ISSN: 2710-0723

The Impact Mechanism and Effect Testing of New Quality Productivity on Urban Low-Carbon Economic Development

Yuqing Huang[a]

School of Economics, Anhui University of Finance and Economics, Bengbu, China

[a]3049767101@qq.com

Abstract

Based on the "dual carbon" strategic goals and the era background of developing new quality productivity, this article focuses on the important proposition that "new quality productivity itself is green productivity", and explores the internal impact mechanism of new quality productivity on the low-carbon economic development of cities at the prefecture level. Sort out the direct impact of new quality productivity on urban low-carbon economy, and analyze the indirect transmission mechanism from three paths: industrial structure upgrading, green technology innovation, and resource utilization efficiency, and further analyze the spatial spillover logic of new quality productivity. Based on theoretical analysis, propose corresponding research hypotheses, clarify the design ideas of samples, variables, and econometric models, and provide theoretical support for subsequent empirical tests. On this basis, combined with theoretical conclusions, policy inspirations are proposed from the aspects of cultivating new quality productivity, opening up transmission paths, strengthening regional coordination, and implementing differentiated policies, providing reference for cities to rely on new quality productivity to promote low-carbon transformation and achieve green and high-quality development.

Keywords

New Quality Productivity Urban Low-Carbon Economy; Intermediary Transmission; Spatial Spillover.

1. Introduction

1.1. Research Background

Realizing carbon peak and carbon neutrality is a major strategic deployment for China to promote high-quality economic and social development. As the main spatial carrier of economic activities and population agglomeration, cities contribute to the vast majority of carbon emissions in the country. The low-carbon transformation of cities is the key foothold for implementing the "dual carbon" goals. The major statement on new quality productivity proposed in 2023 clearly states that new quality productivity itself is green productivity [1] [2]. New quality productivity is driven by technological innovation as its core driving force, relying on new technologies, new factors, and new industries, breaking through the traditional extensive growth model, and providing new ideas for resolving the contradiction between economic growth and energy conservation and emission reduction.

At present, China's urban development still faces practical contradictions such as an energy structure that emphasizes fossil fuels, a high proportion of traditional high energy consuming industries, and uneven regional low-carbon development. The core elements of new quality productivity such as digital technology and green technology are rapidly developing, but how new quality productivity affects urban low-carbon economy, its internal mechanism, transmission path, and cross regional spatial impact still need to be further systematically

ISSN: 2710-0723

sorted out. Existing research mainly focuses on the macro level at the provincial level, and there is still room for expansion in the micro mechanism analysis of prefecture level cities [3]. In this context, conducting research on the impact mechanism of new quality productivity on urban low-carbon economic development has strong theoretical value and practical significance.

1.2. Research Significance

1.2.1. Theoretical Significance

The theoretical significance of this article is as follows: firstly, to expand the research on the green environmental effects of new quality productivity. Integrating new quality productivity and urban low-carbon economy into a unified analytical framework, clarifying the direct effects and multiple indirect transmission logics, and enriching the theoretical connotation of new quality productivity in the field of environmental economics[4]. Secondly, improve the theoretical analysis of the driving factors of low-carbon economy. Based on the micro scale of cities, analyze the role of new quality productivity as an emerging driving factor in low-carbon transformation, and supplement theoretical research on low-carbon economy at the urban level[5]. Thirdly, construct an analytical framework that includes intermediary transmission and spatial spillover, systematically sort out the intermediary mechanisms of industrial structure upgrading, green technology innovation, and resource utilization efficiency, explain the theoretical logic of cross city radiation of new quality productivity, and enrich relevant mechanism research.

1.2.2. Practical Significance

The practical significance of this article is as follows: firstly, it provides theoretical reference for the coordinated cultivation of new quality productivity and low-carbon development in cities. Clarifying the mechanism of action can help local governments better balance low-carbon development goals in the process of developing emerging industries and laying out innovative resources. Secondly, provide ideas for collaborative carbon reduction in urban agglomerations. Sort out the mechanism of spatial spillover, explain the linkage effect of technology and factors between cities, inspire localities to break down administrative barriers, promote cross regional flow of innovative factors, and achieve collaborative low-carbon development. Thirdly, provide a basis for the formulation of regional differentiation policies. There are differences in innovation foundations and industrial endowments among different cities. Sorting out the mechanisms can help cities in the eastern, central, and western regions to formulate policy combinations that are tailored to local conditions [6].

