Dynamic Evaluation and Optimization of Investment Environment in Node Cities on the Maritime Silk Road

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ABSTRACT

Understanding and evaluating urban investment environment is essential for effectively improving the efficiency of resource allocation between cities and promoting overall development of the regional economy. This paper takes 15 node cities on maritime Silk Road covered by the "Belt and Road" as the research object, establishes a dynamic evaluation index system for investment environment, and uses projection pursuit cluster to analyze and evaluate the investment environment of the cities. It is found that the investment environment potential of a city is directly related to the level of social development, economic development, and the degree of opening to the outside world. It is recommended that node cities should seize the important opportunity of the construction of the Maritime Silk Road, introduce world-wide human, financial and material resources to promote regional resources allocation and flow, and continuously improve and upgrade the investment environment quality.

ADDITIONAL INDEX WORDS: *Maritime Silk Road, investment environment, dynamic evaluation, projection pursuit cluster*

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INTRODUCTION

The "Belt and Road" cooperation initiative was proposed by General Secretary Xi Jinping in 2013, which aims to strengthen interconnection with countries along the route under historical symbol of the ancient Silk Road, and build a community of interests, destiny and responsibility characterized by political mutual trust, economic integration, and cultural tolerance. The white paper "The Vision and Actions for Promoting the Joint Construction of the Silk Road Economic Belt and the 21st Century Maritime Silk Road" proposes "to jointly build a smooth, safe and efficient transportation channel under the support of central cities along the route with key ports on the sea as nodes." It can be seen that the development and construction of node cities in the "Belt and Road" strategy carries great significance. The development and construction of a city is closely related to the investment quality. Introduction of high-quality resources can effectively improve the local investment structure, thereby driving economic development.

In fact, the unevenness and heterogeneity in development level of cities along the Maritime Silk Road has caused gaps in investment environment and investment attraction effectiveness among cities. So, what are the development laws for different node cities in time and space? What are the factors that affect and restrict the differences in investment environment? This paper takes 15 maritime Silk Road node cities covered by “Belt and Road” as the research objects. By constructing a dynamic evaluation index system for the investment environment, investment environment of maritime Silk Road node cities is objectively evaluated by projection pursuit cluster analysis. The innovation of this paper is that for the first time, projection pursuit

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cluster analysis is used to dynamically evaluate the investment environment of important node cities on the Maritime Silk Road, and on this basis, suggestions for optimizing the investment environment of node cities are proposed.

METHODS and DATA

Evaluation index system

Investment environment refers to the general term for various social, economic, natural, and cultural factors surrounding the main body of construction investment that can affect the investment process and results. Evaluation of urban investment environment should depend on corresponding indexes. This paper conducts research from the six dimensions of innovation environment, human resources, economic environment, government behavior, social development, and opening to the outside world, and uses innovation performance, economic development level, industrial structure, financial service environment, labor quality, labor cost, input capacity, cultural service level, medical service environment, transportation level, informatization level, environmental status, import and export, investment as the first-level indexes to further establish corresponding second-level indexes. The evaluation index system is shown in Table 1.

Table 1 Dynamic evaluation index system for investment environment

Dimension	First-level index	Second-level index	
Innovation environment	Innovation performance	Number of granted patents	x1
		Internal expenditures for research and experimental activities of high-tech enterprises (thousand yuan)	x2
Economic environment	Economic development level	GDP per capita (yuan)	x3
		Fixed asset investment (100 million yuan)	x4
		Per capita disposable income of urban residents (yuan)	x5

