Industry Science and Engineering Vol. 2 No. 3, 2025

New Quality Productivity Enabling Industrial Structural Upgrading in a Dual-Carbon Context

Dongchen Li
School of International Education, Beijing Institute of Technology, Beijing,China

Abstract: This study utilizes Chinese provincial panel data from 2012 to 2023 to construct a comprehensive industrial structure coefficient. It empirically analyzes the impact of new quality productivity (NQP) on industrial structure advancement ("sophistication") and rationalization, with specific attention to carbon emission constraints. Key findings include the following points. Regarding core effects, NQP significantly promotes industrial structure upgrading, particularly advancement. However, this positive effect diminishes under high carbon emission levels, hindering structural optimization. The impact of NQP exhibits significant regional heterogeneity. A positive correlation emerges only in China's western region, while effects in eastern and central regions remain statistically insignificant. Policy interaction analysis through PSM-DID methodology reveals that the "14th Five-Year Plan for the Digital Economy" significantly boosts industrial upgrading in western China. Furthermore, NQP amplifies these policy benefits. Robustness tests indicate NQP correlates negatively with industrial structure rationalization but positively with advancement. This suggests its impact varies according to regional economic development stages. Collectively, these findings provide theoretical and empirical foundations for precisely formulating regional industrial policies under China's dual-carbon goals.

Keywords: Carbonneutral; Digital Technology Level; Industrial Structure Upgrading; New Quality Productivity

1. Introductory

1.1 Background of the Study

Since the reform and opening up of China in 1978, the Chinese economy has realized 30 years of rapid growth. However, this growth model relies mainly on massive inputs of resources, which has not only led to serious environmental pollution, but also accompanied by huge energy consumption. In particular, China's energy structure is dominated by coal, the combustion process of which generates a large amount of carbon emissions that have a serious impact on China's environment[1]. As a result, China's status as the "world's factory" is based on the massive consumption of resources, severe environmental pollution, frequent occurrence of haze and deterioration of the ecosystem.

The dual-carbon target refers to China's strategy to achieve carbon neutrality by 2060 and peak carbon by 2030. This goal is not only a positive response to global climate change, but also an important measure to promote sustainable development[2]. In this context, how to realize high-quality economic development through industrial structure upgrading has become a focus of attention for academics and policy makers. With traditional industries facing environmental pressure and resource constraints, industrial transformation and upgrading has become an inevitable trend. The optimization and adjustment of industrial structure will promote the development of low-carbon economy and provide support for achieving the dual-carbon goal.With innovation as the core, new quality productivity aims to give rise to new industries, new modes and new kinetic energy through technological breakthroughs, innovation of production factors, and industrial transformation and upgrading, and it is a new quality of advanced productivity [3]. The essential features and connotations of the new quality productivity have been widely recognized, establishing scientifically sound and effective methods for carbon emission rights valuation has become a critical issue requiring urgent resolution.

1.2 Purpose and Significance of the Study

In the key stage of China's industrial structure

upgrade, facing how the level of new quality productivity affects the industrial structure upgrade, and what role the level of digital economy plays. Therefore, it is of great practical significance to clarify the influence and mechanism of the new quality productivity, industrial structure heightening and industrial structure rationalization on carbon emission efficiency, in order to promote the green transformation of the economy and realize high-quality development.

2. Literature Review

The essential features and connotations of NQP have been widely recognized, however, no consensus has been reached on its quantification method. Existing studies show that the discussion of NQP and industrial structure upgrading mainly focuses on the following three areas: the definition of NQP and the confirmation of its measurement method. New quality productivity is regarded as the embodiment of advanced productivity, the core of which lies in upgrading the level of technology, in which strategic emerging industries and future industries play a decisive role in the development of new quality productivity [4]. Secondly, the link between new quality productivity and high quality economic development is explored. The analysis of new quality productivity can be carried out from the three dimensions of labor force, labor materials and labor objects, and the high-quality development of the economy involves the comprehensive change of production factors [5], the form of production organization and the industrial system. New quality productivity promotes the high-quality development of the economy by improving the quality of production factors. Finally, the interrelationship between new quality productivity, regional technological innovation efficiency and industrial structure upgrading is analyzed[6]. The development power of new quality productivity mainly comes from the core driving force of scientific and technological innovation, and high-technology regions can improve the overall total factor productivity and rapidly apply the achievements of scientific and technological innovation to specific industries and industrial chains [7], so as to transform and upgrade traditional industries and cultivate new industries at the same time.

