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Coupled and Coordination Evaluation and Dynamic Evolution of New Quality Productivity and High-Quality Economic Development

Nanxi Shu, Yongtao Zhou

School of Business, Hubei University, Wuhan, China
Email: 1015979050@qq.com

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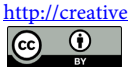

Abstract

Based on the data of 30 provinces in 2010, 2013, 2016, 2019, and 2022, this paper constructed a comprehensive evaluation system of high quality economic productivity, the dynamic model, Dagum gini coefficient, Moran index, Kernel density estimation, and studied the coupling coordination characteristics, regional differences and dynamic evolution rules. The research shows that the coupling and coordination degree of new quality productivity and high-quality economic development in China shows significant regional differences in space, the overall level remains relatively low, it presents the gradient distribution pattern of east & gt; central & gt; west. Although the overall difference has narrowed, the coupling coordination degree still shows distinct differentiation characteristics in space, the dynamics between and within regions remain significant, in particular, the internal differences in the central region are further intensified. Coupled coordination degree has a significant agglomeration effect in space, the eastern region mainly presents a & quot; high-high & quot; agglomeration, While the central and western regions are mainly & quot; low-low & quot; agglomeration, the imbalance of regional development is particularly prominent.

Subject Areas

Business Finance and Investment

Keywords

New Quality Productivity, High Quality Economic Development, Coupling and Coordination Degree, Spatial Difference, Dynamic Evolution

1. Introduction

In January 2024, at the 11th collective study session of the Political Bureau of the 20th CPC Central Committee, General Secretary Xi proposed to "accelerate the devel opment of new-quality productive forces and steadily promote high-quality development". Xi stressed that new-quality productivity relies on technological revolutionary breakthroughs, innovative configuration of production factors, and in-depth industrial transformation and upgrading. It optimizes the basic connotations of laborers, labor materials, and labor objects, takes the soaring total factor productivity as the core, features innovation, focuses on high quality, and embodies advanced productivity.

Through scientific and technological innovation, digital transformation and optimal resource allocation, the new-quality productive forces promote the economic system to the direction of high quality and high efficiency, and the high-quality economic development provides the necessary external conditions for the continuous innovation of the new quality productive forces, and the two form a dynamic relationship of interdependence and mutual promotion. Li Bingyan *et al.* (2024) [1] research found that new quality productive forces contribute to high-quality economic development by promoting scientific and technological progress, optimizing resource allocation and promoting industrial transformation. Hu Ying *et al.* (2024) [2] pointed out that new-quality productive forces promote high-quality economic development through scientific and technological innovation and industrial upgrading. Du Chuanzhong *et al.* (2024) [3] further show that new quality productive forces promote high-quality economic development from multiple dimensions by improving the quality of production factors, promoting new production organization forms, optimizing industrial structure and technological innovation. However, the existing studies focus on the one-way effect of new quality productivity on high-quality economic development, and lack of research on the complex coupling and coordination relationship between the two.

This paper aims to analyze the coupling relationship and coordination mechanism between new-quality productivity and high-quality economic development. First, a scientific index system is constructed. The entropy weight method is applied to calculate the index weight of the two systems and derive a comprehensive index to evaluate the coupling and coordination level. Simultaneously, the Dagum Gini coefficient is used to analyze regional differences and their causes. Second, Moran's I is employed to analyze the spatial correlation of the coupling and coordination of the two systems. Combined with Kernel density estimation, this study characterizes their distribution and space-time evolution features, providing a theoretical basis for policy-making and strategic decision-making.

2. Research Technique

2.1. Construction of the Index System

1) The construction of the new quality and productivity evaluation index

system. Referring to the existing research results [3], this paper constructs a new quality productivity evaluation index system [4] including six dimensions of scientific and technological productivity, digital productivity, green productivity, new workers, new labor materials and new labor objects. The measurement unit, weight and attribute of the specific evaluation indicators are shown in Table 1.

Table 1. New quality productivity evaluation index system.