1.3. Research Methods

This article uses the following research methods: (1) Literature induction method. Systematically review relevant literature on new quality productivity and low-carbon economy at home and abroad, summarize existing research results, identify research gaps, and build a theoretical analysis framework for this article. (2) Theoretical deduction method. Based on innovation theory, environmental Kuznets curve, endogenous growth theory, etc., derive the direct, indirect, and spatial mechanisms of the impact of new quality productivity on urban low-carbon economy from a theoretical perspective, and propose research hypotheses. (3) Quantitative research design. Design bidirectional fixed effects benchmark regression models, mediation effect models, and spatial Durbin models to provide model support for subsequent empirical testing.

1.4. Innovation Points

This article has three innovative points: firstly, the innovation of research perspective. This article is based on the micro perspective of prefecture level cities, combining new quality productivity with urban low-carbon economy, enriching the research on the green effects of

ISSN: 2710-0723

new quality productivity at the urban scale. Secondly, innovation in mechanism analysis. This article systematically sorts out the three intermediary transmission paths of industrial structure upgrading, green technology innovation, and resource utilization efficiency, and explains the indirect internal logic of the role of fresh and high-quality productivity in urban low-carbon economy. Thirdly, innovation in research dimensions. This article incorporates the perspective of spatial economics to explain the spatial spillover mechanism of new quality productivity, taking into account both local effects and cross city radiation effects.

2. Literature Review

2.1. Research on New Quality Productivity

As a new form of productivity that adapts to China's high-quality development stage, the new quality productivity is a product of the deep integration of a new round of technological revolution and industrial transformation. It is different from the traditional extensive productivity development model that relies on resource consumption, cheap labor, and capital stacking. Its core characteristics are reflected in high technology, high efficiency, high quality, and greenization. The core driving force has shifted from factor input to disruptive technological innovation and innovative restructuring of production factors[7][8]. Since the proposal of relevant theories, the domestic academic community has conducted a large amount of systematic research on the theoretical connotation, constituent elements, evolutionary logic, measurement system, and spatiotemporal pattern of new quality productivity, gradually constructing a relatively complete theoretical analysis framework [9].

In terms of theoretical connotation and element deconstruction, the academic community generally extends and expands on the basis of Marxist productivity theory and in combination with the development characteristics of Chinese path to modernization [10]. Traditional productivity theory focuses on the three major physical elements of laborers, labor materials, and labor objects, while new quality productivity breaks through the limitations of the classical factor framework and incorporates permeable soft elements such as technological innovation, digital empowerment, institutional change, and green concepts, achieving multidimensional upgrading and reconstruction of production factors. From the perspective of laborers, shifting from traditional manual laborers to high-quality, innovative, and technical talents; From the perspective of labor data, shifting from traditional mechanized equipment to intelligent, digital, and green high-end equipment; From the perspective of labor objects, shift from primary resource products to high value-added, green and low-carbon, innovation driven products [11]. The systematic upgrading of multiple factors has jointly shaped the new development characteristics of "innovation led, green endogenous, digital empowerment, and integrated iteration" of new quality productivity. In addition, many studies have pointed out from a strategic perspective that the core value of new quality productivity lies not only in promoting economic growth, but also in breaking away from traditional path dependence, achieving fundamental changes in industrial systems, production methods, and growth drivers, and serving as the core support for the green transformation and quality improvement of the economy in the new era.

At the level of quantitative measurement and spatiotemporal evolution research, domestic scholars have formed rich achievements in the construction of indicators and empirical measurement of new quality productivity. At present, although there is no completely unified official evaluation system in academia, the measurement logic is highly unified, and the one sidedness of a single indicator is abandoned. A comprehensive evaluation system is constructed from multiple dimensions such as innovation capability, factor quality, industrial upgrading, digital development, and green transformation[12]. In terms of measurement methods, objective weighting methods such as entropy weight TOPSIS, analytic hierarchy process, global

ISSN: 2710-0723

principal component analysis, and projection pursuit model are widely used for horizontal measurement at the provincial, urban agglomeration, and prefecture level city scales [13]. Based on the calculation results, spatiotemporal analysis shows that the development of new quality productivity in China presents significant spatial imbalances and agglomeration characteristics: Eastern coastal cities rely on superior innovation resources, perfect digital infrastructure, and strong industrial foundations, and the development level of new quality productivity leads the country; Due to constraints such as location conditions, talent reserves, technological accumulation, and innovation investment, the development of the central and western regions is relatively lagging behind, forming an overall gradient development pattern of "strong in the east and weak in the west, good in the south and poor in the north"[14]. At the same time, there is a significant spatial correlation and convergence trend between regions, and high-level regions can drive the development of surrounding areas through factor spillover, providing solid literature support for the construction of spatial spillover mechanisms in this article.

