

A Study on the Measurement of the Geo-Economic relations Between Luoyang and Other Cities in the Central Plains Economic Zone

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Abstract: In 2018, the development plan of the Central Plains Economic Zone was upgraded to a national regional development strategy, providing strategic opportunities and broad prospects for the economic development of the region. Luoyang, as one of the core cities of the Central Plains Economic Zone, how to integrate into the Central Plains Economic Zone with high quality has an important impact on the city's economic and social development. By measuring the geo-economic relations, this paper makes a quantitative analysis of the geo-economic relations between Luoyang and 17 other prefecture level cities in the Central Plains Economic Zone by using the Euclidean distance method. The results show that the geo-economic relations between Luoyang and other prefecture level cities in the Central Plains Economic Zone is relatively normal, and the complementary geo-economic relations is slightly greater than the competitive geo-economic relations. Therefore, in the future development cooperation, we should strengthen the complementary geo-economic relations, handle the competitive geo-economic relations, and strengthen the geo-economic cooperation.

Keywords: Geo-Economic Relations; Euclidean Distance; Central Plains Economic Zone; Luoyang City

1. Introduction

"Geo economy" was first proposed by E.N. Luttwak, an American scholar, who believed that with the collapse of the world's two poles, international competition has changed from military and political competition to mainly occupying the world's economic territory^[1]. The geo-economic relations is based on the differences in resource endowments, economic levels, industrial structures, etc. between economies, reflecting the interaction and regularity between resources, markets, capital, labor and other economic operation factors and geographical locations^[2]. At present, the research on geo-economic measurement methods has been relatively mature, and most of them use the traditional Euclidean distance method to conduct quantitative research on geo-economic relations. Many scholars use the Euclidean distance method to measure the geo-economic relations, but most of them measure the geo-economic relations between countries and provinces. Few of them measure the geo-economic relations between provincial cities. Therefore, studying the geo-economic relations between provincial cities can provide a theoretical basis for formulating the economic development strategy of each city, thus promoting the economic development and prosperity of the city.

The Central Plains Economic Zone is an economic region with Zhengzhou Metropolitan Area as the core and Central Plains Urban Agglomeration as the support, covering Henan Province and surrounding areas. It is a key development area in the national main functional area planning. The Central Plains Economic Zone has an important strategic position in the overall development of the country due to its important geographical location, developed transportation, huge market potential and profound cultural heritage. (For the convenience of data processing, this paper only selects 17 prefecture level cities in Henan Province as the research objects).

2. Data sources and research methods

2.1 Data source

This paper takes 17 prefecture level cities in Henan Province of the Central Plains Economic Zone as the research object, and selects the gross regional product, total investment in fixed assets, total disposable income, R&D expenditure, total transportation of goods by road, and actual use of foreign capital in the socio-economic data as indicators. The data comes from Henan Statistical Yearbook 2021.

2.2 Research methods

According to the geo-economic relations of cities including the Central Plains urban agglomeration, the geo-economic relations can be divided into competitive relations and complementary relations. The competitive relations is divided into general competitive relations and strong competitive relations, and the complementary relations is divided into general complementary relations and strong complementary relations. The former is because of the similarities between cities in economic structure, physical and geographical conditions, resource status and other aspects, which makes different cities have the same competition and desire for resources, talents, technology, market and capital in economic development. The latter refers to that different cities can promote each other, exchange what they need and develop together^[3]. Because the economic distance is affected by the difference of selected economic indicators, it needs to be standardized, so the value range of Euclidean distance is also expanded to a negative value. The calculation formula is as follows:

Assume $A'_0, B'_0, C'_0, D'_0, E'_0, F'_0$ are the standard values of the six comprehensive indicators A, B, C, D, E, F of the study city, and the formula for calculating the actual distance from other cities is:

$$Z_i = \sqrt{(A'_i - A'_0)^2 + (B'_i - B'_0)^2 + (C'_i - C'_0)^2 + (D'_i - D'_0)^2 + (E'_i - E'_0)^2 + (F'_i - F'_0)^2} \quad (1)$$

Where, i is the serial number of other cities except the study city, and $A'_i, B'_i, C'_i, D'_i, E'_i, F'_i$ are the standardized values of A, B, C, D, E, and F.

