

The Current Status and Spatiotemporal Evolution of the Development of New Quality Productivity

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Abstract: This article explores the current development status and spatiotemporal evolution laws of new quality productivity. Firstly, the new quality productivity has been redefined and its theoretical basis and main characteristics have been explained. This study compares the improvement of new quality productivity in different spatial dimensions and points out that the overall development trend of each region is consistent, showing stable growth. Specifically, the growth rates of each region are in the order of eastern, central, western, and northeastern regions. This article summarizes the laws of the evolution of new quality productivity in time and space, emphasizes the comprehensive role of technological progress, policy support, and market demand, and looks forward to future challenges such as globalization, digitization, and environmental change. Research has found that in order to achieve sustained economic growth, each region needs to develop corresponding development strategies based on its own characteristics.

Keywords: new quality productivity, spatiotemporal evolution, technological innovation digitization

1. Introduction

Productivity is one of the core elements driving economic development. Traditional productivity theory mainly focuses on the impact of inputs of labor, capital, and technology on production efficiency. However, with the rapid development of technology and profound changes in the global economy, relying solely on these traditional factors is no longer sufficient to fully explain the increase in productivity in the modern economy. In recent years, "new quality productivity" has been proposed as an emerging concept aimed at describing a new form of productivity characterized by innovation, information technology, knowledge capital, and efficient resource allocation [1]. New quality productivity is not only an improvement in the level of productivity, but also a profound transformation in the connotation and form of productivity.

The emergence and development of new quality productivity marks a new stage of economic and social transformation. However, there is still relatively little systematic research on the definition, current development status, and spatiotemporal evolution of new quality productivity. Current research often focuses on individual technologies or industries, with insufficient exploration of the overall characteristics and dynamic changes of new quality productivity. Therefore, this paper aims to explore the definition of new quality productivity and its differences from traditional productivity, analyze the current development status of new quality productivity in different countries and regions, and study the spatiotemporal evolution law of new quality productivity and its impact on the economy and society.

This study aims to comprehensively understand the current situation and evolution of new quality productivity, including elaborating on its core characteristics and theoretical basis, analyzing the development status worldwide and comparing the characteristics of different countries and regions, as well as exploring its evolution laws in time and space, revealing development trends and challenges faced. Through these studies, this article aims to provide valuable insights for policy makers, business managers, and academic researchers to better address future challenges and opportunities.

2. Definition and theoretical basis of new quality productivity

2.1 Definition of new quality productivity

New quality productivity is a new type of productivity formed in the contemporary economic environment by utilizing advanced technology, innovative management, and knowledge drive [2]. Compared with traditional productivity, new quality productivity places more emphasis on the driving role of technological progress and innovation. It not only involves the research and application of technology, but also includes the optimization of production processes and the transformation of management models. In addition, the new quality productivity emphasizes talent cultivation, believing that high-quality talents are the key to promoting technological and management innovation. The effective utilization of data resources is also a core component. Through precise data analysis and information technology, new quality productivity can achieve efficient allocation and management of resources, thereby significantly improving production efficiency and economic value. This form of productivity not only enhances the competitiveness of enterprises, but also promotes the sustainable development of the entire economic system.

2.2 Theoretical basis

The evolution of productivity theory has gone through a gradual development process from classical economics to modern economics. In the period of classical economics, Adam Smith and David Ricardo proposed the theory of division of labor and capital accumulation, laying the foundation for the improvement of productivity. Adam Smith's theory of division of labor states that through division of labor and specialization, labor productivity can be significantly improved, thereby promoting economic growth. David Ricardo's theory of capital accumulation further elucidates the promoting effect of capital accumulation on productivity growth. With the development of economics, Marxist economics has delved into the relationship between productive forces and production relations, analyzing how the development of productive forces is constrained and driven by production relations. Entering the stage of modern economics, theories have been further enriched, introducing new factors such as human capital and technological progress. Modern economics has constructed a comprehensive theoretical framework that includes technological innovation and informatization, emphasizing the core role of technological progress, talent quality, and information technology in enhancing productivity. This comprehensive theoretical framework not only explains the mechanism of productivity improvement, but also provides theoretical support for policy makers and enterprises to promote sustainable economic development and enhance competitiveness.

