Research on the coordinated development of underdeveloped regional economy and regional high-tech industrial clusters based on the CRITIC model

Biying Xia[1, #], Jiajun Fan[2,#], Yuli Wang[3, #,*]

[1]School of Sun Wah International Business, Liaoning University, Shenyang, 110136, China

[2]School of Business, Anhui University, Hefei, 230601, China

[3]College of Economics and Management, Nanjing Forestry University, Nanjing, 210037, China

[#]These authors contributed equally.

[*]Corresponding author: 1776465150@qq.com

Abstract. This paper selects the order parameters of 11 regional economic subsystems that reflect economic structure, economic aggregate and economic benefits from the perspective of system analysis, and reflects development level and economic strength. And the order parameters of the 12 regional high-tech industrial cluster subsystems of innovation ability, and the method of measuring the order parameters of the system synergy degree is applied. Based on the Criteria Importance Through Intercriteria Correlation (CRITIC) fixed-weight model, a synergy evaluation system of regional economy and regional high-tech industrial clusters is constructed, and finally, an empirical analysis is carried out with Jilin Province, China. The results show that the overall change trend of the synergy degree of the composite system of the regional economy and regional high-tech industrial clusters in Jilin Province can be divided into four stages, and presents an M-shaped development trend of alternating increase and decrease. The development of enterprises in the high-tech zone is not obvious, but the feedback effect of enterprises in the high-tech zone on the regional economy is not obvious. This paper not only fills the research gap on the coordinated development of regional economy and regional high-tech industrial clusters in China's underdeveloped regions in terms of content, but also selects the CRITIC weighting method in terms of methods to accurately define the weights of each indicator.

Keywords: CRITIC; Coordinated development; Underdeveloped areas; Regional economy;

1. Introduction

The high-tech zone enterprises play an inestimable role in the national innovation and development strategy, and the coupling and coordinated development with the regional economy is crucial for China in the period of transformation and development. However, there are differences in the economic production factors of enterprises in the high-tech zone and other economic entities in the region. The differences in natural resource conditions, social and economic conditions, and scientific and technological conditions lead to the unbalanced coordinated development of regional high-tech industrial clusters and regional economic systems. Therefore, it is necessary to study the interaction between enterprises and regional economy in high-tech zones, the degree of action, and the time-varying characteristics of coupling and coordination, and put forward countermeasures and suggestions to balance regional coupling and coordination, which is conducive to the realization of high-quality development of regional economy and the promotion of high-tech Enterprises in the zone realize technological innovation and maximize profits, and give full play to the synergistic effect between the high-tech zone and regional economic development.

In terms of temporal and spatial distribution characteristics, Wang [1] took China as an example to study the temporal and spatial distribution characteristics of the coupling coordination degree between high-tech zones and the city where they are located. The overall level is low, and it has obvious characteristics of spatial differentiation between east and west. With the help of the panel space Durbin model and DEA-Malmquist algorithm, Zhu[2] concluded that the direct effect of China's high-tech industry agglomeration on the quality of economic growth is a positive promotion regardless of China, sub-industry or sub-region. There was a significant inhibitory effect on the steric effect. Shao[3] measured the development level of high-tech zones in 54 countries in six years, the economic benefits of the cities where they are located, and the degree of coupling and coordination between the two, and analyzed the spatiotemporal evolution characteristics of the coupling and coordination of economic efficiency between national high-tech zones and the home city. , the influencing factors of the coupling coordination degree are discussed. Shi[4] took 91 national high-tech industrial development zones in cities as the research object, measured the Mar effect and Jac effect of their knowledge externalities, and gave the radiation range of the knowledge externalities of national high-tech industrial clusters, and calculated them quantitatively. The effect of knowledge externalities on economic growth and technological progress. The study finds that the knowledge spillover effect within the industry is greater in the process of China's high-tech industry agglomeration, and the Jac externality of the high-tech industry cluster in the western region has a more significant positive effect on regional economic growth. In terms of the mechanism of coordinated development, Guo[5] verified the inevitability of the coordinated development of high-tech zones and regional economy, and found that the current level of coordination between high-tech zones and regional economic development in China is generally low, and proposed to improve the regional governance structure and optimize the layout of regional spatial resources. , to speed up the industrial transformation and upgrading of the high-tech zone, and then to enhance the coordinated development of the high-tech zone and the regional economy. Wang[6] discussed the heterogeneous effects of different types of high-tech zones on regional economic growth, as well as the promotion of national high-tech zones on economic development, showing the law of "diminishing marginal effects". Zhang[7] used the entropy method to study and found that China's economic resilience is generally in a non-equilibrium state, the dynamic evolution and development of the economic system has regional heterogeneity, and the difference in economic development is largely affected by the level of innovation and development, and the prosperity of the digital entrepreneurial ecosystem It is conducive to improving the resilience of the regional economy and realizing the symbiotic evolution of the competition and cooperation-oriented system. Mao[8] based on the main line of innovation and development in the Yangtze River Delta, based on the theoretical basis of increasing returns and imperfect competition, the close integration of government, industry, academia and research, and industrial correlation, and extracted three urban areas, high-tech zones and industrial chains as considerations in the Yangtze River Delta. The determinants of innovation development, and through the OLS method to analyze the interrelationship of these three factors and their relative effects on the innovation development of the Yangtze River Delta, and finally, according to the empirical conclusions, the relevant regional policy orientation is derived.

