Research on the Influence of Digital Economy on the Upgrading of Industrial Structure

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Abstract. Based on the provincial panel data of China from 2013 to 2019, this paper calculates the comprehensive index of digital economy development, constructs a variety of econometric models, and discusses the effect and influence mechanism of digital economy on industrial structure upgrading. It is found that the digital economy has a significant positive effect on the upgrading of industrial structure; Digital economy promotes the upgrading of industrial structure by promoting technological innovation; According to the regional inspection, the effect of digital economy on industrial structure upgrading in central, eastern and western regions is gradually decreasing. Finally, according to the results of empirical research, some policy suggestions are put forward.

Keywords: Digital economy; Upgrading the industrial structure; technical innovation.

1. Introduction

Since 2020, novel coronavirus has exerted great influence on the whole world. The production of traditional enterprises has stagnated, workers can't go to work, and enterprises can't run normally. These factors have brought great challenges to the global economy. In contrast, the application of new technologies such as telecommuting, online education, networked leisure and entertainment has achieved unprecedented development, and the emergence of the epidemic has become the "touchstone" for the development of digital economy. The government work report has repeatedly mentioned the need to vigorously develop the digital economy.

China's economy is in the transition stage from a high-growth model driven by investment to a high-quality development model driven by innovation. The influence and mechanism of digital economy on the upgrading of industrial structure have attracted close attention of academic circles. At present, the research is mainly divided into two categories: one is to directly study the relationship between digital economy and industrial structure upgrading. Xu and Fan[1]found that the progress of Internet technology can drive China's industrial structure to become more advanced and improve the integration of traditional service industry and innovative achievements. Zhang[2] proposed that the digital economy has high permeability, which promotes the integration of digital technology and traditional industries, derives new business forms, and promotes the upgrading of the industrial structure. Another kind of research analyzes the transmission mechanism of digital economy promoting industrial structure upgrading. Chen et al.[3] discovered the mechanism of the digital economy enabling the upgrading of industrial structure from the perspective of government intervention. Wang[4]found that the digital economy promotes the upgrading of the industrial structure by improving the allocation of capital and labor.

Innovation is the most important force in upgrading industrial structure, but through literature review, it is found that the transmission mechanism of digital economy promoting industrial structure upgrading through technological innovation is neglected. Therefore, this paper discusses the path of digital economy to promote industrial structure upgrading from the perspective of technological innovation. The possible marginal contributions of this paper are as follows: First, the development index of digital economy is measured by multi-dimensional evaluation indicators, and the influence relationship between digital economy and industrial structure upgrading is discussed from a finer scale by quantile regression. Secondly, bringing technological innovation into the research framework of digital economy and industrial structure upgrading deepens the previous research. Thirdly, the differences of the effects of digital economy on the upgrading of industrial

structure in the eastern, central and western regions are investigated by regions, so as to make the research conclusions and policy recommendations more accurate.

2. research design

2.1 model design

To verify whether the digital economy has promoted the upgrading of industrial structure, the following benchmark regression model is constructed:

$$ISU_{i,t} = \alpha_0 + \alpha_1 DEI_{i,t} + \alpha_2 Z_{i,t} + \mu_i + \delta_t + \varepsilon_{i,t}$$

Among them,$ISU_{i,t}$ represents the upgrading level of industrial structure, $DEI_{i,t}$ represents the development level of digital economy, and $Z_{i,t}$ represents a series of control variables. μ_i is the individual fixed effect, δ_t is the time fixed effect, $\varepsilon_{i,t}$ is the random disturbance term.

To discuss the indirect transmission mechanism of digital economy affecting industrial structure upgrading, the following intermediary effect model is constructed:

$$PATE_{i,t} = \beta_0 + \beta_1 DEI + \beta_2 Z_{i,t} + \mu_i + \delta_t + \varepsilon_{i,t}$$

$$ISU_{i,t} = \gamma_0 + \gamma_1 DEI_{i,t} + \gamma_2 PATE_{i,t} + \gamma_3 Z_{i,t} + \mu_i + \delta_t + \varepsilon_{i,t}$$

$PATE_{i,t}$ means technological innovation.

2.2 Variable Declaration

Explained variable: industrial structural upgrading (ISU). This paper uses the ratio of labor productivity and output value to measure the upgrading of industrial structure.

Explanatory variable: Digital Economy (DEI). There is no clear definition of digital economy, and the measurement caliber of digital economy level is not uniform. In this paper, we refer to the relevant measurement indicators of digital economic development index in the existing research, and build an evaluation index system of digital economic development. The index selection is shown in Table 1. And measure by improved entropy weight method.

Table 1. Evaluation Index System of Digital Economy Development Level in China

Primary indicators	secondary indicators	tertiary indicators
Digital economic development index	digital foundation	Mobile phone penetration rate
		Domain name number
		Length of long-distance optical cable line
		Number of broadband access ports
	digital application	Number of websites owned by enterprises
		Proportion of enterprises with e-commerce transactions
		Proportion of information employment in urban population
	digital transformation	Software business income
		Electronic business sales
		Digital inclusive finance development index

Intermediary variables: Technological innovation (PATE) is measured by the amount of invention patents granted, and the variables are treated in logarithm.

Control variables. This paper controls other variables that may affect the upgrading of industrial structure: human capital (HC); Foreign direct investment (FDI); Economic development level (PGDP); Economic openness (open); Infrastructure level (INF).