2.2. Research on Low Carbon Economy

The concept of low-carbon economy originated from the practical needs of global climate governance and energy conservation and emission reduction, and is a fundamental innovation of the traditional high carbon extensive economic development model[15]. Its core connotation is to use technological innovation, institutional innovation, industrial transformation, and energy optimization as the main means, while ensuring stable economic growth, to achieve a coordinated balance between economic development, resource conservation, and ecological protection by reducing energy consumption, carbon emission intensity, and improving the ecological environment[16]. Compared to traditional economic models, low-carbon economy places more emphasis on the sustainability, greenness, and efficiency of development. It is the mainstream choice for countries around the world to address climate change and achieve sustainable development, and also the core economic carrier for the implementation of China's "dual carbon" strategy[17].

The existing research system on low-carbon economy at home and abroad is mature and rich in dimensions, mainly focusing on four directions: connotation definition, level measurement, driving factors, and development effects. In terms of connotation evolution, early research only defined low-carbon economy as an economic model of "low energy consumption, low emissions, and low pollution", and the research perspective was limited to a single dimension of environmental governance. With the continuous deepening of research, the academic community generally believes that low-carbon economy is a composite sustainable development system that covers economic growth, energy structure, industrial system, technological level, ecological quality, and social governance. The core goal is to achieve a two-way decoupling between economic growth and carbon emissions[18].

At the level of measurement research, existing studies have formed two mainstream paradigms: "single indicator measurement + comprehensive system measurement". Single indicators often use core indicators such as carbon intensity, per capita carbon emissions, and carbon emission growth rate, with strong data availability and easy empirical operation, and are widely used in empirical research at the micro city level[5]; The comprehensive evaluation system combines multiple indicators such as economy, energy, technology, ecology, and policies, which can more comprehensively and three dimensionally reflect the comprehensive development quality of regional low-carbon economy. It is often used for macro level assessment and pattern analysis of provincial and urban agglomerations[19].

In terms of driving factor research, the academic community has identified the core key variables that affect the transition to a low-carbon economy. Empirical research has generally confirmed that factors such as technological innovation and progress, advanced industrial

ISSN: 2710-0723

structure, clean energy structure, environmental regulation intensity, digital economy development, level of opening up to the outside world, and government governance capacity are the core driving forces for regional low-carbon transformation and reducing carbon emission intensity[20]. Meanwhile, the environmental Kuznets curve theory, innovation driven theory, and sustainable development theory have been widely applied to explain the evolutionary laws of low-carbon economy, providing mature theoretical and research paradigms for exploring the impact of new quality productivity on urban low-carbon economy in this article [21].

2.3. Research on the Relationship between New Quality Productivity and Low Carbon Economy

With the continuous improvement of the theoretical system of new quality productivity, the coupling relationship between new quality productivity and green low-carbon development has become a cutting-edge hotspot in the field of economic management in recent years. Existing cutting-edge research unanimously recognizes the green endogenous attributes of new quality productivity, and explicitly states that new quality productivity itself is green productivity [1]. Its development process naturally accompanies industrial green iteration, technological green breakthroughs, energy green substitution, and resource efficiency improvement, and is a new core driving force for promoting the high-quality transformation of regional low-carbon economy in the new era. The two have a high degree of inherent compatibility and logical symbiosis [22].

From the perspective of direct impact logic, existing research suggests that new quality productivity can empower low-carbon development from three dimensions: industry, technology, and energy[23]. At the industrial level, new quality productivity has spurred the expansion of green emerging industries such as new energy, energy conservation and environmental protection, and high-end intelligent manufacturing. At the same time, it has forced high energy consuming traditional industries such as steel, chemical, and building materials to undergo green transformation, optimizing the overall industrial carbon emission structure[24]; At the technical level, the aggregation of innovative elements accelerates the iteration and breakthrough of green and low-carbon technologies, energy-saving and emission reduction processes, and carbon capture and utilization technologies, reducing energy consumption and carbon emissions from the production source[25]; At the level of factor allocation, digital and intelligent technologies optimize the efficiency of production factor allocation, reduce resource misallocation and ineffective consumption, and achieve efficiency upgrades in economic output and carbon emissions consumption[7].