The current research mainly explores the law of coordinated development between enterprises and the regional economy in China's high-tech zones from a macro perspective, and does not select specific types of areas, such as underdeveloped areas, for in-depth research. This study makes up for this deficiency in content, selects the underdeveloped areas as the research object, constructs two subsystems of regional economy and regional high-tech industrial clusters, and applies the method of order parameter measurement of system synergy, and determines the weight based on the CRITIC model. The evaluation system of the synergy degree of regional high-tech industrial clusters is applied, and the model is applied to the measurement of the coordinated development level of the regional economy and regional high-tech industrial clusters in Jilin Province. This paper clarifies the current situation of the coordinated development of regional economy and high-tech industrial clusters in Jilin Province, provides a basis for the interaction and integration of elements between the local regional economy and high-tech zones, and has certain implications for the coordinated development of regional economies and high-tech industrial clusters in other relatively underdeveloped regions. Reference meaning.

2. System construction of regional economy and regional high-tech industrial clusters

2.1 Regional economic subsystem

Regional economy refers to the complex of economic activities produced by the interaction of internal and external factors of economic development in a particular region. It is a relatively comprehensive geographic category concept of economic development. The regional economy can be divided into a certain area from the geographical area, and can also span multiple provinces and cities. But its main division is actually based on economic production factors. The economic development of any region is limited by its own regional natural resource conditions, social economic conditions, scientific and technological conditions and other factors. Therefore, the self-control ability and regional characteristics of the regional economy are extremely high, and the regional economy cannot freely circulate with other economic regions, so it is easy to generate an economic system of intra-regional economy. The system of regional economy includes three aspects: economic structure, economic aggregate and economic benefit. This paper constructs the output value of the primary industry (X_1), the output value of the secondary industry (X_2), the output value of the tertiary industry (X_3), and the GDP (X_4) in these three aspects , total retail sales of consumer goods (X_5), number of permanent residents at the end of the year (X_6), total investment in fixed assets (X_7), total net export trade (X_8), local fiscal revenue (X_9), per capita GDP (X_{10}), per capita disposable income of urban residents (X_{11}) and other indicators .

2.2 Subsystem of regional high-tech industrial clusters

Regional high-tech industrial clusters are the sum total of enterprises in all high-tech development zones in a specific area, including high-tech enterprises and non-high-tech enterprises. High-tech zones refer to industrial development zones established in China in some knowledge-intensive and technology-intensive large and medium cities and coastal areas to develop high-tech industries. A high-tech enterprise is a state-recognized high-tech enterprise within the scope of high-tech. To measure the development status of enterprises in a high-tech zone in a region, it can be inspected from the development level, economic strength and innovation ability. This paper selects the number of registered industrial and commercial enterprises (Y_1), employees at the end of the year (Y_2), total export value (Y_3), total industrial output value (Y_4), tax paid (Y_5), operating income (Y_6), total enterprise assets (Y_7), net profit (Y_8), and the ratio of high-tech enterprises (Y_9), the ratio of R&D expenditure to total income (Y_{10}), the ratio of scientific and technological activities personnel (Y_{11}), the ratio of technology revenue to total revenue (Y_{12}) and other indicators to reflect its development status.