Target layer	The standard layer	Index layer	Method of calculation	Attribute	Weight
New quality productivity	Scientific and technological productive forces	Electronic information manufacturing	Integrated circuit output (one billion yuan)	Forward direction	0.1272
		Innovative product level	Industrial innovation funds of industrial enterprises above the plan (ten thousand yuan)	Forward direction	0.0544
		Technology research and development level	Full-time equivalent for R & D personnel in industrial enterprises (h)	Forward direction	0.0590
	Digital productivity	We will innovate the level of research and development	Number of invention patent applications of high-tech enterprises	Forward direction	0.1114
		Entrepreneurship activity	Number of innovative enterprises per 100 people	Forward direction	0.0294
		Software service level	Software business revenue (ten thousand yuan)	Forward direction	0.0796
		Innovate industrial income	Business income of high technology industry (one thousand yuan)	Forward direction	0.0773
		Investment in technology research and development	Expenditure on new product development of high-tech enterprises	Forward direction	0.0904
	Green productivity	Pollution prevention and control level	Completed investment in industrial pollution control (ten thousand yuan)	Forward direction	0.0337
		Industrial water intensity	Industrial water consumption/GDP of (%)	Negative direction	0.0652
		Waste utilization level	Comprehensive utilization/ production amount of industrial solid waste is (%)	Forward direction	0.0200
		Green invention achievements	Number of green patent applications/number of patent applications	Forward direction	0.0281

Continued

New workers		Human capital structure	The average number of years of education per person	Forward direction	0.0080
		Education funding intensity	Education expenditure/total fiscal expenditure	Forward direction	0.0138
		Student structure in school	Number of students in school/total population in school	Forward direction	0.0116
		The proportion of employment in the tertiary industry	Tertiary industry employment/ total employment	Forward direction	0.0177
New labor data		Traditional infrastructure	Railway mileage	Forward direction	0.0182
		Modern infrastructure	Number of Internet access ports per capita	Forward direction	0.0221
		Economic input in new products	New product development funds/GDP	Forward direction	0.0310
		Robot mounting density	Total robots/total population	Forward direction	0.0503
New labor object		Environmental protection efforts	Environmental protection expenditure/general financial expenditure	Forward direction	0.0194
		Enterprise informatization level	Number of enterprises engaged in e-commerce transactions/total number of enterprises	Forward direction	0.0311

2) Construction of the evaluation index system for high-quality economic development. This paper draws on the existing research results [5], and it constructs the evaluation index system of high-quality development of the urban economy from five dimensions: innovative development, coordinated development, green development, open development, and shared development. The measurement unit, weight and attribute of specific indicators are shown in Table 2.

Table 2. Evaluation index system for high-quality economic development.

The standard layer	Index layer	Measurement index	Attribute	Weight
Innovative development	Patent grant number per 10,000 people	Number of patents granted per 10,000 people (one/10,000 people)	Forward direction	0.0948
	GDP rate of rise	The Regional GDP growth rate is (%)	Forward direction	0.0156
	Technology trading activity	Technology transaction volume/GDP (%)	Forward direction	0.1212
	R & D investment intensity	R & D funds for industrial enterprises above designated size/GDP (%)	Forward direction	0.0331

Continued

Harmonious development	Urban-rural income ratio	Per capita income of rural residents/per capita income of urban residents is (%)	Forward direction	0.0214
	Urban and rural structure	Urbanization rate is (%)	Forward direction	0.0313
	Advanced industrial structure	The added value of the tertiary industry/GDP ratio is (%)	Forward direction	0.0439
Green development	Economic development consumes energy	Power consumption/GDP (billion KWH/100 million yuan)	Negative direction	0.0252
	Waste water discharge capacity per unit of GDP	Wastewater discharge/GDP (ton/100 million yuan)	Negative direction	0.0459
	Emissions per unit of GDP	Waste gas emission/GDP (ton/100 million yuan)	Negative direction	0.1602
	Green environment level	The Green coverage rate of the built-up area is (%)	Forward direction	0.0186
Open development	Business development activity	Total retail sales/GDP (%)	Forward direction	0.0335
	Dependency of foreign capital	Total foreign investment/GDP (%)	Forward direction	0.0703
	Foreign trade dependence degree	Total import and exports/GDP (%)	Forward direction	0.0777
Shared development	Public health care level	Professional (assistant) physician per thousand population (per person/thousand person)	Forward direction	0.0465
	Per capita collection of books in public libraries	Total public library book collection/final population (volume/person)	Forward direction	0.0677
	The participation level of basic medical insurance	The number of urban basic medical insurance participants insured at the end of the year/the total number of regions is (%)	Forward direction	0.0368
	The registered urban unemployment rate	Registered urban unemployment rate is (%)	Negative direction	0.0556

