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Study on the Impact Mechanism of Wenzhou's Digital Economy Development on Carbon Emissions from the Perspective of Resilience

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Abstract: With the proposed dual-carbon target and the continuous development of digital economy, the impact of digital economy on regional carbon emissions has been paid more and more attention. According to the analysis of the development data of Wenzhou city digital economy, the results show that the development of digital economy is helpful to reduce Wenzhou carbon emissions, and the resilience of industrial chain and urban resilience are important mechanisms for digital economy to promote carbon emission reduction. Based on this, suggestions are put forward to speed up infrastructure construction and implement differentiated dynamic development strategy according to the characteristics of Wenzhou city.

Keywords: Digital economy, Carbon emission, Impact path.

1. Introduction

As a large manufacturing city with a proportion of more than 98% private economy and more than 300,000 enterprises, in recent years, Wenzhou has vigorously implemented the "No. 1 Project" 2.0 version of digital economy, built a digital city and Wenzhou on the cloud, expanded the scale of core industries, accelerated the pace of industrial digitalization, promoted the digital development of the city, increased new infrastructure construction, and fully optimized the development environment. Further highlight the "third pole" status of Zhejiang's digital economy development. In recent years, Wenzhou has made the manufacturing industry “smarter” through actions such as "traditional manufacturing remodeling Plan" and industrial digitalization promotion, gathering a number of high- quality enterprises and major projects in emerging industries such as photovoltaic, wind power and energy storage.

In this context, this research on the impact mechanism of digital economy development on Wenzhou's carbon emissions is conducive toproviding beneficial decision-making reference for Wenzhou's innovation-driven transformation and upgrading of new kinetic energy, helping the application of digital carbon reduction in Wenzhou level, in order to provide reference ideas and reference basis for Chinese cities to explore the path of carbon peak carbon neutrality.

2. Theoretical Analysis and Research Hypothesis

2.1. Digital Economy and Carbon Emission

As an emerging economic model, the digital economy, with its green, innovative and shared attributes, provides important support for achieving the Sustainable Development Goals. Digital technologies can not only promote the upgrading of traditional infrastructure, but also effectively predict and control carbon emissions. By using digital technology to deeply analyze and optimize production and resource data, enterprises can not only improve production efficiency and resource utilization, but also significantly reduce resource waste and achieve energy conservation and emission reduction. Therefore, the digital economy can not only promote economic growth and technological innovation, but also contribute to environmental protection and carbon emission reduction, reflecting its key role and extensive influence in modern society. Accordingly, the research hypothesis H1 is proposed in this paper.

H1: The development of digital economy will reduce regional carbon emission in our country.

2.2. Action Mechanism of Digital Economy on Carbon Emission

2.2.1. The mediating role of industrial chain resilience

In the era of digital economy development, digital transformation and adjustment and optimization of the industrial chain system have gradually advanced, and a new system has been established Type digital demonstration platform. New factors, new industries, new models and new forms of business will strengthen the industrial chain system to withstand pressure Capacity provides new opportunities. Industrial chain resilience refers to the ability of industry to resist, adapt, recover and restructure when facing shocks and disturbances. With the deepening of digital technology, the digital economy, as a new business model, will bring about continuous expansion of economic scale, continuous improvement of technological level and rapid upgrading of industrial links, creating powerful technological advantages for effectively preventing industrial chain fragility and fracture risks and coping with shocks. As a new factor of production, data will gradually penetrate into various industries and stages of production activities in the economy and society. In addition, the digital economy also helps to absorb high-quality talents. Based on this, the second research hypothesis of this paper is proposed:

Hypothesis 2: Digital economy reduces urban carbon emission through industrial chain resilience.

2.2.2. The mediating role of urban resilience

At the city level, the digital economy uses modern technologies to provide intelligent solutions for urban infrastructure construction Solutions can enhance the city's ability to withstand changes in the face of different risks and

challenges, ensure that cities cope with potential uncertainties and shocks, and enhance urban resilience; From the perspective of enterprises, the development of digital economy breaks the constraints of time and space, expands the pattern of innovation network in urban agglomerations, and allows the free flow of innovation resources among different regions, which is conducive to the spillover of network innovation between regions. Relying on new digital infrastructure and other emerging technologies, it can effectively reduce information transaction costs, improve the operational efficiency and data sharing degree of enterprises, help enhance the flexibility of enterprises, promote the integration and application of diversified data and innovation resources, improve resource utilization efficiency and product quality, and thus achieve the improvement of resilience level. Based on this, the third research hypothesis of this paper is proposed:

Hypothesis 3: Digital economy reduces urban carbon emission through urban resilience.