To sum up, the index system of the two subsystems of regional economy and regional high-tech industrial cluster constructed in this paper is shown in Table 1:

Table 1 The index system of the order parameters of the regional economy and regional high-tech industrial clusters in Jilin Province

Subsystem	First-level indicator	Secondary indicators/units	Positive and negative
Regional Economic Subsystem	Economic structure	Output value of primary industry （10^8 yuan）/ X_1	Positive correlation
		Output value of the secondary industry （10^8 yuan）/ X_2	Positive correlation

		Output value of the tertiary industry （10^8 yuan）/ X_3	Positive correlation
		GDP （10^8 yuan）/ X_4	Positive correlation
		The total retail sales of social consumer goods（10^8 yuan）/ X_5	Positive correlation
	Economic aggregate	Year-end resident population（10^4 people）/ X_6	Positive correlation
		Total fixed asset investment（10^8 yuan）/ X_7	Positive correlation
		total net export trade（10^8 yuan）/ X_8	Positive correlation
		Local fiscal revenue（10^8 yuan）/ X_9	Positive correlation
	Economic benefits	GDP per capita（yuan）/ X_{10}	Positive correlation
		per capita disposable income of urban residents（yuan）/ X_{11}	Positive correlation
		Number of registered industrial and commercial enterprises（number）/ Y_1	Positive correlation
	The level of development	Year-end employees（10^4 people）/ Y_2	Positive correlation
		total export（10^8 yuan）/ Y_3	Positive correlation
		Industrial output（10^8 yuan）/ Y_4	Positive correlation
Regional high-tech industrial cluster subsystem		Tax paid（10^8 yuan）/ Y_5	Positive correlation
		Operating income（10^8 yuan）/ Y_6	Positive correlation
	Economic strength	total enterprise assets（10^8 yuan）/ Y_7	Positive correlation
		net profit（10^8 yuan）/ Y_8	Positive correlation
		Proportion of high-tech enterprises（%）/ Y_9	Positive correlation
	Creativity	R&D expenditure as a percentage of total revenue（%）/ Y_{10}	Positive correlation
		Proportion of scientific and technological personnel（%）/ Y_{11}	Positive correlation

	Technology revenue as a percentage of total revenue（%）/ Y_{12}	Positive correlation

3. CRITIC Method

Criteria Importance Through Intercriteria Correlation (CRITIC) is an objective weighting method proposed by Diakoulaki et al. in 1995 [9]. This study uses the CRITIC objective weighting method to analyze the indicators related to regional high-tech industrial clusters and regional economic research. This method considers the impact of data volatility and the correlation between data on the weight, and determines the weight of the indicator based on the contrast strength and conflict between the indicators[10]. The calculation steps of determining the index weight by CRITIC method are as follows:

Step 1: Establish an evaluation matrix. Assuming that there are m evaluation objects and n evaluation indicators, x_{ij} represents the value of the j th evaluation index of the ith evaluation object, and the evaluation matrix can be expressed as:

$$\boldsymbol{X} = \left(x_{ij}\right)_{m\times n} = \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ x_{m1} & x_{m2} & \cdots & x_{mn} \end{bmatrix} \tag{1}$$

Step 2: Data normalization.

If the index is a benefit index, the standardized evaluation matrix element z_{ij} is:

$$z_{ij} = \frac{x_{ij} - \min\left(x_{ij}\right)}{\max\left(x_{ij}\right) - \min\left(x_{ij}\right)} \tag{2}$$

If the index is a cost index, the standardized evaluation matrix element z_{ij} is:

$$z_{ij} = \frac{\max\left(x_{ij}\right) - x_{ij}}{\max\left(x_{ij}\right) - \min\left(x_{ij}\right)} \tag{3}$$

