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Study on the Digital Economy Affects Carbon Emissions - Mediating Effects Based on Industrial Structure Upgrading

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Abstract: *Reaching peak carbon emissions and achieving carbon neutrality will mean a broad and profound systemic transformation, which requires the concerted efforts of the whole society. The digital economy, emerging as a driving force for premium economic progress, is poised to play a crucial role in realizing carbon neutrality objectives. Utilizing panel data from provinces spanning 2010 to 2020, this study conducts an empirical investigation into how the digital economy facilitates the enhancement of industrial structures and contributes to reducing emissions, using a mediation effect model. The study also explores how the digital economy's influence on carbon emissions differs between the eastern and central-western regions. The findings reveal a significant influence of the digital economy on carbon emissions, where the evolution of industrial structures acts as a key intermediate mechanism in the digital economy's carbon emission effects. Importantly, the effect of the digital economy on carbon emissions is more significant in the central and western areas compared to the eastern regions. Consequently, the paper proposes these recommendations: (1) Accelerate the establishment of digital economy infrastructure while advancing the development and utilization of digital technologies;(2) Vigorously foster the upgrading of industrial structure and optimise industrial layout, and gradually eliminate highly polluting and low value-added enterprises; (3) It is advisable for the central and western regions to persist in amplifying their investments in the digital economy, and the eastern regions should carry out technological co-operation and knowledge transfer with the central and western regions.*

Keywords: *Digital economy; Carbon emissions; Industrial structural upgrading; Mediating Effects*

1. Introduction

In addressing the global climate crisis, China has set forth the ambitious '30/60' goal — reaching carbon peak by 2030 and achieving carbon neutrality by 2060. This commitment is underpinned by robust policies and measures, signifying not just a response to global environmental imperatives but also a strategic move towards China's green and sustainable evolution. Cutting down on carbon emissions is essential for lessening the negative impacts of climate change, protecting ecosystems, and improving the quality of life for residents. It also aligns with the collective responsibility inherent in global climate governance. While striving for carbon peaking and neutrality presents challenges to China's rapid economic progression, it concurrently opens avenues for transforming the industrial landscape, fostering a green economy, and catalyzing scientific and technological advancements. In this paradigm, low-carbon living and green development form the cornerstone of China's high-quality economic trajectory. China's pursuit of these dual-carbon targets must navigate substantial economic growth demands and the energy-intensive nature of its industry-centric structure. Here, the digital economy emerges as a vital, innovative force. By optimizing resource allocation and enhancing energy efficiency, the digital economy not only drives high-quality economic growth but also contributes to carbon emission reduction. Characterized by its effective integration, scalability, and network effects, the digital economy facilitates greener, more sustainable growth. It does so by reconfiguring factor allocation, transforming economic structures, and redefining industrial ecology. Leveraging technologies like big data and the internet, the digital economy can significantly diminish carbon intensity while fostering economic expansion. Furthermore, the digital economy is instrumental in industrial structure upgrading, a key determinant of a nation's energy consumption pattern and efficiency. This impact is profound on carbon emissions. Driven by digitalization, the shift towards an upgraded industrial framework paves the way for a more low-carbon economic model, thereby aiding China in meeting its dual-carbon objectives.

Currently, studies mainly focus on the linkages among digital economy, industrial structure upgrading and carbon dioxide emissions involved with the following areas: First, exploring the impact of digital economy on carbon emissions. Chen Xin et al. (2023) conducted an empirical study on the relationship between digital economy and regional carbon emissions by using panel data of 30 provinces in China from 2007 to 2017, and concluded that the digital economy and carbon dioxide emissions show an inverted "U" shape relationship. [1] Du Xin (2023) found that the digital economy has an obvious effect on carbon emissions, and there is a cross-border emission reduction effect, which reduces the level of carbon emissions in the region through a circular feedback mechanism. [2]Next, the study delves into the effects of the digital economy on industrial structures. In their 2023 research, Liu Jiaqi and colleagues observed that the digital economy is instrumental in enhancing the configuration of China's three major industries. Additionally, it encourages the evolution of the manufacturing industry towards sectors that are more focused on capital and advanced technology, as well as the evolution of the service sector into a more productive service industry. [3] Zuo Pengfei and colleagues (2020) posited that the merging of digital technology with conventional industries has begun to reveal the digital economy's enhancing impact on industrial structure. [4]In their 2021 research, Bai Xuejie and team examined the effect of the digital economy on the evolution of industrial structure, particularly from the perspective of technology progress focused on efficiency. Their findings indicated that the growth of the digital economy indeed facilitates the transformation of the industrial structure.[5] Additionally, the third aspect investigates how upgrading the industrial structure impacts carbon dioxide emissions. Liu Zhihua et al. (2023) believed that at the national level, scientific and technological innovation, industrial structure upgrading and carbon emission efficiency did have a strong coordination and could produce a positive effect on each other. [6]Shao and colleagues (2022) discovered that refining the industrial structure contributes to lowering carbon emissions, primarily due to its influence on the pricing of energy supply.[7]

