

A Study on Measuring the Development Level of New Quality Productivity in Chinese Provinces Based on Comprehensive Evaluation and Regression Modeling

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Abstract. With the impetus of globalization and scientific and technological progress, new quality productivity has attracted much attention as a key indicator of regional economic competitiveness and sustainable development. This paper analyzes the panel data of Chinese provinces, municipalities and autonomous regions from 2010 to 2019, and explores the development level of new quality productivity and its relationship with scientific and technological innovation, green development and labor mobility. First, the entropy method was used to calculate the information entropy value, information utility value and weight coefficient of each indicator to reveal the importance and contribution of different indicators in regional development. The results of the study show that Guangdong, Jiangsu and Zhejiang are outstanding in terms of new quality productivity, especially in the high-tech industry and environmental protection, where the investment and achievements are remarkable; in contrast, Gansu, Inner Mongolia, Heilongjiang and other provinces are facing greater development challenges and need to increase scientific and technological innovation and environmental protection. Second, the impact of labor mobility on NQP is analyzed by constructing a linear regression model, and it is found that the two show a significant positive correlation, indicating that the improvement of NQP level promotes the enhancement of regional attractiveness to labor. These research results not only provide empirical evidence for local governments to formulate regional economic policies, but also provide important references and strategic suggestions for promoting China's economy towards high-quality development.

Keywords: Integrated assessment; NQP; level of development.

1. Introduction

In recent years, a new round of technological revolution and industrial transformation represented by digital technology and artificial intelligence has developed rapidly, global economic integration has accelerated, and international market competition has become increasingly fierce. In the past few decades, China has become the world's largest manufacturing country relying on its advantage in labor force quantity and demographic dividend. However, with the trend of aging population becoming prominent, the advantage in labor force quantity is gradually weakening, and the development model relying solely on quantity advantage is no longer feasible. China's development is facing unprecedented opportunities and challenges. During this year's National People's Congress and Chinese People's Political Consultative Conference, "new quality productivity" was included for the first time in the government work report and was listed as the top ten government work tasks for 2024. The emergence of new quality productivity as a national key task is based on the new development needs of socialism with Chinese characteristics, an important manifestation of adapting to globalization and information digitization, and reflects China's strategic initiative and innovative competitiveness in the new global economic landscape.

Compared to traditional productivity, new quality productivity is a productivity leap that relies on technological breakthroughs and innovation. It is a productivity centered around new workers, new labor objects, new labor tools, and new infrastructure, and the key lies in quality rather than quantity

[1]. Among them, "new workers" refer to new talents who can fully utilize modern technologies such as artificial intelligence. This means that with the continuous development of new quality productivity, the demand for high skilled and high-quality new talents in the labor market will increase, leading to the restructuring of the labor market [2]. The labor market is one of the most important parts of the economic system, directly related to the growth of the national economy and the long-term development of society. A reasonable labor market structure can accumulate a continuous reserve force for the development of new quality productivity, provide key guarantees for the development of new quality productivity, and is one of the important paths for developing new quality productivity. It can be said that the new quality productivity and the labor market have a close relationship and interaction with each other [3].

This article aims to explore the differences in the performance of technological innovation, green development, and industrial upgrading among different regions by analyzing the development level and influencing factors of new quality productivity in various provinces of China? What impact does labor mobility have on the development of new quality productivity in regions? To answer these questions, first, the entropy method is used to calculate the information entropy, information utility, and weight coefficients of each indicator, revealing the importance and contribution of different indicators in regional development. Secondly, by constructing a linear regression model to analyze the impact of labor mobility on new quality productivity, this paper explores the correlation between the two and their role in promoting regional economic development. The research results will provide empirical evidence for local governments to formulate scientific and reasonable regional economic policies, promoting China's economy to move towards high-quality development.