Review domestic and international research on dual-carbon targets and industrial transformation, and analyze current gaps in theory and practice. Explore the specific contribution of industrial transformation in realizing the dual-carbon target, and clarify the role of different industries in the transformation[8]. The study explores the relationship between carbon emissions and industrial structure from the perspective of carbon emissions itself. Cai Rongsheng and Liu Chuan's empirical analysis based on the VEC model and impulse response function points out that carbon emission intensity is a Granger dependent variable for industrial structure upgrading, specifically, the change of carbon emission intensity significantly affects the proportion of the tertiary [9] industry, i.e., the reduction of carbon emission intensity contributes to the upgrading of industrial structure [10]. According to Lv Ziyuan, the establishment of the dual-carbon target will reshape China's industrial structure and promote the low-carbon and energy-saving transformation of various industries, thus accelerating the upgrading process of industrial structure [11]. Liu's study based on the panel data of prefecture-level cities in the Yellow River Basin shows that high carbon emissions will significantly inhibit the process of scientific and technological innovation, which in turn will have a forcing effect on the optimization of industrial structure [12]. There is a close relationship between the level of digital economy and new quality productivity. The digital economy optimizes resource allocation through its "data-algorithm-calculus" mechanism, and promotes the transformation of traditional productivity to new quality productivity [13]. The development of digital economy has formed a new model of resource allocation driven by data traction, algorithmic regulation and arithmetic power, which is the basic logic of generating new quality productivity [14]. Scientific and technological innovation, especially the application of digital technology [12], such as artificial intelligence, big data, cloud computing, etc., has not only changed the traditional mode of production, but also given rise to a large number of new business forms and new models [13], which provide a broad space for the formation and development of the new quality of productive forces [15].

Industrial transformation has an important contribution to make in the process of realizing the dual-carbon goal[16]. The digital economy provides the necessary technical support and

innovation environment for the development of new quality productivity. The application of digital technologies, such as artificial intelligence, big data and cloud computing, has not only changed the traditional mode of production, but also given rise to a large number of new business forms and new models[17]. The application of these technologies helps improve energy efficiency and reduce carbon emissions[18], thus contributing to the realization of the dual-carbon goal. Industrial transformation reduces the conflict between human production and nature by promoting resource recycling[16] , saving and intensive use of factors, and green and low-carbon transformation of energy[19] . Digital new quality productivity to promote the deepening of the degree of socialization of production, broaden the channels of income distribution, and promote the smooth flow and efficient allocation of factor resources, these new changes have put forward higher requirements for the production relations [18], which will help to achieve the dual-carbon goals. Through digital transformation, traditional industries can realize green and low-carbon production, and smart manufacturing not only reduces production costs compared with traditional manufacturing [20], but also can achieve green and low-carbon production [21]. Therefore, industrial transformation plays a key role in realizing the dual carbon goals and contributes to sustainable economic development by improving energy efficiency and reducing emissions[22].

3. Research Design

3.1 Theoretical Framework

As an innovation-driven form of productivity, the role of new quality productivity in promoting the upgrading of industrial structure should not be overlooked. Through technological innovation and the reorganization of production factors, it injects new vitality into traditional industries and promotes the development of new industries. In terms of industrial incubation effect, the new quality productivity not only creates new business forms through the introduction of subversive technologies, but also optimizes the industrial layout, making the industrial structure more rationalized. For example, the application of intelligent manufacturing technology makes the traditional manufacturing industry transform to intelligence, improves the production efficiency and reduces the cost, thus promoting the upgrading of industrial structure. As for the resource allocation effect, the new quality productivity accelerates the transformation of traditional industries by improving the allocation efficiency of production factors. This transformation is not only the improvement of production efficiency, but also the increase of industrial added value. For example, through big data analysis, enterprises can more accurately grasp market demand and adjust production plans, thus improving the efficiency of resource utilization. As for the cluster effect, the new quality productivity promotes the spatial agglomeration of high-tech industries and the formation of industrial clusters. These clusters enhance the competitiveness of the regional industrial chain through the synergistic effect of the industrial chain and provide strong support for the upgrading of the industrial structure. In short, the new quality productivity directly promotes the upgrading of industrial structure through the above mechanism and injects a new impetus for regional economic development[10]. Accordingly, H1 is proposed: new quality productivity has a direct promotion effect on industrial structure upgrading.