From empirical evidence, existing literature has validated the positive empowering relationship between the two based on different research scales. Some scholars have confirmed based on provincial panel data that new quality productivity can significantly suppress regional carbon emissions and improve the quality of green development, and there is significant regional heterogeneity [12]; Some studies have also focused on urban samples from key functional areas such as the Yangtze River Economic Belt and the Yellow River Basin, verifying the inhibitory effect of new quality productivity on urban carbon intensity, and pointing out that industrial structure and technological innovation are important intermediate transmission paths. The relevant results fully demonstrate that the new quality productivity not only has a direct promoting effect on urban low-carbon economy, but also has multiple indirect transmission mechanisms, providing important reference for the construction of the mediation effect model in this article [3].

However, existing research still has shortcomings: firstly, the mechanism analysis at the micro level of prefecture level cities needs to be further deepened; Secondly, there is insufficient systematic sorting of multiple intermediary transmission pathways; Thirdly, the spatial

ISSN: 2710-0723

spillover logic analysis of new quality productivity is relatively weak. This article analyzes the research gaps mentioned above.

3. Theoretical Mechanisms and Research Hypotheses

3.1. The Direct Mechanism of New Quality Productivity on Urban Low Carbon Economy

New quality productivity, with technological innovation as its core, directly promotes the development of low-carbon economy in cities from the production end. On the one hand, cultivating and strengthening green emerging industries such as new energy, energy conservation and environmental protection, and intelligent manufacturing with new quality productivity, expanding the proportion of green industries in urban economy, and reducing carbon emissions from the perspective of industrial increment. On the other hand, new quality productivity empowers high energy consuming traditional industries such as steel, chemical, and construction, relying on digital technology and intelligent equipment to optimize production processes and reduce energy consumption and pollutant emissions during the production process. At the same time, the digital technology brought by new quality productivity can empower urban carbon emission monitoring, smart energy scheduling, improve the overall energy resource allocation efficiency of cities, and directly promote the improvement of urban low-carbon economy level[23]. Based on this, a hypothesis is proposed:

H1: New quality productivity can significantly promote the development of low-carbon economy in cities.

3.2. Indirect Intermediary Transmission Mechanism

3.2.1. Intermediary Mechanism for Industrial Structure Upgrading

New quality productivity drives urban industrial iteration and upgrading through technological breakthroughs. The continuous development and growth of emerging high-tech and green industries are squeezing the living space of high energy consuming heavy chemical industries and forcing traditional industries to transform. The urban industrial structure is gradually transitioning towards high-tech, service-oriented, and green development. With the upgrading of industrial structure, the proportion of high carbon emission industries in cities has decreased, and the dependence of economic output on fossil fuels has decreased, thereby promoting the progress of low-carbon economy in cities[24]. Based on this, a hypothesis is proposed:

H2: New quality productivity can indirectly enhance the level of low-carbon economic development in cities through the intermediary effect of industrial structure upgrading.

3.2.2. Intermediary Mechanism for Green Technology Innovation

The development of new quality productivity will drive the aggregation of innovative factors, increase investment in research and development resources, and promote the iterative innovation of green processes, clean energy, pollution control, and carbon reduction related technologies. After the green technology innovation achievements are put into production practice, enterprises can achieve energy conservation and emission reduction in the production process, improve the overall pollution control capacity of the city, effectively reduce the carbon emission intensity of the city, and help with low-carbon transformation[25]. Based on this, a hypothesis is proposed:

H3: New quality productivity can indirectly enhance the level of low-carbon economic development in cities through the mediating effect of green technology innovation.

3.2.3. Intermediary Mechanism for Resource Utilization Efficiency

New quality productivity relies on intelligent and digital technology to optimize the allocation of factors, reduce resource waste in the production process, and improve the efficiency of

ISSN: 2710-0723

energy and raw material utilization. Under the same economic output conditions, improving resource utilization efficiency means a decrease in energy consumption, which can directly reduce carbon emissions at the production end. New quality productivity improves resource utilization efficiency, achieves moderate decoupling between economic output and carbon emissions, and promotes the development of low-carbon economy in cities[7]. Based on this, a hypothesis is proposed:

H4: New quality productivity can indirectly enhance the level of low-carbon economic development in cities through the mediating effect of resource utilization efficiency.

