

Evaluation and Countermeasure Analysis of Regional Economic and Trade Development in Northeast China

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Abstract. In order to promote the regional economic development of the Northeast region, the State Council proposed the strategy of "revitalizing the old industrial base in Northeast China" in 2003, based on the regional economic development of the Northeast Anti Japanese Alliance Base in the new era, to enhance the economic benefits of Northeast China. The author summarizes the selection of evaluation indicators for regional economic and trade development through literature review. Guided by the principle component analysis method, the evaluation indicators are selected. The entropy method is used to evaluate the four dimensions of economic growth, economic structure, economic relations, and sustainable economic development in Heilongjiang, Jilin, and Liaoning provinces. Combined with the idea of Northeast Asian cooperation, the author proposes suggestions for the development of regional economic and trade in Northeast China.

Keywords: Northeast region; Regional economic and trade development; Principal component analysis; Entropy method; Evaluation; countermeasure.

1. Introduction

Regional economy is the sum of the production, distribution, exchange, and consumption activities of material and cultural products within a certain geographical space[1]. The Northeast region is the earliest complete natural geographical unit formed in China, with abundant resources, including Heilongjiang Province, Jilin Province, Liaoning Province, as well as Hulunbuir League, Xing'an League, Zhelimu League, and Chifeng City in Inner Mongolia. The entire region covers an area of 1.24 million square kilometers, accounting for 12.4% of the total area of the country[2]. The Northeast region is adjacent to Russia, Mongolia, North Korea, Japan, and South Korea, with deep-water ports such as Dalian and Yingkou, and a superior geographical location; Rich in mineral and forest resources, fertile land, and as an important commodity grain base in China, it is rich in natural resources; A complete heavy chemical industry system has been formed, with industries such as metallurgy, machinery, automobiles, chemicals, and energy as the pillar industries[3]. As a region that occupied over 90% of the country's heavy industrial bases before the reform and opening up, the economic development of the Northeast region is significantly lagging behind the developed eastern regions. According to the National Bureau of Statistics, the GDP growth rates of Heilongjiang, Jilin, and Liaoning in 2021 were 1%, 2.4%, and 0.6%, respectively, ranking last in the country[4]. In the face of the impact of the wave of anti-globalization, it is particularly important to build an evaluation index of regional economic development in the northeast region and scientifically evaluate the economic and trade development in the northeast region accordingly. Only when we understand the problem and apply the right medicine to the case, can we carry forward our own advantages of excellent regional conditions and become a new important connection point for opening up to the outside world that connects Japan, South Korea and Russia.

In the study of evaluating regional economy, experts and scholars have conducted a large amount of research and established distinctive regional economic evaluation index systems. Sorted out in chronological order, the World Bank comprehensively analyzes the global regional economic and social development level and people's living standards using approximately 500 indicators in six categories: human, social, and environmental; The National Bureau of Statistics of China has established more than 1300 indicators in 15 categories, including economic conditions indicators related to survival and development, such as environmental conditions and gross domestic product, such as household income and consumption, population, social security, etc; In 1996, Liu Jianchu et al. established a comprehensive evaluation system based on six categories of indicators: regional

economic resources, regional economic development level, regional economic development scale, regional economic benefits, and ecology and environment[5]; In 1999, Wu Cisheng et al. used the efficacy coefficient method and linear weighted sum function method to comprehensively calculate 12 indicator data from 6 aspects, including economic scale, industrial structure, population and cultural quality, urbanization level, residents' quality of life, economic benefits, and growth rate, to evaluate the regional economy[6]; In 2008, Hu Zhongjun et al. established three indicators of comprehensive development, coordinated development, and sustainable development using the Analytic Hierarchy Process, and constructed a comprehensive evaluation index system for regional economic and social development based on 51 basic indicators[7]; In 2010, Qin Chenglin et al. conducted a comprehensive evaluation of regional development using principal component analysis and analytic hierarchy process, including 36 indicators in 7 categories: economic scale, economic structure, economic growth rate, external economy, sharing of growth achievements, sustainable development ability, and innovation ability[8]; In 2016, Tang Hong et al. used principal component analysis to establish 10 indicators, including gross domestic product, proportion of added value of the tertiary industry to GDP, total capital formation, total import and export, and annual average wage, to conduct representative evaluations of regional economic development [9]; In 2023, Liu Guobin will deeply analyze the importance, potential advantages, breakthrough direction and difficulties faced by the comprehensive revitalization of the old industrial base in northeast China under the "the Belt and Road" initiative [10].

