

Analysis of Grey Correlation Degree between Logistics Industry and Economic Development in Shandong Province P.R.China

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Abstract

In this paper, an empirical grey correlation analysis is used to confirm the correlation between the logistics industry and economy in Shandong. The result shows that there is stronger correlation and coupling, and the logistics industry is chromos with economy in Shandong. All of these are to give some advice on synergetic development between the logistics industry and economy.

Key words: logistics industry; grey correlation analysis; logistics effectiveness.

1. Introduction

In recent years, the rapid economic development and solid accumulated economic fundamentals of Shandong Province have obvious advantages and play a strong economic effect in ecology, resources, location and cost etc. Logistics industry that is hailed as the accelerator of the economic development as well as the third profit source of enterprises is the artery of national economic development and basic industry, and its development level is one important sign which can measure the modernization level and economic strength on a country or a region. At present, China's economic development has entered a new normal, and under the new normal how to achieve the rise of Shandong, and how to optimize the industrial structure of the Shandong, the logistics industry will be breakthrough to speed up the development of Shandong economy.

Revant research in China includes two types: relationship research and coordination research. Long [1] analyzed the situation of logistics and economic growth on the Yangtze River Economic Belt. Firstly, to qualitatively discuss relations between those, secondly, to quantitatively analyze the relationship between those by means of Logistic function model, finally, to put forward some countermeasures and suggestions for the development of logistics in the region of the Yangtze river economic belt. Shen,etc.[2] found that there is a long-term stable equilibrium relationship between logistics and economic growth in the Dalian port, and there is a one-way causal relationship between port logistics and economic growth, and variance contribution rate of the port logistics to economic growth is low. Wang [3] explored the three factors to affect the logistics capacity by using principal component analysis method, and on this basis, to draw the conclusion that there were a long-term equilibrium relationship among the three factors as well as between logistics and economic growth. Gao [4] established VAR model, and analyzed linkage relations between logistics industry and economic growth by pulse functions.

The results showed that the development of logistics industry should promote economic growth, and the economic growth in Guangdong Province led to the rapid development of the logistics industry, but the promoting effect of economic growth was not very significant because of the logistics industry in Guangdong Province was still in the early stages of development. The coordination degree of logistics industry and economic growth in the three provinces of northeast China was calculated by using the coordination degree model, and the results showed that there were some differences in the coordination degree of the three provinces in the northeast of China. From the present situation of research on domestic and foreign, It is paid more attention on the coordination development of the logistics industry and economic growth, and have achieved some results, but there are still some shortcomings such as single calculation method and more qualitative research, etc.. In this paper, we construct the grey correlation model and analyze its correlation the relationship, and puts forward the concrete suggestions from many aspects, based on the data of logistics industry and economic growth of 2005-2014 in Shandong Province.

2. Steps to build grey correlation model

Grey correlation analysis is a kind of analysis method to measure the degree of association degree based on the similarity or dissimilarity of form and trend between the factors. Taking into account randomness and uncertainty of the logistics system and economic system, and the relationships of the logistics industry and economic growth being changing in different periods, the small sample data are used in the development of logistics in recent years, which reflected information is not exact, not comprehensive, and with grey. Therefore, we can calculate the correlation degree of each index in the system and each index of another system, but also calculate the main stress factors to be affected by another system by selecting grey correlation model, so the other methods are not compared to it. Grey correlation analysis method is according to the similarity degree of sequence geometry curve to determine the strength of relations among the sequences, the closer the curves are, the greater the degree of correlation among the sequences are, conversely, the smaller it is. If the trend of the two sequence changes is consistent, that is, the degree of synchronization is higher, and then it indicates that the correlation degree of the sequences is higher. The analysis steps of grey relational are as follows:

2.1 To determine the analysis sequence

To establish the original sequence of dependent variable reference sequence and independent variable comparative sequence. A data sequence that reflect the features of the system behavior is called dependent variable reference sequence, a data sequence that is constitute of various factors affecting system behavior is called independent variable comparative sequence. $X_0 = \{x_0(k) | k = 1, 2, \dots, n\}$ Denotes the reference sequence, and $X_i = \{x_i(k) | k = 1, 2, \dots, n\} (i = 1, 2, \dots, m)$ denotes the comparative sequence, where X_i denotes value of i at time k .

