote k industry in region i and j proportion of GDP.  $S_{ij}$  is the similarity coefficient.  $0 < S_{ij} < 1$ ,  $S_{ij} = 0$ , 1, respectively denote the industrial structure of i and j is completely different and exactly the same. The bigger  $S_{ij}$ , the stronger of the similarity of the two regions' industrial structure.

### INTRODUCTION OF THE LOCATION ENTROPY AND GRAY RELATIONAL ANALYSIS

Although the similarity coefficient can quantitatively assess the similarity of the two industrial structures, but only an overall evaluation, unable to penetrate within the industry, to explore differences in their internal structure, which are also its limitations. To this end, we introduce entropy method and location of gray correlation coefficient, to further determine, using a variety of indicators to arrive the various components of the industrial structure and convergence within the regional economies. As follows:

- Calculate location entropy of various components within the regional economies:

$$LQ_{ik} = \frac{l_k / l_i}{L_k / L}, i = 1, 2, \dots, m, k = 1, 2, \dots, n \quad (2)$$

- where, i denote the certain city, k denote certain industry in the region.  $l_k$  and  $l_i$  denote all industrial staff of industry of k in the i city.  $L_k$  and  $L$  represent all industrial staff of industry of k in the region. In the actual analysis process of this study, we selected the most representative of five

industries in Shandong Peninsula for analysis: Manufacturing, electric power, transportation, wholesale and retail and financial sectors.

- Thus, we can conclude that location entropy matrix:

$$LQ_{ik} = \begin{pmatrix} LQ_{11} & \dots & LQ_{1n} \\ \dots & \dots & \dots \\ LQ_{m1} & \dots & LQ_{mn} \end{pmatrix}$$

Calculate and conclude the location entropy matrix

- Gray relational analysis of the regional industrial structure within the cities

First, determine the reference sequence  $X_0(k)$ , In this study, reference sequence selected as the industrial structure of Shandong Peninsula's Cities. The urban industrial structure as a comparative sequence  $X_j(k)$ .

Find the absolute difference between reference sequence and the compare sequence  $\Delta_i$ ,

$$\Delta_i = |X_0(k) - X_i(k)|$$

Then find the Second-order minimum and the Second-order maximum,  $\min_i \min_k \Delta_i$  and  $\max_i \max_k \Delta_i$ :

$$\begin{aligned} \min_i \min_k \Delta_i &= \min\{\min \Delta_i(1), \min \Delta_i(2), \dots, \min \Delta_i(n)\} \\ i &= 1, 2, \dots, m \\ \max_i \max_k \Delta_i &= \max\{\max \Delta_i(1), \max \Delta_i(2), \dots, \max \Delta_i(n)\}, \\ k &= 1, 2, \dots, n \end{aligned}$$

Calculate the gray correlation coefficient and gray correlation

Gray correlation coefficient:

$$x_i(k) = \frac{\min_i \min_k \Delta_i + s \max_i \max_k \Delta_i}{\Delta_i + s \max_i \max_k \Delta_i}, s \in [0, 1] \quad (3)$$

Based on experience,  $s = 0.5$ .

$$\text{Gray correlation: } r_i = \frac{1}{N} \sum_{k=1}^n x_i(k)$$

### EMPIRICAL ANALYSIS BASED ON JOINT ECONOMIC DEVELOPMENT OF THE SHANDONG PENINSULA

To measure the linkage of regional economic development of Shandong Peninsula. This study selected representative five cities in Shandong Peninsula: Qingdao, Yantai, Weifang, Weihai and Rizhao. Four of the five cities located in coastal areas, have a strong ability to transit trade and transport and good momentum of development, with strong economic strength, in the Shandong Peninsula City and has a

Table 1: City correlation coefficient

	Qingdao	Yantai	Weifang	Weihai	Rizhao
Qingdao		0.999791	0.999782	0.999794	0.999779
Yantai			0.99978	0.999789	0.99978
Weifang				0.999782	0.99977
Weihai					0.999781
Rizhao					

Table 2: Shandong Peninsula urban location entropy matrix

	Manufacture	Electric power	Transportation	Wholesale and retail	Financial sector
Qingdao	1.095561	0.035997	0.106038	0.061733	0.06662
Yantai	22.20079	0.884871	1.532724	1.469519	1.817147
Weifang	11.60188	0.680537	0.320253	1.33196	0.658702
Weihai	13.92392	0.82951	0.743926	1.283766	0.711009
Rizhao	11.50386	0.787936	2.20622	1.575871	1.260697

Table 3: The order of the gray correlation of industrial structure of cities

Qingdao	Yantai	Weifang	Weihai	Rizhao
0.54139	0.591336	0.67104	0.746097	0.830804

Table 4: The sort of gray correlation in different industries

Manufacture	Electric power	Transportation	Wholesale and retail	Financial sector
0.527971	0.671947	0.702509	0.717603	0.760636

strong representation. The data we selected are from the "China City Statistical Yearbook" (2001-2009). Most of which is the data of 2009.

According to (1), we obtain the correlation coefficient of the 5 cities and other cities in the Shandong Peninsula, as shown in Table 1.

From Table 1: the correlation coefficient between the Shandong Peninsula's cities is great, indicating a high correlation with similar industrial structure and internal economic structure, This also demonstrates that there will be some internal sense of competition in the development process, will have a rival on limited funds, technology, talent, markets, which is bad for the overall development of the regional economy. How to make some differences in industrial structure among the various cities within the region, format complementary advantages, allocate resources; format industrial cooperation, mutual benefit, is the important aspect needed in future work to address.

