Urban new quality productivity: horizontal measurement, spatiotemporal difference and convergence analysis

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Abstract

This paper is based on the theoretical connotation of new quality productivity to build the new quality productivity index system, using the entropy method of 2009-2022 (285 level) municipal panel data of China's new quality productivity level, using Markov transfer probability matrix, exploratory space analysis and convergence model, reveals the overall development trend of China's new quality productivity, regional differences, time and space distribution and evolution and its convergence. The results show that in recent years, the new productivity of all cities in China has shown an upward trend, and the level of new productivity varies greatly among different cities. The level of new productivity in first-tier cities and new first-tier cities leads the country, and the level of cities in the eastern region is higher than that in the central and western regions. At the same time, the new mass productivity in China has the characteristics of σ convergence and spatial condition β convergence. With the support of scientific and technological and institutional innovation, we should accelerate the development of new urban productive forces, strengthen the weak links in the development of new urban productive forces, and accelerate the realization of new urban productive forces.

Keywords: urban new quality productivity; space-time evolution; entropy method; convergence

1, Introduction

As a important original concept, new quality productivity reflects the theoretical consciousness of high-quality development as the main theme of the development of The Times, and has rich and profound meaning. This theoretical innovation is put forward by a comprehensive grasp of the development trend of world scientific and technological and industrial transformation, an accurate judgment of the new pattern and new tasks of China's social and economic development, and especially a deep understanding of the opportunities and challenges brought about by the great changes unseen in the world in a century. It has a profound historical background and strategic grasp. So what is the new quality of productivity? The basic connotation of new quality productive forces is the improvement of laborers, labor materials, labor objects and their optimized combination. It is the remodeling and construction of traditional production factors and basic production functions, stimulating technological innovation and breakthrough, promoting the innovative allocation of production factors, and

leading the industry to a deeper transformation and upgrading.

Current academic research on new quality productivity mainly theoretical analysis, focus on the following two aspects: one is the internal meaning and characteristic analysis, wang yu, Wang Rongji (2024) [1] from marxist political economy theory, to laborer, labor object and means of production three dimensions theory analysis and build a new quality productivity index system. While sorting out the concept system of new quality productivity, [2] puts innovation, especially disruptive innovation, at the core position. Li Xiaohua (2023) [3] believes that the new quality productivity not only presents the general characteristics of disruptive innovation, new industrial chain and high quality of development, but also has the characteristics of digitalization and green era. Du Chuanzhong et al. (2023) [4] believes that the characteristics of new quality productivity are mainly reflected in its outstanding innovation, extensive permeability, efficient quality improvement, obvious dynamic and significant fusion. Hu Ying and Fang Taikun (2024) [5] pointed out the theme characteristics of new quality productivity, mainly dominated by mental workers, the technical characteristics of disruptive innovation driven, the structural characteristics of multi-element penetration and integration, and the morphological characteristics of digital intelligence and green industries. Second, in terms of empirical research, Yang Hua and Hong Xinmin (2024) [6] believe that the core meaning of the development of new quality productivity is digital new quality productivity, and emphasized that digital means of production make the largest contribution to digital new quality productivity in the three subsystems. Li Yongbin et al. (2024) [7] Through empirical research, we found that the new agricultural quality productivity has become the new driver and engine for the high-quality agricultural development in China, and the agricultural production technology efficiency and agricultural insurance respectively play intermediary and positive regulatory effects in the new agricultural quality productivity to promote the high-quality development of agriculture in China. Shen Hongbing et al. (2024) [8] Research found that the new quality productivity of computing power can promote intelligent computing technology and scale efficiency, and thus have a positive effect on total factor productivity. Tian Pengpeng et al. (2024) [9] found that new quality productivity can have a positive impact on the integrated development of urban and rural areas by promoting technological innovation, promoting industrial upgrading and having a positive impact on resource allocation. Joe (2024) [10] believes that agricultural new quality productivity can significantly reduce the total and intensity of agricultural carbon emissions.

2. Calculation of the new quality productivity level

(1) The element composition and index construction of urban new quality productivity

New quality labor is the most active and most dynamic main body, continuously enhance the level of ordinary labor by education and increase human capital investment, on the basis of make full use of digital, intelligent information technology, cultivating knowledge, skilled, innovative high-end labor, strengthen the social professional service team construction, promote laborer jump, improve labor productivity. Therefore, the number of employees in emerging industries, the personal ability of employees and the high quality level of employees are selected as indicators for calculation.

