A study on the Statistical Measurement of new Economic Dynamics - an Empirical Study Based on 31 Chinese Provinces

Wenjing Ren

{rwj13400133518@163.com}

School of Statistics, Jilin University of Finance and Economics, Changchun, Jilin, 130117, China

Abstract. The new round of scientific and technological revolution and industrial change is developing deeply, and the new economic dynamics have become an important support point for high-quality economic development. This paper constructs a system of indicators of new economic dynamics from five levels: innovation drive, digital economy, green development, openness level and public services, respectively, and uses the entropy-weighted TOPSIS method to empirically analyse the new economic dynamics of 31 Chinese provinces. Finally, the paper puts forward a number of suggestions for the development path of promoting new economic dynamics.

Keywords: new economic dynamics; five major development concepts; statistical measurement; entropy-weighted TOPSIS method

1 Introduction

The economy is the lifeblood of a country's development. The Chinese economy is currently at a critical stage of transition from "high speed development" to "high quality development", and accelerating the cultivation of new economic power plays a pivotal role in promoting the transformation and upgrading of China's economy. Therefore, measuring the level of development of new economic dynamics is an important topic worth exploring.

Based on this, this paper focuses on the measurement of the development level of China's new economic dynamics and analyses the economic mechanism behind it. The marginal contributions of this paper are: first, using the entropy-weighted TOPSIS method to measure the weights of the five indicators, it is concluded that openness level and innovation drive are important factors influencing the development of new economic dynamics; second, through empirical analysis, it is found that the development level of new economic dynamics in China is characterised by uneven regional development; the provinces with advantages and disadvantages in the five index layers is clear; the level of openness and the digital economy have a greater impact on the overall level of development, and corresponding countermeasures are proposed in response to the existing problems.

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2 Literature Review

Based on the research results of the existing literature, this paper compares the existing literature from three perspectives.

There is no uniform definition of new economic dynamics. The definition given by the National Bureau of Statistics is "the new economy represented by new industries, new business models and new business models is the new dynamic energy". According to Li Zuojun [1], the new dynamic energy of the economy is a new system that aims to improve quality and efficiency, and gradually achieve economic sustainability.

Studies on the statistical measurement of new economic dynamics have been divided into two main types. The first is to construct the index system for the comprehensive evaluation.The NBS constructs an index of new economic dynamism containing six elements, and measures it using a linear weighting method. Chai Shigai [2] constructed a comprehensive evaluation index system for new economic dynamics by assigning equal weights to indicators from two dimensions of inputs and outputs. The second is a total factor productivity-based measurement approach. Zheng Jianghuai [3] construct a kinetic energy index that approximates a proxy for TFP at three levels. Ma Xiuzhen [4] measured Qingdao's total factor productivity using the Solow model and proposed the direction and path of the old and new kinetic energy transformation.

The term new economic dynamics is more similar to the foreign field of research on the transformation and upgrading of industrial structures. The research results of William Paddy and Clark's Paddy-Clark law reflect the economic law of industrial structure change. Raphael Kaplinsky, Mike Morris [5] argue that industrial upgrading can be facilitated by the government to expand the capabilities of the national innovation system.

In summary, it has not yet formed a unified measurement system, and the method of assigning indicators is also relatively single. Therefore, this paper will use the entropy-weighted TOPSIS method to study the kinetic energy of China's new economy based on existing research.

3 Evaluation system of new economic dynamics

3.1 Construction of a comprehensive evaluation index system

This paper refers to the approach of Shao Mingzhen [6] and takes the five major development concepts of "innovation, coordination, green, openness and sharing" as the guidance, and builds a comprehensive evaluation system, as shown in Table 1 [7].