2.2 To apply dimensionless method to data

The dimensionless treatment refers to a method that handles variable sequence in order to ensure the reliability of the analysis results, when the original variables have different dimensions or magnitude. The factor sequences form a new matrix sequence after the dimensionless. There are usually equalization method and initialization method for the dimensionless method. In this paper, we select initialization method and formulas for the dimensionless. The initial value of the calculation formula is as follows:

$$X'_i = \frac{X_i}{x_i(1)} = \{x'_i(1), x'_i(2), \dots, x'_i(n)\}, x_i(1) \neq 0, i = 0, 1, 2, \dots, m.$$

2.3 Standardization Processing

The corresponding difference list will be produced, and calculate the deference as well as absolute value on the comparative sequence and the reference sequence after standardization processing. A list of the corresponding difference include: with the reference sequence difference (absolute value) $\Delta_i(k) = |x'_i(k) - x'_0(k)|$, The maximum difference the minimum difference on two stages:

$$\Delta(\max) = \max_i \max_k \{\Delta_i(k)\} \text{ and } \Delta(\min) = \min_i \min_k \{\Delta_i(k)\}.$$

2.4 To calculate relative coefficient

$$\xi_i(k) = \frac{\Delta(\min) + \rho\Delta(\max)}{\Delta_i(k) + \rho\Delta(\max)}, \rho \in (0,1); k = 1, 2, \dots, n, i = 1, 2, \dots, m$$

Where ρ is a distinguishing coefficient, which is used to control the effect due to the $\Delta(\max)$ being large and to lead to distortion of the correlation coefficient, in general, we select $\rho = 0.5$.

2.5 To calculate correlation degree

Correlation degree reflect the degree of correlation between the reference sequence and the comparative sequence when there exist multiple levels of influence factors, we can take one layer as a reference sequence, and calculate together with other comparative sequence, and finally form an association matrix. The formula for the calculation of correlation degree is as follows:

$$r_i = \frac{1}{n} \sum_{k=1}^n \xi_i(k) (k = 1, 2, \dots, n).$$

2.6 To arrange its order from high to low according to the size of the correlation degree

If the value of correlation degree is closer to 1, then it becomes more and more relevant between them. When $\rho = 0.5$, if According to experience, when correlation degree of the two sequences is greater than 0.7, then it means that there is a significant correlation between them. In this paper, we can specify that the linkage ability is weak when $0 < r_i \leq 0.5$, and that linkage ability is strong when $0.5 < r_i \leq 0.7$, and that linkage ability is stronger when $0.7 < r_i \leq 0.9$, and that linkage ability is stronger when $0.9 < r_i \leq 1$.

3. Correlation analysis of logistics industry and economic growth in Shandong Province

In the calculation of correlation degree of logistics industry and economic growth, the indicators for the logistics industry and the economic development is involved. Based on the scientific principle, practical principle and integrity principle, we will establish the following indicators: The indicators of development of the logistics industry include: Shandong highway mileage X_1 (kilometer), Shandong railway mileage X_2 (kilometer), logistics freight volume X_3 (tons), logistics freight turnover X_4 (million tons kilometer), total fixed asset investment X_5 (10 thousand yuan), the added value of postal and telecom sector X_6 (10 thousand yuan), the numbers of truck in road transport X_7 (one truck), the added value of logistics industry X_8 (10 thousand yuan), logistics professionals in Shandong X_9 (10 thousand people), where X_1, X_2, X_5, X_7 and X_9 are called the logistics supply indicators; X_3 and X_4 are called the logistics demand indicators; and X_6 and X_8 are called the logistics effectiveness indicators. The indicators of economy growth include: Shandong GDP Y_1 (billion yuan), the added value of primary industry Y_2 (billion yuan), the added value of second industry Y_3 (billion yuan), the added value of third industry Y_4 (billion yuan), total volume of social retail consumer Y_5 (billion yuan), where Y_1 is called the general economic quantity indicator; Y_2, Y_3 and Y_4 are called the economic structure indicators; and Y_5 is called the economical potential indicator.

The various index are selected in statistical yearbook of Shandong Province statistical network. We calculate its correlations degree on the basis of logistics industry and the economy as a reference sequence, respectively, which we calculate it by matlab7.1 and programming and combining with table 1.