2.2. Data Source

For this study, panel data from Chinese mainland 30 provinces (excluding 20, 2010, 2013, 2016, 2019 and 2022) were selected as the study sample. The data mainly comes from China Statistical Yearbook, China Science and Technology Statistical Yearbook, China Environmental Statistical Yearbook, China E-commerce Report and other authoritative statistical data. For some missing data, interpolation was used to ensure data integrity and reliability of study conclusions.

2.3. Data Source

2.3.1. Entropy Method

Index of alization. The principle of the entropy weight method is to use the information entropy to determine the weight of the index according to the information provided by the observed value of each index. The greater the weight, the greater the contribution rate of the index in the system. This paper uses the entropy method to calculate the comprehensive index of new quality productivity and high quality economic development, and first normalizes the original index.

2.3.2. Coupled Coordination Degree Model

Drawing on the existing research results of [6], the calculation formula for constructing the coupling degree is as follows:

$$C = 2 \times \sqrt{\frac{P_1 \times P_2}{\left(P_1 + P_2\right)^2}} \tag{1}$$

C is the coupled correlation degree of the two, P_1, P_2 and the comprehensive evaluation index of new quality productivity system and the comprehensive evaluation index of high quality economic development system respectively.

2.3.3. The Dagum Gini Coefficient and Its Decomposition Method

The Gini coefficient and its decomposition method can subdivide the overall inequality into intra-group and inter-group inequality, and reveal the root of inequality. The Dagum Gini coefficient has strong adaptability in handling the subsample distribution, overlapping and regional differences of the coupled coordination between new quality productivity and economic high-quality development [7]. Therefore, this method is used to comprehensively explore the spatial differences and the potential influencing factors [8].

2.3.4. The Moran's I Index

The Moran's I index is an important tool for assessing spatial regional correlations. The global Moran's I index is used to reveal the spatial autocorrelation of the overall data and provide an overview of the global spatial correlation, while the local Moran's I index focuses on the aggregation relationship and spatial state of each subsystem, deeply analyzes the spatial relationship of specific subregions and reveals the local pattern.

2.3.5. Kernel Density Estimation

The kernel density estimation method assumes that $f(x)$the density function of the random variable $Y$is:

$$f\left(x\right) = \frac{1}{Nh}\sum_{i=1}^{N} K\left(\frac{X_i - x}{h}\right) \tag{2}$$

In equation (20), the X_i coupling coordination degree of each province is indicated, x is the mean of the coupling coordination degree of each province, $N$is the number of sample provinces, $K$is the Kernel function, and $h$is the bandwidth [9]. Gauss kernel is used as shown in equation (21) [10]:

$$K\left(x\right) = \frac{1}{\sqrt{2\pi}} \exp\left(-\frac{x^2}{2}\right) \tag{3}$$

3. Coupling and Coordination Evaluation of New Quality Productivity and High-Quality Economic Development and Regional Differences

3.1. Overall Characteristics

According to formulas (1)-(6), 2010, 2013, 2016, 2019 and 2022 were selected as

observation points. The original data of each index of 30 provinces in China were standardized, and the new quality productivity index and high quality economic development index of each province were calculated by entropy method. Subsequently, according to equation (8), the coupling coordination degree and its mean value of 30 provinces were calculated, and the partition mean was calculated according to the three regions. The specific results of the coupling and coordination of the new quality productivity and the high-quality economic development in 30 provinces are shown in Table 3 and Table 4.

Table 3. Coupled coordination score of new quality productivity and economic high-quality development.