Table 1. System of indicators of new economic dynamics

Target level	Guideline level	Indicator layer	Unit	Nature
New economic dynamics	Innovation driven	R&D expenditure as a percentage of GDP	%	+
		R&D staff full time equivalents	Year of the person	+
		Number of patents granted for inventions per 10,000 R&D personnel	Pieces per 10,000 people	+
	Digital Economy	Mobile phone penetration rate	Department/person	+
		Internet broadband access subscriber coverage	Household/person	+
		E-commerce sales as a share of GDP	%	+
	Green development	Greenery coverage in built-up areas	%	+
		Value of electricity consumption per unit of GDP	kWh/yuan	-
		Sulphur dioxide emissions per unit of GDP	Tonnes/billion	-
		Share of actual foreign investment use in GDP	US$ million	+

	Level of openness	External Trade Dependence	%	+
		Total imports and exports of customs special supervision zones as a proportion of GDP	%	+
	Public Services	Number of hospital beds per 10,000 population	Sheets per 10,000 people	+
		Number of traffic accidents per 10,000 people	From 10,000	-
		Expenditure on education as a proportion of public finance expenditure	%	+

3.2 Data sources

In order to better measure the level of development of new economic dynamics in China, this paper selects the later year 2021 as the research object and takes 31 provinces in China as the research sample. The data mainly comes from the China Statistical Yearbook, followed by the CEE database and the China Science and Technology Statistical Yearbook.

4 Statistical measurement of new economic dynamics

4.1 Entropy weighting method

The main methods for determining the weight of indicators are Analystic Hierarchy Process, standard deviation method and entropy weighting method. As the data used in this paper are quantitative cross-sectional data, the entropy weighting method is commonly used for cross-sectional data, and the assignment of entropy weighting method is more objective, so the entropy weighting method is chosen in this paper.

The steps of the entropy method can be divided into the following :construct the initialization matrix, build a standardised matrix, find the information entropy of each indicator, calculate information utility values, determine the weighting of each indicator. See equation (1)(2).

$$w_j = \frac{1+ln\,(m)^{-1}\sum_{i=1}^{m} p_{ij} ln p_{ij}}{\sum_{j}^{n} 1+ln\,(m)^{-1}\sum_{i=1}^{m} p_{ij} ln p_{ij}} \tag{1}$$

$$Of\ which\ p_{ij} = \frac{y_{ij}}{\sum_{i}^{m} y_{ij}} + 0.001 \tag{2}$$

4.2 TOPSIS Method

The purpose of this paper is to explore the cross-sectional comparison of provinces, and the TOPSIS method can be used for cross-sectional comparison between multiple evaluation units, and avoids the subjectivity of the data, and there is no strict limitation on the amount of sample size, so the TOPSIS method is chosen for comprehensive evaluation in this paper [8].

The steps of the TOPSIS method can be divided into the following: build a weighted matrix, determine the positive and negative ideal solutions, calculate the distance of each evaluation object to the positive and negative ideal solution, calculate the overall evaluation index. See equation (3).

$$D = \frac{\sum_{j}^{n}(max\,(z_{1j},z_{2j},\ldots,z_{mj}) - w_j * y_{ij})^2}{\sum_{j}^{n}(max\,(z_{1j},z_{2j},\ldots,z_{mj}) - w_j * y_{ij})^2 + \sum_{j}^{n}(min\,(z_{1j},z_{2j},\ldots,z_{mj}) - w_j * y_{ij})^2} \tag{3}$$

5 Empirical analysis of new economic dynamics

5.1 Determination of the weighting of indicators

The weights of the indicators of the level of development of new economic dynamics were measured using the entropy weighting method, as shown in Table 2.

Among the five major aspects of the guidelines, the level of openness has the greatest weight, at 37.01%, indicating that the level of openness is the most important factor influencing the development of new economic dynamics; innovation drive accounts for 26.49%, indicating that innovation has always been an important force driving economic and social development; the digital economy accounts for 21.09%, indicating that the digital economy is a key force in China's high-quality economic development.

Table 2. Weights of indicators

Target level	Guideline level	Indicator layer	Weighting
New economic dynamics	Innovation driven 0.2649	R&D expenditure as a percentage of GDP	0.0561
		R&D staff full time equivalent	0.1223
		Number of patents granted for inventions per 10,000 R&D personnel	0.0864
	Digital Economy 0.2109	Mobile phone penetration rate	0.0421
		Internet broadband access subscriber coverage	0.0567
		E-commerce sales as a share of GDP	0.1121
	Green development 0.0649	Greenery coverage in built-up areas	0.0221
		Value of electricity consumption per unit of GDP	0.0209
		Sulphur dioxide emissions per unit of GDP	0.0220
	Level of openness 0.3701	Share of actual foreign investment use in GDP	0.1228
		External Trade Dependence	0.0906
		Total imports and exports of customs special supervision zones as a proportion of GDP	0.1568
	Public Services 0.0891	Number of hospital beds per 10,000 population	0.0256
		Number of traffic accidents per 10,000 people	0.0246
		Expenditure on education as a proportion of public finance expenditure	0.0390

5.2 Comprehensive evaluation analysis

Based on the weights of the indicators of the level of development of new economic dynamics, the TOPSIS method is used for weighting to arrive at a comprehensive evaluation index of the level of development of new economic dynamics in each province.