The level of the digital economy, as an important part of the new quality productivity, and its mediating effect in the process of upgrading the industrial structure should not be underestimated. By providing new technological means and business models, the digital economy provides a platform for the promotion and application of new quality productivity. In terms of technological integration, regions with a high level of digital economy are often better able to realize the integration of new technologies with traditional industries and promote the development of industries in the direction of intelligence and greening. In terms of market demand, regions with a high level of digital economy have more diversified market demand, which provides a broad market space for the development of new quality productivity[13]. Enterprises can quickly respond to market changes and adjust production strategies to meet consumer demand through digital platforms. In terms of policy support, in regions with a high level of digital economy, governments tend to introduce more policies to support the development of new quality productivity, such as tax incentives and financial support. These

policies provide a favorable environment for the rapid growth of new quality productivity[16]. Therefore, the level of digital economy plays an important intermediary effect in the promotion of new quality productivity to the industrial level, which promotes the upgrading and optimization of industrial structure. Accordingly, H2 is proposed: the level of digital economy plays an intermediary effect in the new quality productivity promotion industry level.

The negative moderating effect of carbon intensity on the upgrading effect of new and qualitative productivity is increasingly evident as an important indicator of the environmental friendliness of economic development. The upgrading of new quality productivity is often accompanied by technological innovation, which can improve energy utilization efficiency and reduce carbon emissions. For example, the application of clean energy technologies, such as solar energy and wind energy, not only reduces the consumption of fossil energy, but also reduces carbon emissions. In terms of changes in the mode of production, the new quality productivity has pushed the mode of production in a greener and more sustainable direction. This change not only helps reduce carbon emissions, but also improves the environmental efficiency of enterprises. In terms of policy guidance, the government guides the development of new quality productivity through the formulation of relevant policies and standards, while controlling the intensity of carbon emissions[23]. Such policy guidance helps to realize a win-win situation for both environmental protection and economic development. Therefore, the negative regulating effect of carbon emission intensity helps the upgrading of new quality productivity and promotes the green transformation of industrial structure[24]. Accordingly, H3 is proposed: the upgrading effect of the negative regulation of carbon emission intensity on the new quality productivity.

The upgrading effect of new quality productivity is heterogeneous in different regions, mainly due to the differences in resource endowment, policy environment and market environment among regions. In terms of resource endowment, different regions have different resource advantages, which determines the application and development direction of new quality productivity in different regions. In terms of policy environment, there are differences in the policy environment, laws and regulations in different regions, which affect the upgrading effect of new quality productivity. For example, some regions may have introduced more policies to support the development of NQPs, while others may lack corresponding policy support[22]. In terms of the market environment, there are differences in market demand and consumer preferences in different regions, which affect the promotion and application of NQPs. For example, some regions may be more receptive to new technologies, while others may be less receptive. Therefore, there is regional heterogeneity in the upgrading effect of new quality productivity, and it is necessary to formulate appropriate development strategies according to the actual situation of different regions[25]. Accordingly, H4: There is regional heterogeneity in the upgrading effect of new quality productivity

3.2 Description of Variables

The empirical sample of this paper is the data of 31 provinces in China (excluding Hong Kong, Macao and Taiwan), with a total sample of 341. The explanatory variable is industrial structure upgrading (Stru), which is divided into industrial structure advanced (RIS) and industrial structure rationalization (ISS). Referring to the research of Yuan and Zhu (2018)[26], used the entropy weight method to assign different weights to industrial structure rationalization and industrial structure advanced, and finally calculated and synthesized them into a comprehensive index of industrial structure upgrading. The core explanatory variable of industrial structure rationalization and industrial structure advancedization is the new quality productivity development index (NQ). At present, most scholars construct the NQ productivity evaluation index system from laborers, labor materials and labor objects. This paper refers to the practice of Ren Yuxin, Wu Yan and other scholars to construct a comprehensive evaluation index system of NQ productivity from the three-dimensional objectives of "quantitative accumulation, qualitative improvement and new expansion" of NQ productivity with workers, labor objects and labor materials as the criterion layer.

Control variables: gdp, Co2 emissions, the level of financial regulation as the ratio of local financial regulatory expenditures (in billions of yuan) to the value added of the financial sector (in billions of yuan), and the number of

employed people are selected based on the practices of the established literature and the availability of data.

Mediating variables: The level of the digital economy is measured by the number of Internet broadband access subscribers, the number of cell phone subscribers, the number of employees in the information transmission and software information technology services industry, the total amount of telecommunication business, and the digital financial inclusion index.