In summary, significant progress has been made by the scholarly community in researching the interplay between the digital economy, carbon emissions, and industrial structure, and put forward a lot of valuable theories and ideas, but there is still room for further research. However, there is still room for further research. Few papers have included the digital economy, industrial structure upgrading and carbon emission in the same research framework to explore the relationship among them. Based on the above researches, this paper builds a mediating effect model, empirically analyses the direct impact of digital economy on carbon emissions, and deeply explores the mediation effect of industrial structure upgrading. Drawing from the study outcomes, the paper suggests practical strategies for the digital economy to facilitate a more logical and sophisticated evolution of industrial structure, thereby decreasing carbon emissions. This offers fresh insights and useful references for the scientifically-informed creation of policies aimed at reducing carbon emissions.

2. Theoretical Mechanisms and Research Hypotheses

2.1 Mechanisms of the Impact of the Development of the Digital Economy on Carbon Dioxide Emissions

The rise of the digital economy, characterized by the growth of big data and cloud computing, has led to the creation of new industrial sectors. Such progress has been vital in promoting energy efficiency and lowering emissions. [8]In an era where reducing carbon dioxide emission intensity is crucial, the digital economy is key in managing both new and existing emission levels. Firstly, the widespread adoption of the internet has diminished information asymmetry, thereby lowering search costs for businesses, enhancing the efficiency of resource and energy utilization, and improving overall economic operation efficiency. This, in turn, facilitates the reduction of carbon emission intensity. Secondly, the digital economy encourages the shift of enterprises towards more capital- and technology-intensive models, which are instrumental in lowering carbon emission intensity — a crucial pathway for emission reduction in the foreseeable future. Thirdly, it fosters a 'dematerialization' trend in production and consumption patterns. The increasing prevalence of online shopping, video conferencing, and cloud-based office operations are transforming traditional lifestyles, contributing to a reduction in carbon dioxide emission intensity. From these analyses, Hypothesis 1 is formulated: The advancement of the digital economy significantly reduces carbon dioxide emissions.

2.2 Mechanisms of the Impact of Digital Economy Development on Industrial Structure Upgrading

Industrial structure upgrading is fundamentally a dynamic process in which high-productivity sectors gradually supplant low-productivity ones as the primary industries. In contemporary industrial frameworks, this generally entails a transition from primary and secondary sectors to the tertiary sector.

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The digital economy aids this progression via channels such as consumer demand, investment needs, capital distribution, and the impact of labor resources. The effect of the digital economy on enhancing industrial structures can be divided into two key routes: digital industrialization and the digitization of industries. Firstly, digital industrialization. This aspect has spawned numerous industries where technological development is the primary driver and digital elements are key production factors, such as the information and communication industry and the internet sector. Progress in digital industrialization has steered industrial structures towards a more technology-intensive and environmentally friendly orientation. Secondly, industrial digitization focuses on merging traditional industries with the internet, embedding digital technology into the production and operational processes of various industries, thereby facilitating the transformation and upgrading of traditional sectors. Following these analyses, Hypothesis 2 is proposed: The advancement of the digital economy has a substantial and positive impact on industrial structure.