Table 3. Comprehensive evaluation index

Province	Index Value	Sequence	Province	Index Value	Sequence
Shanghai	0.6776	1	Hebei	0.2329	17
Beijing	0.5275	2	Guangxi	0.2278	18
Guangdong	0.4704	3	Liaoning	0.2082	19
Jiangsu	0.4502	4	Hunan	0.2066	20
Chongqing	0.4066	5	Heilongjiang	0.1701	21
Zhejiang	0.4013	6	Shanxi	0.1682	22
Tianjin	0.3808	7	Ningxia	0.1633	23
Jiangxi	0.3522	8	Gansu	0.1626	24
Hainan	0.3490	9	Xinjiang	0.1589	25
Shandong	0.3470	10	Guizhou	0.1507	26
Shaanxi	0.3237	11	Yunnan	0.1449	27
Anhui	0.3173	12	Jilin	0.1447	28
Sichuan	0.2985	13	Qinghai	0.1217	29
Henan	0.2960	14	Inner Mongolia	0.1212	30
Fujian	0.2822	15	Tibet	0.1210	31
Hubei	0.2331	16			

Based on the evaluation results in Table 3, the comprehensive evaluation index of new economic dynamics of each province in China was ranked into 3 echelons, the first echelon is Shanghai, Beijing, Guangdong, Jiangsu, Chongqing, China, Zhejiang, Tianjin, Jiangxi, Hainan and Shandong; the second echelon is Shaanxi, Anhui, Sichuan, Henan, Fujian, Hubei, Hebei, Guangxi, Liaoning and Hunan; and the third echelon is Heilongjiang, Shanxi, Ningxia, Gansu, Xinjiang, Guizhou, Yunnan, Jilin, Qinghai, Inner Mongolia and Tibet.

Looking at the provinces, Shanghai and Beijing have a much higher level of development of new economic dynamics than other provinces, Guangdong, Jiangsu, Chongqing and Zhejiang are higher than the development level of most provinces. All of them belong to the eastern region, except Chongqing which belongs to the western region. Five provinces have an overall evaluation index below 0.15, are Yunnan, Jilin, Qinghai, Inner Mongolia and Tibet, all of which belong to the western region, except Jilin which belongs to the northeastern region.

It can be seen that the level of development of new economic dynamics in the eastern region is significantly better than that in the western region. The level of development of new economic dynamics in China is characterised by uneven regional development.

5.3 Analysis of the results of the various dimensions of the new economic dynamics

Based on the weights of the indicators of the level of development of new economic dynamics, the TOPSIS method is used for weighting to arrive at a comprehensive evaluation index of the level of development of new economic dynamics in each province.