Districting groups	province	In 2010,	In 2013,	In 2016,	In 2019,	In 2022,	mean	type
East	Beijing	point seven two one nine	point seven three four three	point seven one three nine	point seven two four four	point seven three two one	point seven two five three	Intermediate coordination
	Tianjin	point five five two two	point five five nine one	point five four one two	point four eight six six	point four nine five seven	point five two seven zero	Forced coordination
	Hebei	point three five zero zero	point three five eight six	point three seven eight three	point four three eight nine	point four two eight three	point three nine zero eight	Mild dysregulation
	Liaoning	point four four six four	point four seven zero one	point four zero three four	point three seven eight nine	point three six eight nine	point four one three five	On the verge of dysregulation
	Shanghai	point six eight eight one	point six six two eight	point six two eight eight	point five nine one zero	point six one two zero	point six three six five	Primary coordination
	Jiangsu	point six nine three seven	point seven zero nine seven	point six nine six three	point six two nine one	point six three nine four	point six seven three seven	Primary coordination
	Zhejiang	point five eight zero nine	point five nine three zero	point five seven six five	point five five eight seven	point five eight four zero	point five seven eight six	Forced coordination
	Fujian	point four seven five five	point four six zero one	point four three five four	point four three zero one	point four six three three	point four five two nine	On the verge of dysregulation
	Shandong	point five zero six nine	point five three seven zero	point five three one three	point four eight four one	point five one two two	point five one four three	Forced coordination
	Guangdong	point seven two five three	point seven two nine three	point six nine seven one	point six nine six zero	point six seven seven one	point seven zero five zero	Intermediate coordination
	Guangxi	point three zero nine three	point three one six seven	point three zero nine zero	point two nine seven zero	point three two six five	point three one one seven	Mild dysregulation
	Hainan	point three six seven two	point three six eight five	point three seven three seven	point three five nine four	point three nine zero seven	point three seven one nine	Mild dysregulation
Middle part	Shanxi	point three five two three	point three five three three	point three one seven three	point three two six seven	point three three two three	point three three six four	Mild dysregulation
	Nei Monggol	point three three five nine	point three four zero three	point three two seven four	point two nine nine eight	point three zero six zero	point three two one nine	Mild dysregulation
	Jilin	point three seven nine eight	point three seven four nine	point three five four six	point three three zero seven	point three three two five	point three five four five	Mild dysregulation
	The Heilongjiang River	point three seven three two	point three five six one	point three one five five	point two seven eight five	point two nine two one	point three two three one	Mild dysregulation
	Anhui	point three six two seven	point three nine zero eight	point three eight eight zero	point four one zero four	point four five four three	point four zero one two	On the verge of dysregulation
	Jiangxi	point three four one seven	point three four zero five	point three two six nine	point three six five nine	point three nine two two	point three five three five	Mild dysregulation
	Henan	point three six zero nine	point three six six five	point three six five two	point four one five seven	point three seven four one	point three seven six five	Mild dysregulation
	Hubei	point four one one three	point four two four one	point four two six seven	point four zero five four	point four four two seven	point four two two one	On the verge of dysregulation
	Hunan	point three six eight one	point three six nine two	point three five five four	point three six eight two	point four one three five	point three seven four nine	Mild dysregulation

Continued

	Chongqing	point four zero three four	point four two two five	point four one four three	point three nine two six	point four four seven one	point four one six zero	On the verge of dysregulation
	Sichuan	point three eight one three	point three nine six two	point three eight three four	point three nine seven nine	point four one one three	point three nine four zero	Mild dysregulation
	Guizhou	point two seven four zero	point two seven one zero	point two seven three five	point two eight eight nine	point three one eight one	point two eight five one	Moderate dysregulation
	Yunnan	point three zero six six	point two nine six one	point two seven seven six	point two eight three one	point three zero eight seven	point two nine four four	Moderate dysregulation
The west area	Shaanxi Province	point three eight three five	point four zero six six	point three eight two six	point three nine two seven	point four zero two seven	point three nine three six	Mild dysregulation
	Gansu	point three two seven six	point three four six three	point three four seven five	point three nine two one	point three four one seven	point three five one zero	Mild dysregulation
	Qinghai	point two eight three eight	point three two nine nine	point three two one one	point two nine two nine	point two nine nine nine	point three zero five five	Mild dysregulation
	Ningxia	point three one zero nine	point three three eight four	point three two zero four	point three five four six	point three eight six four	point three four two one	Mild dysregulation
	Xinjiang	point three two two zero	point three one three six	point two nine one zero	point three zero zero zero	point three zero five two	point three zero six three	Mild dysregulation

Table 4. The national mean of coupling coordination and the mean of the three regions.