It indicates the economic distance between two cities. The greater the distance, the greater the difference and the stronger the complementarity between the two cities; The smaller the difference between the two cities, the stronger the competition.

2.3 Index selection and calculation

A=total road freight volume of a region/total freight volume of the region; B=R&D expenditure amount of a region/GDP of the region in the current year; C=total investment in fixed assets of a region/GDP of the region in the current year; D=total disposable income of a region/GDP of the region in the current year; E=GDP of the second industry in a region/GDP of the tertiary industry in the region; F=the actual amount of foreign capital used by a region in the current year/the region's GDP in the current year.

2.3.1 Standardized value processing of indicators

Because the selected indicator values have different representativeness and different unit dimensions, it will affect the comprehensive measurement of geo-economic relations. By standardizing the original data of six comprehensive indicators, A, B, C, D, E, F, we can get the dimensionless data to compare indicators between regions. The calculation formula is:

$$X' = (X_i - \bar{X})/S_X \quad (2)$$

$$S_X = \sqrt{(X_i - \bar{X})^2/n} \quad (3)$$

\bar{X} is the average value of this column of data; S_X is the standard deviation of X series data; n is the number of samples of each series of data; The calculation method of A', B', C', D', E', F' is the same as the formula.

2.3.2 Euclidean distance

After the standardized values are obtained, the Euclidean distance between Luoyang and other 17 prefecture level cities in the Central Plains Economic Zone is calculated by formula (1), and the results are shown in Table 2.

Table 1 Geographical Location Weights of Luoyang and Other Cities in the Central Plains Economic Zone

Road distance	weight	Prefecture level city
$S < 200$	2	Jiyuan, Jiaozuo, Pingdingshan, Zhengzhou, Sanmenxia, Xuchang
$200 \leq S < 300$	1.6	Kaifeng, Nanyang, Luohe, Xinxiang, Hebi, Zhoukou
$300 \leq S < 400$	1.2	Zhumadian, Anyang, Puyang, Shangqiu, Xinyang

2.3.3 Standardize and adjust European distance

In order to make the results easy to identify, the European distance needs to be standardized, and the processing formula is:

$$D'_i = (D_i - \bar{D}_i) / S_{di} \quad (4)$$

$$S_{di} = \sqrt{\frac{\sum (D_i - \bar{D}_i)^2}{n}} \quad (5)$$

Where \bar{D}_i is the i average European distance between the city and all other cities and the standard deviation of the European distance between the city and all other cities. The positive and negative of D'_i indicates the complementary competition between the two cities. D'_i is positive, indicating that there is a complementary relations between the two cities. The greater the positive value, the stronger the complementary relations between the two cities; if D'_i is negative, it indicates that the two cities are in competition. The greater the absolute value of negative value, the stronger the competition between them^[4].

Due to the different distance between Luoyang and other cities in the Central Plains Economic Zone, the distance will have a certain impact on the spatial flow and allocation of resources between cities, and thus play a role in strengthening or weakening the competition or cooperation between cities. Therefore, the geographical location weight W_i is introduced to adjust the standardized D'_i , where W_i is calculated according to the previous highway mileage, and the specific calculation formula is in the empirical analysis section. The adjusted weighted distance is recorded as WD_i , and the formula is:

$$WD_i = W_i \times D'_i \quad (6)$$

Multiply the normalized value by the weight W_i to get the weighted Euclidean distance value WD_i , and the result is shown in Table 3.