According to (2), we can get location entropy matrix, as shown in Table 2.

By analyzing the location entropy matrix: in Shandong Peninsula's cities, the manufacturing location entropy is much higher than other industries, which account for the actual situation that the secondary industry is the most important proportion of GDP in Shandong Province. Shows the manufacturing sector is still pillar in Shandong Peninsula and it is still a traditional development model. Except manufacturing, we see that, Yantai and Rizhao transportation, wholesale and retail, financial industry location entropy larger part of the momentum of rapid development, the development of good prospects. And Qingdao, Weifang and other cities in some sectors of the location of other entropy value is less than 1, the momentum has slowed, indicating that is in transition, need to improve.

According to (3), we obtain the gray correlation coefficient and gray correlation degree of Shandong Peninsula's Cities, as shown in Fig. 1, 2 and Table 3, 4.

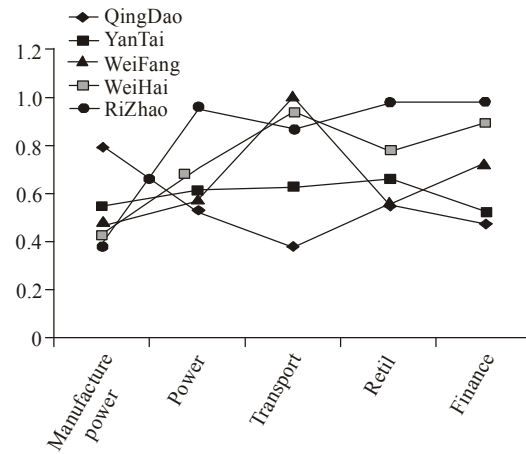


Fig. 1: The similarity of the urban industrial structure

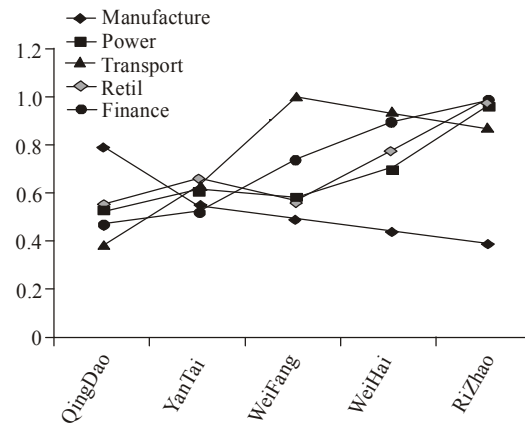


Fig. 2: The similarity of the cities in Shandong peninsula

It can be seen from Fig. 1, the urban industrial structure has some similarities, the gray correlation is given in Table 3. Shandong Peninsula industries

similarity was ranked from small to big: Qingdao, Yantai, Weifang, Weihai City, Rizhao. Similarly, from Fig. 2: the similarity of different industries is different. Table 4 shows the similarity of its sort, manufacturing is the smallest.

This shows that, although the manufacturing share of the largest GDP in the Shandong Peninsula City location maximum entropy, but because of uneven development around the

Coastal cities and inland cities, the focus of development is different and the city's own manufacturing capacity is different due to the uneven development, resulting in its development is very uneven. To Qingdao as the representative of the more developed cities, the capacity of use and manufacture sophisticated equipment is much higher than other cities. Followed by wholesale and retail electricity power. Transportation industry with the highest association, to the most prominent is the city of Weifang. This difference is related to the urban areas, the Weifang's transportation is extremely convenient, which is important goods distribution center of Shandong Peninsula. The highest correlation is consistent with the actual situation.

From the above analysis, we can see: Shandong Peninsula City, there is a high correlation of its internal, while there are differences of correlation in different cities and different sectors of the industrial structure in the development process, It will have an competition on limited funds, technology, personnel and market. As for its different intrinsic correlation, we have the analysis through the degree of urban development in the peninsula, due to the different levels of development within various cities, in some industries, the degree of correlation is also different, Such as the development of Qingdao, with its high technological level and better ability to ahead the city of Weihai, Rizhao on manufacturing sector, which has the largest similarity on industrial structure and become the industry leader in the peninsula area. Meanwhile, analysis from the correlation of industrial structure, we should also see that in some industries, such as transportation, the Shandong Peninsula has a good location and convenient transportation, which has the largest industrial gray related degree. In planning for the future development of the process, it can be developed to increase the overall regional influence.

## CONCLUSION

Coordinated development of regional economy, is the future path of economic development and the inevitable trend of development, how to integrate the advantages of regional economic resources, coordinate the pace of development within the city, highlighting the region to maximize the advantage, to earn the

resources and markets in the increasingly fierce competition, is the major issues placed in front of decision makers in future. Based on the location entropy and gray correlation analysis method, this study systematic analysis of the Shandong Peninsula City intrinsic relevance and correlation differences. Get the linkage between economic from different industries and different cities. The result shows that the Shandong Peninsula City to a high internal correlation and Qingdao and transportation industries with the largest city and industrial structure of gray correlation respectively. And gives the analysis of economic management. Provides a theoretical basis and the new direction of thinking for further elaboration and analysis of regional development, which has some theoretical and practical significance.

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