2.3. Construction of theoretical framework

Based on the above analysis, the theoretical framework of this paper is shown in Figure 1.

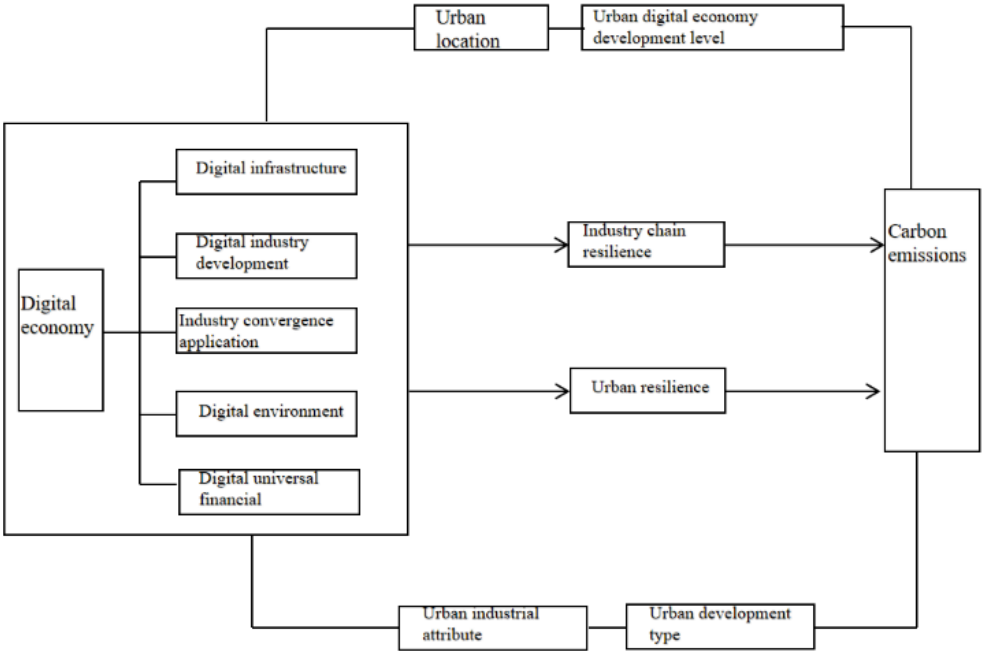

Figure 1. Theoretical framework diagram of the digital economy's impact path on carbon emissions

3. Analysis of the development level of Wenzhou digital economy

3.1. Measurement Method

In this paper, entropy weight method is used to calculate the weight of each index.The specific steps are as follows:

(1) In order to eliminate the difference of different indicators, the range method is used to standardize the data.

(2) Calculate the proportion sij of the i index of the j index.

(3) Calculate the entropy ej of the j index.

(4) Calculate the weight Wj of the JTH index.

3.2. Data Source and Index Selection

Combined with previous research results (Zhao Tao et al., 2020; Xu Weixiang et al., 2022; Wang Jun et al., 2021; Zhang Xun et al. Et al., 2019), based on five dimensions, this paper constructs an indicator system for the development level of Wenzhou's digital economy. The specific indicators are set in Table 1, and thedevelopment level of Wenzhou's digital economy is finally measured by entropy weight TOPSIS method.

Table 1. Index system of Wenzhou digital economy development level

Indicators		Variables (units)	Data source
Digital infrastructure	Internet penetration	Number of people with broadband Internet access	China City Statistical Yearbook
	Number of mobile Internet users	Number of mobile phones per 100 people	China Urban Statistical Yearbook
Digital industry Development	Information industry foundation	Number of employees in information transmission, computer services and software (10,000)	China Urban Statistical Yearbook
	Output of telecommunications industry	Total telecommunications business (ten thousand yuan)	China City Statistical Yearbook
Integration and utilization of digital industry	Primary industry: Digitalization of agriculture	Number of agricultural and rural informatization demonstration bases	Ministry of Agriculture and Rural Affairs of the People's Republic of China
	Tertiary Industry: Digital Financial Inclusion Index	Digital Financial Inclusion Index	The Digital Finance Research Center of Peking University and Ant Financial Group
Digital environment	Digital innovation capability	Science and technology as a share of government expenditure	China Urban Statistical Yearbook
	Government Environment	Number of microblogs of government agencies	China's Internet Development Statistics Report
Digital Universal Financial	Breadth of coverage	Digital Financial Inclusion Reach Index	The Digital Finance Research Center of Peking University
	Depth of use	Digital financial inclusion uses depth index	The Digital Finance Research Center of Peking University
	Degree of digitization	Digital Financial Inclusion Digitalization Index	The Digital Finance Research Center of Peking University

4. Research Design

4.1. Model Setup

In addition to its direct impact, the digital economy may also indirectly affect regional carbon emissions through some intermediary mechanisms. In order to examine the indirect mechanism of industrial chain resilience and urban resilience, this paper constructs an intermediary effect model.