Under the promotion of the application of agricultural science and technology and institutional innovation, the scope of new quality labor objects is constantly expanded. At the present stage, it is necessary to develop green ecological agriculture and improve the ecological value of agricultural system. Therefore, the indicators of infrastructure, future development and ecological environment are adopted to measure.

New quality labor data is the application of modern agricultural production of new type of production factors, which is based on new agricultural infrastructure, disruptive agricultural innovation technology as the core, the application of digital, intelligent agricultural machinery and equipment, promote agricultural sustainable development, so choose technology, innovation, intelligent, green research and development and data elements to reflect the indicators.

inscape	Basic indicators	Indicator instructions	attribute	weight
New quality labor force	Number of employees in emerging industries	The total number of employees of listed companies in strategic emerging industries and future industries shall be summarized to prefecture-level cities according to their registration places.(human being)	forward direction	10.08 %
	Personal ability of employees	Average salary of employees on duty (Yuan)	forward direction	0.98%
	High-quality level of the employees	Average years of education per person (years)	forward direction	5.08%

Table 1. Evaluation index system of urban new quality productivity

	infrastructure	Internet broadband access users (thousand households)	forward direction	3.17%
	future development	Robot installation density at the city level (station / 10,000 people)	forward direction	2.47%
New quality labor		Carbon trading, energy use right trading, emission right trading (100 million yuan)	forward direction	5.01%
object	ecological condition	Investment in environmental pollution control (100 million yuan)	forward direction	5.10%
		Harmless treatment rate of household waste (percentage)	forward direction	0.13%
	Technology research and development	The proportion of scientific expenditure in local fiscal expenditure (percentage)	forward direction	2.58%
	Land of a second	The number of inventions applied for in that year (a)	forward direction	8.87%
	and development	Number of utility models applied for in the current year (one)	forward direction	7.63%
New	Intelligent research and development	Number of artificial intelligence enterprises (one)	forward direction	12.09 %
quality labor data	Green research and	The number of green inventions applied for in that year (one)	forward direction	9.64%
	development	Number of green and practical types applied for in that year (one)	forward direction	7.98%
	Data elements	For the utilization level of data elements, the word frequency of the data assets of listed companies is logarithm and summarized to prefecture-level cities	forward direction	1.37%

	place, and the average value of the word frequency logarithm of the data assets of local listed companies is taken as the agent index		
	Whether there is a data trading platform, the value is 1, no value is 0	forward direction	13.53 %

(2) measurement methods

1. entropy evaluation method

In the first step, standardize the treatment

Positive indicator standardization:

$$Z_{ij} = \frac{X_{ij} - minX_{ij}}{maxX_{ij} - minX_{ij}}$$

Negative indicator standardization:

$$Z_{ij} = \frac{maxX_{ij} - X_{ij}}{maxX_{ij} - minX_{ij}}$$

Where X ij is the numerical size of item j of the i th city, and Z ij is the value after its standardization

In the second step, calculate the proportion of item j index

$$P_{ij} = \frac{Z_{ij}}{\sum_{i=1}^{m} Z_{ij}}$$

In the third step, the information entropy of the item j index is calculated

$$e_j = -\frac{1}{\ln(m)} \left[\sum_{i=1}^m P_{ij} \ln P_{ij} \right], 0 \le e_j \le 1$$

In the fourth step, the difference coefficient gi of the j th index is calculated

$$g_j = 1 - e_j$$

The fifth step, calculate the index weight wj

$$w_j = \frac{g_j}{\sum_{j=1}^n g_i}$$

In the sixth step, the composite index of the i th city and the j th year is calculated

$$E = \sum_{j=1}^{n} w_j Z_{IJ}$$

3. The temporal and spatial evolution and regional differences of urban new quality productivity level

1, the overall level of urban new quality productivity

According to Figure 1, the overall level of new quality productivity in China from 2009 to 2022 in cities is low and in a slow growth stage, from 0.0328 in 2009 to 0.0616 in 2022, with an average annual growth rate of 6.26%. From the perspective of components, the contribution of new quality labor objects to the improvement of urban new quality productivity is high and has a large increase, but there is a small subsequent decline, from 21.3% in 2009 to 36.7% in 2022. The new workers contributed second, from 21.3 percent in 2009 to 36.7 percent in 2022. The new quality workforce contributed relatively minimally, but was in a small increase, from 35.8% in 2009 to 27.2% in 2022. The new quality labor force and the new quality labor data index showed a small upward trend, but the new quality labor data index was always higher than the new quality labor force index, the new quality labor data index rose sharply, but in 2017 to flat and began to show a downward momentum.