The theoretical support of new quality productivity covers multiple important theoretical frameworks, including innovation theory, knowledge economy theory, and digital economy theory [3]. Innovation theory emphasizes the crucial role of technological progress and management innovation in promoting productivity improvement. Through continuous technological innovation and management practice innovation, enterprises can continuously improve their products and services, increase production efficiency, and enhance market competitiveness. The theory of knowledge economy focuses on the accumulation, innovation, and application of knowledge and information, and believes that knowledge capital is the core driving force of modern economic development. In the knowledge economy, enterprises enhance their innovation capabilities and competitive advantages by creating, acquiring, and applying knowledge. The theory of digital economy emphasizes the crucial role of data and information technology in enhancing productivity. Through data-driven decision-making and the application of information technology, enterprises can achieve digitalization and intelligence of their production processes, improve resource utilization efficiency and management effectiveness. These theories together constitute the theoretical support for new quality productivity, providing theoretical guidance and practical paths for enterprises and policy makers to address the challenges and opportunities in the modern economic environment.

2.3 Core features

2.3.1 Technological innovation

Technological innovation is an important driving force for new quality productivity, which improves production efficiency and product quality by developing new technologies and optimizing existing ones. It includes the development of new products, improvement of production processes, and expansion of technological applications. Technological innovation has driven the emergence of new

products, which typically have breakthrough advancements in functionality, performance, or design. Through continuous research and development investment, enterprises can launch unprecedented products in the market, thereby meeting the ever-changing consumer demands and market trends. For example, the emergence of smartphones and electric vehicles is the result of technological innovation, which has changed people's lifestyles and consumption habits. Technological innovation is also reflected in the continuous improvement of production processes. By introducing advanced production equipment and process technology, enterprises can improve production efficiency, reduce production costs, and ensure product consistency and high quality. For example, the application of automated production lines and intelligent manufacturing systems not only improves production speed, but also reduces the error rate caused by human operation. Technological innovation also includes applying new technologies to new fields and industries. Through cross-border applications, enterprises can expand their business areas and markets. For example, the application of artificial intelligence technology in multiple fields such as healthcare, finance, and manufacturing has driven the digital transformation of these industries and created new business models and opportunities.

2.3.2 Talent capital

Talent capital refers to a highly skilled and high-quality workforce and management talent. New quality productivity relies on a high-level talent team that can drive technological innovation, optimize management processes, and adapt to rapidly changing market environments. A high-level talent team, especially technical experts with professional knowledge and innovative abilities, is the core driving force of technological innovation. They continuously explore and develop new technologies to drive enterprises to maintain a leading position at the forefront of technology. Excellent R&D personnel can not only develop breakthrough new products, but also optimize existing technologies, improve production efficiency and product performance. For example, the innovation of top scientists and engineers in high-tech fields is often the source of new technologies and products. High quality management talents also play a key role in improving productivity. They can improve the operational efficiency and resource allocation capability of the organization through refined management and optimized processes. Excellent managers are able to identify and solve bottlenecks in production and management, implement effective strategies and plans, thereby improving the overall operational efficiency of the enterprise. In a rapidly changing market environment, high-quality talents with adaptability and flexibility are the key to the success of enterprises. They are able to quickly respond to market changes, adjust strategies, and ensure that the enterprise maintains competitiveness in a fiercely competitive market. These talents usually have strong learning and adaptability abilities, and can quickly grasp emerging market trends and technological dynamics, helping enterprises cope with changes in the external environment. High quality talents can also promote the construction of corporate culture and enhance teamwork. Talents with leadership and collaborative spirit can motivate team members, drive the achievement of organizational goals, and cultivate a positive work atmosphere. This culture and atmosphere can further enhance employees' work enthusiasm and creativity, thereby promoting productivity improvement.

2.3.3 Data and information technology

Dataization and informatization involve applying information technology to various aspects of the production process, including data collection, analysis, and application. Through data-driven decision-making and integration of information systems, new quality productivity can achieve more efficient resource allocation and production process optimization.