	The national average	East region mean	Central region mean	Mean in western region
2010	0.4232	0.5553	0.3687	0.3307
2013	0.4312	0.5620	0.3719	0.3434
2016	0.4158	0.5433	0.3562	0.3316
2019	0.4123	0.5252	0.3627	0.3356
2022	0.4264	0.5367	0.3792	0.3503
mean	0.4218	0.5445	0.3678	0.3383

3.2. Regional Characteristics

1) Intermediate coordination: During the sample period, only the mean value of the coupling coordination degree between Beijing and Guangdong was in the intermediate coordination state. The coupling coordination degree in Beijing fluctuated around 0.72 during the sample period, while the coupling coordination degree in Guangdong decreased significantly from 2013 and rebounded in 2022.

2) Primary coordination: The average degree of coupling coordination between Jiangsu and Shanghai is in the primary coordination state. Jiangsu reached intermediate level in 2013, while Shanghai dropped to barely coordinated level in 2019.

3) Earely coordination: The mean value of coupling coordination in Tianjin, Zhejiang and Shandong is in a barely coordinated state. Tianjin entered a state of imbalance in 2019 and 2022, while Shandong fell into the state of imbalance in 2019.

4) On the verge of imbalance: The average value of Liaoning, Fujian, Anhui, Hubei and Chongqing is on the verge of imbalance. Liaoning showed mild imbalance in 2019 and 2022, while Anhui and Hubei (central provinces) showed an overall gradual upward trend between 2010 and 2019.

5) Mild disorder: The average value of 16 provinces, including Hebei, Guangxi, Hainan, Shanxi, Inner Mongolia, Jilin, Heilongjiang, Jiangxi, Henan, Hunan, Sichuan, Shaanxi, Gansu, Qinghai, Ningxia and Xinjiang, are all in a state of mild disorder. Among them, Hebei showed a gradual upward trend during the study period, and was close to the disorder level by 2019 and 2022. Heilongjiang has gradually declined since 2010, and had a moderate imbalance in 2016 and 2019. Hunan, Sichuan and Shaanxi are showing an upward trend, all reaching the verge of imbalance in 2022. The mean of Qinghai and Xinjiang was close to 0.3, approaching the state of moderate disorder in mild dysregulated provinces.

6) Moderate imbalance: The mean value of Guizhou and Yunnan is in a state of moderate imbalance, but Guizhou rises to a mild imbalance state in 2022, and Yunnan also enters a state of mild imbalance state in 2022.

3.3. Regional Difference Analysis

Using Dagum Gini coefficient and its decomposition principle, using MATLAB software, calculate the regional differences and sources of coupling and coordination between new quality productivity and high-quality economic development, and obtain the overall Gini coefficient, regional gini coefficient, inter-regional Gini coefficient and its contribution rate. The results are shown in Table 5 [11].

Table 5. Gini coefficient and its decomposition of the coupling coordination of new quality productivity and high-quality economic development.

A particular year	G	G_w			G_{nb}			G_z		
		East	Central section	West	East-middle	East-west	Middle-west	Within the area	Between the area	Supervariable density
2010	0.16	0.13	0.02	0.06	0.20	0.25	0.07	20.26	76.57	3.15
2013	0.15	0.13	0.03	0.07	0.20	0.24	0.06	20.98	74.39	4.61
2016	0.15	0.13	0.05	0.07	0.21	0.24	0.07	21.39	73.95	4.65
2019	0.15	0.12	0.06	0.07	0.18	0.22	0.08	22.79	70.52	6.67
2022	0.14	0.12	0.08	0.07	0.18	0.21	0.08	23.24	68.76	7.98
mean	0.15	0.126	0.048	0.068	0.194	0.232	0.072	21.732	72.838	5.412

Note: G and indicate the overall Gini G_w, G_{nb}, G_z coefficient, regional Gini coefficient, inter-regional Gini coefficient and contribution rate respectively.

The results showed that the Gini coefficient of the 30 provinces decreased from 0.16 to 0.14, indicating a downward trend of overall spatial differentiation. The average Gini coefficient in the eastern region is 0.126, with the largest differentiation; the western region is 0.068, and the central region is 0.048, with the least differentiation. Overall, the western and central regions had lower internal spatial differentiation than the eastern regions. From the perspective of the changing trend,

the overall Gini coefficient gradually decreased, the Gini coefficient in the eastern region first gently decreased, the western region remained stable, and the central region increased significantly. The study shows that the degree of coupling coordination varies significantly between regions, the overall difference between the eastern region and the whole country gradually shrinks, the western regions are stable, and the central regions expand.