2. Correlation analysis between the level of new quality productivity and labor mobility

2.1. Indicator selection and data sources

2.1.1. Indicator selection.

Based on the connotation of new quality productivity and referring to relevant literature, we summarize that the main factors reflecting the development level of new quality productivity include technological innovation, green development, industrial upgrading, and development conditions. We attempt to establish a comprehensive evaluation index system for new quality productivity [4] [5] [6], with detailed indicators at each level shown in Table 1. Among them, carbon emission intensity, energy consumption intensity, and rationalization of industrial structure are negative indicators, while the rest are positive indicators:

Table 1. Comprehensive evaluation index system for new quality productivity

| Level 1 indicators | Secondary indicators | Measurement modalities (tertiary indicators) |
|--------------------------|--|---|
| Technological innovation | Research capacity X1 | R&D Personnel equivalent full-time equivalent (person-years) |
| | Investment in scientific research X2 | R&D Project funding/GDP (%) |
| Green development | Innovation capacity X3 | Number of three types of patents granted (units) |
| | Environmental protection efforts X4 | Expenditures on environmental protection/GDP (%) |
| | Carbon intensity X5 | Carbon footprint/GDP (%) |
| | Energy intensity X6 | Energy consumption/GDP (%) |
| Industrial upgrade | Green Innovation X7 | Number of green patents granted (units) |
| | Rationalization of industrial structure X8 | Industrial structure rationalization index $x=TL = \sum_{i=1}^n \left(\frac{Y_i}{Y}\right) \ln \left(\frac{Y_i/L_i}{Y/L}\right)$ Where, Y denotes value of production, L denotes employment, i denotes industry, n denotes number of industry sectors. |
| | Advanced industrial structure X9 | Advanced industrial structure=Share of gross output value of primary sector*1+Share of gross output value of secondary industry*2+Share of gross output value of tertiary industry*3 |
| | Digital infrastructure X10 | Length of fiber optic cable lines (kilometers) |
| | Digital resources X11 | Internet broadband access ports (10,000) |
| Developmental conditions | Future industries X12 | Number of Artificial Intelligence Enterprises (number) |
| | Research organization X13 | Number of R&D organizations (number) |
| | Expenditures on education X14 | Expenditure on education/GDP (%) |
| | Efforts in science and technology expenditures X15 | Expenditures on science and technology/GDP (%) |
| | Culture, sports and recreation development X16 | Expenditures on culture, sports and media/GDP (%) |

The descriptive statistics of the above mentioned main variables are shown in Table 2, in which \bar{X}_i , σ_i , \max_i , \min_i denote the mean, standard deviation, maximum and minimum values of the raw data for the i th indicator variable, respectively. \bar{X}'_i , σ'_i denote the new mean and the new standard deviation, respectively, of the i th indicator variable after some data processing.

Table 2. Results of descriptive statistics for indicators

| norm | \bar{X}_i | σ_i | \max_i | \min_i | \bar{X}'_i | σ'_i |
|------|-------------|-------------|--------------|----------|--------------|-------------|
| X1 | 22194.0054 | 42506.3563 | 286009.8000 | 22.2000 | 0.0775 | 0.1486 |
| X2 | 0.0034 | 0.0067 | 0.0850 | 0.0000 | 0.0393 | 0.0793 |
| X3 | 49325.2567 | 73531.5418 | 527390.0000 | 264.0000 | 0.0931 | 0.1395 |
| X4 | 0.0091 | 0.0091 | 0.0742 | 0.0022 | 0.0969 | 0.1261 |
| X5 | 0.0003 | 0.0003 | 0.0029 | 0.0000 | 0.9106 | 0.1193 |
| X6 | 0.0001 | 0.0001 | 0.0010 | 0.0000 | 0.9214 | 0.1169 |
| X7 | 0.0091 | 0.0091 | 0.0742 | 0.0022 | 0.1104 | 0.1535 |
| X8 | 10.2111 | 11.3883 | 78.6258 | 1.3122 | 0.8849 | 0.1473 |
| X9 | 2.3806 | 0.1250 | 2.8337 | 2.1323 | 0.3541 | 0.1782 |
| X10 | 827812.9330 | 746497.8433 | 3679239.3400 | 803.0000 | 0.2248 | 0.2029 |
| X11 | 1717.5972 | 1521.8930 | 8149.1000 | 32.8393 | 0.2078 | 0.1869 |
| X12 | 3066.4833 | 4662.0941 | 43264.0000 | 90.0000 | 0.0689 | 0.1080 |
| X13 | 366.2500 | 856.7821 | 6848.0000 | 1.0000 | 0.0533 | 0.1251 |
| X14 | 0.0494 | 0.0566 | 0.3875 | 0.0197 | 0.0809 | 0.1538 |
| X15 | 0.0052 | 0.0049 | 0.0398 | 0.0014 | 0.0996 | 0.1279 |
| X16 | 0.0053 | 0.0043 | 0.0285 | 0.0018 | 0.1314 | 0.1609 |

