# Digital Technology、 Carbon Emission and Industry Structure

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**Abstract.** In an age of digital economy, digital technology is a hugely important factor in promoting the upgrading of industrial structures. Using panel data from 30 provinces of China between 2012 and 2020 analyzes empirically the incidence and mechanism of operation among digital technologies, carbon emission and industrial structure by constructing a fixed-effect model, a mediating-effect model, and a threshold threshold model. It is found that, firstly, the application of digital technology can significantly promote the optimization of industrial structure with certain robustness;secondly, carbon emission has a significant mediating effect. On this basis, this paper proposes effective policy recommendations that can help promote industrial structure upgrading, such as vigorously developing digital technologyand playing the intermediary role of carbon emissions in digital technology and industrial structure upgrading.

**Keywords:** Digital Technology, Industrial Structure, Fixed Effects, Intermediary Effects.

## 1 Inroduction

The development of the Internet, big data, and artificial intelligence has led to the derivation of a new economic form of "digital economy". In this context, the research on digital technology and industrial structure upgrading with many researchers focusing primarily on the following three aspects:

First is the aspect of digital technology. Zhao Xing et al. [1] selected indicators to measure the level of digital technology from two aspects: digital technology foundation and digital technology application. Yang et al. [2] studied the relationship between digital technology and agricultural development. Secondly, improvements to the industrial structure. Guo Shouting et al. [3] pointed out that there is a U-shaped nonlinear relationship between the influence of the development of digital inclusive finance in the region on the modernization of the industrial structures. Finally, the impact of digital technology on industrial structure. Ding Shouhai et al. [4] argue that the digital economy affects the modernization of the industrial structures by shifting the demand-side of the domestic big cycle. Liu He dong[5] showed that there is an incremental inverted


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U-shaped effect of digital industrialization on the modernization of the industrial structure, and a positive incremental influence of industrial digitization on the modernization of the industrial structure.

In summary, numerous studies have been conducted on digital technology and the modernization of the industrial structures. In this paper, we attempt to investigate the relationship between carbon emissions and modernization of the industrial structures from a carbon emissions perspective.

## 2 Theoretical Analysis and Research Hypothesis

On the one hand, digital technology has the potential to reduce production and distribution costs, to improve allocative efficiency, and to promote the upgrading of industrial structures[6]. In contrast, digital technology used in a variety of industries, breaking through the traditional business model and overcoming regional barriers. For the government, the application of digital technology allows the government to reasonably control the supply of energy (Guo Yueqin et al.)[7]; for enterprises, through the application of digital technology, companies can effectively control energy use; for residents, the application of digital technology improves people's demand for green products and low-carbon consumption For residents, the application of digital technology increases people's demand for green products and awareness of low carbon consumption[8]. Meanwhile, if the carbon emission intensity continues to increase, enterprises may be forced to accelerate the development of related low-carbon industries(Fan Dongshou)[9]. Therefore, we hypothesize the following:

H1.The development of digital technology can effectively promote the upgrading of industrial structure

H2. digital technology has an impact on industrial structure upgrading by reducing carbon emissions.

## 3 Empirical Analysis

### 3.1 Variable Measures and Data Sources

The variables are shown in Table 1.

**Table 1.** Variable Measures.

| Type | Variable | Explanations |
|---|---|---|
| Explained Variables | Industry Structure | The ratio of the value added of the tertiary industry to the value added of the secondary industry |
| Core Explanatory Variables | Digital Technology | Digital technology level measurement index system |
| Mediating Variables | Carbon Emission | the ratio of carbon dioxide emissions to regional GDP |
| Control Variables | GDP | Regional GDP per capita |

| | | |
|---|---|---|
| | Gap | Urban-rural income gap |
| | Gov | The general budget expenditure of local finance / the GDP of the region |
| | Fdi | Total investment in foreign-invested enterprises |

**Variable sources** The data in this article comes from the "China Statistical Yearbook" and the statistical yearbooks of each province.

### 3.2 Model Building

Baseline regression model and mediating effect model are shown in Table 2.

**Table 2.** Model Building.

| Model | Formula | Explanations |
|---|---|---|
| Baseline Regression Model | $Ais_{i,t} = \alpha_0 + \alpha_1 Dige_{i,t} + \alpha_2 Z_{i,t} + \mu_i + \delta_t + \varepsilon_{i,t}$ | $Ais_{i,t}$ denotes the industrial structure, $Dige_{i,t}$ denotes the level of digital technology, $Z_{i,t}$ denotes control variable |
| Mediating Effect Model | $Ais_{i,t} = \gamma_0 + \gamma_1 Dige_{i,t} + \gamma_2 co2_{i,t} + \gamma_3 Z_{i,t} + \mu_i + \delta_t$ - $co2_{i,t} = \beta_0 + \beta_1 Dige_{i,t} + \beta_2 Z_{i,t} + \mu_i + \delta_t + \varepsilon_{i,t}$ | $co2_{i,t}$ denotes the mediating variable. |

## 4 Empirical results and analysis

### 4.1 Analysis of baseline regression results

The Hausman criterion[10] was applied to discuss which of the fixed-and random-effects is more appropriate for further investigation. On the basis of the results of Hausman's test, the p value was deemed to be 0.0379<0.05, so the fixed-effect model was selected for regression analysis. On the basis of the test results in Table 3, when only the baseline explanatory variables are regressed in (1), with an estimated coefficient of 0.166, indicating that digital technology is indeed enhancing the modernization of the regional industrial structure. Where (4) is achieved by adding control variables into model 1, as can be seen from the regression results, the estimated coefficient of the digital technology level regression is 0.569, which is significant at the 1% level of significance, displaying that every one unit increase in the standard of digital technology can lead to an average 0.569 unit increase in industrial structure upgrading, conditional on controlling variables being taken into account. Also the model fits better compared to model 1. H1 is confirmed.