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	Industrial structure	The proportion of secondary industry in GDP (%)	x6
		The proportion of tertiary industry in GDP (%)	x7
	Financial service environment	Financial industry employees (10,000 people)	x8
		balance of various RMB deposits of financial institutions at the end of the year (100 million yuan)	x9
		RMB loan balance of financial institutions at the end of the year (100 million yuan)	x10
Human Resources	Labor Quality	Students Enrollment in General Institutions of Higher Learning (10,000 people)	x11
	Labor cost	Employees' average salary (yuan)	x12
Government Behavior	Input Capacity	Education Expenditure (10,000 yuan)	x13
		Science and technology expenditure (10,000 yuan)	x14
	cultural service level	Book collection in public library (thousand volumes)	x15
	Medical service environment	Number of doctors (person)	x16
		Number of hospital beds	x17
Social development	Transport level	Expressway mileage (km)	x18
		Total freight volume (10,000 tons)	x19
	Informatization level	Number of mobile phone users at the end of the year (10,000 households)	x20
		Number of Internet broadband access users (10,000 households)	x21
	Environmental status	per capita park green area (square meters)	x22
Opening to the outside world	import and export	Total import and export volume (100 million US dollars)	x23
	Investment	Foreign direct investment (100 million US dollars)	x24

Data processing

This paper takes projection pursuit method to process the indexes of each city for analysis. Projection Pursuit is a statistical method used to analyze and process high-dimensional data. By minimizing a certain projection index, it finds the optimal projection direction that can reflect the structure or characteristics of the original high-dimensional data, and projects the high-dimensional data to low-dimensional space for analysis. In the case of big data dimension, its structure or characteristics are

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usually presented in multiple projection directions. In this way, projection tracking can use dimensionality reduction methods to find the projection direction that reflects the data structure, and exclude interference effect produced by data in the projection direction irrelevant with the structure. Therefore, by projection pursuit, it is possible to effectively discover the structure and characteristics of high-dimensional values, obtain the total feature value of the evaluation target, and clearly reflect the value of each element.

Data source

This paper takes 15 Chinese node cities on the Maritime Silk Road--Shanghai, Tianjin, Ningbo-Zhoushan, Guangzhou, Shenzhen, Zhanjiang, Shantou, Qingdao, Yantai, Dalian, Fuzhou, Xiamen, Quanzhou, Haikou, Sanya--as research objects to dynamically evaluate their investment environment. The data comes from the 2014-2018 Statistical Yearbook, Statistical Bulletin and "China City Statistical Yearbook" of each city. Individual missing data was supplemented by averaging method.

RESULTS

2013-2017 urban investment environment evaluation index analysis

According to the steps of projection pursuit evaluation model, MATLAB genetic algorithm toolbox is used to process the original data about the investment environment of 15 maritime Silk Road node cities. The evaluation results of the investment environment evaluation index of each city in 2013-2017 are shown in

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Table 2.

Seen from investment environment evaluation index and development trend of each city, it can be known from Table 2 that the investment environment evaluation index of each city in 2013-2017 is between (-0.3, 3.5), showing insignificant upward trend; but there is a big gap in investment environment between cities. For example, Shanghai Investment Environment Evaluation Index in 2013-2017 has always been above 3.4, while Shantou Investment Environment Evaluation Index was at -0.2976 in 2016, indicating that the investment environment of the Maritime Silk Road node cities has significant differences in temporal and spatial distribution, with a gap of 3.7877.

Some cities show an upward trend in five-year investment environment evaluation index, such as Ningbo-Zhoushan, Shenzhen, Sanya, etc., indicating that the construction of the Maritime Silk Road contributes to the economic development of these cities; while some cities show a downward trend, such as Tianjin, Dalian, Fuzhou, Haikou, etc. It shows that after the proposal of the Maritime Silk Road, the investment environment development in these cities is in a disadvantageous position, and corresponding policy measures are not proposed in time following the trend of the times, or the policy measures have little effect in improving economic effects. Some cities show upward and downward fluctuations, such as Qingdao, Yantai, Xiamen, Quanzhou, Guangzhou, Shantou, Xiamen, etc., indicating that investment environment development in these cities has slightly poor stability.