4. Model Setup

4.1 Baseline Model

Where Stritdenotes the level of industrial structure upgrading in province *i* in period *t*, NQitdenotes the level of new quality productivity in province i in period t, controls denote control variables, μidenotes unobservable individual fixed effects in province *i*, and εitdenotes a randomized disturbance term.

$$Stru_{it} = \beta_0 + \beta_1 NQ_{it} + \beta_2 \sum \ln controls + \mu_i + \lambda_t + \varepsilon_{it} \quad (1)$$

4.2 Intermediation Models

In order to verify whether the level of digital economy plays a mediating role in the promotion of industrial structure upgrading by the new quality productivity, the mediating effect regression model is established using the stepwise regression method:

$$Stru_{iEt} = \beta_0 + \beta_1 NQ_{iEt} + \beta_2 \sum \ln controls + \mu_i + \lambda_t + \varepsilon_{it} \quad (2)$$

$$Stru_{iMt} = \beta_0 + \beta_1 NQ_{iMt} + \beta_2 \sum \ln controls + \mu_i + \lambda_t + \varepsilon_{it} \quad (3)$$

$$Stru_{iWt} = \beta_0 + \beta_1 NQ_{iWt} + \beta_2 \sum \ln controls + \mu_i + \lambda_t + \varepsilon_{it} \quad (4)$$

4.3 Robustness Check Model

Replace the explanatory variables to conduct robustness tests. The explanatory variable in the previous part of the paper is industrial structure upgrading (Stru). Replacement of the explanatory variables intends to u j'jse industrial structure advanced and industrial structure rationalization for the study respectively.

$$RIS_{it} = \beta_0 + \beta_1 NQ_{it} + \beta_2 \sum \ln controls + \mu_i + \lambda_t + \varepsilon_{it} \quad (5)$$

$$ISS_{it} = \beta_0 + \beta_1 NQ_{it} + \beta_2 \sum \ln controls + \mu_i + \lambda_t + \varepsilon_{it} \quad (6)$$

4.4 DID Test Model

Taking the introduction of the 14th Five-Year Plan for the Digital Economy as an exogenous shock, based on the strength of the policy text: if the frequency of keywords related to "new quality productivity" or "industrial intelligence" in the provincial plan exceeds the median, it is recorded as 1; the others are recorded as 0. The impact on the industrial structure before and after the implementation of the policy is examined. The impact on industrial structure before and after the implementation of the policy is studied.

$$Stru_{it} = \beta_0 + \beta_1 Treat_i + \beta_2 Post_t + \beta_3 (Treat_i \times Post_t) + \beta_4 NQ_{it} + \gamma Controls_{it} + u_i + \lambda_t + \varepsilon_{it} \quad (7)$$

5. Empirical Component

5.1 Benchmark Regression Results

Based on the benchmark model constructed earlier, stata 18 software was used to analyze the mechanism of the new quality productivity level on industrial structure upgrading, and the results are shown in Table 1:

Table 1 demonstrates the results of the basic regression analysis of the impact of new quality productivity on industrial structure upgrading. As can be observed from the first column of Table 2, the coefficient of new quality productivity is 0.539, a result that is statistically significant ($p<0.01$), which initially confirms the positive association between new quality productivity and industrial structure upgrading. In further analysis, when controlling for individual effects, time effects, and a range of control variables, as shown in the third column of Table 1, the coefficient of new-quality productivity is adjusted to 0.391, a result that remains significant at the 5% significance level. This further emphasizes that the direct effect of new quality productivity on industrial structure upgrading is statistically robust. H1 of this study is verified.

Table 1. Benchmark Regression Results

	(1)	(2)	(3)
	Stru	Stru	Stru
NQ	0.539***	0.878***	0.391*
	(3.58)	(4.46)	(2.40)
ln_gdp		0.0686	0.106***
		(1.92)	(5.92)
ln_CC		0.0100	0.0681
		(0.47)	(1.95)
ln_LM		-0.211***	0.212**
		(-6.20)	(2.75)
FL		-0.332	-0.195
		(-1.04)	(-1.94)
_cons	0.519***	1.275***	-2.778***
	(18.04)	(4.84)	(-4.34)
N	372	372	372

t statistics in parentheses
$^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$

5.2 The Results of the Mediation Effect

Based on the above, the level of digital economy is chosen as a mediating variable to explore the role played by technological innovation in the mechanism of the influence of new quality productivity on industrial structure upgrading, and the mediating effect model is constructed to carry out the empirical test, and the results are shown in Table 2:

In this section, structural equation modeling (SEM) was used to analyze the data in depth to explore the impact of new quality productivity (NQ) on industrial structure upgrading (Stru) and its mechanism of action. The results of the analysis show that industrial structure upgrading (Stru) acts as the dependent variable and the mediating variable DL has a significant effect. In the first equation, the impact coefficient of DL on Stru is 1.393414 and statistically significant (P=0.000), indicating that DL has a significant positive impact on Stru. Meanwhile, the impact coefficient of NQ on Stru is -1.372715 and equally significant (P=0.000), indicating that NQ has a significant negative impact on Stru. The constant term (_cons) is 0.5092167 and significant, indicating that the baseline level of Stru is statistically significant after controlling for the effects of DL and NQ. The second equation shows that the coefficient of the effect of NQ on DL is 1.3721 and significant (p=0.000), indicating that there is a significant positive effect of NQ on DL.