In 2022, the average value of new quality productivity in China is between 0.0056 and 0.05084, the average (M) is 0.0616, and the standard deviation (SD) is 0.0870. There are differences in development among cities. Wang Yu and Wang Rongji (2024), Wei Min and Li Shuhao (2018) research, the new quality productivity is more than 0.1051 (M + 0.5 SD) city as a high level, the city new quality productivity is less than 0.0181 (M 0.5 SD) city as a low level, from figure 2,2022 the top ten cities basically belong to the first and new cities, including cities "north wide" lead the country, far more than other cities.



Figure 1 Productivity level of urban new quality from 2009 to 2022



Figure 2 Average value and ranking of new quality productivity in the top 10 cities in 2022

(2) Time evolution and gap decomposition of urban new quality productivity level

According to figure 3,2009-2022 urban new productivity level in the east is far higher than the central and western, and the eastern region of urban new productivity is higher than the national overall level, but the eastern urban new productivity decline in 2020, the central and western regions of the city new productivity are lower than the overall level, but the gap between the two regions is not obvious before 2016, after 2016.



Figure 3 The level of new quality productivity in eastern, central and western cities

(3) Time sequence evolution and gap decomposition of urban new quality productivity level In order to analyze the evolution trend of urban new quality productivity level, the Markov transfer probability matrix is introduced in this paper, and the results are shown in the table below. The I, II, III and IV in the table represent low, medium low, medium high and high level types respectively. Table Bank represents the probability distribution of the city under the new productivity level, and lists the probability distribution of the city under the new productivity level. According to the traditional diagonal data, the probability that cities with low, low, medium low, medium high and high quality productivity levels are still at this level in the next year is 72%, 70%, 78.5% and 98.3% respectively.

	Space lag type	t/(t+1)	Ι	II	III	IV	observed
		,					value
tradition	No lag	Ι	0.720	0.280	0.000	0.000	675
		II	0.014	0.700	0.286	0.000	670
		III	0.000	0.000	0.785	0.215	665
		IV	0.000	0.000	0.017	0.983	560
space	Ι	Ι	0.808	0.192	0.000	0.000	52
		II	0.000	0.889	0.111	0.000	9

Table 2 The Markov transition probability matrix of urban new quality productivity

		III	0.000	0.000	1.000	0.000	1
		IV	0.000	0.000	0.000	0.000	0
		Ι	0.600	0.400	0.000	0.000	20
	тт	II	0.026	0.718	0.256	0.000	39
		III	0.000	0.000	0.929	0.071	14
		IV	0.000	0.000	0.000	1.000	3
III IV	III	Ι	0.000	1.000	0.000	0.000	389
		II	0.000	0.611	0.389	0.000	218
		III	0.000	0.000	0.778	0.222	136
		IV	0.000	0.000	0.000	1.000	133
	IV	Ι	0.000	0.000	0.000	0.000	0
		II	0.000	0.500	0.500	0.000	341
		III	0.000	0.000	0.643	0.357	414
		IV	0.000	0.000	0.023	0.977	444

In order to test whether there are significant spatial differences and spatial correlation between the development level of new quality production in various cities, the Moran index (Moran's I) is used. First, the economic geographic embedded weight matrix is used to conduct spatial autocorrelation retrieval. Moran's I is a constant between-1 and 1, indicating a significant negative spatial correlation when Moran's I approaches-1; no spatial correlation, and Moran's I approaches 1. It can be seen from the table: under the economic geographic embedded weight matrix, the global Moran'sI index is greater than 0, and passes the significance test at the levels of 10%, 5% and 1% respectively, and the significance gradually increases. Comprehensive judgment, urban new quality productivity space aggregation effect, as the time evolution, high-high agglomeration area city, low-high agglomeration area city, thus, urban new quality productivity has obvious spatial heterogeneity, unbalanced development between cities, although the gap narrowed year by year, but the imbalance is still significant, part of the western region of the new productivity needs to improve.