Table 1: The value of evaluation indicators in 2005-2014

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
X_1	80132	204911	212236	220687	226693	229858	233181	244586	252785	259514
X_2	3402	3405	3379	3329	3620	3833	4177	4306	4397	4546
X_3	147999	167511	198507	247489	284463	298055	314962	330270	344401	260983
X_4	558286	665521	642854	1010234	1095569	1174705	1258364	1099119	1026088	817690
X_5	434704 1	466377 1	5633819	7850746	1018091 2	1338804 8	1395680 9	1591001 0	1983096 1	2192728 5
X_6	675467 0	928687 7	1179935 7	1426202 6	1586785 4	1920900 0	7236000	7976000	8637000	1067848 9
X_7	481752	482766	504923	564382	670759	876023	1007184	1016174	1105405	1027673
X_8	968.64	1212.3 3	1334.62	1721.24	1742.33	1971.00	2328.38	2516.19	2065.16	2326.25
X_9	213.2	218.3	226.7	231.9	245.1	254.4	254.3	256.4	269.8	271.4
Y_1	18367	21900	25777	30933	33897	39170	45362	50013	55230	59427
Y_2	1964	2139	2509	3003	3227	3588	3974	4282	4566	4798
Y_3	10479	12574	14648	17572	18902	21238	24017	25736	27443	28788
Y_4	5925	7187	8620	10359	11768	14343	17371	19996	23222	25840
Y_5	6167	7217	8607	10659	12363	14620	17155	19652	22295	25112

Table 2: The value of correlation degree obtained on the basis of the indicators of economy growth as the reference sequence in 2005-2014

	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9
Y_1	0.6714	0.5723	0.8089	0.7746	0.6675	0.6057	0.7057	0.8588	0.5835
Y_2	0.5168	0.6413	0.8756	0.7781	0.6534	0.5996	0.8771	0.8367	0.6547
Y_3	0.6249	0.6305	0.8836	0.8266	0.6669	0.6539	0.7947	0.9121	0.6405
Y_4	0.7187	0.6093	0.7684	0.7591	0.8392	0.6743	0.6935	0.7916	0.6182
Y_5	0.7182	0.6057	0.7813	0.7643	0.7985	0.6602	0.6990	0.8010	0.6152
sum	3.2500	3.0591	4.1178	3.9027	3.6255	3.1937	3.7700	4.2002	3.1121
mean	0.6500	0.6118	0.8236	0.7805	0.7251	0.6387	0.7540	0.8400	0.6224

3.1 Analysis of stress factors in the development of the logistics industry to economy in Shandong Province

From table 2, it can be seen that all the indicators of logistics to economic growth in Shandong province indicate a strong correlation above. The largest logistics index factors that affect the economy of Shandong is the added value of logistics industry, followed by logistics freight volume, logistics freight turnover and the numbers of truck in road transport. The linkage ability of these factors and economic is stronger, which has a big impact on improving the level of economic development in Shandong Province. But comparing to the highway mileage, the railway mileage has a low impact on economy in Shandong, in addition the ordering of correlation degree of quantity and quality of logistics personnel and economy is lower in all logistics indicator in Shandong Province.

In all correlation degree, r_{38} is the biggest, and the relation for logistics industry and the secondary industry in share of GDP is the most closely related, and the added value of logistics industry do the largest contribution to the second industry. Especially, the manufacturing industry in the second industry, from transport of raw materials and warehousing to distribution of manufactured goods, are inseparable from the support of logistics activities. Moreover, the growth of logistics industry indicate that the increasing of all kinds of logistics activities, and improving the efficiency, which can better meet the logistics needs of the secondary industry. r_{21} is the smallest, that is, the related degree of the logistics industry and the primary industry is medium, and whose interactions are not very obvious.

From the influence of the logistics industry to Shandong's economic, the correlation of logistics supply, logistics demand, logistics effectiveness and global economic has averaged 0.6401, 0.7918 and 0.7323, respectively, which correlation degree are relatively strong and there exists the obvious interactions among them. In contrast, the relation of logistics demand and the global economy is most closely, and it means that raising the level of the logistics needs is the largest contribution to the economic growth of Shandong province. The logistics industry has a saying: "there exists something, only flow", and "only flow increasing if something increasing". The logistics industry belongs to the service industry, which the increasingly strong logistics service demands promote the development of the logistics industry in Shandong province. On this basis, it promotes the rapid growth of the economy in Shandong province.

From the influence of the logistics industry to the economic structure, the correlation of logistics supply, logistics demand, logistics effectiveness and the economic structure has averaged 0.6786, 0.8152 and 0.7447, respectively, which the relationship of the logistics demand and the economic structure is most closely with increasing demand for the freight volume and turnover volume. According to the traditional industry, the logistics industry is belongs to the third industry. The growth logistics freight volume and freight turnover can promote the development of the second industry, an disproved the output value of the third industry, and increase the proportion of the second and the third industry in the GDP of Shandong Province, and promote the development of related industries, and promote reasonable adjustment for the Shandong economic structure under the new normal. This is coincided with the transformation of economic growth and vigorously developing the third industry policy.