Table 2. Mediated Effects Test

	(1)
Stru	
DL	1.393 ***
	(18.15)
NQ	-1.373 ***
	(-9.14)
_cons	0.509 ***
	(24.88)
DL	
NQ	1.372 ***
	(18.15)
_cons	0.00700
	(0.49)
/	
var(e.Stru)	0.0326 ***
	(13.06)
var(e.DL)	0.0162 ***
	(13.06)
N	372

t statistics in parentheses
$^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$

5.3 Heterogeneity Test

In order to further test the heterogeneity of the impact of new quality productivity on industrial structure upgrading, this paper conducts a heterogeneity analysis. In order to study whether there are regional differences in the impact of new quality productivity on industrial structure upgrading, the 31 provinces are divided into three sub-samples of the eastern region, the western region and the central region to carry out regional heterogeneity test to explore the impact of new quality productivity on the upgrading of industrial structure, and the results are shown in Table 3:

The eastern region includes 11 provinces: Beijing, Tianjin, Hebei, Liaoning, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong and Hainan; the central region includes 10 provinces: Shanxi, Inner Mongolia, Jilin, Heilongjiang, Anhui, Jiangxi, Henan, Hubei, Hunan and Guangxi; and the western region includes 10 provinces: Chongqing, Sichuan, Guizhou, Yunnan, Shaanxi, Gansu, Qinghai, Ningxia, Xizang and Xinjiang.

According to the regional heterogeneity regression results in Table 4, the impact of new quality productivity on industrial structure upgrading in the eastern, central and western regions shows significant differences. In the regression analysis, the coefficients of the new quality productivity measurements in the eastern and central regions are 0.258 and 0.688 respectively, neither of which reaches statistical significance, while the coefficient in the western region is 0.815 and is significant at the 5% significance level. This indicates that the new quality productivity in the western region has a strong positive relationship with the variables in the model and this relationship is statistically significant.This may also mean that the western region has made significant progress in some of the key drivers of new quality productivity, such as technological innovation and industrial upgrading.

Table 3. Heterogeneity Regression Results

	(1)	(2)	(3)
	Stru	Stru	Stru
NQ	0.258	0.688	0.815**
	(0.98)	(1.62)	(4.07)

ln_gdp	0.236*	0.0361	-0.0276
	(2.92)	(0.39)	(-0.51)
ln_CC	0.0328	0.0800	0.0791
	(0.71)	(0.97)	(1.18)
ln_LM	0.492	-0.476	0.0532
	(1.07)	(-1.06)	(0.29)
FL	0.753	-0.232	-0.137***
	(1.71)	(-0.31)	(-5.80)
_cons	-5.946	2.945	-0.420
	(-2.00)	(0.81)	(-0.32)
N	132	120	120

t statistics in parentheses
$^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$

5.4 Robustness Check

This paper plans to use replacement of explanatory variables for robustness testing. The explanatory variable in the previous part of the paper is industrial structure upgrading (Stru). Replacement of explanatory variables is intended to be studied using industrial structure advanced and industrial structure rationalization respectively. And the results are shown in Table 4:

In the robustness regression analysis in Table 5 of this paper, we observe that the effect of new quality productivity (NQ) on the rationalization of industrial structure (RIS) and industrial structure sophistication (ISS) shows significant heterogeneity. In model (1), the coefficient of NQ is -0.240 and significant at 1% significance level ($p<0.01$), which suggests a negative correlation between the increase of new quality productivity and industrial structure rationalization. This finding may reflect the fact that in the early stage of the development of new quality productivity, resources may tend to flow more to the more efficient industries rather than being allocated equally, resulting in the process of industrial structure rationalization being hindered. On the contrary, in model (2), the coefficient of NQ is 1.467 and is significant at the 5% significance level ($p<0.05$), showing that NQ productivity has a positive effect on the advanced industrial structure. This may imply that with the further development of NQ productivity, it plays a positive role in promoting the optimization and upgrading of industrial structure, especially in terms of increasing the value added of industries and promoting technological innovation.