4.2. Variable Selection and Data Source

The explained variable is the proxy index of carbon emissions (CE), that is, the natural logarithm of the sum of total carbon dioxide emissions; The core explanatory variable was the development level of digital economy (DEI); The intermediate variables were industrial resilience (ICR) and urban resilience (UR). The control variables were population size (POPU), economic development level (GDP), industrial structure (INDU), fixed asset investment (INVE) and openness to the outside world (OPEN).

The data sources used in this paper are China Statistical Yearbook, China Energy Statistical Yearbook, China Environmental Statistical Yearbook, National Bureau of Statistics and provincial statistical yearbooks.

5. Empirical Analysis

5.1. Baseline Regression

The result of Hausmann test shows that the P-value is less than 0.05, so this paper uses the fixed effect model to conduct an empirical analysis of the digital economy. When testing the direct impact of the development of digital economy on carbon emissions, it can be seen from Table 2 that the coefficients of digital economy are -0.389 and -0.549 respectively, both of which are significant at the level of 1% and are not affected by control variables, indicating that digital economy has a significant emission reduction effect, so H1 is established.

Table 2. Baseline regression results

Variables	(1) CE	(2) CE
DEI	-0.389*** (-4.39)	-0.549*** (-6.02)
POPU	0.0513 (1.39)	0.306*** (10.22)
GDP	0.125*** (6.26)	0.112*** (8.23)
INDU	0.113*** (5.65)	0.101*** (6.26)
INVE	0.147* (2.27)	0.0207 (0.34)
OPEN	0.0170 (0.46)	0.0895** (2.74)
N	2345	2345
R^2	0.169	
adj.R^2	0.059	

Note: *, ** and *** are significant at the 10%, 5% and 1% level respectively.

5.2. Endogeneity Test

It can be seen from the results that the regression coefficients of the digital economy are all significant at the level of 1%, so it can be proved that the benchmark conclusion of this paper is reliable.

5.3. Robustness Test

In order to ensure the reliability of the results, the study tested by replacing the explained variable, replacing the core explanatory variable and changing the sample size respectively. It was found that the development of digital economy could significantly reduce per capita carbon emissions, indicating that the results passed the robustness test.

5.4. Analysis of Mechanism of Action

5.4.1. Intermediary mechanism of industry chain resilience

Table 3. Tests the mediating effect of industry chain toughness

Variables	(1) CE	(2) ICR	(3) CE
DEI	-0.389*** (-4.39)	1.899*** (12.33)	-0.327*** (-3.57)
ICR			-0.0309* (-2.36)
POPU	0.0513 (1.39)	0.368*** (6.23)	0.0627 (1.69)
GDP	0.125*** (6.26)	0.147*** (4.472)	0.128*** (6.48)
INDU	0.113*** (5.65)	-0.179*** (-5.37)	0.109*** (5.35)
INVE	0.147* (2.27)	0.399** (2.77)	0.157* (2.38)
OPEN	0.0170 (0.46)	-0.111* (-2.08)	0.0129 (0.39)
N	2345	2345	2345
R^2	0.169	0.789	0.171
adj.R^2	0.059	0.762	0.061

Note: *, ** and *** are significant at the level of 10%, 5% and 1% respectively.

Column (1) results show that digital economy development has an inhibitory effect on total urban carbon emissions, which has been confirmed in the baseline regression above. From the results in column (2) and (3), it can be seen that the estimated coefficient of digital economy development on industrial chain toughness is significantly positive, while that of industrial chain toughness on total carbon emission is significantly negative, which is 1.899 and - 0.327 respectively, indicating that the development of digital economy contributes to the improvement of industrial chain toughness and thus produces the effect of carbon reduction. Given that the estimated coefficient of digital economy development in column (3) is significant but decreased compared with that in column (1), it can be concluded that the toughness of industrial chain has a partial intermediary effect, that is, the higher the development level of digital economy, the greater the toughness of industrial chain and the less carbon emissions, and the toughness of industrial chain plays a transmission role in the process of carbon reduction of digital economy, so hypothesis 2 has been verified.