In summary, in recent years, the evaluation of regional economic development has been mostly based on principal component analysis to establish evaluation models and select indicators. There are differences in the selection of indicators for different regional conditions, time series, and research methods. The existing research on the economic evaluation of the Northeast region has a relatively long history, and there have been new changes in the economic and trade situation. Therefore, this article will select indicators and evaluate the economic and trade of the Northeast region.

2. Construction of the Evaluation System for the Development Level of Regional Economy and Trade in Northeast China

2.1. Connotation and Characteristics of Regional Economy

To construct a scientific statistical evaluation index system, it is necessary to fully consider the connotation and characteristics of regional economic development[11]. Regional economic development not only manifests in the narrow sense of increasing total social wealth, but also includes multiple aspects such as economic growth, economic structure, economic relations, and sustainable economic development.

2.2. Construction of evaluation indicators

Due to the complex system of regional economy, evaluation indicators are constrained and influenced by various factors, and the range of regional economic evaluation indicators is wide, which can easily lead to problems such as duplicate indicators or insufficient correlation. To simplify the research while ensuring its effectiveness, the idea of principal component analysis is introduced. By extracting representative, main, and quantifiable indicators from a large number of indicators and comparing a small number of comprehensive indicators, the research difficulty is reduced.

2.3. Principles for establishing indicators

Starting from practical needs and considering the need for selective and focused research, different evaluation perspectives will lead to different conclusions. Therefore, it is necessary to choose evaluation indicators with high representativeness, which are in line with regional and institutional conditions, and choose factors with more development needs and resource conditions.

On the basis of comprehensive analysis, grasp the dominant factors and conduct in-depth analysis. The dominant factors have important impacts and constraints on regional economic development, such as the two excellent ports of Dalian and Yingkou in Liaoning Province, which play an important role in the development of import and export and the circulation of goods in the Northeast region. In recent years, due to global warming, the Ice Silk Road and the Arctic route have significant implications for the future development of the Northeast region's economy, and therefore need to be considered^[12].

Pay attention to the combination evaluation of regional conditions. The combination of regional conditions may amplify or offset the advantages of regional development. The heavy industrial base and deepwater ports in the Liaodong Peninsula complement each other, and the transportation of industrial raw materials and product exports rely on deepwater ports. The industrial foundation can develop and improve the construction of deepwater ports, serving as a combination of resource conditions that promote and supplement each other, creating a virtuous cycle.

Analyze various indicators from a dialectical perspective. The influencing factors have different effects on different industries, regions, and economic entities. Analyzing from a dialectical perspective requires combining favorable and unfavorable factors; Combining quantity and quality; A combination of absolute and relative quantities.

View indicators from a developmental perspective. Combining dynamic and static indicators^[13]. Different influencing factors have different impacts on regional economic development at different times. For example, the abundant mineral resources in Northeast China played a promoting role in promoting economic development by providing heavy industrial resources in the early stages of the founding of the People's Republic of China and the reform and opening up. However, the formation of resource exhausted cities now has a negative impact on regional economic development.