3. Empirical results and analysis

3.1 Benchmark regression analysis

Table 2 reports the results of benchmark regression test. The estimation coefficient of digital economy in model (1) is significantly positive, and the upgrading level of industrial structure increases by 1.855 units for every unit of digital economy. The development of digital economy can effectively promote the upgrading of regional industrial structure.

This confirms the influence of digital economy development on the overall industrial structure upgrading, but the essence of fixed effect is mean regression, which does not reveal the influence of digital economy development on differentiated industrial structure. This paper further uses quantile regression to enrich the upgrading effect of industrial structure. The regression results are shown in Table 2. From the regression results, the regression coefficients of digital economy are significantly positive at 0.25, 0.4, 0.5 and 0.6 quantiles. The development of digital economy has a strong driving effect on the upgrading of industrial structure, but the driving effect shows a trend of slow decline with the increase of quantiles. The possible reasons are as follows: with the change of industrial structure, the upgrading space is shrinking, which requires more powerful kinetic energy to stimulate the upgrading of high-level industrial structure. At present, the data modeling and analysis ability of experience knowledge such as big data and artificial intelligence is slightly insufficient for high-level industrial structure, so the incremental effect of industrial structure decreases slightly.

Table 2. Benchmark regression results

variable	mean reversion	Quantile regression				
	（1） FE	（2） Q25	（3） Q40	（4） Q50	（5） Q60	（6） Q75
DEI	1.855**	2.038*	1.954**	1.894**	1.815**	1.705
	(2.60)	(1.79)	(2.15)	(2.25)	(1.98)	(1.36)
Control	YES	YES	YES	YES	YES	YES
N	210	210	210	210	210	210
R2	0.688					
FE	YES	YES	YES	YES	YES	YES

Note: * P<10%, ** P<5%, *** P<1%. The same below.

3.2 Intermediary effect test

Table 3 shows the test results of intermediary effect of technological innovation. According to the results in column (2), it can be seen that the regression coefficient between digital economy andtechnological innovation is significantly positive at the level of 1%. The coefficient of digital economy and technological innovation in column (3) is significantly positive. According to the causal stepwise regression test, it is judged that technological innovation plays a partial intermediary role in the digital economy affecting the upgrading of industrial structur.

Table 3. Test results of intermediary effect

variable	（1）	（2）	（3）
	ISU	PATE	ISU
DEI	1.855**	2.322***	1.371*
	(2.60)	(3.67)	(1.73)
PATE			0.209*
			(1.91)
Control	YES	YES	YES
N	210	210	210
R2	0.688	0.903	0.696
FE	YES	YES	YES

Table 4. Regional heterogeneity test

variable	ISU
DEI*east	2.732***
	(4.14)
DEI*middle	4.999***
	(5.80)
Control	YES
N	210
R^2	0.570
FE	YES

3.3 Regional heterogeneity analysis

Different regions in China have different resource endowment conditions and unbalanced economic development, so the impact of digital economy on industrial structure upgrading in different regions may be different. This paper divides the region into three regions: east, middle and west. DEI*east and DEI*middle respectively represent the cross-product terms of virtual variables and digital economy in the eastern and central regions. The results of Table 4 show that although the development level of digital economy in different regions is different, it plays a significant positive role in promoting the upgrading of industrial structure, with the central region > the eastern region > the western region.

4.   conclusions and policy recommendations

Whether and how the digital economy affects the upgrading of industrial structure is a hot issue that the government and all sectors of society pay close attention to. This paper uses a variety of econometric models to discuss the effect and internal influence mechanism of digital economy on industrial structure upgrading from a more subtle scale. It is found that: firstly, the development of digital economy has a significant positive impact on the upgrading of industrial structure, and can make substantial contributions to the upgrading of industrial structure. Second, the digital economy can promote the upgrading of industrial structure by promoting technological innovation. Thirdly, the effect of the development of digital economy on the upgrading of industrial structure has obvious regional heterogeneity, with the central part > the eastern part > the western part.

Based on the research conclusions, this paper puts forward the following policy suggestions:

First, improve the construction of digital infrastructure and lay a solid foundation for the development of digital economy. China needs to continue to promote and deepen the development of digital economy, strengthen the digital infrastructure, promote the co-construction and sharing of information and communication infrastructure such as 5G base stations, wireless optical cables, mobile communication networks, etc., and make the digital economy a continuous driving force to

guide the upgrading of industrial structure and technological innovation. Second, improve the ability of technological innovation and provide "new vitality" for upgrading the industrial structure driven by the digital economy. Optimize R&D conditions, create a good atmosphere for innovation, and strengthen support for technological innovation of enterprises and R&D investment of scientific research institutions and universities; Formulate relevant policies to encourage independent innovation and build a perfect innovation incentive mechanism; Establish a collaborative innovation mechanism between the government and Industry-University-Research, and form a benign interaction between digital industry development and scientific and technological innovation. Third, implement a differentiated and dynamic digital economy development strategy. To promote the development of digital economy in the future, we should give full consideration to the differences of economic and technological development levels in different regions. In the central and western regions, it is necessary to speed up the development of digital economy and narrow the "quantity" gap with the eastern regions. In the future, the eastern region should pay more attention to the improvement of the "quality" of digital economy, and improve the utilization efficiency of digital facilities in technological innovation and even industrial structure upgrading.

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