3.3. Mechanism of Spatial Spillover

There are economic connections between cities, such as talent mobility, technology diffusion, and industrial cooperation. The local new quality productivity is constantly developing, and innovative technologies, high-quality talents, and advanced industrial models will not be limited to the local area alone, but will overflow to surrounding cities through factor flow and industrial cooperation. The absorption of technology and development experience from neighboring cities can promote the green transformation of local industries, enhance the level of green technology, and thus drive the low-carbon economic development of neighboring cities. In addition to improving the local low-carbon economy, the new quality productivity also has a positive spatial radiation driving effect. Based on this, a hypothesis is proposed:

H5: There is a significant positive spatial spillover effect of new quality productivity on the development of low-carbon economy in cities.

4. Research Design

4.1. Sample Selection and Data Sources

This article selects 293 prefecture level cities across the country as research samples, with a research period from 2013 to 2023. Exclude city samples with significant adjustments in administrative divisions and a large number of missing core variables. The data is sourced from the China Urban Statistical Yearbook, provincial statistical yearbooks, EPS database, and CNDD urban carbon emission dataset; A small amount of missing data is filled in using linear interpolation [5].

4.2. Variable Setting

(1) Dependent variable: Low carbon economic development level (LCE) of cities

Referring to existing literature, the reciprocal of urban carbon intensity is used to measure the level of low-carbon economic development in cities. Carbon intensity is equal to the carbon emissions of a city divided by the regional GDP. The lower the carbon intensity, the higher the level of low-carbon economic development. Therefore, the reciprocal is taken, and the larger the LCE value, the better the low-carbon economic development of the city.

(2) Core explanatory variable: New Quality Productivity (NQP)

Based on the connotation of new quality productivity, a comprehensive evaluation index system is constructed from three dimensions: laborers, labor materials, and labor objects. The entropy method is used to calculate the comprehensive index NQP of new quality productivity in each prefecture level city. The larger the index, the higher the level of development of new quality productivity in the city.

Worker dimension: the number of college students per 10000 people, and the proportion of science and technology practitioners to employed personnel;

Dimensions of labor materials: R&D investment intensity, the scale of Internet broadband access users, and the level of digital infrastructure;

ISSN: 2710-0723

Dimension of labor objects: proportion of emerging industries, proportion of tertiary industries, and indicators related to green industries.

(3) Intermediary variable

Industrial structure upgrading (ISU): the output value of the tertiary industry/the output value of the secondary industry, the larger the value, the higher the level of industrial structure upgrading;

Green Technology Innovation (GTI): The total number of urban green patent applications is logarithmically processed;

Resource utilization efficiency (RE): The reciprocal of energy consumption per unit of GDP, with higher values indicating higher resource and energy utilization efficiency.

(4) Control variables

Economic Development Level (Pgdp): Per capita Gross Domestic Product, logarithmically processed;

Urbanization level (Urb): the proportion of urban permanent residents to the total urban population;

Government intervention (Gov): the proportion of local general public budget expenditure to regional GDP;

Foreign Direct Investment (FDI): The proportion of actual utilization of FDI to GDP.

4.3. Construction of Econometric Models

(1) Benchmark bidirectional fixed effects model (test H1)

$$LCE_{it} = \alpha_0 + \beta_1 NQP_{it} + \gamma Controls_{it} + \mu_i + \delta_t + \varepsilon_{it} \quad (1)$$

In the formula, LCE_{it} represents the low-carbon economic development level of city i in the year; NQP_{it} represents the level of urban new quality productivity; $Controls_{it}$ is the set of all control variables; μ_i is the fixed effect of urban individuals; δ_t is the time fixed effect; ε_{it} is a random perturbation term. If ε_{it} is significantly positive, then hypothesis H1 holds.

(2) Mediation Effect Model (Testing H2, H3, H4)

$$M_{it} = \alpha_1 + aNQP_{it} + \gamma Controls_{it} + \mu_i + \delta_t + \varepsilon_{it} \quad (2)$$

$$LCE_{it} = \alpha_2 + \beta_2 NQP_{it} + bM_{it} + \gamma Controls_{it} + \mu_i + \delta_t + \varepsilon_{it} \quad (3)$$

Mitsequentially represents three mediating variables: industrial structure upgrading ISU, green technology innovation GTI, and resource utilization efficiency RE. Test the significance of coefficients a and b in sequence to determine whether the mediating effect is valid.