In summary, the selection of indicators has a decisive impact on the research results. Based on the study of factors such as geographical location, natural resources, input factors, market conditions, and environmental conditions in the Northeast region, and referring to Tang Hong's (2016) indicator selection, four categories of 11 indicators, including economic growth, economic structure, economic relations, and sustainable economic development, were selected, as shown in Figure 1:

Table 1: Index System for Regional Economic Evaluation in Northeast China

Primary indicators	Secondary indicators	unit	Indicator attribute
			Forward direction
economic growth	GDP growth index	%	Forward direction
	Growth rate of fixed assets investment	%	
	Fiscal revenue growth rate	%	
			Forward direction
			Forward direction
economic structure	Proportion of tertiary production	%	Forward direction
	Consumption proportion of rural and urban residents	%	
	Per capita income ratio between urban and rural areas	%	
			Forward direction
			Negative direction
economic relations	Growth rate of trade volume	%	Forward direction
		%	
sustainable development	Number of annual patent applications	One	Forward direction
	Forest coverage	%	

Per capita arable land area

Mu/person

Forward
direction

Forward
direction

Data sources: Author collation

3. Empirical Evaluation and Analysis of Regional Economic Development in Northeast China

3.1. Sample Selection

This article takes Heilongjiang, Jilin, and Liaoning provinces as samples and selects various indicators for the evaluation of regional economic development in 2019. The data is sourced from the 2020 and 2021 China Statistical Yearbook, Heilongjiang Statistical Yearbook, Liaoning Statistical Yearbook, Patent Statistical Yearreport, etc.

Table 2: Original Data of Regional Economic Indicators in Northeast China

index	LiaoNing	JiLin	HeiLongJiang
GDP growth index	104.30%	105.30%	106.40%
Growth rate of fixed assets investment	0.20%	1.60%	4.30%
Fiscal revenue growth rate	9.70%	4.20%	8.30%
Three production ratio	52.60%	45.40%	55.80%
Rural urban per capita income ratio	39.20%	45.70%	46.10%
Per capita consumption ratio in rural and urban areas		109.00%	54.60%
price index	101.40%	101.60%	101.30%
Growth rate of trade volume	14.90%	0.50%	17.10%
Forest coverage	38.34%	44.30%	48.20%
Number of annual patent applications	498710	204557	31057
Per capita arable land area (mu/person)	1.8	4	6.27

Data sources: 2020, 2021 China Statistical Yearbook, Heilongjiang Statistical Yearbook, Liaoning Statistical Yearbook, Patent Statistical Yearbook, etc

3.2. Objective Weight and Score Calculation of Indicators

Due to the difference between indicator units and dimensions, in order to facilitate the comprehensive calculation of indicators, it is necessary to normalize the forward processing of each reverse indicator and the dimensionless standardization of all indicators. The calculation principle is as follows ^[14]:

Step 1: The dimensions and units of each indicator are different and cannot be directly calculated and compared. Therefore, before calculating the weight of each indicator, it is necessary to standardize it:

When the indicator is a positive indicator, its standardization formula is:

$$x'_{ij} = \frac{x_{ij} - x_j^{\min}}{x_j^{\max} - x_j^{\min}}$$

When the indicator is negative, its standardization formula is:

$$x'_{ij} = \frac{x_j^{max} - x_{ij}}{x_j^{max} - x_j^{min}}$$

Table 3: Standardized Data

index	LiaoNing	JiLin	HeiLongJiang
GDP growth index	0	0.47619	1
Growth rate of fixed assets investment	0.694915	1	0
Fiscal revenue growth rate	1	0	0.968992
Three production ratio	0.692308	0	1
Rural urban per capita income ratio	0	0.942029	1
Per capita consumption ratio in rural and urban areas	0.871324	1	0
price index	0.666667	0	1
Growth rate of trade volume	0.86747	0	1
Forest coverage	0	0.604462	1
Number of annual patent applications	1	0	0.360525

Step 2: To eliminate negative values and standardize the indicator values, there may be situations where the values are small or negative. In order to unify and facilitate the calculation, the standardized values are translated to eliminate the above situation.

$$x''_{ij} = H + x'_{ij}$$

Where H is the amplitude of the indicator shift, usually taken as 1.