Table 4. Robustness Regression Results

	(1)	(2)
	RIS	ISS
NQ	-0.240***	1.467**
	(-3.40)	(3.13)
ln_gdp	-0.0985***	0.453***
	(-12.73)	(8.84)
ln_CC	-0.00799	0.198*
	(-0.53)	(1.97)
ln_LM	0.148***	0.321
	(4.42)	(1.45)
FL	0.00573	-0.536
	(0.13)	(-1.86)
_cons	0.132	-7.733***
	(0.48)	(-4.20)
N	372	372

t statistics in parentheses
$^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$

5.5 PSM-DID Regression Test Results

In order to identify the causal effect of new quality productivity empowering industrial structure upgrading, this study constructs a quasi -natural experiment with the introduction of the 14th Five-Year Plan for Digital Economy as an exogenous policy shock. According to the frequency of keywords such as "new quality productivity" and "industrial intelligence" in the provincial planning text (over the median is assigned a value of 1, otherwise it is 0), the treatment and control groups are divided, and a double difference model (DID) is set up. At the same time, propensity score matching (PSM) was used to pre-match the samples to eliminate the differences in initial regional characteristics (e.g., GDP, carbon emissions, etc.) and to ensure that the treatment and control groups meet the assumption of parallel trends.and the results are shown in Table 5:

Table 5. PSM-DID Regression Test Results

variant	sample	W	E	M
DID				
Treat×Post	0.138*	0.251***	0.087	0.095
	(1.96)	(3.78)	(0.91)	(1.12)
Treat×Post×NQ	0.215***	0.308***	0.112*	0.124
	(3.45)	(4.22)	(1.85)	(1.63)
Rixed effect				
Province fixed effects	be	be	be	be
Year fixed effects	be	be	be	be

sample size	372	142	120	120
R^2	0.682	0.721	0.645	0.659

This regression utilizes a double-differencing approach to analyze policy effects by subregion. The core term Treat×Post has a coefficient of 0.138 in the full sample, indicating that the treatment group is on average 13.8 percent more effective than the control group after the implementation of the policy and is significant at the 10 percent level; the coefficient of 0.251 is significant at the 1 percent level in the western region, indicating that the effect of the policy is significant; and the coefficients of 0.251 are not significant in the eastern and central regions. The interaction term Treat×Post×NQ has a coefficient of 0.215 in the full sample, indicating that NQ can significantly enhance the policy effect, and this effect is stronger in the western region. The control variables NQ and ln_gdp are positively significant in all regions, while ln_CC and FL are negatively significant in some regions. Generally speaking, the effect of the policy is prominent and regulated by NQ in the west, while the effect is not significant in the east and the center.

6. Findings

This study constructs a comprehensive coefficient of industrial structure based on China's provincial panel data from 2012 to 2023, and empirically examines the impact of new quality productivity on industrial structure from the perspectives of "sophistication" and "rationalization", especially from the perspective of carbon emission constraints. The study also empirically examines the impact of new quality productivity on industrial structure, especially under the perspective of carbon emission constraints. The results show that new productivity can effectively promote the upgrading of regional industrial structure, but carbon emission has a negative moderating effect on the industrial upgrading effect of digital technology level to a certain extent. Under the background of high carbon emissions, the driving effect of new quality productivity will be inhibited, resulting in its effect on industrial structure optimization being less significant than expected. In addition, the effect of new quality productivity on industrial upgrading shows obvious regional differences. The following are the main conclusions of this study:

Positive correlation between NPPs and industrial structure upgrading: The study finds a significant positive correlation between the development of NPPs and industrial structure upgrading. This indicates that the improvement of new productivity is not only positively associated with industrial structure upgrading, but also that this relationship remains significant after controlling for other relevant factors, providing strong evidence for the role of new productivity in promoting low-carbon industrial structure upgrading. Negative moderating effect of carbon emissions: the study also finds that under the background of high carbon emissions, the level of digital technology promotes industrial structure upgrading significantly, which is in line with the research hypothesis 2. Regional variability: the impact of carbon emissions on the level of digital technology and industrial upgrading shows obvious regional variability. There is a significant positive correlation between new quality productivity and industrial structure upgrading in the western region, while the eastern and central regions do not reach statistical significance, which may reflect the different characteristics and potentials of different regions in the development of new quality productivity and industrial structure upgrading. In order to verify the robustness of the research results, this paper adopts the method of replacing the explanatory variables for the test. The results show that the impact of new quality productivity on the rationalization of industrial structure (RIS) and industrial structure sophistication (ISS) exhibits significant heterogeneity. There is a negative correlation between the increase of new quality productivity and industrial structure rationalization, while it has a positive impact on industrial structure sophistication. This suggests that at different stages of economic development, the impact of new quality productivity on industrial structure may be different, and initially it may be more inclined to flow to more efficient industries rather than being evenly distributed, while as it develops, it positively promotes the optimization and upgrading of industrial structure.The PSM-DID test confirms that the 14th Five-Year Plan for the Digital Economy significantly improves the level of industrial structure upgrading in the west (Treat×Post=0.251), and new quality productivity can strengthen the effect (interaction term 0.308). In the context of digital policy,new quality productivity significantly drives industrial structure upgrading through

technological innovation and factor reorganization, but high carbon emission will weaken its positive effect.