During the five inspection periods from 2010 to 2022, the mean Gini coefficient between the eastern and western regions was 0.232, showing the highest regional difference. The mean Gini coefficient between the eastern and central regions was 0.194, which was lower than the difference between the eastern and western regions, but the difference was small. The mean Gini coefficient for the central and western regions was 0.072, indicating the smallest regional difference. In the overall trend, the Gini coefficient between the eastern and central regions and the eastern and western regions is gradually decreasing, indicating that the differences between these regions are narrowing. However, the Gini coefficient in the central and western regions was basically stable at around 0.07, indicating that the fluctuation of regional differences is small [12].

The data show that the contribution rate between regional differences is the highest to the overall inequality, but there is a trend of gradual decline; followed by the contribution rate within the region, the contribution rate increases year by year during the sample period, while the contribution rate of supervariable density is relatively low. The study shows that regional difference is the main factor for the spatial differentiation of coupling coordination between new quality productivity and high-quality economic development, followed by internal regional difference, and the influence of supervariable density on coupling coordination is limited.

4. Research Results

4.1. Spatial Correlation Measure of Coupling Coordination of New Quality Productivity and High Quality Economic Development

4.1.1. Global Spatial Autocorrelation Analysis

Based on the mean value of the coupling coordination of new quality productivity and high-quality economic development, the global Moran index of each province is calculated through the adjacent space matrix, and the results are shown in **Table 6**. The data in the table show that the global Moran index, which couples the coordination of new quality productivity and high quality economic development, showed an overall upward trend, increasing from 0.332 in 2010 to 0.419 in 2022, and the index passed the 1% significance level test each year. This shows that the coupling and coordination degree of new urbanization and agricultural carbon emission efficiency in Chinese provinces has significant autocorrelation in space, and shows obvious spatial agglomeration effect, and shows positive correlation, that is, high value areas usually gather together, and low value areas also tend to be adjacent to each other.

Table 6. Moran index of the coupling of new quality productivity and high quality development.

A particular year	Moran Index I	Standard deviation	Normal statistic Z	P price
In 2010,	0.332	0.122	3.017	0.001
In 2013,	0.306	0.122	2.794	0.003
In 2016,	0.354	0.122	3.193	0.001
In 2019,	0.332	0.121	3.039	0.001
In 2022,	0.419	0.122	3.732	0.000

4.1.2. Local Spatial Autocorrelation Analysis

In this paper, based on the adjacent space matrix, the local Moran index is used to study the spatial correlation of the coupled coordination degree of each province, draw the Moran scatter plot (plot omitted), and calculate the distribution of provinces in the scatter plots in 2010 and 2022 (Table 7). The results showed that most provinces during the sample period were concentrated in the "high-high" and "low-low" agglomeration areas, indicating that the same-direction agglomeration effect dominated. The "high-high" cluster areas are mainly concentrated in the eastern region, and in the central Anhui province, the "low-low" and "low-high" cluster areas are mainly distributed in the central and western regions. In 2022, only Chongqing entered the "high-low" agglomeration area in the western region, while the provinces in the eastern region still dominated, indicating that the coupling coordination imbalance of east-middle-west decline in space. Although Anhui entered the "high-high" agglomeration area in 2022, and Hubei and Chongqing entered the "high-low" agglomeration area, the changes are small, indicating that the coupling and coordination of China's new quality productivity and high-quality economic development has formed a relatively stable "hierarchical differentiation feature" [13].