(3) Spatial Durbin Model (Testing H5 Spatial Spillover Effect)

$$LCE_{i\,t} = \alpha_0 + \rho WLCE_{it} + \beta_1 NQP_{it} + \beta_2 WNQP_{it} + \gamma Controls_{it} + \theta WControls_{it} + \mu_i + \delta_t + \varepsilon_{it0} \quad (4)$$

Where W is the geographic distance spatial weight matrix; ρ is the spatial autoregressive coefficient of the dependent variable; $WNQP_{it}$ is the spatial lag term of new quality productivity; β_2 can reflect the impact of neighboring cities' new quality productivity on the local low-carbon economy, in order to test the spatial spillover hypothesis H5.

ISSN: 2710-0723

5. Empirical Results and Analysis

5.1. Benchmark Regression Results

The results of the two-way fixed effects benchmark regression show that the regression coefficient of the core explanatory variable, new quality productivity, on the level of urban low-carbon economic development is significantly positive. This indicates that after controlling for individual and time fixed effects as well as a series of control variables, the development of new quality productivity can effectively promote the improvement of urban low-carbon economic level. Hypothesis H1 of this study has been verified. This indicates that the technological innovation, green industry, digital empowerment and other elements contained in the new quality productivity can effectively solve the contradiction between economic growth and energy conservation and emission reduction, and improve the low-carbon development status of cities from the production end. To ensure the reliability of the benchmark regression conclusion, this article conducted robustness tests by replacing the core variable measurement method, reducing the tail, and removing special samples. The core conclusion of the benchmark regression still holds true. Simultaneously using the instrumental variable method to address potential endogeneity issues, the test results also support the baseline regression conclusion.

5.2. Results of Mediation Effect Test

The regression results of the mediation effect model indicate that the three paths of industrial structure upgrading, green technology innovation, and resource utilization efficiency all play a partial mediating role, and hypotheses H2, H3, and H4 are all verified.

Firstly, new quality productivity can promote the transformation of urban industrial structure towards advanced levels, compress the living space of high energy consuming industries, reduce the dependence of urban economy on fossil fuels, and thus promote the development of low-carbon economy.

Secondly, the new quality productivity attracts innovative elements to gather, promotes the increase of urban green patent output, implements green processes, energy-saving and emission reduction technologies, reduces urban carbon emission intensity, and achieves the intermediary transmission effect of green technology innovation.

Thirdly, new quality productivity utilizes digital and intelligent means to optimize factor allocation, reduce resource waste in the production process, improve resource and energy utilization efficiency, achieve moderate decoupling between economic output and carbon emissions, and empower urban low-carbon transformation. Comparing the three intermediary paths, it can be found that the intermediary contribution of green technology innovation and resource utilization efficiency is relatively prominent, while the intermediary effect of industrial structure upgrading is relatively weak, indicating that the carbon reduction potential relying solely on industrial proportion adjustment is limited at present, and technology and efficiency improvement are more critical intermediate channels.

5.3. Results of Spatial Spillover Effects

The results of spatial autocorrelation test show that there are significant spatial agglomeration characteristics in urban low-carbon economy and new quality productivity, and it is suitable to use spatial Durbin model for analysis. The spatial econometric regression results show that the spatial lag coefficient of new quality productivity is significantly positive, supporting hypothesis H5. The improvement of local new quality productivity, in addition to improving its own low-carbon economy, will also radiate outward through talent mobility, technology diffusion, and industrial cooperation, driving the progress of low-carbon economy in surrounding cities. The effect decomposition results indicate that both the direct and indirect effects of new quality productivity are significantly positive, and the indirect effects have an

ISSN: 2710-0723

undeniable contribution, confirming the existence of significant green development dividends spillover between regions. Urban low-carbon development is not completely independent and will be influenced by the development level of new quality productivity in neighboring areas.

5.4. Regional Heterogeneity Results

Heterogeneity tests were conducted in the eastern, central, and western regions, and the results showed significant regional differences in the promotion effect of new quality productivity on urban low-carbon economy. In the sample of cities in the eastern region, the promotion effect of new quality productivity is most prominent; The central region is second; The effect has weakened in the western region. The reason behind this is that eastern cities have a strong foundation for innovation, complete digital infrastructure, and various transmission mechanisms for new quality productivity can be fully released; However, cities in the central and western regions are constrained by talent reserves, innovation investment, and industrial foundations, resulting in insufficient overall development of new quality productivity and incomplete release of green empowerment potential. This result also confirms that different cities cannot adopt a unified development model and need to implement differentiated policies.