2.3 Mechanisms of the Impact of Industrial Structure Upgrading on Carbon Dioxide Emissions

First, there is a significant difference in energy consumption across various industries. The secondary sector frequently encompasses industries characterized by high energy usage and significant pollution. Industries within the secondary sector are often characterized by high energy usage and elevated levels of pollution. Transforming the industrial structure to favor the service sector can lead to a shift towards more energy-efficient practices. Additionally, this structural upgrade facilitates technological innovation. This advancement facilitates the creation of advanced low-carbon technologies, contributing to the decrease in carbon dioxide emissions. Moreover, it fosters the creation and widespread adoption of low-carbon energy sources, addressing carbon emissions at their origin. Lastly, it aids in refining the energy consumption pattern, endorsing the use of clean energy sources, which further decreases carbon dioxide emissions. This interconnection has been empirically validated by numerous researchers. In 2014, Li Ke employed a dynamic panel smooth transition model to investigate the relationship between China's industrial structure and its carbon emissions, finding that advancing a more sophisticated industrial structure serves as an efficient strategy for carbon reduction.[9] In the same year, Wang Wenju and Xiang Qifeng, drawing from input-output theory, developed a dynamic input-output model for adjusting industrial structures. Their research indicated that adjustments in industrial structure alone could lead to a reduction in carbon emissions ranging from 39.317 to 56.3893 billion tons by 2020.[10] From the preceding analysis, we propose Hypothesis 3: The upgrading of the industrial structure markedly curbs carbon dioxide emissions. Furthermore, Hypothesis 4 posits that the upgrading of the industrial structure acts as a mediator between the digital economy and carbon dioxide emissions.

3. Model Construction

3.1 Benchmark Regression Model

In order to verify the impact of digital economy on carbon emission intensity, the following benchmark regression model is constructed:

$$CE_{it} = \alpha_0 + \alpha_1 DA_{it} + \alpha_2 X_{it} + \mu_t + \varepsilon_{it} \tag{1}$$

Explanation: The explanatory variable is the carbon dioxide emission intensity of province i in year t; the core explanatory variable DAit is the digital economy development index of province i in year t. The control variables Xit are population level (lnpop), foreign direct investment (fdi), urbanisation rate (urban) and energy intensity (ee). The item of α0 is a constant term, and μ_t is a time fixed effect and ε_{it} is a random error term.

3.2 Mediating Effects Model

According to the above analyses, the digital economy can achieve carbon dioxide emission reduction through industrial structure upgrading. This paper adopts the stepwise regression method to empirically test the mediation effect model. The model is constructed as follows:

$$IS_{it} = \beta_0 + \beta_1 DA_{it} + \beta_2 X_{it} + \mu_t + \varepsilon_{it} \tag{2}$$

$$CE_{it} = \gamma_0 + \gamma_1 DA_{it} + \gamma_2 IS + \gamma_3 X_{it} + \mu_t + \varepsilon_{it} \tag{3}$$

The process for testing the mediation effect in this study follows these steps: Initially, we conduct the baseline regression using equation (1). If α1 is significantly negative, this confirms the digital economy's significant impact on reducing carbon emissions. Next, equation (2) assesses the digital economy's effect on intermediary variables. If β1 is significant, we proceed to the final step. Lastly, equation (3) examines the carbon emission reduction effect of the intermediary variables, determining whether the mediation is partial or complete based on the significance of γ1 and γ3.

3.3 Variable Selection

3.3.1 Explanatory Variables

Carbon dioxide emission intensity (CE_{it}) is used as the explanatory variable in this study, and carbon dioxide emissions per 10,000 Yuan of GDP are used to measure it.

3.3.2 Core explanatory variables

Digital economy development index (DA_{it}) is regarded as the core explanatory variables in this paper. Owing to the facts that the previous studies used the Internet users, Internet penetration rate and other single indicators which could not completely reflect the level of development of the digital economy, this study refers to Zhao Tao et al. (2020) and combines the availability of data [11], from the perspective of Internet penetration rate, mobile phone penetration, the number of Internet-related employees, Internet-related output, inclusive financial index these five aspects to choose five indicators, constructing the evaluation system of the digital economy development index, entropy method to calculate the development level of digital economy in 32 Provinces of Chinese Mainland from 2010 to 2020. For detailed indicator information, see Table 1.