Dataization first involves collecting various types of data in real-time during the production process. These data may come from production equipment, sensors, operator inputs, and market feedback. By monitoring and recording key indicators in the production environment such as production speed, equipment status, and raw material consumption in real-time, enterprises can obtain a large amount of accurate data. These data provide a foundation for subsequent analysis and decision-making. The analysis of data is the core link in the process of dataization. With the help of advanced data analysis tools and algorithms, enterprises can extract valuable insights from the large amount of data collected. For example, through big data analysis and machine learning techniques, enterprises can identify potential problems in the production process, predict equipment failures, identify production bottlenecks, and evaluate the effectiveness of different production strategies. This data-driven analysis can provide scientific basis and help managers make more accurate decisions. The ultimate goal of dataization and informatization is to apply the analysis results to the actual production process. Enterprises can optimize production processes and improve resource utilization based on the results of data analysis. For example, reducing waste by adjusting production parameters in real-time, or optimizing production plans based on market demand forecasts. The application of information systems

is not limited to the production process, but also includes supply chain management, inventory control, and sales strategies. Through comprehensive data applications, overall production efficiency is improved. The integration of information systems is a key step in achieving dataization and informatization. Integrating different data sources and information systems enables enterprises to process data and provide decision support on a unified platform. For example, by integrating ERP systems, MES systems, and CRM systems, enterprises can achieve cross departmental information flow, improve information transparency, and decision-making efficiency. This integration enables departments to share information, coordinate operations, and optimize production processes and resource allocation.

Through data-driven decision-making and effective integration of information systems, new quality productivity can achieve more efficient resource allocation, production process optimization, and global business improvement. Digitization and informatization not only enhance the visualization level of the production process, but also strengthen the responsiveness of enterprises to market changes, enabling them to maintain a competitive advantage in fierce market competition.

3. The spatiotemporal evolution of new quality productivity

3.1 Time dimension

The evolution of new quality productivity has gone through multiple stages. Initially, the improvement of productivity relied on mechanization and automation technology in the industrialization process. The characteristics of this stage were the standardization and mechanization of production processes, which faced challenges such as high equipment costs and high skill requirements for workers. Entering the 21st century, the information technology revolution has brought digital transformation, including key technologies such as the Internet, artificial intelligence and big data. These technologies have significantly improved productivity, but also triggered new challenges to information security and data privacy. In recent years, with the application of advanced technologies such as 5G, edge computing and blockchain, productivity has further jumped, and production and service methods have become more intelligent and efficient. The main characteristics of this intelligent stage are adaptability and real-time optimization, but it also faces challenges in terms of technical complexity and high requirements for data processing and analysis capabilities.

3.2 Spatial dimension

The overall trend of the development of new quality productivity in different regions is consistent, showing a stable growth trend. This consistency indicates that China's progress in the field of new quality productivity is extensive and positive, especially significant progress has been made in technological breakthroughs, innovative allocation of production factors, and deep industrial transformation and upgrading. Technological breakthroughs are reflected in the introduction and application of advanced technologies, while innovative allocation of production factors includes the optimization of resource allocation and exploration of new production models. Industrial transformation and upgrading point to the transformation of traditional industries and the rise of emerging industries. Specifically, the development rate varies among different regions, with the eastern region experiencing the largest growth rate due to its better economic foundation and strong technological innovation capabilities; The central region closely follows, showing certain development potential and room for improvement; Although the growth momentum in the western region is relatively significant, it lags behind relatively; The growth rate in Northeast China is the smallest, which may be limited by economic restructuring and resource utilization efficiency. Overall, the development trends of various regions reflect China's overall strategy and local implementation effects in promoting the development of new quality productivity, as is shown in Figure 1.

As is shown in Figure 1, from a local perspective, except for the Northeast region, the overall new quality productivity of other regions in China showed a steady upward trend from 2012 to 2022. However, during the period of 2020 to 2022, the growth rate in the central and western regions has decreased, which may be related to the impact of the epidemic. In contrast, the eastern region, due to its strong economic development momentum, has hardly been significantly affected by the epidemic. Due to factors such as population loss, the level of new quality productivity in the Northeast region remained almost unchanged from 2013 to 2015, and subsequently only slowly increased.