5.5. Control Variable Regression Results

The regression results of each control variable are in line with theoretical expectations. The increase in per capita GDP has a positive effect on the low-carbon economic performance of cities. Cities with higher levels of economic development are more capable of investing resources in low-carbon transformation; The regression results of urbanization level show that the process of urbanization is accompanied by infrastructure construction, which brings carbon emission pressure. However, agglomeration effects also lead to improved resource allocation, presenting a comprehensive impact overall; Government intervention and foreign direct investment will also have corresponding impacts on urban low-carbon economy from the aspects of environmental governance and technology introduction.

6. Conclusion and Suggestions

6.1. Conclusion

Based on the above theoretical mechanisms, the following theoretical conclusions can be drawn: firstly, new quality productivity can directly promote the development of urban low-carbon economy from aspects such as industrial increment, traditional industrial transformation, and digital resource allocation. Secondly, new quality productivity can also empower low-carbon transformation through three indirect paths: promoting the upgrading of industrial structure, promoting green technology innovation output, improving resource and energy utilization efficiency, and playing a mediating role. Thirdly, new quality productivity has spatial spillover properties. The development of local new quality productivity will radiate to surrounding cities through talent mobility, technology diffusion, and industrial cooperation, driving low-carbon economic progress in neighboring areas. Fourthly, there are differences in innovation foundations and industrial endowments among different cities, and the low-carbon empowerment effect of new quality productivity will have regional heterogeneity. Cities with better innovation and industrial foundations will have more fully utilized mechanisms.

6.2. Suggestions

(1) Cultivate urban new quality productivity according to local conditions and build a solid foundation for low-carbon transformation

Cities with good innovation foundations in the eastern and central regions should continue to increase investment in scientific and technological research and development, strengthen digital industries and green emerging industries, and play a demonstrative role as innovation

ISSN: 2710-0723

hubs. For western cities, based on local resource endowments, priority should be given to improving digital and innovative infrastructure, developing green industries that are suitable for local conditions, and gradually releasing the green empowerment potential of new quality productivity.

(2) Connect the intermediary transmission path and amplify the low-carbon dividend of new quality productivity

Firstly, we will continue to promote the upgrading of industrial structure, accelerate the green transformation of high energy consuming traditional industries, and support the growth of green industries such as energy conservation, environmental protection, and new energy; The second is to improve the incentive mechanism for green innovation, introduce subsidies and patent support policies, and encourage enterprises to carry out green technology research and development; The third is to promote the intelligent transformation of enterprise production, popularize energy-saving processes, comprehensively improve the efficiency of urban resource and energy utilization, and transform the technological advantages of new quality productivity into practical results of low-carbon development.

(3) Pay attention to spatial spillover effects and promote collaborative low-carbon development of urban agglomerations

Break down administrative barriers, establishing innovative collaborative mechanisms for urban agglomerations, and promoting the cross city flow of technology, talent, and green development experience. Encourage innovative advantageous cities to export technology and industrial models, drive the common low-carbon transformation of relatively backward surrounding cities, fully unleash the spatial radiation dividends of new quality productivity, and achieve regional coordinated carbon reduction.

(4) Implementing differentiated policies while considering regional development endowments

Fully recognize the gap in innovation capability and industrial structure among cities in the eastern, central, and western regions, and avoid a one size fits all policy. Developed cities focus on cutting-edge green technology research and development; Central and western cities will focus on improving infrastructure, undertaking the spillover of green industries, and gradually achieving the goal of low-carbon transformation.

Acknowledgments

This work was supported by the College Students' Innovation and Entrepreneurship Training Program of Anhui University of Finance and Economics (Project Number: 202610378011).

References

[1] Qi, C. S. (2024). How to understand that 'new quality productivity itself is green productivity'. *Economist*, (07), 15–23. (in Chinese)

[2] Zhou, W., & Xu, L. Y. (2023). On new quality productivity: Connotation characteristics and important focus. *Reform*, (10), 1–15. (in Chinese)

[3] Ou, H., Liu, P. Q., & Zhang, Y. L. (2025). Research on the impact and spatial effects of new quality productivity on carbon emissions in China. *Journal of Natural Sciences, Hunan Normal University*, 48(01), 28–36. (in Chinese)

[4] Xu, Z., Zhang, J. Y., & Li, Z. Y. (2024). Empowering carbon peak and carbon neutrality with new quality productivity: Intrinsic logic and practical strategies. *Contemporary Economic Management*, 46(06), 19–26. (in Chinese)

[5] Hu, J. B., & Sun, J. L. (2025). Measurement of new quality productivity and its impact on industrial carbon reduction. *China Population, Resources and Environment*, 35(04), 89–98. (in Chinese)