Table 1: Construction of indicators for the digital economy development index

<table>
<tr><th>First-level Indicator</th><th>Second-level Indicator</th><th>Third-level Indicator</th><th>Direction</th></tr>
<tr><td rowspan="5">Comprehensive Development Index for the Digital Economy</td><td>Internet Penetration Rate</td><td>Internet users per 100 people</td><td>+</td></tr>
<tr><td>Number of Internet-related Employees</td><td>Percentage of employees in computer services and software industry</td><td>+</td></tr>
<tr><td>Internet-related Output</td><td>Total telecommunication services per capita</td><td>+</td></tr>
<tr><td>Number of Mobile Internet Users</td><td>Mobile phone subscribers per 100 people</td><td>+</td></tr>
<tr><td>Digital Financial Inclusion Development</td><td>China digital inclusive finance index</td><td>+</td></tr>
</table>

3.3.3 Mediating Variables

The mediating variable in this paper is upgrading Industrial Structure (IS), which is measured by the proportion of value added of the tertiary industry to that of the secondary industry.

3.3.4 Control Variables

The following factors that may have an impact on CO2 emissions were selected as control variables for this study:

Table 2: Descriptive statistics of main variables

variable	N	mean	sd	min	max
ce	330	2.333	1.723	0.340	8.251
da	330	0.166	0.160	0.00100	0.819
urbn	330	0.584	0.125	0.338	0.896
fdi	330	1.968	1.549	0.0100	7.960
lnpop	330	5.467	1.288	2.053	8.275
ee	330	1.697	3.086	0.437	54.74
is	330	1.296	0.719	0.527	5.244

(1) Population Level (lnpop): This metric reflects population density, calculated by dividing a province's year-end population by its administrative area. A rise in population typically escalates energy consumption, subsequently increasing carbon dioxide emissions. (2)Foreign Direct Investment (FDI): This indicator represents the level of foreign investment, quantified by the ratio of foreign direct investment to GDP. Foreign investors often introduce advanced technology to local areas, enhancing resource utilization efficiency, reducing pollution, and decreasing CO2 emissions. (3) Urbanization (urban): Measured by the percentage of the population residing in urban areas. Urbanization generally leads to heightened energy consumption, which in turn elevates carbon emissions. (4) Energy efficiency

(ee), measured by energy intensity, i.e. the lower the energy consumption per unit of GDP, the higher the energy efficiency.

Descriptive statistics for the main variables are shown in Table 2:

3.4 Empirical Analyses

3.4.1 Benchmark Regression Results

This study utilizes panel data from 30 provinces in Chinese Mainland spanning 2010 to 2020 to empirically test the impact of China's digital economy on carbon emissions. The results of the Hausman test, indicating a statistic of 12.25 and a P-value of 0.0315, surpass the 5% significance threshold. This necessitates the adoption of the fixed effect model for our analysis. In the regression model, time fixed effects are controlled for in Column (1), with a gradual addition of control variables from Columns (2) to (5). Baseline regression results are shown in Table 3. The baseline regression results reveal that the primary explanatory variable 'da' consistently exhibits a significantly negative coefficient, affirmed at the 1% significance level. This underscores the substantial role of digital economy growth in lowering carbon dioxide emission intensity, thus supporting Hypothesis 1. This complements the objective of attaining high-quality economic growth. The advancement of the digital economy is instrumental not only in refining the economic structure and altering growth dynamics but also significantly contributes to the reduction of carbon dioxide emissions, thereby lessening the ecological footprint of economic development. The digital economy, by driving technological innovations and optimizing resource allocation, plays a pivotal role in curbing carbon emissions. Innovations in the realm of big data and the Internet of Things (IoT) enable real-time monitoring of production, distribution, and supply chain alterations, thereby enhancing the efficiency of resource use and curtailing carbon emissions. Moreover, the digital economy promotes the 'dematerialization' of production and consumption patterns, exemplified by online services and virtual products, which lower the need for producing and transporting material goods and further diminish carbon emissions.