2.1.2. Data sources.

Based on the indicator system established in the previous section, we choose 30 provinces in China (excluding Tibet, Hong Kong, Macao and Taiwan) as the research objects of this part of the paper, and collate the panel data of each province for 2010-2019 by querying official websites such as China Statistical Yearbook, China Science and Technology Statistical Yearbook, China Education Expenditure Statistical Yearbook, China Energy Statistical Yearbook, China Fiscal Yearbook, and China Research Data Service Platform (CNRDS). out the panel data of each province from 2010-2019. The data on mobile population in each province are obtained from the National Bureau of Statistics (NBS). For a few missing data, linear interpolation was used to complete.

2.2. Statistical Measurement of the Development Level of New Quality Productivity in Chinese Provinces

2.2.1. Measurements.

In this part, MATLAB software is selected to calculate the information entropy value, information utility value and weighting coefficient of each index based on the panel data of each index of provinces, municipalities and autonomous regions in China by using the entropy value method, and the results are shown in Figure 1:

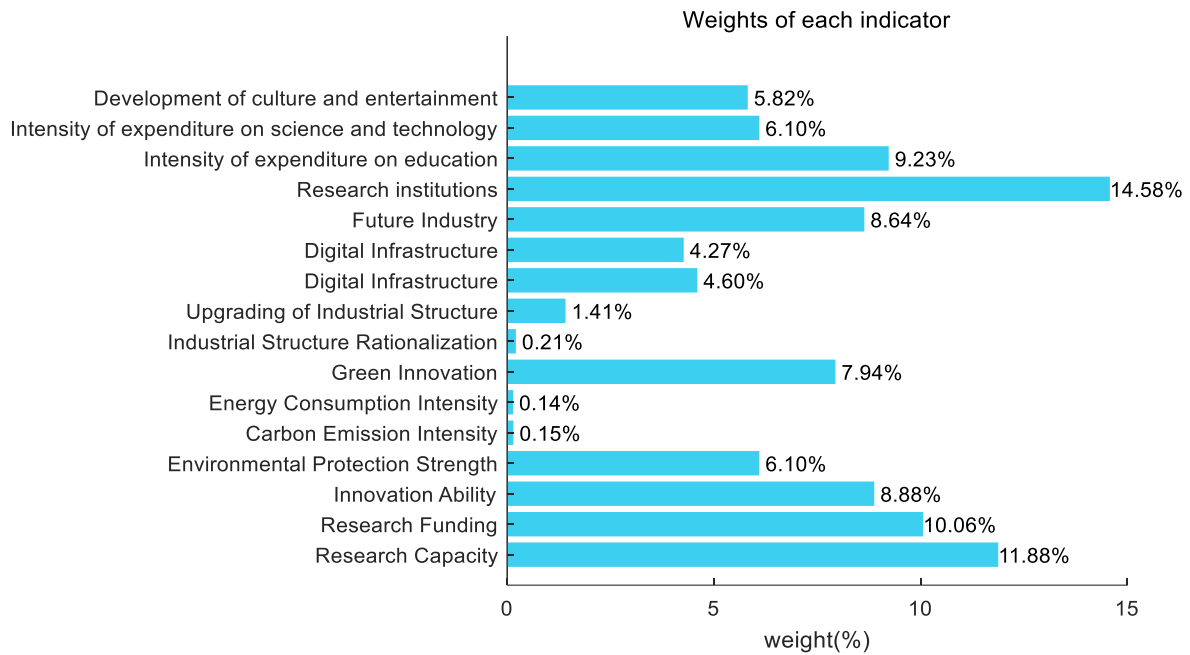


Figure 1. Weighting coefficients for indicators