From the influence of the logistics industry to the economic potential, the correlation of logistics supply, logistics demand, logistics effectiveness and the economic potential has averaged 0.6873, 0.7728 and 0.7306, respectively. It can be seen that the logistics demand is relatively large logistics factors which has influence on the economy potential. So, expanding logistics demand can not only tap the economic potential, but also enhance the potential for economic development in Shandong province. Today, China is in the period of post industrialization, and with the acceleration of urbanization process, because of accelerating social division of labor and specialization process as well as accelerating the separation of production and consumption activities, the demand of the logistics activities which the production has close relationship with consumption will continue to rise. Because the logistics demand has close relationship with economic, what improve the demand ability of logistics industry can enhance contribution to the economy of Shandong province; that is, the level of demand for logistics industry is a stress factor for the economic development of Shandong province.

Table 3: The value of correlation degree obtained on the basis of the indicators of logistics industry as the reference sequence in 2005-2014

	Y_1	Y_2	Y_3	Y_4	Y_5
X_1	0.6198	0.4712	0.5281	0.5793	0.5979
X_2	0.6586	0.7377	0.6852	0.6053	0.6207
X_3	0.8404	0.9062	0.8938	0.7452	0.7718
X_4	0.8209	0.8430	0.8519	0.7509	0.7686
X_5	0.7148	0.6649	0.6876	0.8169	0.7880
X_6	0.6721	0.6886	0.6904	0.6568	0.6590
X_7	0.7291	0.8962	0.7900	0.6312	0.6560
X_8	0.8587	0.8467	0.9002	0.7313	0.7543
X_9	0.6715	0.7507	0.6864	0.6182	0.6337
Sum	6.5859	6.8052	6.7136	6.1351	6.2500
Mean	0.7318	0.7561	0.7456	0.6817	0.6944

3.2 Analysis of constraint factors in the economy growth to the development of the logistics industry in Shandong province

From table 3, we can be seen a relatively strong correlation degree for the various index of economy and the development of the logistics industry in Shandong, which there is significant coupling between logistics industry and economic growth. What the logistics industry has bigger influence to the first industry, which is the basic industry of Shandong province. In recent years, It is accelerated for the development of agriculture which promote the development of the logistics industry because the benefit farming and support agriculture policy are implemented on agricultural in Shandong province. At the same time, in all of the correlation, r_{32} is the biggest, which reflects that Shandong province is still a big agricultural province. The rapid development of the first industry in Shandong province call for speeding up the velocity of circulation of agricultural products and increasing corresponding flow capacity so that the demand for logistics is added the scale of logistics industry is expanded in Shandong province. But r_{12} is the smallest, which shows that the correlation degree of the first industry and the Shandong highway mileage is weak, and the development of agriculture has very small influence on the growth of Shandong highway mileage.

From the influence of economy to the logistics supply, the correlation of the total economy, economic structure, economic potential and the logistics supply has averaged 0.6788, 0.6766 and 0.6593, respectively. Obviously, the correlation of the total economy, the economic structure and the logistics supply are consistent. The rapid development of economy can play a great role in promoting improvement of logistics infrastructure. Under this background, It is improved for the management ability of logistics enterprise so that supply of the whole logistics industry will greatly improve. From the influence of economy to the logistics demand, the correlation of the total economy, economic structure, economic potential and the logistics supply has averaged 0.8307, 0.8318 and 0.7702, respectively, which shows a strong correlation, and reflects significant interaction of the economic growth and the logistics demand. As a result, comparatively speaking, the relationship between the economic structure and the logistics demand is the most closely, which also reflects that three industrial structures in Shandong province have a good foundation for the development from the side.

Create a good environment for the development of logistics industry, strengthen the scale of the development of logistics industry, improve the infrastructure for the development of the logistics industry, and enhance logistics industry demand. From the influence of economy to the logistics effectiveness, the correlation of the total economy, economic structure, economic potential and the logistics effectiveness has averaged 0.7654, 7523 and 7067, respectively. The rational proportion of economic structure can promote economic rapid growth, however, rapid economic growth can produce a powerful impetus to the logistics, and stimulate increasing demand for logistics, which can correspondingly improve the total value of logistics industry.