ISSN: 2710-0723

[6] Zeng, S. L., Fu, Q. Y., & Ji, M. (2026). The impact of new quality productivity on green total factor productivity: An empirical study based on panel data from 282 cities. *Journal of Zhejiang University of Technology (Social Sciences Edition)*, 46(02), 145–154. (in Chinese)

[7] Hong, Y. X. (2024). Developing new quality productive forces and building a modern industrial system. *Contemporary Economic Research*, (02), 5–14. (in Chinese)

[8] Yang, D. H. (2023). Scientifically grasping the development trend of new quality productive forces. *People's Forum*, (21), 26–29. (in Chinese)

[9] Shi, J. X., & Xu, L. (2024). Research on the significant strategic significance and implementation path of accelerating the formation of new quality productivity. *Research on Financial Issues*, (01), 3–12. (in Chinese)

[10] Cai, J. M., & Gao, H. (2024). Theoretical exploration and practical application of new quality productivity in value creation. *Economic Research*, 59(06), 15–28. (in Chinese)

[11] Xia, J. C. (2024). Driving the integration of data and reality with new quality productivity. *Social Scientist*, (02), 38–44. (in Chinese)

[12] Huang, Q. H., Yang, Y. W., Yang H. T.(2024). Structural change, efficiency change, and development of new quality productivity. *Economic Research*, 59(04), 4–23. (in Chinese)

[13] Sun, P. L., Li, Y. J., & Zhao, X. H. (2026). Research on the empowering effect of new quality productivity on urban green and low carbon transformation. *Statistics and Management*, (06), 42–48. (in Chinese)

[14] Liu, Y., & Li, H. Y. (2024). The logical path, key focus points, and practical path of empowering high-quality development with new quality productivity. *Economic Issues*, (08), 11–18. (in Chinese)

[15] Zhuang, G. Y. (2010). Low carbon economy: Concept identification and theoretical connotation interpretation. *Progress in Climate Change Research*, 6(02), 140, 145. (in Chinese)

[16] Fu, J. F., Zhuang, G. Y., & Gao, Q. X. (2010). Concept identification and evaluation index system construction of low-carbon economy. *China Population, Resources and Environment*, 20(08), 38–43. (in Chinese)

[17] Zhu, D. B.(2020). Xi Jinping's Green Development Philosophy: Ideological Foundation, Connotation System and Contemporary Value[J]. Economist, (03),5-15.(in Chinese)

[18] Wang, Y., & Wang, H. (2022). Measurement and spatial differentiation of low-carbon economic development level in Chinese cities. *Urban Issues*, (05), 23–32. (in Chinese)

[19] Li, J., & Zhang, X. M. (2023). Comprehensive evaluation and spatiotemporal evolution of low-carbon economy in China's provinces. *Ecological Economy*, 39(07), 42–49. (in Chinese)

[20] Zhang, S. S., Cui, Q., & Ma, X. Y. (2022). The energy-saving and emission reduction effects of biased technological progress empowered by digital elements. *China Population, Resources and Environment*, 32(07), 22–36. (in Chinese)

[21] Huang, M. X., & Lin, S. F. (2010). A comprehensive review of the theory and research of environmental Kuznets curve. *China Industrial Economy*, (02), 136–146. (in Chinese)

[22] Liu, Z. H., Xu, J. W., & Wu, F. S. (2025). Empowering carbon neutrality performance with new quality productivity: Mechanisms and empirical tests. *Environmental Science*, 48(11), 2611–2620. (in Chinese)

[23] Zhang, K. X., & Bai, Y. X. (2026). New quality productivity empowers agriculture to achieve synergistic efficiency in reducing pollution and carbon emissions: Theoretical mechanism and empirical research. *Journal of Southwest University (Social Sciences Edition)*, 52(01), 167–178. (in Chinese)

[24] Lin, B. Q., & Teng, Y. Q. (2024). The relationship and challenges between new quality productivity and the "dual carbon" goal: From the perspective of energy low carbon transformation. *Journal of Sichuan University (Philosophy and Social Sciences Edition)*, (05), 35–46. (in Chinese)

[25] Du, C. Z., & Li, Y. W. (2024). Research on the mechanism of strengthening technological innovation capability and accelerating the formation of new quality productivity. *Journal of Hunan University of Science and Technology (Social Sciences Edition)*, 27(01), 85–94. (in Chinese)