5.4.2. Intermediation mechanism of urban resilience

Table 4. Tests the mediating effect of urban resilience

	(1) CE	(2) UR	(3) CE
DEI	-0.389*** (-4.39)	0.276*** (21.09)	-0.285** (-2.89)
ICR			-0.329* (-2.40)
POPU	0.0513 (1.39)	0.0157** (3.09)	0.0569 (1.55)
GDP	0.125*** (6.26)	0.0187*** (6.35)	0.129*** (6.54)
INDU	0.113*** (5.65)	-0.0043 (-1.63)	0.109*** (5.57)
INVE	0.147* (2.27)	0.0365*** (3.87)	0.159* (2.47)
OPEN	0.0170 (0.46)	0.0149** (3.18)	0.0225 (0.62)
N	2345	2345	2345
R^2	0.169	0.664	0.171
adj.R^2	0.059	0.617	0.061

Note: *, ** and *** are significant at the 10%, 5% and 1% level respectively.

Column (1) shows that the development of digital economy has an inhibitory effect on the total urban carbon emissions, which is significantly negative at the 5% level. The results in column (2) and (3) show that the estimated coefficient of digital economy development on urban resilience is significantly positive, while the estimated coefficient of urban resilience on total carbon emissions is significantly negative, 0.276 and -0.285, respectively, indicating that the development of digital economy can help improve urban resilience and thus reduce carbon emissions. Considering that the estimated coefficient of digital economy development in column (3) is significant but decreased compared with that in column (1), it is concluded that there is a partial intermediary effect of industrial chain resilience, that is, the higher the development level of digital economy, the greater the resilience of the city and the less carbon emissions, and the urban resilience plays a transmission role in the process of carbon reduction in the digital economy, so hypothesis 3 is established.

6. Conclusions

The transmission mechanism results show that the digital economy can not only directly achieve carbon emission reduction effect, but also indirectly inhibit carbon emission through the two intermediary Bridges of industrial chain resilience and urban resilience. That is, the digital economy can accelerate the improvement of industrial chain resilience and urban resilience, thereby promoting carbon emission reduction and promoting the realization of double dividends of economy and environment. In addition, from the perspective of supply chain, with the rise of the manufacturing value chain, the digital economy will further enhance the carbon reduction ability of cities through

industrial chain resilience and urban resilience.

7. Policy Recommendations

(1) Deepen the development of the digital economy and increase capital investment

Wenzhou should adhere to and continuously consolidate the development of digital economy, increase investment in digital economy related industries, improve the construction of digital infrastructure, and improve the level of digital innovation. Specifically, through digital enabling the whole life cycle of traditional industries, to achieve significant cost reduction, shorten the product cycle. At the same time, vigorously promote the demonstration and establishment of benchmarking enterprises, focusing on the intensive land use of enterprises, harmless raw materials, clean production, waste resources, and low-carbon energy, encourage the transformation of green and low- carbon production methods and the wide application of green and low- carbon technologies, and create green benchmarking enterprises. Through the digital economy to lead the industrial collaborative carbon reduction, the construction of China (Wenzhou) "data safety port", in financial services, medical health, transportation and other fields to achieve large-scale data, the whole process, automatic interconnection, to help the digital economy, intelligent, low carbon development.

(2) Pay attention to the improvement of chain resilience, and promote digital empowerment and emission reduction

In addition, Wenzhou should anchor the emerging track of digital economic development, integrate resources through digital intelligent empowerment, strive to create an integrated digital platform, accelerate the upgrading of the overall operating efficiency of various industries, and achieve multi-directional and whole-chain transformation and optimization with the help of Internet and other technologies. The digital economy can significantly improve the carbon emission performance by improving the level of economic development, optimizing the upgrading of industrial structure and accelerating technological innovation. Therefore, the Wenzhou government should actively promote the deep integration of digital economy and traditional industries, and promote the development of China's economy in the direction of digitization, intelligence and low carbon. At the same time, Wenzhou government should encourage and support the development of low-carbon industry, increase its proportion in the national economy, promote the development of industrial structure towards rationalization, advanced and ecological direction, and make full use of the positive externality of industrial structure on carbon emission performance.

(3) Positioning cities for development and bridging the digital divide

In the process of deepening the development of the digital economy, we need to focus on strengthening inter-city collaboration and learning capabilities. Drawing on the development experience of similar cities, Wenzhou should combine its own competitive advantages, draw on each other's strengths, and realize the inclusive sharing of digital elements. According to the regional characteristics of Wenzhou city, environmental regulation level, carbon emission, consumer group distribution, demand, resource endowment and other factors, reasonable planning and design of Wenzhou digital economy spatial development distribution pattern, formulate flexible and agile dynamic development program. At the same time, industrial funds, digital finance and other means can be used, led by industry associations, to encourage the participation of the government, industry leaders and all kinds of social capital, to provide financial support and financial security for the development of digital industry and low-carbon industry, and reduce the risk of low-carbon transformation.

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