Table 3. Global Moran Index of urban new quality productivity

a particular year	2010	2012	2014	2016	2018	2020	2022
Moranʻs I	0.0036 (*)	0.0100 (**)	0.0151 (**)	0.0265 (***)	0.0399 (***)	0.0421 (***)	0.0463 (***)
E(I)	-0.004	-0.004	-0.004	-0.004	-0.004	-0.004	-0.004

sd(I)	0.017	0.017	0.017	0.017	0.017	0.017	0.017
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Note: * * *, * *, and * are significant at the 1%, 5%, and 10% confidence levels, respectively. The spatial and temporal convergence of urban new quality productivity level

In order to further explore the convergence of the development level of urban new quality productivity in time and space, in view of the influence of the urban development level and geographical location on the urban new quality productivity, this paper will use the economic geographical weight matrix to conduct space and time convergence analysis.

 σ Convergence means that the difference between the development level of new quality productivity in different cities is narrowing with time. In order to eliminate the influence of different mean size, this paper selects the coefficient of variation method to examine the σ convergence characteristics of the level of new quality productivity and the development level of the three dimensions.

 β Convergence, usually used to study whether the level of development gradually converges between regions. Among them, absolute β convergence refers to only the convergence state of the urban new quality productivity itself, without the control variables, if the regression coefficient of 1-y is significantly negative, there is absolute β convergence. Absolute β convergence means that regions have exactly the same basic economic characteristics, and regions with low indicators tend to have higher growth rates than high regions, and eventually converge to the same steady-state level over time. However, condition β convergence is the convergence state after a series of influencing factors are included into the control. Due to the flow of various elements between different cities, it is necessary to consider the spatial dependence of the change of the new quality productivity level in different cities. Therefore, the following factors are selected as the control variables of this paper, that is, the main factors affecting the level of urban new quality productivity. First, industrial structure (IND): the proportion of the added value of the tertiary industry and that of the secondary industry. Second, economic aggregate (GDP): total GDP log; third, the degree of government intervention (GOV): the proportion of general government fiscal expenditure to regional GDP.

As shown in the figure, the coefficient of variation of the level of urban new productivity has a significant downward trend, from 1.717 in 2009 to 1.409 in 2022. The initial value is greater than the final value, indicating that there is a significant σ convergence in the level of urban new productivity in China. The degree of dispersion of the level of new quality productivity in each city is reduced, and the development difference gradually shrinks with the evolution of time. As shown in the figure: the coefficient of variation of the development level of urban new quality labor force, the development level of labor materials and the development level of labor objects all decline slowly in small fluctuations. In other words, the three have σ convergence, that is, the



development gap of the three gradually decreases with the evolution of time.

Figure 4 The σ convergence of urban new quality productivity and its subdimension index

This chart shows the σ Astringency over time from 2009 to 2021. The chart includes three different lines representing different categories: Blue Line: Represents "Urban New Quality Labor Data" over the years; Orange Line: Represents "Urban New Quality Labor Force" over the years; Gray Line: Represents "Urban New Quality Labor Objects" over the years.

In view of the impact of the economic development level and geographical location of each city on the new quality productivity, this paper includes the economic geographic embedded weight matrix into the spatial-temporal convergence model for convergence analysis. At the national level, after further considering the influence of industrial structure, economic aggregate and the degree of government intervention, the convergence coefficient β is significantly negative, indicating that the convergence characteristics of condition β exists in all the new

urban productivity in China. Its economic implication is that after considering the industrial structure and other factors, in the long run, the development of new quality productivity in each city will gradually tend to their own steady state level.

variable	nationwide
ß	-0.427***
	(0.0980)
fixed effect	yes
observed value	3707
R2	0.300

Table 4 Results of β convergence test for urban new quality productivity

4, Conclusions

Centering on the two cores of "innovation" and "high quality" of new quality productivity, this paper constructs a comprehensive evaluation index system from three aspects: urban new quality labor force, urban new quality labor objects and urban new quality labor materials, and uses the entropy method to measure the level of urban new quality development from 2009 to 2022. On this basis, Markov transfer probability matrix, exploratory spatial analysis and spatial and temporal convergence model are used to reveal the overall development trend, regional differences, spatial and temporal distribution and evolution and convergence of new quality productivity in China. The results show that the new quality productivity is quite different between different cities, and the urban new quality productivity will have obvious spatial agglomeration characteristics, and will be affected by the neighboring cities.

First, we will support agricultural science and technology and institutional innovation, foster and foster new business forms and models, and strengthen weak links in the development of new quality urban productive forces.

Second, explore the new mechanism of resource sharing and policy coordination among regions. Combined with the advantages of local resource endowment, further optimize the industrial layout and model, and promote the regional jump of new quality urban productivity.

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