The standardized evaluation matrix Z is calculated as:

$$\boldsymbol{Z} = \left(z_{ij}\right)_{m\times n} = \begin{bmatrix} z_{11} & z_{12} & \cdots & z_{1n} \\ z_{21} & z_{22} & \cdots & z_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ z_{m1} & z_{m2} & \cdots & z_{mn} \end{bmatrix} \tag{4}$$

Step 3: Determine the contrast strength of the indicator according to the standard deviation σ_j. The standard deviation σ_j of the j th indicator is:

$$\sigma_j = \sqrt{\frac{1}{m}\sum_{i=1}^{m}\left(x_{ij} - \overline{x}_j\right)^2} \tag{5}$$

Step 4: Using correlation coefficient r_{ij} to calculate the conflict between indicators. The correlation coefficient r_{ij} between the ith indicator and the j th indicator is:

$$r_{ij}=\frac{\sum_{k=1}^{n}\left(z_{ki}-\bar{z}_i\right)\left(z_{kj}-\bar{z}_j\right)}{\sqrt{\sum_{k=1}^{n}\left(z_{ki}-\bar{z}_i\right)^2}\cdot\sqrt{\sum_{k=1}^{n}\left(z_{kj}-\bar{z}_j\right)^2}},\ i\neq j \tag{6}$$

In formula (6), z_{ki} and z_{kj} are the normalized values of the ith index and the jth index of the kth evaluation object, and $\bar{z}_i$ and $\bar{z}_j$ are the mean values of the indexes i and j, respectively. The conflicting quantitative index value of the jth indicator and other indicators is R_j:

$$R_j=\sum_{i=1}^{n}\left(1-r_{ij}\right),\ i\neq j \tag{7}$$

Step 5: Calculate the index information amount C_j. The information content C_j of the jth indicator is:

$$C_j=\sigma_j\sum_{i=1}^{n}\left(1-r_{ij}\right)=\sigma_j R_j,\ i\neq j,\ j=1,2,\cdots,n \tag{8}$$

Step 6: Calculate the indicator weight. The objective weight w_j of the jth indicator is:

$$w_j=\frac{C_j}{\sum_{k=1}^{n}C_j},\ j=1,2,\cdots,n \tag{9}$$

In formula (9), the larger the C_j is, the larger the amount of information contained in the jth evaluation index, and the greater the relative importance of the index, that is, the greater the weight of the index j.

4. Collaboration model

4.1 Construction of subsystem collaboration model

The regional high-tech industrial cluster and regional economy are regarded as a composite system $S=\{S_1,S_2\}$, in which S_1 is the regional high-tech industrial cluster subsystem, and S_2 is the regional economic subsystem. Consider the subsystem $S_i\ (i\in[1,2])$, let its evaluation index be $x_i=\left(x_{i1},x_{i2},\cdots,x_{in}\right)$, where $\lambda_{ij}\le x_{ij}\le\mu_{ij},\ n\ge 1,\ j=1,2,\cdots,n$, λ_{ij}、μ_{ij} are the critical values of x_{ij} when the system is stable. It is assumed that $\left(x_{i1,}x_{i2},\cdots x_{il}\right)$ is a positive index, and its value is positively correlated with the degree of order of the system; $\left(x_{il+1},x_{il+2},\cdots,x_{in}\right)$ is a reverse index, and its value is negatively correlated with the degree of order of the system. Then the systematic order degree $y_i\left(x_{ij}\right)$ of the evaluation index component x_{ij} of the subsystem S_i is:

$$y_i\left(x_{ij}\right)=\begin{cases}\dfrac{x_{ij}-\lambda_{ij}}{u_{ij}-\lambda_{ij}},\ i\in\left[1,l\right]\\[2ex]\dfrac{u_{ij}-x_{ij}}{u_{ij}-\lambda_{ij}},\ i\in\left[l+1,n\right]\end{cases} \tag{10}$$

Based on the theory of synergy, the contribution of the evaluation index to the system can be calculated by "integrating" the components of each evaluation index. In this paper, the linear weighting method is used for integration, that is, the systematic order degree $y_i\left(x_i\right)$ of the evaluation index x_i is:

$$y_i\left(x_i\right)=\sum_{i=1}^{n} w_i y_i\left(x_{ij}\right),\ w_i \geq 0,\ \sum_{i=1}^{n} w_i=1 \tag{11}$$