Table 4. Results of the measurement of new economic dynamics by dimension

Province	Innovation Drive		Digital Economy		Green Development		Open Level		Public Services	
	value	sort	value	sort	value	sort	value	sort	value	sort
Shanghai	0.3816	6	0.7844	1	0.6288	17	0.6995	1	0.4318	23
Beijing	0.5989	2	0.7678	2	1.0000	1	0.3088	5	0.4831	20
Guangdong	0.6813	1	0.3374	10	0.7448	6	0.4984	2	0.6132	17
Jiangsu	0.5899	3	0.3604	6	0.7719	4	0.2855	7	0.6506	11
Chongqing	0.1578	17	0.3530	8	0.7319	8	0.4192	3	0.6427	13
Zhejiang	0.5185	4	0.4173	5	0.6955	13	0.2404	10	0.6208	15
Tianjin	0.2003	15	0.4680	4	0.6225	19	0.3473	4	0.2883	31
Jiangxi	0.1310	20	0.4884	3	0.8193	2	0.2021	14	0.7295	2
Hainan	0.0616	28	0.3487	9	0.6851	14	0.2999	6	0.4125	25
Shandong	0.3921	5	0.2675	12	0.7035	11	0.2142	13	0.7831	1
Shaanxi	0.2499	9	0.2339	17	0.6700	15	0.2624	8	0.6615	8
Anhui	0.2736	7	0.2372	15	0.7619	5	0.1856	15	0.6416	14
Sichuan	0.2353	10	0.2224	19	0.7239	9	0.2508	9	0.6135	16
Henan	0.2044	14	0.1319	26	0.7020	12	0.2331	11	0.7243	3
Fujian	0.2152	12	0.3584	7	0.7852	3	0.1614	16	0.6569	9
Hubei	0.2619	8	0.1541	24	0.7372	7	0.1042	19	0.4250	24
Hebei	0.1402	19	0.1879	21	0.6301	16	0.1235	18	0.6812	4
Guangxi	0.0766	22	0.1614	23	0.6098	21	0.2276	12	0.5965	18
Liaoning	0.1758	16	0.2020	20	0.5742	24	0.1401	17	0.4500	21
Hunan	0.2225	11	0.1388	25	0.7206	10	0.0816	20	0.6751	5
Heilongjiang	0.2121	13	0.1049	28	0.4694	26	0.0562	22	0.4442	22
Shanxi	0.0721	24	0.2441	13	0.5816	23	0.0625	21	0.4852	19
Ningxia	0.0718	25	0.2857	11	0.2541	30	0.0352	26	0.3783	27
Gansu	0.0705	26	0.2387	14	0.3317	29	0.0235	28	0.6446	12
Xinjiang	0.0190	31	0.2357	16	0.3343	28	0.0444	25	0.6524	10
Guizhou	0.0555	29	0.0853	29	0.5450	25	0.0165	29	0.6659	6
Yunnan	0.0695	27	0.0784	30	0.5976	22	0.0512	23	0.6647	7
Jilin	0.1553	18	0.1093	27	0.6203	20	0.0505	24	0.3612	28
Qinghai	0.0749	23	0.1796	22	0.3406	27	0.0000	31	0.4099	26

Inner Mongolia	0.0397	30	0.2264	18	0.0478	31	0.0236	27	0.3471	30
Tibet	0.1008	21	0.0378	31	0.6241	18	0.0046	30	0.3485	29

As shown in Table 4, from the innovation-driven level, the top three provinces with the highest innovation-driven scores are Guangdong, Beijing and Zhejiang respectively. Guizhou, Inner Mongolia and Xinjiang are at the bottom. Guizhou's thin base and weak foundation in science and technology innovation has not yet been transformed; Inner Mongolia's low intensity of investment in science and technology has largely restricted the enhancement of innovation capacity; Xinjiang's key core technologies have not yet been conquered.

At the digital economy level, Shanghai and Beijing have a digital much higher than the digital economy development level of other provinces. The digital economy index of Guizhou, Yunnan and Tibet is less than 0.1. The scale of Guizhou's digital economy industry is small and the total number of digital economy talents is scarce; Yunnan's government digital foundation is relatively weak; Tibet's investment in information technology is relatively small and far from meeting the needs of information construction and development.

In terms of green development, Beijing has the highest level of green development, actively implementing the "Green Beijing" strategy. Although Qinghai has the lowest level of green development, it is actively developing and utilising new energy sources and building a national clean energy industry.

In terms of openness, Shanghai's level of openness is much higher than that of other provinces. However, at the same time, 12 provinces in China have an openness level index of less than 0.1, indicating that all provinces in China need to improve their openness level and promote trade and investment liberalisation and facilitation.

In terms of public services, the top three provinces are Shandong, Jiangxi and Henan. The three provinces with the lowest public service ratings are Tibet, Qinghai and Tianjin. Tibet's policy documents not perfect ; Qinghai's resource allocation not reasonable; and Tianjin facing the challenges in education, pensions and healthcare.