The regression outcomes in Column 5 provide an in-depth analysis of the control variables: Initially, a substantial positive link is observed with the rate of urbanization, signifying an escalation in carbon emissions correlated with increased energy consumption and production scale amid swift urbanization.[12] Additionally, the population density variable (lnpop) is observed to significantly diminish the intensity of carbon dioxide emissions，[13]; the benefits of shared facilities and energy savings from population agglomeration outweigh the emissions from production scale expansion. Lastly, energy intensity (ee) notably contributes to carbon dioxide emissions, likely linked to China's reliance on less-clean energy sources. The extensive dependence on non-renewable energy sources significantly exacerbates carbon dioxide emissions.

Table 3: Benchmark regression results

	(1) ce	(2) ce	(3) ce	(4) ce	(5) ce
da	-2.3693*** (-5.9229)	- 1.6246*** (-3.9149)	- 1.6741*** (-4.0226)	- 1.0701*** (-2.9017)	- 1.0528*** (-2.8569)
urban		-3.1909*** (-8.0303)	0.0708 (0.1129)	1.9381*** (3.0140)	1.9463*** (3.0342)
fdi			-0.4410*** (-6.0285)	-0.2464*** (-3.8664)	-0.2473*** (-3.8980)
lnpop				-0.5725*** (-6.8403)	-0.5794*** (-6.9413)
ee					0.0286*** (2.7617)
cons _	3.2202*** (10.9288)	4.8167*** (13.7207)	4.1823*** (12.6652)	5.8117*** (15.1604)	5.7990*** (15.1849)
Year fe	Yes	Yes	Yes	Yes	Yes
N	330	330	330	330	330
r2_a	0.0579	0.1000	0.2024	0.3061	0.3066

t statistics in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

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3.4.2 Mediating Effects

This study investigates the intermediary function of industrial structure upgrading (IS) in the nexus between the digital economy development index (DE) and carbon dioxide emission intensity (CE). Next, we will analyze the results presented in Table 4. Empirical findings, as presented in Column 1, indicate that the digital economy development index significantly fosters industrial structure upgrading. The outcomes in Column 2 affirm this notable promotion with a 1% level of significance, thus corroborating Hypothesis 2. Additionally, the findings in Column 3 indicate that the upgrading of industrial structure significantly curbs carbon dioxide emissions, confirmed at the 5% significance level, thus confirming Hypothesis 3. It's noteworthy that the regression coefficient's absolute value for the digital economy in Column 3 is 0.3896, less than that in Column 1 (1.0528). This implies a reduced suppressive impact of the digital economy on carbon emissions following the inclusion of the industrial structure index in the regression analysis. The mediating effect, calculated as β1y2/a1, reveals that industrial structure upgrading accounts for a 63% mediating effect in the process of digital economy suppressing carbon emissions. In essence, industrial structure upgrading serves as a 63% intermediary in this process, thereby verifying Hypothesis 4.

To ensure the robustness of these findings, a Sobel test was conducted. The Goodman-1 test confirms the validity of the mediating effect, demonstrating significance at the 10% level. The mediating impact accounts for 63% of the overall effect, surpassing the direct effect by 170%, with the total effect being 270% of the direct impact. This further substantiates the validation of Hypothesis 4. Thus, it becomes clear that the digital economy has the potential to lessen carbon dioxide emission intensity via the avenue of enhancing the industrial structure.

Table 4: Results of the three-step regression

	(1) ce	(2) is	(3) ce
da	- 1.0528***	2.2276***	-0.3896
is			-0.2977**
			(-2.2919)
cons _	5.7990*** (15.1849)	-0.1012 (-0.5482)	5.7689*** (14.9347)
Year fe	Yes	Yes	Yes
Control	Yes	Yes	Yes
N	330	330	330
r2_a	0.3066	0.5138	0.3119