Table 2 Results of investment environment evaluation index

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City	2013	2014	2015	2016	2017	2017vs2013
Shanghai	3.4724	3.4667	3.4901	3.4605	3.4392	0
Tianjin	1.9303	2.0384	1.9986	1.8228	1.7144	-1
Ningbo-Zhoushan	0.3890	0.3437	0.3697	0.3978	0.4432	4
Guangzhou	2.0449	1.8946	1.9011	1.9466	1.9597	0
Shenzhen	1.2544	1.1873	1.3230	1.3060	1.3585	1
Zhanjiang	-0.1140	-0.0993	-0.1122	-0.1144	-0.1639	1
Shantou	-0.2567	-0.2763	-0.2632	-0.2976	-0.2743	-1
Qingdao	0.4221	0.4753	0.3888	0.3355	0.3619	1
Yantai	0.1491	0.1409	0.1729	0.1499	0.1935	-1
Dalian	0.5972	0.5635	0.3702	0.3113	0.3400	-3
Fuzhou	0.3468	0.2424	0.2318	0.1631	0.2547	2
Xiamen	0.1400	0.1349	0.1920	0.1678	0.2021	1
Quanzhou	0.1820	0.1850	0.1801	0.2395	0.1795	-3
Haikou	-0.1092	-0.0922	-0.1057	-0.1864	-0.1892	-2
Sanya	-0.2013	-0.2902	-0.2778	-0.2099	-0.1781	2

By comparing the rankings of investment environment evaluation index of the maritime Silk Road node cities from 2013 to 2017, it is found that Ningbo-Zhoushan has changed a lot in 2017 compared with 2013, with an increase of 4 in ranking, indicating that compared with other cities, Ningbo-Zhoushan enjoy good investment environment development; Quanzhou and Dalian have moderate changes, with a fluctuation of 3 in ranking; Tianjin, Shenzhen, Zhanjiang, Shantou, Qingdao, Yantai, and Xiamen have little changes in rankings, showing fluctuation within 1 ranking; The ranking of Shanghai, Guangzhou remains stable during the five years from 2013 to 2917, showing no changes. In general, the ranking of investment environment evaluation index for the 15 node cities does not change significantly from 2013 to 2017.

Vector analysis of the optimal projection direction

According to the projection pursuit cluster model, the optimal projection direction

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vector is calculated using the MATLAB genetic algorithm toolbox, with results shown in Table 3. The magnitude of each component in the optimal projection direction vector represents the contribution of a single index to the investment environment evaluation index. From 2013 to 2017, the number of doctors, the number of hospital beds, RMB loan balance of financial institutions at the end of the year, foreign direct investment, total freight volume, etc. had the highest values, which indicates their greatest contribution to the investment environment evaluation index. Within 5 years, the contribution ranking of the 5 indexes has only slightly changed. In 2013, the total freight amount had the highest contribution. From 2014 to 2017, the number of doctors contributed the most to the investment environment evaluation index. It can be seen that with higher medical level, transport level and financial institution loans in a city, the investment environment evaluation index is higher, which means easier investment attraction. The proportion of the secondary industry in GDP, the proportion of tertiary industry in GDP, the per capita park green area, and expressway mileage have the least effect on the investment environment of each city. It can be seen that a city's industrial structure, greening level and highway mileage level are not key factors affecting investment in node cities today.

Table 3 Optimal Projection Direction Vector in 2013-2017

Index	2013	2014	2015	2016	2017
a1	0.2078	0.1884	0.1886	0.1712	0.1790
a2	0.2203	0.1937	0.1953	0.2037	0.2117
a3	0.1227	0.1378	0.1461	0.1533	0.1617
a4	0.1888	0.1817	0.1679	0.1601	0.1624
a5	0.1457	0.1304	0.1819	0.1885	0.1994