From the horizontal comparison of provinces, the leading provinces and cities in the comprehensive evaluation index do not lead in every dimension, for example, Shanghai ranks first in the country in terms of digital economy and openness, but ranks low in terms of public services. Provinces in the first tier are ranked higher in openness and digital economy, while most of the public service indicators are ranked lower; provinces in the second tier are ranked in the middle because of their lower rankings in digital economy and openness, although some of their green development and public service indicators are ranked higher; provinces in the third tier The provinces in the third tier are all ranked lower in all indicators.

6 Conclusions and Recommendations

6.1 Research findings

In terms of the overall results, the level of development of new economic dynamics in the eastern region is significantly better than that in the western region, and the level of development of new economic dynamics in China is characterised by uneven regional development.

In terms of the various dimensions, the level of openness has the greatest weight among all indicator layers, with innovation-driven accounting for 26.49%, digital economy 21.09%, and public services and green development accounting for smaller weights of 8.91% and 6.49% respectively. Guangdong, Beijing and Zhejiang scored the highest for innovation-driven, while Guizhou, Inner Mongolia and Xinjiang ranked bottom among provinces. Shanghai and Beijing have much higher digital economy indices than other provinces, while Guizhou, Yunnan and Tibet have smaller digital economy indices. The top three provinces with the highest public service ratings are Shandong, Jiangxi and Henan, while the three provinces with the lowest ratings are Tibet, Qinghai and Tianjin. Beijing has the highest level of green development, and the provinces that rank behind Beijing have less difference in green development index.

From the horizontal comparison of provinces, the leading provinces and cities in the comprehensive evaluation index do not lead in every dimension. Provinces with the top level of opening up and the digital economy have a high overall level of development of new economic dynamics.

6.2 Policy Recommendations

Promoting coordinated regional economic development. We will further implement the strategy of coordinated regional development, build a regional economic layout with complementary advantages and high-quality development, thereby promoting coordinated regional economic development.

Steadfastly promoting a high level of openness to the outside world. Implement a more proactive opening-up strategy, comprehensively improve the level of openness to the outside world, actively implement policies to promote foreign investment, increase the amount of investment by foreign-funded enterprises and encourage foreign investment in the central and western regions. Implement high-level trade and investment liberalisation and facilitation policies, and improve the level of trade liberalisation and facilitation innovation.

Adhere to the core position of innovation drive. Adhere to the implementation of the innovation-driven development strategy and increase the financial investment in scientific research. Deepen the implementation of the digital economy development strategy, actively promote the construction of a strong network and digital China, and build innovative development clusters for cross-border e-commerce industries.

Develop new policies according to local conditions. The level of development of the five major indicator layers varies from province to province. Therefore, it is necessary to take into account the actual situation and introduce relevant policies. For example, in response to Shanghai's high digital economy and openness index, but low public service index, the government can reasonably allocate social resources and focus on making up for the shortcomings of public service facilities such as healthcare, elderly care and childcare.

References

[1] Li Zuojun. Where to start to cultivate new dynamic energy for economic growth[J]. Economic Research Reference,2017(24):11.

[2] Chai Shigai, Li Jinchang. Research on statistical measurement of new dynamics of China's economic growth[J]. Statistics and Information Forum,2021,36(01):47-58.

[3] Zheng Jianghuai, Song Jian, Zhang Yuchang, et al. Assessment of the progress of the old and new dynamics of China's economic growth[J]. China Industrial Economy,2018(06):24-42.
[4] Ma Xiuzhen, Sun Xiwu. Total factor productivity improvement and the transformation of old and new dynamics--Qingdao as an example[J]. Journal of Qingdao University of Science and Technology (Social Science Edition),2018,34(02):25-30.
[5] Raphael Kaplinsky, Mike Morris. A Handbook for Value Chain Research [R].Prepared for the IDRC, 2001.
[6] Shao Mingzhen, Ma Shurui, Qu Xiaofang, et al. Study on the statistical measurement, economic effects and development path of new economic dynamics in Henan Province[J]. Statistical Theory and Practice,2021(03):15-22.
[7] Ma Shurui. Statistical measurement of new economic dynamics in Henan Province and analysis of its economic effects [D]. Henan University, 2021.
[8] Liu Zhaomin, Zheng Hongling. Research on the measurement of new dynamics of regional economy based on entropy power TOPSIS--Hebei Province as an example[J]. Journal of Hebei North College (Social Science Edition),2021,37(04):65-71.