t statistics in parentheses
*$p < 0.1$, ** $p < 0.05$, ***$p < 0.01$

3.4.3 Heterogeneity Analysis

The foundational regression findings suggest that the growth of the digital economy typically assists in lowering the intensity of carbon dioxide emissions. However, the question arises: is this CO2 reduction effect uniformly effective across different regions? In response, this study performs a sub-regional regression analysis, as elaborated in Table 5. This analysis indicates that the coefficient in Column (1) lacks significance, whereas the coefficient in Column (2) is significant. This empirical evidence suggests that the carbon emission reduction impact of the digital economy is more beneficial for the central and western regions. These regions are characterized by ongoing industrial structure upgrading and restructuring, unlike the eastern region, which boasts a more mature economic development and industrial structure. In the central and western regions, the digital economy provides essential technological support for improving the industrial structure. This contributes to more efficient resource allocation and, as a result, more effectively reduces carbon emissions. When comparing carbon dioxide emission intensities, it's evident that the eastern region has a notably lower emission intensity. In contrast, the central and western regions demonstrate a significant dependence on traditional energy sources and display lower energy utilization efficiency. The digital economy offers a pathway for transforming the energy structure in these regions, which can lead to more effective carbon emission reductions. To summarize, the central and western regions, which are marked by their less advanced economic development and greater dependence on conventional energy sources, the digital economy presents more

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substantial opportunities for altering the existing industrial and energy structures, thus aiding in carbon emission reduction. As a consequence, the impact of the digital economy on reducing carbon emissions is less pronounced in the central and western regions compared to the eastern region.

Table 5: Heterogeneity analysis

	Eastern Regions ce	Central and Western Regions ce
da	-0.1565 (-0.7181)	-2.0187** (-2.5173)
urbn	-4.0149*** (-2.8776)	7.7230*** (3.5890)
fdi	0.1442*** (3.3657)	-0.8410*** (-5.9691)
lnpop	-0.0301 (-0.1457)	-0.1307 (-0.8922)
ee	0.0246*** (3.5875)	0.1801 (1.1747)
_cons	4.2319*** (6.5735)	1.9685 (1.5591)
Year fe	Yes	Yes
N	132	198
r2_a	0.3620	0.3112

t statistics in parentheses * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

3.4.4 Robustness Test

This paper conducts a robustness test, with the results presented in Table 6. Initially, the problem of endogeneity, stemming from the possibility of bidirectional causality, is taken into account.While the digital economy can influence carbon intensity, countries with high carbon emissions might also expedite their industrial digital upgrading in response to the dual-carbon targets, indicating possible two-way causality. In response to this issue, the primary explanatory variables are delayed by one period in the analysis of endogeneity. The empirical results presented in Column 1 demonstrate that the regression outcomes remain significant even after this adjustment, thus affirming the robustness of these findings.

Secondly, the distinct economic scales and development foundations of Guangdong and Jiangsu are acknowledged. These provinces, as extreme examples, may substantially influence the empirical results. Following prior research protocols, this paper excludes Guangdong and Jiangsu from the sample set. The regression outcomes post-exclusion align closely with the initial results, suggesting that the empirical findings are robust, even when the extreme provincial samples are omitted.

Table 6: Robustness Test

	Lagged by one period ce	Guangdong and Jiangsu excluding ce
L.da	- 1.1197*** (-3.0334)	
da		- 1.2740*** (-3.2083)
urban	2.1450*** (3.1770)	2.4492*** (3.6133)
fdi	-0.2436*** (-3.7796)	-0.2769*** (-4.1791)
lnpop	-0.5887*** (-6.6304)	-0.5379*** (-6.3587)
ee	0.0245*** (2.9629)	0.0299** (2.5904)
_cons	5.5231*** (13.9317)	5.4678*** (13.6325)
Year fe	Yes	Yes
N	300	308
r2_a	0.2963	0.2930

t statistics in parentheses

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* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

4. Conclusions and Implications

This study analyzes panel data from 30 provinces in Chinese Mainland between 2010 and 2020, examining the impact of digital economy development on carbon dioxide emission intensity through fixed effect and intermediate effect models. Key findings include:

(1) Nationally, both the digital economy and industrial structure upgrading significantly inhibit carbon emissions, with the digital economy's effect being more pronounced.

(2) The development of the digital economy notably fosters industrial structure upgrading.

(3) The digital economy indirectly curbs carbon emissions by promoting industrial structure upgrading.

In light of these findings and considering China's digital economy and dual-carbon goals, the paper proposes the following policy implications:

(1) Enhance digital economy infrastructure and advance digital technology development and application to facilitate greening through digitalization. This includes accelerating digital infrastructure like satellite and Internet networks and investing in R&D of technologies that boost energy efficiency and reduce carbon emissions. Providing incentives and backing for businesses to adopt and advocate for digital technologies is crucial in revolutionizing traditional industrial sectors.