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a6	−0. 2764	−0. 2357	−0. 2344	−0. 2685	−0. 2861
a7	−0. 2312	−0. 2484	−0. 2508	−0. 2424	−0. 1885
a8	0. 2295	0. 2171	0. 2272	0. 2309	0. 2416
a9	0. 2324	0. 2381	0. 2248	0. 2279	0. 2354
a10	0. 2383	0. 2472	0. 2445	0. 2474	0. 2515
a11	0. 1990	0. 1930	0. 1921	0. 1958	0. 1986
a12	0. 0130	0. 0128	0. 0129	0. 0156	0. 0200
a13	0. 2241	0. 2309	0. 2356	0. 2361	0. 2366
a14	0. 2054	0. 2135	0. 2156	0. 2073	0. 2055
a15	0. 2016	0. 2075	0. 2020	0. 2048	0. 2088
a16	0. 2676	0. 2754	0. 2750	0. 2782	0. 2674
a17	0. 2584	0. 2686	0. 2620	0. 2567	0. 2525
a18	−0. 0167	−0. 0096	−0. 0366	−0. 0126	−0. 0231
a19	0. 2848	0. 2674	0. 2580	0. 2390	0. 2452
a20	0. 0717	0. 0673	0. 0630	0. 0619	0. 0683
a21	0. 2031	0. 2312	0. 2452	0. 2269	0. 1949
a22	−0. 0378	−0. 0926	−0. 0938	−0. 0697	−0. 0544
a23	0. 1793	0. 2131	0. 2111	0. 2188	0. 2167
a24	0. 2653	0. 2562	0. 2345	0. 2456	0. 2589

According to the optimal projection direction vector from 2013 to 2017, the evaluation value of each index dimension is obtained, as shown in Figure 1 and Figure 2.

Figure 2 shows that for proportion of the six dimensions affecting investment environment of node cities along the Maritime Silk Road in 2013, innovation environment accounts for 13%, economic environment 19%, human resources 6%, government behavior 13%, social development 36%, opening to the outside world 13%, showing structural characteristics dominated by social development and economic environment, and human resource dimension has obvious constraints on the urban investment environment. It can be seen from Figure 1 that the contribution of economic environment dimension to the urban investment environment has gradually

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grown, and the contribution of social development dimension has declined slightly, while human resource dimension is still the biggest constraint on the urban investment environment. On the whole, proportion of the six dimensions has little change with regard to investment environment of these node cities from 2013 to 2017. The two dimensions of social development and economic environment play a dominant role, while human resources dimension has always been a “weak link” in investment environment development of these cities.