Using ArcGIS software, the average value of the development level of new quality productivity in each province of the country in the period of 2010-2019 was selected to draw a heat map of the new quality productivity level score in each region, and the results are shown in Figure 2.

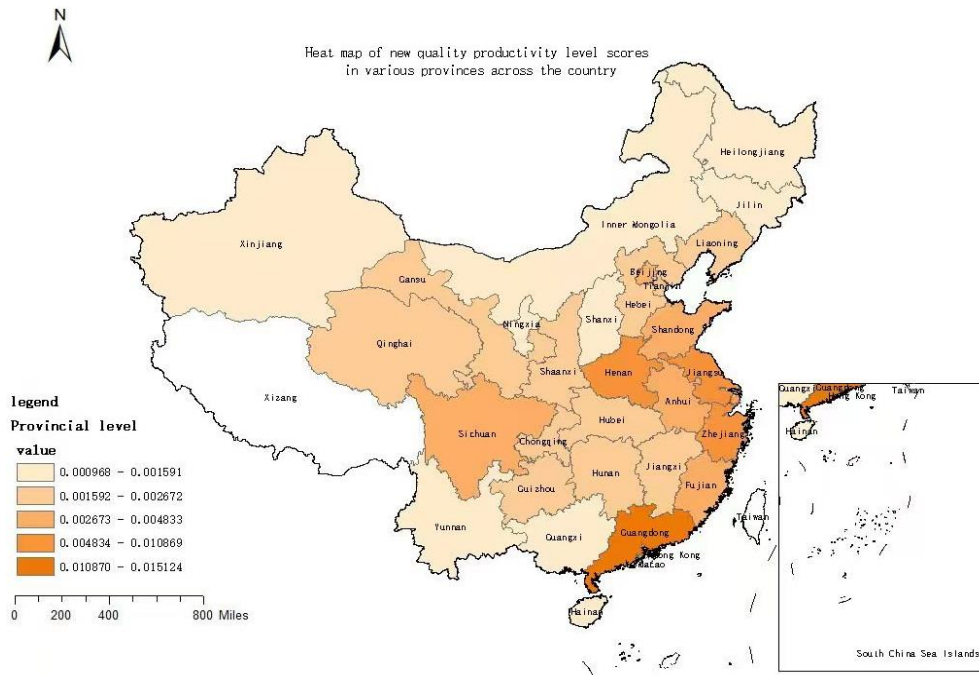


Figure 2. Heat map of new quality productivity level scores of provinces across the country

2.2.2. synthesize and analyze.

According to the new quality productivity level scores calculated by each region and combined with the four first-level indicators of scientific and technological innovation, green development, industrial upgrading, and development conditions [7] [8], Guangdong, Jiangsu, Zhejiang and other regions are outstanding in the new quality productivity level scores. With a score of 0.0151, Guangdong ranks at the top, showing significant advantages in green development, scientific and technological innovation and industrial upgrading, especially in the number of high-tech enterprises, the number of patents authorized, and the control of carbon emissions, which highlights the strength and vitality of Guangdong as a major economic province in the country. Jiangsu and Zhejiang are also at the forefront, making remarkable achievements in the fields of scientific and technological innovation and industrial upgrading, and injecting a strong and lasting impetus to regional economic development.