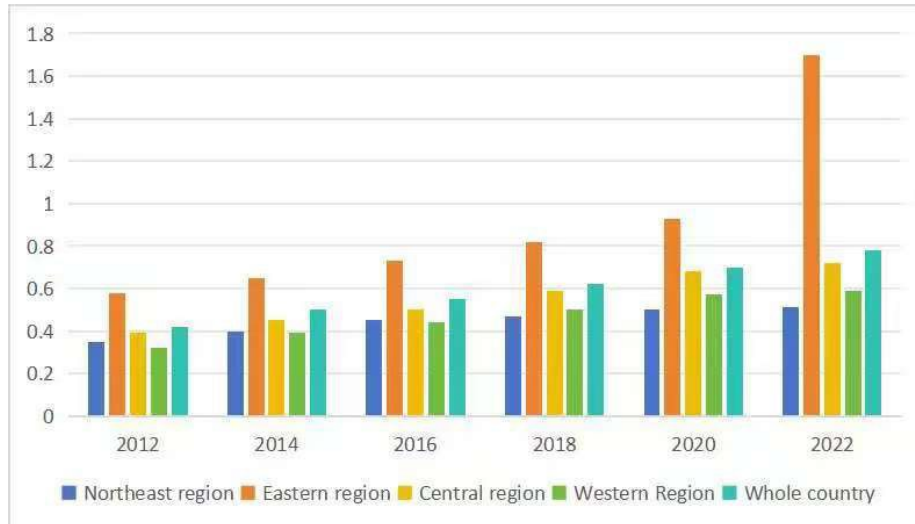


Figure 1: Bar chart of national and regional new quality productivity data over the years

Longitudinal comparison shows that from 2012 to 2022, the score of new quality productivity gradually increased. Horizontal comparison reveals significant differences in the scores of new quality productivity development among different regions. Guangdong ranked first with a score of 119.83, while Ningxia only received 32.5, ranking last. Guangdong, Jiangsu, Zhejiang, Shanghai, and Shandong provinces are leading in the level of new quality productivity, all of which are located in the eastern region. Especially Guangdong, Jiangsu, Zhejiang, and Shanghai, which are located in the Yangtze River Delta region, have benefited from the environmental advantages brought by the integration of the Yangtze River Delta. The rapid development of the digital economy in this region has promoted significant improvements in new quality productivity. Therefore, in the process of promoting the development of new quality productive forces, we should continue to implement the spatial layout of coordinated regional development in China during the 14th Five Year Plan period, accelerate the modernization process in the eastern region, and promote the formation of a spatial development pattern characterized by the eastern region taking the lead, the western development, the rise of the central region, and the revitalization of the northeast.

3.3 Case studies

In the evolution of new quality productivity, China and Germany have provided typical successful cases. China has shown outstanding performance in the fields of artificial intelligence and e-commerce, successfully applying technology to manufacturing and service industries through government policy support and research and development investment, driving rapid economic growth. Germany's "Industry 4.0" strategy enhances the global competitiveness of the manufacturing industry by promoting intelligent manufacturing and digital transformation, and addresses the challenges of technological updates and changes in market demand. In specific industries, cloud computing and artificial intelligence in high-tech fields have significantly improved productivity, such as Amazon's use of cloud service platforms to optimize logistics and supply chain efficiency. In the manufacturing industry, the introduction of intelligent manufacturing and automated production lines has improved production efficiency and flexibility. Tesla's smart factory is a typical case of this transformation, demonstrating the potential of new technologies in improving production efficiency and product quality.

Comparing the evolution of new quality productivity across different time periods and spatial dimensions can reveal the relationship between technological development and economic growth. The law of spatiotemporal evolution indicates that the development of new quality productivity is driven by technological progress, policy support, and market demand. The rapid iteration of technology brings about a leap in productivity, while regional policies and economic environments affect the popularization and application of technology. In the future, new quality productivity will continue to be driven by technological innovation and will need to address new challenges brought about by globalization, digitization, and environmental changes. Countries and regions need to develop corresponding development strategies based on their own characteristics to achieve sustained economic growth and competitive advantages.

4. Development trends and challenges of new quality productivity

4.1 Future development trends

The future development of new quality productivity will be driven by such technological trends as artificial intelligence and automation, IoT and edge computing, 5G and communication technology, green technology and sustainable development. Artificial intelligence and machine learning will enhance the automation level of production processes, strengthen the adaptability and efficiency of production. IoT technology will realize the deep connection of equipment, and edge computing will improve data processing speed and security. 5G technology will significantly improve network speed and support complex real-time application scenarios. The application of green technology and clean energy will promote low-carbon industries and efficient resource utilization, meet environmental regulations, and achieve sustainable development. At the same time, globalization will promote the development of new quality productivity, sharing technological progress through global supply chains and market expansion, but it will also bring international competition, and enterprises need to optimize resource allocation. The trend of regionalization is increasing, and local governments and enterprises are paying attention to the independent development of regional economy, promoting technological innovation and industrial upgrading, and promoting differentiated competition between regions.