In formula (11), w_i is the weight of each evaluation index. w_i was determined by the CRITIC method. The CRITIC method is an objective weighting method, which reflects the potential role of each indicator on the evaluation results under the condition of having a certain value. Its basic principles are as follows:After standardizing the data, the standard deviation σ_i of the i th indicator is calculated as:

$$\sigma_i=\sqrt{\frac{1}{m} \sum_{j=1}^{m}\left(x_{ij}-\bar{x}_i\right)^2} \tag{12}$$

Calculate the conflict amount R_i between the i th evaluation index and other indexes as:

$$R_i=\sum_{j=1}^{n}\left(1-r_{ij}\right),\ i \neq j \tag{13}$$

Calculate the amount of information C_i contained in the ith evaluation index as:

$$C_i=\sigma_i \sum_{j=1}^{n}\left(1-r_{ij}\right)=\sigma_i R_i,\ i \neq j \tag{14}$$

The weight w_i of the evaluation index is calculated as:

$$w_i=\frac{C_i}{\sum_{i=1}^{n} C_i},\ i=1,2,\cdots,n \tag{15}$$

4.2 Construction of Collaborative System Model

The degree of coordination between regional high-tech industrial clusters and regional economic composite systems reflects the comprehensive coordination degree between the development of regional high-tech industrial clusters and the operation of regional economic systems, namely:

$$Y_{(t)}=sig(\ \bullet\ )\sqrt{\left|Y_1(t)-Y_1(t-1)\right| \bullet \left|Y_2(t)-Y_2(t-1)\right|} \tag{16}$$

$$sig(\ \bullet\ )=\begin{cases}1,\ Y_1(t)-Y_1(t-1) \geq 0, Y_2(t)-Y_2(t-1) \geq 0 \\ -1,\ \text{else}\end{cases} \tag{17}$$

$Y_1(t)$ refers to the orderly contribution of the regional high-tech industrial cluster subsystem at time t, $Y_2(t)$ is the ordered contribution of the regional economic subsystem at t, $Y_{(t)} \in[-1,1]$, when $Y_{(t)}$ tends to 1, it indicates that the regional high-tech industrial cluster and the regional economy The greater the degree of synergy, the effective synergistic development between regional high-tech industrial clusters and regional economic systems or between internal elements. The smaller the $Y_{(t)}$, the smaller the degree of coordination between the two systems, and the disordered development between the regional high-tech industrial cluster and the regional economic system.

5. Empirical Analysis

5.1 Selection of Research Objects and Data Collection

Jilin Province is located in Northeast China and is an important industrial base and commercial grain production base in China. All along, Jilin Province has been striving to give full play to the advantages of the revitalization of old industrial bases and promote steady economic growth. The per capita GDP of Jilin Province has been lower than the national average for a long time, and the ranking of the local per capita GDP has further declined in the past three years, falling to the bottom five in the country. Therefore, this paper regards Jilin Province as a relatively underdeveloped area of China's economy, and studies the current situation of the coordinated development of the local economy and high-tech industrial clusters. The data in this article comes from the 2010-2021 Jilin Provincial Statistical Yearbook, the Jilin Provincial National Economic and Social Development Statistical Bulletin, and the "China Torch Statistical Yearbook". A few missing data are filled by multiple imputation methods. The descriptive statistics of the data are shown in Table 2:

Table 2 Descriptive statistics of order parameter indicators of regional economy and regional high-tech industrial clusters in Jilin Province

