

Research on the Driving Force of Industrial Structure Optimization in the Development of Digital Economy

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Abstract: The development of the digital economy realizes the optimization and upgrading of industrial structure by cultivating new industrial formats and promoting the integration of traditional industrial technologies. Based on the data of 30 provinces in China from 2013 to 2022, the four-dimensional index system of informatization, Internet, digital transaction, and digital finance is constructed. Verifying the fixed-effect model shows that the digital economy has a significant role in promoting the optimization and upgrading of the industrial structure. It is suggested that priority should be given to strengthening the mechanism of digital infrastructure innovation and R&D and provincial coordinated development.

Keywords: Digital economy, Industrial structure, R&D intensity.

1. Introduction

With the iterative innovation of the new generation of information technologies, such as the Internet, big data, cloud computing, artificial intelligence, and blockchain, the digital economy is gradually evolving into the core engine driving the modernization and sustainable growth of the industrial system. The in-depth development of the digital economy has not only triggered a fundamental change in the traditional paradigm of allocation of production factors but also reconstructed the pattern of factor circulation, reshaped the economic spatial form, and reconstructed the international competitive advantage system on a global scale [1]. The Digital Economy Cooperation Initiative promulgated at the 2016 G20 Hangzhou Summit systematically defined the connotation of the digital economy for the first time, defining it as a new economic form that uses data elements as the key means of production, relies on intelligent network carriers, and empowers efficiency leaps and economic structure optimization through information and communication technologies [2]. The strategic plan of the 19th National Congress of the Communist Party of China emphasizes the need to accelerate the construction of a manufacturing power, deepen the digital transformation of advanced manufacturing, promote the deep coupling of intelligent technology and the real economy, focus on cultivating emerging fields such as mid-to-high-end consumption, green and low-carbon economy, and modern supply chain management, and build a new momentum system for economic growth. The report of the 20th National Congress of the Communist Party of China further clarified that efforts should be made to promote the systematic integration of the digital economy and the real economy and build a digital industrial cluster with global competitiveness. At present, the development of the digital economy has become the core carrier for China's implementation of the national strategy and has irreplaceable strategic value for deepening the supply-side structural reform and implementing the innovation-driven development strategy [3].

2. Literature Review

After entering the 21st century, China's economy has entered a new normal stage. The main driving force of economic growth has changed from factor- and investment-driven to innovation-driven, and at the same time, the industrial structure has gradually transformed from heavy chemical industry and low-end industries to high-end emerging industries.

Regarding the exploration of the relationship between the digital economy and industrial structure, the current research mainly focuses on the following two dimensions:

First, Digital economy and high-quality development. Tong Jiadong et al. [4] pointed out that the digital economy is a new economic form characterized by data, networking, intelligence, sharing, and inclusiveness and is a new engine to promote high-quality economic development. Ren Baoping [5] believes that it injects new advantages into high-quality economic development by reshaping the productivity at the material, spiritual, and institutional levels and optimizing the reform mechanisms such as quality, motivation, and efficiency. The digital economy is closely related to high-quality development, and it will inject new vitality into urban-rural integration by improving rural infrastructure, governance, and industrial online development [6]. The research of Han Zhaoan et al. [7] shows that the coupling and coordination degree of China's digital economy and high-quality development is highly spatially correlated, especially in the Yangtze River Economic Belt. Technological innovation and industrial structure are the key intermediary factors for the digital economy to promote high-quality development [8].

Second is the interaction between the digital economy and the industrial structure. The interaction between the digital economy and the industrial structure is mainly reflected in two aspects: first, direct impact, that is, the upgrading of the industrial structure through the information and communication technology industry and its derivative new business forms [9]; The second is indirect influence, through the deep integration of digital technology and traditional industries, and the optimization of the industrial structure

with the help of information technology innovation and digital transformation [10]. In addition, the digital economy also promotes the optimization and upgrading of regional industrial structure through transmission mechanisms such as scientific and technological innovation, resource allocation, and human capital [11]. These studies provide important theoretical support for understanding the role of the digital economy in promoting high-quality economic development and upgrading the industrial structure.

Based on the existing research, this paper systematically analyzes the role of the digital economy in promoting economic development from the macro and micro dimensions, combines the current situation of China's industrial structure, constructs the provincial comprehensive development level index system of the digital economy from four aspects: informatization, Internet, digital transaction and digital finance, uses the provincial panel data to calculate the development level index, and discusses its impact on the optimization and upgrading of the industrial structure, fills the research gap, and enriches the relevant theoretical system.

3. Theoretical Analysis and Research Hypothesis

3.1. The Direct Impact of The Digital Economy on The Upgrading of The Industrial Structure

The rise of the digital economy has accelerated the transformation of traditional industries to digitalization, automation, and intelligence, significantly improved the efficiency of resource allocation, and promoted the upgrading of the economic model to high efficiency, energy conservation, and innovation orientation. First, with the help of advanced technologies such as data analysis, artificial intelligence, and cloud computing, enterprises can manage production processes more accurately, optimize products and services, and then enhance product quality and innovation capabilities, which has played a positive role in promoting the optimization of industrial structure. Secondly, the deep integration of digital technology and traditional industries, through big data and cloud computing and other means of in-depth analysis of massive data, effectively improves the efficiency of supply and demand matching, alleviates the problem of resource misallocation, and injects strong impetus into the upgrading of the industrial structure.