4.2 Main challenges

New technologies face technological and market bottlenecks in practical applications. Technical bottlenecks include insufficient maturity and integration of technology, such as artificial intelligence still encountering immature algorithms and data quality issues in certain fields, and the complexity and high cost of technology limiting its popularity. Market bottlenecks involve the uncertainty of market demand and the lag in technological applications. Although new technologies have broad potential, the acceptance and adaptation speed of the market often lags behind technological progress. In addition, capital barriers, talent barriers, and policy barriers also pose major challenges. The development of new quality productivity requires a large amount of capital investment, and startups and developing countries face funding shortages. The application of technology still requires talents with relevant knowledge and skills, but talent shortage and skill mismatch may limit productivity improvement. At the same time, the lagging and uncertain policy environment, especially the imperfect regulations and standards, will also hinder the promotion and application of technology.

4.3 Response strategies

To promote the development of new quality productivity, the government should formulate support policies including tax incentives, innovation rewards, and research and development funding to encourage enterprises to invest in new technologies and promote their application. At the same time, it is necessary to improve the regulatory system, establish relevant regulations and standards, provide legal protection for the application of new technologies, reduce compliance risks for enterprises, and promote the healthy development of technology. In addition, promoting international cooperation can share technological achievements, facilitate global technology exchange and standardization, and enhance the global competitiveness of technology. In terms of enterprises, they should increase research and development investment, pay attention to cutting-edge technological trends, optimize resource allocation, flexibly adjust production lines and supply chains to adapt to market changes and maintain competitive advantages, enhancing market adaptability and respond to constantly changing demands through market research and product innovation. In terms of education and training, it is necessary to strengthen the technical training of employees, improve their ability to apply new technologies, cooperate with universities and research institutions, cultivate high-quality talents needed for future industries, and develop vocational skill improvement plans to support skill certification and continuing education, in order to enhance the overall quality of the workforce.

5. Conclusion

The current development status and spatiotemporal evolution of new quality productivity reveal the complexity and diversity of productivity enhancement in the context of global economic change and technological progress. At present, the main manifestation of new quality productivity is to promote the improvement of productivity through the dual influence of intelligent technology, green technology,

and globalization and regionalization. The rapid development of intelligent technologies, such as artificial intelligence and the Internet of Things, has significantly optimized production processes and efficiency, while the rise of green technology also emphasizes the importance of sustainable development. However, the evolution of new quality productivity is not without challenges. Bottlenecks such as technological maturity, market acceptance, capital demand, and talent shortage have constrained its comprehensive application and promotion. Especially in the coordination between technology and market, there are still many difficulties at this stage, which need to be solved through various efforts such as policy support, corporate strategic adjustments, and education and training. From the perspective of temporal and spatial evolution, the improvement of new quality productivity presents a trend of regional differentiation, and the interaction between globalization and regionalization forces shapes the spatial layout of productivity. Each region adopts different strategies and technological means to promote productivity improvement based on its own resource endowment and market demand. This spatiotemporal evolution not only reflects the trend of global economic integration, but also demonstrates the potential of localized innovation.

In summary, the development of new quality productivity is a dynamic and complex process that requires continuous tracking of technological progress and market changes, flexible adjustment of strategies, and response to emerging new challenges. Future success will depend on how to effectively integrate resources, promote technological innovation, and develop reasonable policies and training measures to achieve sustainable and efficient development of productivity.

Author Contribution Statement

Nuo Xu and Yizhao Sun contributed to the work equally and should be regarded as co-first authors.

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References

- [1] Han J B, Sha D C, Li C. *Evolution of New Quality Productivity: Dimension, Structure and Path* [J]. *Journal of Technical Economics & Management*, 2024, (1): 8-16.
- [2] Huang Q H, Sheng F F. *Evolution of New Quality Productivity: Dimension, Structure and Path* [J]. *Reform*, 2024, (2): 15-24.
- [3] Jiang Y M, Qiao Z Y. *New Quality Productivity: Logic, Connotation and Path* [J]. *Social Science Research*, 2024, (1): 10-18.