Indicator	Max	Min	Mid	Mean
$X_1/10^8$ yuan	1362.20	893.50	1148.35	1130.91
$X_2/10^8$ yuan	42032.90	21913.20	33431.15	32842.34
$X_3/10^8$ yuan	34427.90	16551.10	26396.65	25932.13
$X_4/10^8$ yuan	13235.52	6410.48	10222.50	10176.00
$X_5/10^4$ people	2726.50	2375.37	2653.80	2632.34
$X_6/10^8$ yuan	7855.75	3504.92	4494.79	5170.41
$X_7/10^8$ yuan	13923.20	7441.70	11788.15	11534.01
$X_8/10^4$ yuan	-5343552.00	-9149039.00	-7048473.50	-7136182.67
$X_9/10^8$ yuan	1263.78	602.41	1150.47	1095.41
X_{10}/ yuan	54980.00	23370.00	39193.50	39654.92
X_{11}/ yuan	35646.00	15411.47	25715.64	25847.61
Y_1/ number	37939.00	8546.00	21049.05	21053.36
Y_2/ people	466679.00	212155.00	373139.00	351429.08
$Y_3/10^3$ yuan	43852124.18	5291271.00	13391666.86	17638074.40
$Y_4/10^3$ yuan	758842033.00	279064778.00	627463848.00	589712416.08
$Y_5/10^3$ yuan	98966762.00	21425041.00	75003457.50	69466328.42
$Y_6/10^3$ yuan	810275736.00	674527274.00	740477750.82	740475796.86
$Y_7/10^3$ yuan	812546924.00	195663084.00	616401448.00	564903566.83
$Y_8/10^3$ yuan	79669363.00	20784398.00	59373576.50	55425069.33
Y_9/%	52.36	5.69	16.31	17.76
Y_{10}/%	1.71	0.36	0.93	0.98
Y_{11}/%	15.87	11.16	13.26	13.23
Y_{12}/%	6.60	1.37	3.78	3.83

5.2 Weight calculation

Based on the relevant data of Jilin Province's economic system and high-tech zone enterprises from 2010 to 2021, this paper calculates the CRITIC weight, and uses SPSSAU software to calculate the weight of the index. The weight calculation results are shown in Table 3.

Table 3 Index weights of order parameters of regional economy and regional high-tech industrial clusters in Jilin Province

Indicator	CRITIC weight calculation

	Amount of information V_i	Correlation P_i	Index Weight W_i
X_1 /10^8 yuan	1.380	4.392	6.49%
X_2 /10^8 yuan	1.344	4.417	6.33%
X_3 /10^8 yuan	1.460	4.375	6.87%
X_4 /10^8 yuan	1.290	4.552	6.07%
X_5 /10^4 people	4.263	15.894	20.07%
X_6 /10^8 yuan	2.852	8.447	13.43%
X_7 /10^8 yuan	1.464	4.660	6.89%
X_8 /10^8 yuan	2.822	10.451	13.28%
X_9 /10^8 yuan	1.572	5.416	7.40%
X_{10} / yuan	1.361	4.652	6.41%
X_{11} / yuan	1.437	4.567	6.77%
Y_1/ number	3.169	11.568	9.41%
Y_2 / people	2.867	8.076	8.51%
Y_3 /10^3 yuan	3.069	8.814	9.11%
Y_4 /10^3 yuan	2.295	7.449	6.81%
Y_5 /10^3 yuan	2.400	7.234	7.12%
Y_6 /10^3 yuan	3.020	11.892	8.97%
Y_7 /10^3 yuan	2.458	7.126	7.30%
Y_8 /10^3 yuan	2.089	6.986	6.20%
Y_9 /%	3.790	12.632	11.25%
Y_{10} /%	2.783	10.194	8.26%
Y_{11} /%	3.216	11.380	9.55%
Y_{12} /%	2.528	10.851	7.51%

Among the regional economic subsystems, for the first-level indicators, the proportion of the total economic volume is the highest, reaching 59.74%, indicating that the total economic volume is the primary factor driving local economic development; economic structure and economic benefits can also reflect the regional economy to a certain extent. The status quo, their weights are 19.69% and 20.58% respectively; for the secondary indicators, the total population, total retail sales of social consumer goods and total import and export have obvious influences on regional economic development, with their weights being 20.07%, 13.43%, 13.28%, indicating that regional economic development is mainly driven by domestic demand. In the regional high-tech industrial cluster subsystem, for the first-level indicators, the development level and innovation capability can better reflect the current situation of high-tech industrial clusters, and their weights are 40.96% and 36.37% respectively. For the secondary indicators, the proportion of high-tech enterprises and the weight of scientific research personnel are relatively large, reaching 11.25% and 9.55% respectively, indicating that innovation is the engine of enterprise development in the high-tech zone.