Table 7. Local spatial clustering of the coupling and coordination of the new quality productivity and the high-quality economic development.

type	In 2010,	In 2022,
High-high cluster area	Shanghai, Jiangsu, Beijing, Zhejiang, Tianjin, Shandong, Fujian	Shanghai, Jiangsu, Beijing, Zhejiang, Shandong, Tianjin, Fujian, Anhui
Low-high agglomeration area	Hainan, Jiangxi, Anhui, Hebei and Guangxi	Hainan, Jiangxi, Hebei, Hunan, Henan, Guangxi
Low-low cluster area	Hunan, Henan, Jilin, Hubei, Chongqing, Shaanxi, Shanxi, Heilongjiang, Sichuan, Inner Mongolia, Ningxia, Gansu, Yunnan, Xinjiang, Qinghai, and Guizhou	Guizhou, Shanxi, Shaanxi, Liaoning, Ningxia, Sichuan, Gansu, Jilin, Xinjiang, Heilongjiang, Qinghai, Inner Mongolia, Yunnan
High-low cluster area	Liaoning, Guangdong	Hubei, Chongqing, and Guangdong

4.2. Dynamic Evolution of the Coupling and Coordination between New Quality Productivity and High-Quality Economic Development

Nuclear Density Analysis

Based on Matlab, the Gaussian core density distribution map of new quality productivity and high-quality economic development in China and three regions from 2010 to 2022 (omitted). From the perspective of distribution location and morphology, it shows that the center of the coupling coordination nuclear density curve of 30 provinces in the country is stable, but the height of the main peak decreases and the width increases, indicating that the inter-regional gap is expanding. In the eastern region, the curve shifted to the left, and the peak degree decreased first and then rose, reflecting the decline of the overall coordination degree, but the width of the curve narrowed, indicating the narrowing of regional differences. In the central region, the curve moved right, but still concentrated at the lower level, the main peak decreased but the width expansion was limited, indicating a slow increase of coordination and strong concentration. The curve in the western region shows a trend of "one main peak and two peaks", indicating that although the coordination degree has been improved, the dispersion is significant, and the overall level is still low for [14].

From the perspective of distribution ductility, the right tail appears, indicating that the coupling coordination degree of a few provinces is significantly higher than that of other provinces, reflecting the regional imbalance between regions, but the coupling coordination degree in the eastern and central regions is relatively stable. The central and western regions have the phenomenon of dragging, and some provinces perform well in the range of high coordination, especially in areas close to 0.45.

From the perspective of polarization phenomenon, the transformation from the multi-peak pattern of "one main and two sides" to a single main peak indicates that the national coupling and coordination level develops from multi-polarization to single polarization, and the absolute difference between provinces is gradually narrowed. The eastern region tends to have a single main peak, the polarization phenomenon is weak, and the coordination level tends to be consistent. There is some polarization phenomenon in the central region, and the distribution is concentrated but the overall level is low. The central and western regions show multiple peak distribution, significant polarization phenomenon, large differences within the region, some provinces develop rapidly, and other provinces relatively lag behind [15].

5. Conclusions

This paper constructs a comprehensive index system, uses the entropy method to measure the new quality productivity and high-quality economic development level in 30 provinces of China, analyzes the coupling coordination degree and its spatial difference and dynamic evolution characteristics, and draws the following conclusions:

First, the degree of coupling coordination shows significant regional differences in space, and the overall level is low, and more than half of the provinces are on the verge of imbalance or lower level. The eastern region has performed well, forming a pattern of "high in the east and low in the west". The central and western regions have a large space for improvement, and policy support and resource optimization are urgently needed to promote coordinated regional development.

Second, the spatial distribution is significantly different, the overall difference convergence but the regional and internal dynamics changes obvious. The difference between the east and the west narrowed, and the internal difference between the central part expands. The intra-regional differences are east, west and central, and the differences are east-west, east-middle and middle-west. The contribution rate of the difference between regions decreases, while the contribution rate of the central region increases, so special attention should be paid to the central equilibrium.

Third, the spatial correlation analysis showed that the coupling coordination degree showed significant spatial agglomeration characteristics, and the Moran index increased overall. Most of the eastern provinces are located in "high-high" agglomeration areas, while the central and western regions are dominated by "low-low" agglomeration, and the development imbalance among regions is significant [16].

Fourth, the dynamic evolution characteristics show that the center of the core density curve of 30 provinces is stable but the main peak decreased and widened, and the gap between regions widened. The eastern curve moves to the left, and the resource allocation needs to be optimized, and policy support needs to be strengthened; the western curve shows a pattern of "one main and two peaks", and the dispersion intensifies, accelerating regional coordinated development.

Conflicts of Interest

The authors declare no conflicts of interest.

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