(2) Actively support industrial structure upgrading to leverage its intermediary role fully. This involves using digital means for industry innovation and reform, enhancing production efficiency, optimizing resource use, and promoting industry digitalization. The government must focus on refining industrial structures, methodically phasing out businesses with high carbon emissions and low economic value, while fostering the growth of industries that are low in carbon, high in value, and technologically innovative.

(3) Implement region-specific digital economy development strategies. Central and western provinces should increase investment in the digital economy, utilizing digital technology for CO2 emission reduction. Governmental financial support and tax incentives can facilitate this. The focus in the eastern region should be on innovating and applying digital technologies, while also promoting technological collaboration and knowledge sharing with the central and western regions, thereby advancing nationwide digital economy development and CO2 emission reduction.

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References

[1] Chen Xin, Jin Dianchen, Zhang Yahao. Whether the Digital Economy Can Contribute to the Achievement of the "Dual Carbon" Goal: An Empirical Analysis Based on a Provincial Panel in China [J]. Social Scientist, 2023, (08): 70-76.

[2] Du Xin. Mechanisms and Effects of Digital Economy for Carbon Emission Reduction - An Empirical Examination Based on the Perspective of Green Technological Progress [J]. Science & Technology Progress and Policy, 2023, 40 (19): 22-32.

[3] Liu Jiaqi, Xue Fei, Fu Yamei. Research on Industrial Structure Upgrading Effect of Digital Economy - Based on the Dual Perspective of Supply and Demand [J]. Statistics & Decision, 2023, 39 (18): 125-128.

[4] Zuo Pengfei, Jiang Qiping, Chen Jing. Internet Development, Urbanization and the Transformation and Upgrading of China's Industrial Structure [J]. The Journal of Quantitative & Technological Economics, 2020, 37 (07): 71-97.

[5] Bai Xuejie, Song Pei, Li Lin, Liao Sainan. Can Digital Economy Promote China's Industrial Structure Transformation? --Based on the Perspective of Efficiency-based Technological Progress [J]. Journal of Xi`an Jiaotong University (Social Sciences), 2021, 41 (06):1-15.

ISSN 2616-5902 Vol. 5, Issue 26: 197-205, DOI: 10.25236/AJBM.2023.052630

[6] Liu Zhihua, Xu Junwei, Zhang Caihong. Science and Technology Innovation, Industrial Structure Upgrading and Carbon Emission Efficiency - A PVAR Analysis Based on Inter-provincial Panel Data [J]. Journal of Natural Resources, 2022, 37 (02): 508-520.

[7] Shao Shuai, Fan Meiting, Yang Lili. Economic Structural Adjustment, Green Technology Progress and Low-Carbon Transition Development in China - An Empirical Examination Based on the Overall Technology Frontier and Spatial Spillover Effect Perspectives [J]. Management World, 2022, 38 (02): 46-69+4-10.

[8] She Qunzhi, Wu Liu. Carbon Emission Reduction Effect of Digital Economy Development [J]. Economic Survey, 2022, 39 (05): 14-24.

[9] Li Ke. An Empirical Test of the Relationship between Industrial Structure and Carbon Emissions in China - An Analysis Based on a Dynamic Panel Smoothing Transformation Model [J]. Journal of Applied Statistics and Management, 2014, 33 (03): 381-393.

[10] Wang Wenju, Xiang Qifeng. Assessment of China's Industrial Restructuring and the Potential for Energy Conservation and Emission Reduction [J]. Chin Industrial Economics, 2014 (01): 44-56.

[11] Zhao Tao, Zhang Zhi, Liang Shangkun. Digital Economy, Entrepreneurial Activity and High Quality Development - Empirical Evidence from Chinese Cities [J]. Management World, 2020, 36 (10): 65-76.

[12] Li Xin. Study on the Impact of China's Digital Economy Development on Carbon Emissions [D]. Shanxi University of Finance and Economics, 2023.

[13] Sun Meng, Fei Bufan. Population Agglomeration and Carbon Emissions: An Empirical Investigation Based on the Perspective of Spatial Spillover Effects [J]. Population Journal, 2022, 44 (05): 72-85.