5.3 Collaborative Analysis of Subsystems and Coupling System Collaborative Analysis

Equation (2) is used to calculate the order degree of regional economy and regional high-tech industrial cluster subsystems; on this basis, formula (7) is used to calculate the synergy degree of regional economy and regional high-tech industrial cluster composite system. Figure 1 shows the changes in the degree of order and synergy between the regional economy and high-tech industrial clusters in Jilin Province.

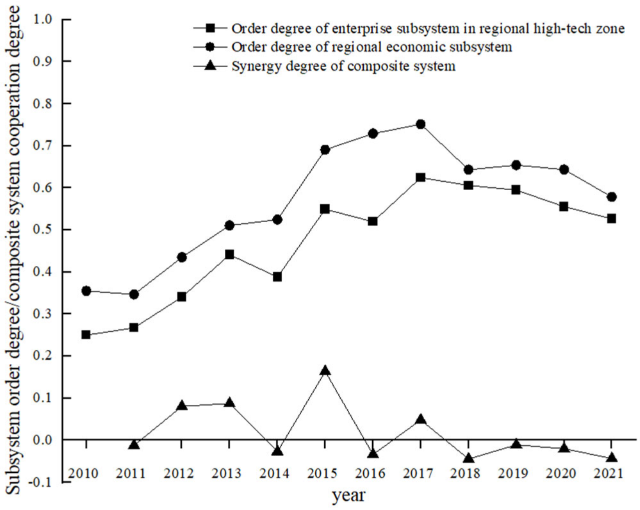

Figure 1 Changes in the order degree and synergy degree of the regional economy and regional high-tech industrial clusters in Jilin Province from 2010 to 2021

5.3.1 Analysis of order degree of subsystems

It can be seen from Figure 1 that the orderliness of the regional economic subsystems and regional high-tech industrial cluster subsystems in Jilin Province generally showed a trend of first rising and then falling. From 2010 to 2017, the orderliness of the two subsystems increased steadily, and peaked in 2017, at 0.62 and 0.75, respectively. From 2018 to 2021, the orderliness of the two subsystems gradually decreased, decreasing by 13.09% and 10.07%, respectively. On the whole, before 2017, the regional economy and the high-tech industrial cluster system developed in a good direction, but after 2017, there was a setback. By comparing the order degree of the two subsystems, it can be seen that the order degree of the regional economic subsystem is significantly higher than that of the high-tech industrial cluster subsystem, indicating that the regional economy has always been ahead of the high-tech industrial cluster and has supported the development of enterprises in the high-tech zone.

5.3.2 Analysis of the Synergy Degree of the Composite System

The development synergy degree of the regional economy and regional high-tech industrial clusters in Jilin Province generally presents an M-shaped development trend of alternating increase and decrease, the minimum value is -0.04, the maximum value is 0.16, and the overall level of coordination. The overall change trend of the synergy degree of the composite system can be divided into four stages:

Stage 1: From 2010 to 2011, the regional economic system declined slightly, the regional high-tech industrial cluster system rose slightly, and the economic system was significantly more orderly than high-tech zone enterprises. system, its development is ahead of the high-tech zone enterprises; and the composite synergy degree at this time is negative, that is, the two subsystems are incompatible.

Stage 2: From 2012 to 2013, the orderliness of the regional economy and regional high-tech industrial cluster systems both increased, and the growth rates were similar; the synergy degree of the composite system was positive at this stage and stabilized at around 0.08, indicating that the two subsystems were in Moderate level of synergy.

Stage 3: From 2014 to 2018, the regional economic system showed a rapid growth trend in the early stage, and then a rapid decline in the later stage; the order degree of the regional high-tech industrial cluster system showed an M-shaped development trend of alternating increase and decrease; the synergy degree of the composite system was positive and negative Alternately, only the synergy degrees in 2015 and 2017 were positive, which were 0.16 and 0.05, respectively, and the difference was about 70%, indicating that the two subsystems could carry out effective synergistic development, but this synergistic relationship was not stable.