In addition, the vigorous development of the digital economy has given rise to a series of emerging technology industries, such as the Internet, artificial intelligence, blockchain, and big data. The rapid growth of the digital economy has not only given birth to new business formats such as the sharing economy and Internet finance but also opened a development path for traditional industries that is completely different from the traditional ones. These emerging industries have not only injected new vitality into economic growth, but also integrated into the traditional production field as a service industry, profoundly changed the production and lifestyle, prompted enterprises to climb to the high end of the value chain, and realized the transformation from low-end products to high-end products, thereby promoting the comprehensive upgrading of the industrial structure. Based on the above analysis, the following hypotheses are proposed:

H1: The digital economy has a positive role in promoting

the upgrading of the industrial structure.

3.2. The Impact of R&D Intensity on Industrial Structure Upgrading

Technological innovation is the key factor to promote the digital economy and promote the upgrading of the industrial structure, and R&D expenses are an indispensable source of funds to support this innovation activity. First and foremost, the boom in the digital economy has exacerbated the urgent need for technological innovation, which in turn has pushed up the level of investment in R&D. This is a core mechanism for the digital economy to drive the upgrading of the industrial structure.

Furthermore, in the context of the interweaving of the digital economy and industrial structure upgrading, the speed and depth of the transformation of the industrial structure to a technology-intensive one profoundly impacts the allocation of R&D investment. If the pace of industrial structure transformation is slow, the investment of enterprises and governments in the field of technological innovation may be reduced accordingly, resulting in a decline in R&D intensity. Conversely, if the transformation of the industrial structure is advancing rapidly, enterprises and governments are more likely to increase their support for technological innovation, thereby increasing R&D intensity. Therefore, the dynamic change of industrial structure transformation is an important factor affecting R&D investment and the effect of the digital economy in promoting industrial upgrading. Based on the above analysis, the following hypotheses are proposed:

H2: R&D intensity plays an intermediary role in the relationship between the digital economy and the upgrading of the industrial structure.

4. Study Design

4.1. Data Sources

Considering the availability and operability of the data, this paper collects and sorts out the panel data of 30 provinces in China from 2013 to 2022, and the data used are all from the National Bureau of Statistics, China Statistical Yearbook, provincial statistical yearbooks, and statistical bulletins. And websites such as provincial statistical bureaus.

4.2. Variable Selection

4.2.1. Explanatory variables

The explanatory variable in this paper is the upgrading of industrial structure, referring to the practice of Gan Chunhui et al. [14], and the industrial structure rationalization index is used to measure here, that is, the reciprocal of the Theil index is used to measure the rationalization of the industrial structure, and the larger the reciprocal of the Theil index, the more reasonable the industrial structure.

4.2.2. Core explanatory variables

In this paper, the level of digital economy development (dig) is taken as the core explanatory variable, concerning Liu Jun et al. [12-14]. Based on the actual development of China's digital economy and drawing on existing research, the digital economy indicators are refined into four first-level dimensions: informatization progress, Internet evolution, digital transaction expansion, and digital finance deepening, and are divided into the core layer of the digital economy (digital industry sector), the narrow category (digital service application and platform economy) and the broad level (e-commerce, sharing economy and other industrial digital

practices). Based on the availability of city-level data and the completeness of the indicator system, this paper standardizes each index, uses the entropy method to determine the weight, and finally calculates the level of digital economy development (dig).

4.2.3. Control variables

Referring to the analysis of the correlation between the

digital economy and the upgrading of industrial structure, this paper selects the level of informatization, marketization, technology market development, openness, social consumption, and financial development as the control variables, and the descriptive statistical analysis of each variable is shown in Table 1.

Table 1. Descriptive statistical results of variables

Variable	Name	Sample size	Mean	S.D.	Min	Max
HIS	Upgrading of industrial structure	300	0.115	0.136	0.013	1.226
dig	Digital economy	300	0.231	0.200	0.018	0.883
II	Level of informatization	300	0.064	0.057	0.014	0.29
MI	Market-oriented level	300	0.546	0.158	0.043	0.853
Dcm	The level of development of the technology market	300	0.015	0.028	0.000	0.175
Oe	Degree of openness to the outside world	300	0.266	0.296	0.008	1.548
Scl	The level of social consumption	300	0.381	0.068	0.222	0.538
Fdl	Level of financial development	300	3.213	1.156	1.518	8.131
RD	R&D intensity	300	0.017	0.011	0.004	0.064

4.2.4. Intermediary variables

The mediating variable in this paper is R&D intensity, which is measured by the proportion of RD expenditure in regional GDP.