Policy Recommendations

In order to effectively promote the development of new and high-quality productivity and optimize and upgrade the industrial structure, the Government should start with top-level design and formulate a comprehensive medium- and long-term development plan to ensure policy coherence and stability. This includes the implementation of targeted fiscal policies, especially support for strategic emerging and future industries, and the use of green and digital financial tools to provide financial support for new and quality productivity. At the same time, institutional innovation is key, and there is a need to improve incentives for innovation, strengthen intellectual property protection and optimize market access rules in order to create a policy environment conducive to innovation. Through the dual regulation of the market and the Government, it is possible to optimize the allocation of resources and guide the flow of key factors, such as labour, data, capital and technology, to the area of new and qualitative productivity, stimulating its potential to enhance carbon emission efficiency.

In terms of industrial structure, emphasis should be placed on promoting intelligent manufacturing and green production technologies, facilitating the transformation of the industrial structure from labor- and resource-intensive to technology- and knowledge-intensive, increasing the proportion of clean energy used, and upgrading the efficiency of carbon emissions through technological innovation and industrial restructuring. Intelligent and digital transformation of traditional industries should be carried out to improve their efficiency and environmental friendliness, and industrial layout should be rationally planned to develop circular economy parks and industrial agglomerations, and to promote the efficient flow of elements upstream and downstream of the industrial chain and the rational use of resources.

Taking into account regional differences, policies should adopt a differentiated strategy. The western region should strengthen support for technological innovation and industrial upgrading, and unleash the potential of new quality productive forces through fiscal incentives and tax concessions. Eastern and central regions, on the other hand, should focus on optimizing and upgrading their industrial structures, optimizing resource allocation, and promoting the development of industrial clusters. All regions need to incentivize innovation by increasing the proportion of clean energy use, enhancing carbon emission efficiency, strengthening intellectual property protection, and simplifying market access rules. Strengthening inter-regional cooperation and resource sharing, especially technology transfer and industrial collaboration from eastern regions to central and western regions, will play an important role in promoting coordinated regional development and the overall enhancement of new quality productivity. Together, these measures will promote high-quality economic development and sustainability.

References

[1] Hongduo Liu, Jinyan Wu, Xuan Wu, et al. Local-led industrial policy innovation enables the emergence of new quality productivity: a research perspective based on the "chain leader system" of the industrial chain. Xinjiang Social Science, 2024, (03): 53- 67. DOI: 10.20003/j.cnki.xjshkx.2024.03.006.

[2] Wanli Zhao, Linchun Quan. The Value Implications, Internal Logic and Practical Direction of Enabling High-Quality Development by New-Quality Productivity. Modern Communication, 2024, (12):57-65+123.

[3] Xiaodong Chen. Accelerating the construction of modernized industrial system with new quality productivity. Struggle,2024, (22): 12-13. DOI:10.16634/j.cnki.cn23-1001/d.2024.22.002.

[4] Yuxin Ren, Yan Wu, Zhe Wu. Financial agglomeration, industry-university-research cooperation and new quality productivity. Financial Theory and Practice,2024,45(03):27-34. DOI: 10.16339/j.cnki.hdxbcjb.2024.03.004.

[5] Wenhui Zhou, Yijun Wang, Lijia Chen. Research on the driving mode of regional new quality productivity empowered by digital economy under the group perspective. Journal of Yunnan University of Finance and Economics,2025,41(01):69-79. DOI: 10.16537/j.cnki.jynufe.001000.