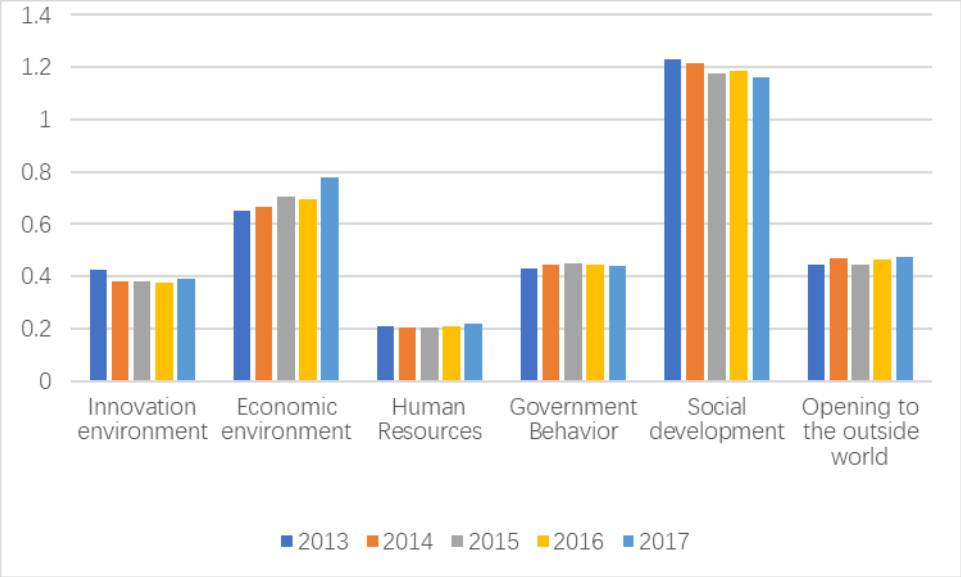

Figure 1 2013-2017 trend chart of index dimension evaluation value

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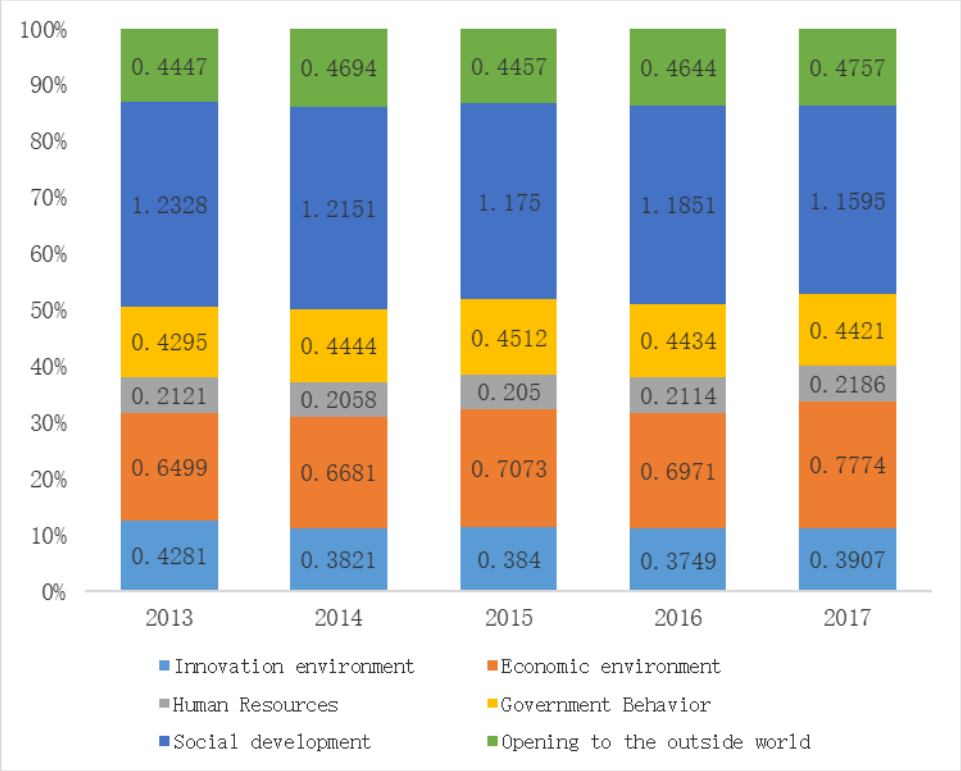

Figure 2 Proportion of the six major indexes in contribution in 2013-2017

CONCLUSION

This paper uses projection pursuit cluster analysis method to dynamically evaluate and analyze the investment environment of 15 node cities from 2013 to 2017 from the six selected dimensions of innovation environment, economic environment, human resources, government behavior, social development, and opening to the outside world. It is known that since the construction of the Maritime Silk Road Economic Belt has entered a period of stable development, the impact of the three dimensions of human resources, government behavior, and innovation environment no longer means a significant factor for urban investment environment in recent years, but the three basic dimensions of social development, economic environment and opening to the outside world still have the most direct and long-lasting impact on investment

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environment potential of the node cities. Therefore, in the future，we must first guarantee development in these basic dimensions. In addition, based on the investment environment evaluation index and cluster analysis results of each city in a numerical value order from high to low, we found that the 15 Maritime Silk Road node cities present four different investment environment evaluation categories. Each category shows obvious difference in contribution to Maritime Silk Road, which indicates that different types of cities currently have different development level in investment environment, all of which still have factors that hinder the city development, and fail to achieve effective flow and exchange of resources between different cities.

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