Step 3: Using the Specific Gravity Method to Dimensionalize Data

$$y_{ij} = \frac{x''_{ij}}{\sum x''_{ij}}$$

Step 4: Calculate the entropy value of the jth indicator:

$$e_j = -\frac{1}{\ln n} \sum_{i=1}^n y_{ij} \ln y_{ij}$$

Step 5: The coefficient of difference for the jth indicator is:

$$g_j = 1 - e_j$$

Among them, j=1, 2,..., p

Step 6: The weight of the jth indicator is:

$$\omega_j = \frac{g_j}{\sum_{i=1}^p g_j}$$

Among them, j=1, 2,..., p

Table 4: Calculation Results

index	Entropy	diversity factor	weight
GDP growth index	0.965425	0.034575	0.087785
Growth rate of fixed assets investment	0.965512	0.034488	0.087565
Fiscal revenue growth rate	0.960991	0.039009	0.099045
Three production ratio	0.965533	0.034467	0.087512
Rural urban per capita income ratio	0.961616	0.038384	0.097457
Per capita consumption ratio in rural and urban areas	0.963084	0.036916	0.093728
price index	0.965713	0.034287	0.087054
Growth rate of trade volume	0.963157	0.036843	0.093544
Forest coverage	0.965948	0.034052	0.086457
Number of annual patent applications	0.963593	0.036407	0.092438
index	0.965571	0.034429	0.087415

Using standardized data and multiplying weights to obtain a comprehensive score:

$$Z_i = \sum_{j=1}^p \omega_j x'_{ij}$$

Table 5: Comprehensive Results

Economic growth	Economic structure	Economic relations	Sustainable development
Liaoning 0.159895	0.142253	0.139183	0.092438
Jilin 0.129367	0.185536	0	0.095283
Heilongjiang 0.183759	0.184969	0.180598	0.207198

3.3. Evaluation of Economic Development in Northeast China

2.3.1 Unbalanced economic development within the Northeast region

According to the rating index, the level of economic growth in Heilongjiang is higher than that in Liaoning and Jilin. Since the "the Belt and Road" initiative was put forward, Heilongjiang Province, as a province with greater geographical advantages in the construction of Russian border warehouses, has always enjoyed the dividends of import and export trade. From the economic relations in the figure and the high score of foreign trade indicators, it can be seen that Heilongjiang Province's exports drive economic growth. Liaoning has deep-water ports such as Yingkou and Dalian, adjacent to South Korea, North Korea, and Japan, with obvious advantages in foreign trade location. Relatively speaking, as an inland province, Jilin Province lacks its own unique export advantages, and its economic growth rate is relatively slow. The increase in GDP, fiscal revenue, and fixed assets is relatively small. In terms of economic relations, there are huge differences among the three provinces. Liaoning and Heilongjiang have a higher level of urbanization, and the proportion of the tertiary industry is relatively large. Jilin has more development potential. There are significant differences in the sustainable development capabilities of the three provinces' economies, with Heilongjiang Province having significant advantages in terms of per capita arable land area and forest coverage, while the innovation capacity represented by the annual number of patent applications is slightly insufficient. The sustainable development capabilities of Jilin and Liaoning provinces are relatively similar, but Jilin's innovation capabilities are relatively weak.

2.3.2 Regional Economic Structure Similarity in Northeast China

The similarity in regional economic structure in Northeast China is relatively high, especially in the scores of Heilongjiang Province and Jilin Province. This indicates that the proportion of the

tertiary industry, rural and urban population consumption and expenditure structure in Northeast China are relatively similar, facilitating the flow of talent and resources between regions, and coordinated regional development.

2.3.3 Economic growth is not as high as the national level, and there is a significant gap in regions such as the Yangtze River Delta and the Pearl River Delta

In 2021, the national GDP growth rate was 8.1%, indicating that there is still a gap between the GDP growth rate of the three northeastern provinces and the national average level. However, there is a significant gap between the proportion of the tertiary industry, trade volume and growth rate, and the number of annual patent applications compared to other regions such as the Yangtze River Delta and Pearl River Delta.