In addition, Beijing, Shandong and Shanghai have also achieved higher scores in terms of new quality productivity levels, and these provinces have certain advantages in terms of scientific and technological innovation, industrial upgrading and development conditions. As the capital of China and a center of scientific and technological innovation, Beijing performs well in terms of the number of high-tech enterprises, the number of R&D personnel, and infrastructure construction, laying a solid foundation for the innovative development and sustained growth of the regional economy. Shandong and Shanghai excel in infrastructure development and industrial structure upgrading, laying the foundation for sustained regional economic growth [9] [10].

In contrast, Gansu, Inner Mongolia and Heilongjiang face greater development challenges. Gansu scored only 0.0018, indicating that there is more room for development and adjustment needs in terms of new quality productivity. Inner Mongolia and Heilongjiang still have room for progress in science and technology innovation and green development, and need to increase investment to promote economic restructuring and industrial upgrading.

2.3. Analysis of the correlation between labor mobility and the level of development of new quality productivity

Based on the results of the Sixth and Seventh Population Censuses conducted by the National Bureau of Statistics (NBS), we obtained the net inflow/outflow data by subtracting the household population from the resident population in each province. The net inflow/outflow data obtained from the seventh

census were then subtracted from the net inflow/outflow data obtained from the sixth census to obtain the net inflow/outflow difference, which is shown in table 3.

Table 3. Labor mobility by province

| region | Net inflow/outflow of people in the Rokupu 2010 | Net inflow/outflow of people from Chippewa in 2020 | Net inflow/outflow differential |
|--------------|---|--|---------------------------------|
| Anhui | -911.97 | -1016.65 | -104.68 |
| Beijing | 705.83 | 797.21 | 91.38 |
| Fujian | 152.26 | 257.53 | 105.27 |
| Gansu | -159.20 | -281.33 | -122.13 |
| Guangdong | 1929.55 | 2937.78 | 1008.23 |
| Guangxi | -556.79 | -682.66 | -125.87 |
| Guizhou | -685.18 | -715.24 | -30.06 |
| Hainan | 18.56 | 71.09 | 52.53 |
| Hebei | -5.63 | -302.12 | -296.49 |
| Henan | -1025.15 | -1549.13 | -523.98 |
| Heilongjiang | 7.61 | -369.02 | -376.63 |
| Hubei | -452.20 | -675.04 | -222.84 |
| Hunan | -508.00 | -402.58 | 105.42 |
| Jilin | 30.46 | -193.92 | -224.38 |
| Jiangsu | 369.78 | 616.53 | 246.75 |
| Jiangxi | -256.63 | -520.15 | -263.52 |
| Liaoning | 121.25 | 68.94 | -52.31 |
| Neimenggu | 29.81 | -37.13 | -66.94 |
| Ningxia | -2.18 | 34.38 | 36.56 |
| Qinghai | 10.55 | 3.37 | -7.18 |
| Shandong | 31.32 | 13.66 | -17.66 |
| Shanxi | 98.34 | -48.04 | -146.38 |
| Shaanxi | -107.54 | -98.83 | 8.71 |
| Shanghai | 883.40 | 1017.79 | 134.39 |
| Sichuan | -956.33 | -732.71 | 223.62 |
| Tianjin | 301.91 | 281.56 | -20.35 |
| Xinjiang | 156.02 | 299.35 | 143.33 |
| Yunnan | 33.57 | -71.2 | -104.77 |
| Zhejiang | 709.54 | 1417.85 | 708.31 |
| Chongqing | -430.37 | -210.87 | 219.50 |

So that the average score of the new quality productivity level from 2010 to 2019 is the explained quantity, and the difference of net inflow/outflow of population is the explained quantity, the linear regression model is constructed by using MATLAB software, and the scatter plot is plotted for correlation analysis, as shown in Figure 3.