Table 4 Classification of geo-economic distance types

type	Threshold WD_i	Prefecture level city
Strong complementary type	$WD_i > 1$	Zhoukou, Xinyang, Zhumadian
General complementary type	$0 < WD_i \leq 1$	Shangqiu, Nanyang, Kaifeng
General competitive type	$-1 < WD_i \leq 0$	Hebi, Anyang, Puyang, Sanmenxia, Luohe, Jiyuan
Stronge competitive type	$WD_i \leq -1$	Xuchang, Pingdingshan, Xinxiang, Zhengzhou, Jiaozuo

It can be seen intuitively from Table 4 that the geo-economic relations between Luoyang and other prefecture level cities in the Central Plains Economic Zone shows that in general, the number of competitive cities is greater than the number of complementary cities. Among them, Jiaozuo and Luoyang have the highest degree of competition, and Yuncheng and Luoyang have the highest degree of complementarity.

3. Analysis of geo-economic relations

3.1 Strong complementary geo-economic relations

There are three cities with strong complementary geo-economic relations with Luoyang, namely Zhoukou, Xinyang and Zhumadian. Through comprehensive measurement, it is found that even though there is strong competitiveness in investment efficiency, disposable income of residents, ability to attract foreign investment, capital abundance and fixed asset investment between the two cities, due to the distance between the two cities, the geo-economic relations between the two cities at the level of comprehensive measurement also becomes a complementary economic relations.

3.2 General complementary geo-economic relations

The cities with general complementary geo-economic relations with Luoyang mainly include Shangqiu, Nanyang and Kaifeng. Through comprehensive calculation, it is found that these cities are highly competitive with Luoyang in terms of industrial structure, ability to attract foreign capital, investment efficiency and capital abundance, but most other indicators are complementary. Therefore, the geo-economic relations between Luoyang and the six cities above is generally complementary.

3.3 General competitive geo-economic relations

There are five cities with general competitive geo-economic relations with Luoyang, including Hebi, Anyang, Puyang, Sanmenxia, Luohe and Jiyuan, which are also the most types of geo-economic relations. Through comprehensive calculation, it is found that Luoyang and the above cities are complementary to each other in terms of disposable income, R&D expenditure amount, fixed asset investment, and actual use of foreign capital, but on the whole, most indicators are in a competitive state with Luoyang. Therefore, the geo-economic relations between Luoyang and the above cities is a general competitive geo-economic relations.

3.4 Strong competitive geo-economic relations

There are five cities with strong competitive geo-economic relations with Luoyang, including Xuchang, Pingdingshan, Xinxiang, Zhengzhou and Jiaozuo. According to the comprehensive calculation results, Luoyang and the above cities have a great similarity in terms of total fixed asset investment, total disposable income, R&D expenditure, total road transport of goods, and actual use of foreign capital, and are highly competitive. Therefore, the geo-economic relations between Luoyang and the above five cities is a strong competitive geo-economic relations.

4. Conclusion

By measuring the geo-economic relations between Luoyang and other cities in the Central Plains Economic Zone, it is found that the number of competitive cities is greater than that of complementary cities. However, the study found that the competitiveness and complementarities in the geo-economic relations between cities are relative. In the calculation, it was found that in several cities with strong competitive relations with Luoyang, there are also some indicators that are complementary to Luoyang. However, in general, if the competitiveness is strong, the complementarities will be weak.

In general, first, Luoyang should strengthen complementary geo-economic relations. Complementary relations are conducive to better cooperation between regions. Second, we should properly handle the relations between cities with competitive geo-economic relations. However, in the future development, we should constantly improve our own advantages, actively undertake industrial specialties, strengthen infrastructure construction, optimize industrial structure, and do a good job in featured cultural tourism. Third, we should strengthen geo-economic cooperation. At present, opportunities and challenges coexist in the geo-economic relations between Luoyang and other cities in the Central Plains Economic Zone. We should constantly explore our own superior resources, create a distinctive regional economic system, and further promote the realization of the goal of a new highland of inland economic growth in the entire Central Plains Economic Zone.

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