4.3. Model Setting

To test the hypothesis, this paper follows a two-way fixed-effect model from the application level to control for individual and temporal effects.

$$HIS_{it} = \alpha_0 + \beta_1 dig_{it} + \gamma control_{it} + \lambda_i + \mu_t + \varepsilon_{it} \quad (1)$$

HIS_{it} represents the industrial structure upgrade of province i in year t , dig_{it} is the green finance index of province i in year t , $control_{it}$ represents the control variable, μ_t represents the time fixed effect, λ represents the individual fixed effect, and ε_{it} represents the random error term.

According to the theoretical analysis, to verify whether R&D intensity can be used as a channel for the digital economy to promote the upgrading of industrial structure, this paper constructs the following mediating effect model concerning the research of Wen et al. [15].

$$RD_{it} = \alpha + \beta_2 dig_{it} + \gamma control_{it} + u_{it} \quad (2)$$

$$HIS_{it} = \alpha_1 + \delta RD_{it} + \beta_3 dig_{it} + \gamma control_{it} + u_{it} \quad (3)$$

Where, RD_{it} indicates the R&D intensity of province i in year t . When the coefficient of model 2 (β_2) and the coefficient of model 3 (δ) are both significant, the mediating effect is significant. The coefficient of model 3 is β_3 , if it is significant, it indicates that there is a partial mediation effect, otherwise, it is a complete mediation effect.

5. Empirical Analysis

5.1. Fixed-Effect Regression Results

To better explore the impact of the digital economy on industrial structure upgrading, after considering the fixed effects of city and time, column (1) presents the preliminary regression analysis results without introducing any control variables, while column (2) presents the benchmark regression results after incorporating a series of control variables. The empirical analysis shows that the coefficient of

the core explanatory variable digital economy (dig) is significantly positive, indicating that the digital economy has a promoting effect on the upgrading of industrial structure, and hypothesis H_1 is verified. The digital economy is one of the important engines of economic development, representing the direction of high-tech and leapfrog development of the economy.

Table 2. Benchmark regression of digital economy to industrial structure upgrading

variable	(1)	(2)
dig	0.693 ***	0.982 ***
	(0.205)	(0.182)
cons	-0.045	-0.084
	(0.047)	(0.06)
Control variables	NO	YES
Two-way fixation	YES	YES
Observations	300	300
R-squared	0.041	0.33

Note: *, ** and 1% are significant, respectively, with standard errors in parentheses. The same applies hereinafter.

5.2. Analysis of Mediating Effect Regression Results

In this paper, the mediating role of R&D intensity (RD) is verified according to the model, and the regression results are shown in Table 3. The regression results (1) showed that the digital economy (dig) was positively correlated with R&D intensity, and the regression results showed that both RD and dig were at the 1% level. At the significance level of 1%, there is a positive correlation with industrial structure upgrading (HIS), and its regression coefficients are 7.626 and 0.883, respectively, compared with model 2. It can be found from the results of model 4 that the coefficient of dig decreases from 0.982 to 0.883, indicating that there is a partial mediating effect in RD, which is verified H_2 .

Table 3. Mediator effect regression results

variable	(1)	(2)
	RD	HIS
dig	0.013*** (0.004)	0.883*** (0.182)
RD		7.626*** (2.479)
Control variables	YES	YES
Two-way fixation	YES	YES
Observations	300	300
R-squared	0.580	0.354

6. Conclusion and Countermeasure

This paper selects the panel data of 30 provinces in China from 2013 to 2022, and firstly constructs the provincial digital economy development level index system, which mainly covers four dimensions, namely, information development, Internet development, Based on the development of digital transaction and digital finance, the development level is calculated, and the impact of digital economy and its four sub-dimensions on industrial structure upgrading is empirically analyzed with the help of fixed effect model, and the following conclusions are drawn:

Nationwide, the digital economy and its four major components have significantly promoted the upgrading of China's industrial structure. First, the digital economy uses technologies such as big data, cloud computing, and artificial intelligence to help traditional industries transform to digital and intelligent, improving efficiency and service levels. Second, the digital economy has stimulated the emergence of new industries and business models, demonstrating the positive interaction between the digital economy and innovation. The improvement of innovation capability provides technical and talent support for the digital economy, while the new technologies and applications of the digital economy have led to profound changes in the industrial structure, reconstructed the traditional industrial chain and production model, and promoted the deep integration and coordinated development of the digital industry and the traditional industry.

Given this, relevant policy recommendations focus on deepening the development of the digital economy and enhancing its supporting role in the optimization and upgrading of China's industrial structure. All provinces need to strengthen the importance of the development of the digital economy to ensure that the digital transformation strategy is fully implemented. The first task is to consolidate the digital economy's infrastructure while ensuring the necessary financial investment to support its development. Second, accelerate the cultivation of high-quality and innovative digital talents and improve the talent team's quality in the digital economy field. Finally, it is necessary to broaden the application scope and coverage of the digital economy and strive to make simultaneous efforts in digital industrialization and industrial digitalization to achieve the efficient and sustainable development of the digital economy.

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