In general, the correlation is significant for indicators $Y_1 - Y_5$ of representing the level of the economic development and selected nine factors of representing the level of development of the logistics industry, which the relevant factors that affect the logistics industry in Shandong Province ranked from high to low are as follows: the added value of primary industry, the added value of second industry, the general economic quantity, the total volume of social retail consumer and the added value of third industry. Obviously, the correlation degree of the economic structure factor and the logistics demand is the biggest. What the economy develops to a certain level can bring the increase of the product, improve the people's consumption level, and drive something to flow, so as to improve the development of logistics industry.

If the economic development of Shandong province would achieve this level, the rational development of economic structure is very necessary. The rational development of economic structure has a huge impact on the logistics industry, therefore, from a certain extent, the rational factors of economic structure has become the constraint factor of the development of logistics industry in Shandong province. In short, the relationship between logistics demand and economic potential is very close; the coupling effect between logistics effectiveness and economic structure is relatively strong.

4. Policy and recommendations to promote the linkage of economic growth and the development of the logistics industry in Shandong province

4.1 To optimize the industrial structure so as to lay a solid foundation for the development of logistics industry

Why is the overall quality and benefit not high in the development process of economy of Shandong province? the major reasons are not high level of industrial structure, a big gap between urban and rural development and imbalance relation of investment and consumption in Shandong province. In general, the unreasonable economic structure restricts the development of economy. Firstly, to optimize the primary industry. Because Shandong province is a major agricultural province, the optimization and upgrading of the agricultural industry can promote economic development, and improve the logistics demand of Shandong province. Secondly, to energetically develop the third industry. The development of the third industry can accelerate the process of industrialization and modernization, promote the optimization and upgrading of the industrial structure, promote employment, and promote the upgrading of the industrial process. At the same time, the development of the third industry will drive the development of modern logistics industry, so as to promote rapid development of the logistics industry on the solid foundations. Thirdly, to speed up the development of the second industry. For example, the manufacturing industry of the second industry, from transportation, warehousing and distribution of the raw materials to finished products distribution and handling, it is needed support of strong logistics capabilities, in addition the status of manufacturing industry for Shandong province has been significantly improved, which the service level of logistics demand is increasing, and the dependence is more and more big. So the development of the second industry, can not only increase the demand on the logistics industry, but also promote the development of related industries, and promote the optimization and upgrading of industrial structure the Shandong province.

4.2 to improve the global economy, to stimulate the logistics demand

The rapid growth of the economy has a huge demand for logistics, so as to stimulate the investment in logistics, and improve the logistics supply capacity. Shandong province should be efforts to build the Shandong peninsula blue economic zone, Lunan economic belt, and Northern economic zone. It should take measures on integration of regional resources, vigorously implementing the development of high-efficiency agriculture, further tapping tourism resources, and expanding the level of opening, so as to promote the Shandong economic development to step a new level, enhance the economic strength, resulting in huge demand on logistics industry, and promote logistics industry with the economic rapid development and continue to move forward.

4.3 to strengthen the construction of logistics infrastructure, to improve the logistics supply capacity

The logistics business cannot do without an efficient logistics infrastructure, including roads, railways, waterways, and warehouse etc... From the above analysis, it can be seen that correlation of Shandong province railway mileage and economy is low, so the process of the development of the logistics industry, Shandong also want to break through the bottleneck of logistics infrastructure, promote the logistics industry development faster and better into the fast lane.

We should strengthen the logistics infrastructure construction in Shandong province; further strengthen the construction of highways and railways so that the logistics infrastructure meets the requirement of economic development and development of modern logistics in Shandong province.

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Reference

- Y.Long, empirical research on the relationship between logistics and regional economic growth of the Yangtze River Economic belt, huadong normal university, 2014.
- Q.W.Shen, Z.L.Han and J.K.Guo, Study on the relationship between port logistics and economic growth in the city-- taking Dalian as an example, geography and geo-information science, 2013(1):69-73.
- Z.D.Wang, empirical analysis of factors on influencing the development of the logistics industry and economic growth, china university of science and technology, 2014.
- X.L.Gao, A.H.Wang and X.C.Fang, An empirical study on the relationship between regional logistics and regional economic growth in Guangdong,Industrial engineering, 2012(1):60-65.
- C.X.Zhou, study on the coordination of logistics and economic growth in northeast china, logistics technology, 2014(9):242-244.
- J.L.Deng, grey prediction and grey decision, Wuhan: Huazhong university of science and technology press,2002.
- S.F.Liu, grey system theory and its application, Beijing:sciencepress, 2010.