4. Countermeasures for Regional Economic Development in Northeast China

4.1. Actively opening up to the outside world and developing foreign trade and logistics industries that can cope with the epidemic

Northeast China has a relatively complete industrial system, which is convenient for production and export to countries along the the Belt and Road in Northeast Asia, Russia and Mongolia^[15]. Heilongjiang Province can leverage its geographical advantages to develop transportation and logistics industries, establish cross-border e-commerce service institutions such as bonded warehouses and border warehouses, and provide services for cross-border e-commerce between Russia and Mongolia. Similarly, Liaoning can build more bonded warehouses and logistics hubs for countries such as Japan, South Korea, and North Korea, providing services for cross-border e-commerce imports and exports, and laying the foundation for the preparation and construction of the China Japan South Korea Free Trade Zone. From 2020 to 2021, the three eastern provinces were repeatedly and long-term affected by the epidemic, with industries such as industry and service industries severely affected, and foreign trade, logistics, and other industries severely hindered.

4.2. Leveraging Port Advantages, Improving Multimodal Transport, and Actively Promoting the Establishment of Arctic Routes

Liaoning is one of the four major provinces in China's marine economy, which directly contributes and indirectly drives coastal areas, such as regional economic growth and fiscal revenue^[16]. Integrate resources, prevent vicious competition in ports, support and develop port related enterprises, increase added value, promote the interactive development of port economy and regional economy, and promote the comprehensive revitalization of the old industrial base in Northeast China^[17].

The railway lines in the old industrial base of Northeast China are relatively developed, but due to container standards, prices, and other reasons, the development level of multimodal transportation is not high. Actively developing multimodal transportation can effectively save logistics time and costs, and promote the flow of resources and products within and between regions.

As an emerging waterway, the Arctic route can save voyage and enhance the shipping center status of Northeast ports such as Dalian and Dandong. The construction of the Arctic route will be a huge engine for trade and financial development in the Northeast region^[18].

4.3. Leveraging the advantages of latecomers and industrial foundations, and developing through innovation

The number of patent applications in the three northeastern provinces is relatively small in developed regions. The government can provide tax subsidies or preferential loans to innovative enterprises to enhance their innovation capabilities. For emerging Internet plus enterprises and digital economy enterprises, the Northeast can attract them to settle in through preferential land prices, school enterprise cooperation and other ways. Utilize the advantages of latecomers and excellent

industrial infrastructure, attract various enterprises to settle in, transform the economic development mode, introduce talents [18], and break the dilemma of "investment cannot pass mountains and seas".

4.4. Establish a regional economic evaluation index system to increase coordinated regional development

A sound regional economic evaluation system can promote efficient development of the regional economy, making development strategies and directions traceable. The economic structure of Northeast China is relatively similar, with cultural connectivity and convenient transportation, which facilitates the sharing and flow of resources between regions. However, there are significant differences in the level of economic development within the region, which can be driven by the mechanism of leading regional growth, with Dalian and Harbin as the leading regions, from point to area, to drive the economic development of Northeast China.

4.5. Mechanized agricultural production to promote green development

According to the characteristics of the vast plains and sparse population in the Northeast region, highly mechanized agricultural production can be developed to promote mechanization and technology in agricultural production. Pay attention to the development benefits of resource-based cities, adhere to green and scientific development, protect resources, efficiently exploit, and achieve green development^[19].

5. Conclusion

This paper absorbs the idea of principal component analysis and uses entropy method to comprehensively evaluate the regional economic development in Northeast China. On this basis, it comes to the following countermeasures: the regional economic development in Northeast China should, on the basis of deepening its participation in the "the Belt and Road" strategy and the "maritime power" strategy, establish and improve the regional economic evaluation index system, strengthen regional resource exchange, and introduce advanced talents and technology through preferential policies, Adhere to green and sustainable development, improve regional competitiveness, and achieve sound and rapid economic development.

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