Stage 4: From 2019 to 2021, the overall order degree of regional economy and high-tech industrial cluster systems will show a downward trend; the synergy degree of the composite system has always been negative and decreased year by year, from -0.01 to -0.04, that is, the difference between the two subsystems. It is in a state of imbalance between, and the imbalanced state has a tendency to aggravate.

6. Conclusion

(1) For Jilin Province, which has a relatively underdeveloped economy, maintaining a stable growth of the total economic volume can promote local economic development more than optimizing the industrial structure and improving economic benefits. It is worth noting that in order to promote the economic growth of Jilin Province, it is necessary to clearly focus on driving domestic demand, ensure the continuous growth of the resident population, stimulate the vitality of market consumption, and encourage import and export trade. In addition, for the high-tech industrial cluster in Jilin Province, it is still necessary to adhere to the innovation-driven development strategy, strive to increase the proportion of high-tech enterprises, and encourage scientific research and innovation of enterprises.

(2) The synergistic relationship between the regional economy and regional high-tech industrial clusters in Jilin Province is generally weak and relatively unstable, and the synergy degree generally presents an M-shaped development trend of alternating increases and decreases. In addition, regional economic development has always been ahead of high-tech industrial clusters. Therefore, at this stage, the regional economy of Jilin Province supports the development of regional high-tech industrial clusters, while the regional high-tech industrial clusters have little feedback on the regional economy.

Overall, the coordinated development of the regional economy and regional high-tech industrial clusters in Jilin Province is in its infancy, and an internal mechanism for interactive integration has not yet been formed. The synergy between the two systems is generally low and not stable enough, which only reflects the role of regional economy in promoting high-tech industrial clusters, and does not show the spillover effect of high-tech industrial clusters on regional economy.

References

[1] Wang Jinfu, Wang Yadan, Yang Shuangshuang. Research on the evaluation of the spatiotemporal pattern of the coordinated development of high-tech zones and regional economies [J]. Science and Technology Progress and Countermeasures, 2016, 33(19): 118-124.

[2] Zhu Xi'an, Zhang Xiu. Research on the Spatial Spillover Effect of High-tech Industry Agglomeration and Regional Economic Growth Quality: A Research Based on the Panel Space Durbin Model [J]. Economic Issues Exploration, 2020(03):169-184.

[3] Shao Hanhua, Zhou Lei. Research on the Coordination of Space-Time Coupling between National High-tech Zones and Urban Economic Efficiency [J]. Science and Technology Progress and Countermeasures, 2018,35(14):36-42.

[4] Shi Huan, Li Hongbo. Analysis of Knowledge Externality Effect of China's High-tech Industrial Clusters [J]. Technological Economy, 2022, 41(01): 66-76.

[5] Guo Xuemeng, Wang Zhigang. Mechanism Analysis and Empirical Research on the Coordinated Development of High-tech Zones and Regional Economy [J]. Dongyue Lun Cong, 2021, 42(05): 33-46. DOI: 10.15981/j.cnki. dongyueluncong.2021.05.004.

[6] WANG Z, YANG Y, WEI Y. Has the Construction of National High-Tech Zones Promoted Regional Economic Growth?—Empirical Research from Prefecture-Level Cities in China[J]. Sustainability, 2022, 14(10): 6349 .

[7] Zhang Xiuyan, Bai Wen, Zheng Xue. Correlation identification and evolution characteristics analysis of my country's regional economic resilience [J]. Journal of Social Sciences of Jilin University, 2021, 61(01): 90-101+237. DOI: 10.15939/j .jujsse.2021.01.jj2.

[8] Mao Chen, Zhang Guangming.Theoretical and Empirical Analysis of the Determinants of Innovation and Development in the Yangtze River Delta[J].Reform and Strategy,2009,25(01):150-153.DOI:10.16331/j.cnki.issn1002-736x.2009.01.021 .

[9] Diakoulaki D, Mavrotas G, Papayannakis L. Determining objective weights in multiple criteria problems: The critic method[J]. Computers & Operations Research, 1995, 22(7): 763-770.

[10] Zhang Yu, Wei Huabo. A CRITIC-based Multi-attribute Decision-Making Combination Weighting Method [J]. Statistics and Decision-Making, 2012(16):75-77.DOI:10.13546/j.cnki.tjyjc.2012.16.009.