[6] Xueping Wu, Zhongying Zhang. Research on the impact of digital economy development on industrial structure upgrading in Anhui Province. Finance Theory and Teaching,2024,42(06): 77-86. DOI: 10.13298/j.cnki.ftat.2024.06.012.
[7] Yuanyin Pang. The realization path of digital economy empowering new quality productivity development in the new era. Times Economy and Trade,2024,21(12): 21-23. DOI: 10.19463/j.cnki.sdjm.2024.12.001.
[8] Wenshi Luo, Jinghao Lu. Research on the Impact of Digital Economy on Regional Industrial Structure Upgrading - Based on Empirical Evidence from 288 Prefecture-level Cities in China. China Business Journal,2024,33(23): 29-32. DOI: 10.19699/j.cnki.issn2096-0298.2024.23.029.
[9] Japeng Chen, Dandan Liu, Aiting Xu. Does Industrial Structure Upgrading Reduce Carbon Emission Intensity? --An Examination Based on Green Tax Perspective. China Environmental Management,2024,16(04): 80-90. DOI: 10.16868/j.cnki.1674-6252.2024.04.080.
[10]Chenlu Zhang, Fan Zhang. Impact of new quality productivity and industrial structure upgrading on carbon emissions--an empirical study based on panel data of the Yangtze River Economic Belt. Journal of Changjiang University (Social Science Edition),2024,47(04):59-67.
[11]Manfeng Liu, Sijia Cheng. Has carbon emissions trading promoted the optimization and upgrading of regional industrial structure? Management Review,2022,34(07):33-46. 11-5057/f.2022.07.015.
[12]Jing Zhang, Jun Shen, Meng Xu. Does Carbon Emission Trading Promote Industrial Structure Transformation and Upgrading? --Empirical Evidence from China's Carbon Emissions Trading Pilot Policy. Economic Issues,2023(08):84-91. 2023.08.010.
[13]Jingbing Sun, Zhenyang Gu. Will Carbon Emission Trading Mechanism Force Industrial Structure Transformation and Upgrading? --Based on the perspective of synergistic agglomeration of manufacturing and productive service industries. Ecological Economy,2023,39(05):59-68.
[14]RongshengCai , Chuanyang Liu. CarbonLow, Technological Progress and Industrial Structure Upgrading: An Empirical Analysis Based on VEC Model and Impulse Response Function. Financial Research,2012(06):33-36. 2012.06.009.
[15]Ziyuan Lv. The impact of digital economy on industrial structure upgrading--with carbon emission as the mediating variable . Research on Business Economics,2023(14):98-102.
[16]Y Wang, L Li. Digital economy, industrial structure upgrading, and residents' consumption: Empirical evidence from prefecture-level cities in China. International Review of Economics & Finance, 2024, 92: 1045-1058. Sui B, Sharma S S, Yao L Y, et al. Does aging affect renewable energy? the role of extreme events and economic development. Energy Economics, 2024, 133: 107491.
[17]X Xing, A Ye. Consumption Upgrading and Industrial Structural Change: A General Equilibrium Analysis and Empirical Test with Low-Carbon Green Transition Constraints. SUSTAINABILITY, 2022, 14(20): 13645. DOI:10.3390/su142013645.
[18]K Tang, Y Wang, H Wang. The impact of innovation capability on green development in China's urban agglomerations. Technological Forecasting and Social Change, 2024, 200: 123128.
[19]H J Wang, M Q Zheng, H T Yin, et al. Green innovation, industrial structure and urban eco-efficiency in Chinese cities. Economic Analysis and Policy, 2024, 82: 1011-1024.
[20]M Tao, Poletti S, Wen L, et al. Modelling the role of industrial structure adjustment on China's energy efficiency: Insights from technology innovation. Journal of Cleaner Production, 2024, 441: 140861.
[21]X Liu, C Qin, B Liu, et al. The economic and environmental dividends of the digital development strategy: evidence from Chinese cities. Journal of Cleaner Production, 2024, 440: 140398.
[22]M Zhong, Umar M, Mirza N, et al. Mineral resource Optimization: the Nexus of sustainability, digital transformation, and green finance in OECD economies. Resources Policy, 2024, 90: 104829.
[23]Y Feng, Y Gao, X Xia, et al. Identifying the path choice of digital economy to crack the “resource curse” in China from the perspective of configuration. RESOURCES

POLICY, 2024, 91: 104912. DOI: 10.1016/j.resourpol.2024.104912.

[24]Huaping Sun; Tingting Chen, Christoph Nedopil Wang. Spatial impact of digital finance on carbon productivity. Geoscience Frontiers, 2024, 15(3): 101674.

[25]Vaithilingam S, Ong C S, Moisescu O I, et al. Robustness checks in PLS-SEM: A review of recent practices and recommendations for future applications in business research. Journal of Business Research, 2024, 173: 114465.

[26]Hang Yuan, Chengliang Zhu. Have national high-tech zones promoted the transformation and upgrading of China's industrial structure. China Industrial Economy,2018, (08):60-77. DOI: 10.19581/j.cnki.ciejournal.2018.08.004.