From the perspective of control variables, the level of regional economic development can significantly promote the upgrading of regional industrial structure; government expenditure has a significant role in promoting the upgrading of industrial structure, which indicates that when government expenditure increases, the government will

make corresponding policies to promote the upgrading of industrial structure; the level of foreign investment also plays an important role in the upgrading of industrial structure. The level of foreign investment also plays an important role in the upgrading of industrial structure, and foreign investment is conducive to the region learning advanced technology and management experience, thus optimizing the management structure and accelerating the upgrading of industrial structure.

**Table 3.** Baseline regression test results.

| | (1) Ais | (2) Ais | (3) Ais | (4) Ais | (5) TH | (6) Ais |
|---|---|---|---|---|---|---|
| Dige | 0.166 | 0.268 | 0.969*** | 0.569*** | 0.250** | |
| | (0.65) | (1.12) | (4.23) | (4.23) | (0.122) | |
| Gdp | | 0.000*** | 0.000*** | 0.000*** | -0.000 | 0.000*** |
| | | (11.24) | (4.94) | (4.94) | (0.000) | (0.000) |
| Gap | | -0.560*** | 0.002 | 0.002 | 0.294*** | 0.186 |
| | | (-4.50) | (0.01) | (0.01) | (0.087) | (0.173) |
| Gov | | 0.037*** | 0.030*** | 0.030*** | -0.005*** | 0.027*** |
| | | (10.50) | (8.96) | (8.96) | (0.002) | (0.003) |
| Fdi | | 0.000** | 0.000*** | 0.000*** | 0.000 | 0.000** |
| | | (2.03) | (3.34) | (3.34) | (0.000) | (0.000) |
| _cons | 0.998*** | 1.001*** | -0.350 | -0.350 | -0.238 | -1.227 |
| | (11.10) | (3.14) | (-0.85) | (-0.85) | (0.219) | (0.805) |
| MP | | | | | | 0.187 |
| | | | | | | (0.124) |
| Individual | Yes | Yes | No | Yes | | |
| Time | Yes | No | Yes | Yes | | |
| r2_a | 0.703 | 0.748 | 0.805 | 0.805 | 0.873 | 0.792 |

## 4.2 Analysis of baseline regression results

The following robustness tests were conducted in Table 4:

**Table 4.** Robustness testing method.

| Method | Explanations |
|---|---|
| Replace the Ais | The share of tertiary industry value added in regional GDP (TH) is selected as in (5). |
| Replace the Dige | Mobile phone penetration (MP) is used to measure the level of technology in the digital economy, as in (6). |

The regression results show that the conclusion of H1 is robust.

### 4.3 Mediating Effect Tests

The test results are displaied in Table 5 below. column (8) indicates the effect of digital technology level on carbon emission intensity, and from the model, it is found that the estimated coefficient of digital technology level is 0.025, which is significant and positive, displaying that developments in digital technology helps to promote carbon emission reduction. The development of digital technology optimizes the allocation of resources, while reducing carbon emissions in manufacturing and operation through intelligent and informative technologies.Column (9) presents the results of the joint effect of the level of digital technology and carbon emission intensity on upgrading industrial structures, indicating that carbon emission intensity may be able to mediate and is a mediating variable of digital technology enabling the upgrading of industrial structures, and H2 is tested.

**Table 5.** Results of intermediate effect test.

| | (7) | (8) | (9) |
|---|---|---|---|
| | Ais | co2 | Ais |
| Dige | 0.268 | 0.025** | 0.26** |
| | (0.239) | (0.012) | (0.242) |
| co2 | | | 0.006 |
| | | | (1.328) |
| r2_a | 0.780 | 0.056 | 0.780 |

## 5 Conclusions and Policy Recommendations

The research findings show that: first, digital technology level development can effectively foster industrial structure upgrading; second, carbon emission intensity has a significant mediating effect and is an important driver of transmission for digital technology to assist as part of the modernisation of industrial structures. With the transformation of China's rapid economic development into a high-quality development stage, accelerating the optimization and upgrading of industrial structure has become an important part of high-quality economic development. This paper advances the following policy recommendations:

### 5.1 Vigorously Develop Digital Technology

Focusing on developing digital technologies like "Internet+" and "artificial intelligence". Furthermore, accelerate the construction of digital economics industrial parks to provide good operation space for various digital enterprises, promote industrial clustering, and thus bring about a greater agglomeration effect.

### 5.2 Paying much attention to the intermediary role of carbon emissions in the impact of digital technology on the upgrading of industrial structures

Through the application of digital technology, energy use and carbon can be reduced in the production and manufacturing stages as well as in the operations and sales stages of traditional industries. Combining the level of digital technology with pollution emission detection equipment will not only help reduce carbon emissions to achieve the "double carbon" target, but also help develop green process technology better. Formulate relevant policies to constrain enterprises to reduce pollutant emissions, so that they have a good sense of green environmental protection.

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