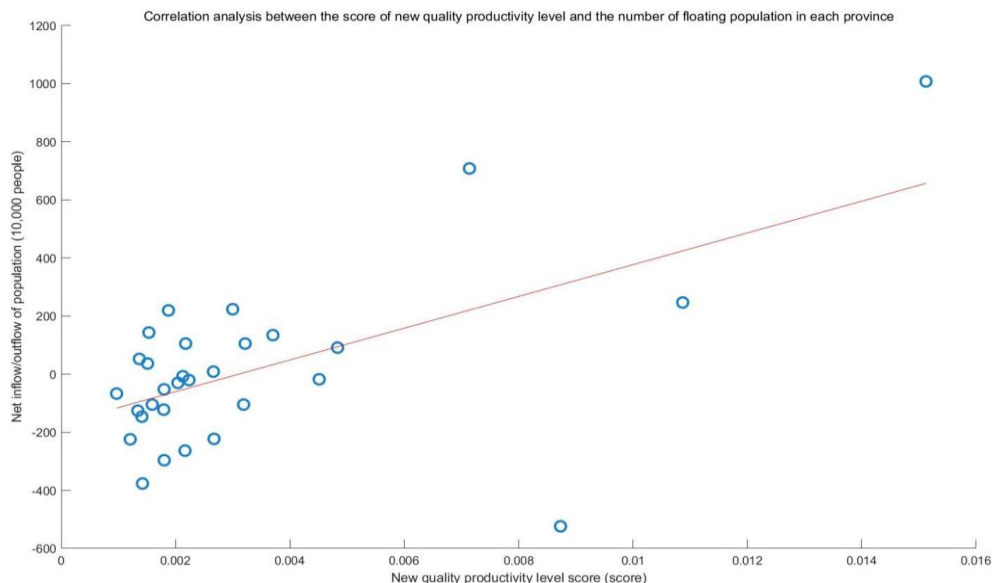


Figure 3. Correlation analysis between the new quality productivity level score and the net inflow of population by province

The F-statistic is 15.26 with a p-value of 0.000539, which indicates that the number of mobile population has a significant effect on the new quality productivity level score. The R-squared value is 0.353 with a correlation coefficient of 0.5941, which implies that there is a moderate correlation between the number of mobile populations and the number of mobile populations in the new quality productivity level score. It can also be seen from the scatter plot that there is a positive correlation between the number of mobile population and the new quality productivity level score, therefore, we believe that the new quality productivity level score has a more significant positive effect on the number of mobile population. This means that as the level of new quality productivity increases, the number of mobile population also tends to increase, implying that the city will be more attractive to the labor force.

3. Conclusion

Modern society is fully entering the era of big data and artificial intelligence, and the deepening of the impact of data on all walks of life, a new data-based information world is being constructed. In order to adapt to the development of the new productivity, the development trend of talents and labor force structure have been given new requirements, and the study of the changing situation of the demand for talents and the evolution trend of labor force structure is of great significance to promote the social and economic development in the information age.

Based on a large number of studies on the connotation, development significance, policy measures and other related contents of the development of new quality productivity, this paper launches a study on the correlation between the change of talent demand and labor mobility and new quality productivity. Generally speaking, under the background of the era of rapid development of big data, the industry development trend is shifting to the direction of digital transformation and intelligent development, and the labor market will be more in need of new and high-quality talents who are familiar with advanced production technology and have certain innovation ability. Second, the overall level of new quality productivity development in the country during the period under examination showed a steady upward trend, but regional differences were obvious. Guangdong, Jiangsu, Zhejiang and other regions excel in the new quality productivity level score, while Gansu, Inner Mongolia and Heilongjiang face greater development challenges in comparison. Finally, through the correlation analysis of labor mobility and the development level of new quality productivity, the study found that the number of mobile population in the new quality productivity level score has a medium correlation with the number of mobile population. This indicates that the NQP score has a more significant positive effect on the number of mobile population, and as the level of NQP increases, the number of mobile population tends to increase.

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