

The Influence of Digital Economy Development and Household Consumption Upgrading on Industrial Structure Upgrading

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Abstract. Data elements have become one of the important factors of production. This paper uses the panel data from 10 provinces in China from 2022 to 2023 for empirical analysis, studies the impact of digital economy on the upgrading of industrial structure, and analyzes how the digital economy promotes the upgrading of industrial structure from the perspective of residents' consumption. The results show that the development of digital economy has a significant positive effect on the industrial structure upgrading, and the effect of digital economy after the threshold value; the development of digital economy can promote the industrial structure upgrading by promoting the consumption upgrading; the effect of digital economy on promoting the industrial structure upgrading decreases from the west to the east.

Keywords: Intermediation effect of upgrading industrial structure in digital economy

1. Introduction

The world today is undergoing a new transformation in technology and industry. China's digital economy is an important force in promoting industrial transformation and upgrading. What is the direct effect of the development of digital economy to promote the upgrading of industrial structure? To what extent the development of digital economy promotes industrial upgrading is realized by the intermediary role of residents' consumption upgrading is the problem to be studied in this paper.

2. Literature review

The digital economy is an economic activity mainly based on the Internet and related information and communication technologies (ICT). This kind of activities take the data elements as the key resources, take the information network as the carrier. (2022) found that the positive driving effect of digital economy development in the eastern and central region on the optimization of industrial structure is significantly greater than that in the western region. Wang Xiaowen et al. (2023) and Shen Yufeng, Liao Dongsheng (2022) found that the role of digital economy in promoting the promotion of industrial structure is more obvious in the central and western regions. However, a few scholars have pointed out that the development of the digital economy is not necessarily beneficial to industrial upgrading and economic development. This paper constructs a fixed-effect model to investigate the linear relationship of digital economy for the upgrading of industrial structure, and constructs a threshold panel model to investigate the nonlinear relationship. This paper will also analyze the regional heterogeneity of the impact of digital economy on the upgrading of industrial structure.

3. Theoretical mechanisms and research hypotheses

3.1 Digital economy and industrial structure upgrading

The development of the digital economy has expanded the scope of the use of digital technologies such as the Internet, big data, artificial intelligence and cloud computing, promoted the integrated development of the digital economy and industries. The rapid rise of e-commerce, digital inclusive finance and platform economy has promoted the change of production and consumption forms. Hypothesis 1b: There is a threshold effect on the promotion effect of digital economy on the upgrading of industrial structure.

3.2 Digital economy and the upgrading of consumer consumption

The development of the digital economy has expanded consumption channels and changed consumption patterns and habits. The digital economy with 5G, cloud computing, blockchain, artificial intelligence and other digital technologies as the core has promoted the digital development of the industry, broken the spatial distance between rural areas and urban areas, and greatly tapped the consumption potential of rural residents. With the improvement of residents' income level, its consumption structure will continue to upgrade. Based on the above analysis, study hypothesis 2. Hypothesis 2: Digital economy has a significant positive effect on promoting the upgrading of residents' consumption.

3.3 Digital economy, household consumption upgrading and industrial structure upgrading

Under the condition of "consumer first" market economy, the change of customer demand will eventually lead to the change of the supply structure of goods. Only by constantly developing and innovating products can manufacturers adapt to the changes in the market, otherwise they will be eliminated. The emergence of new demand will promote the rapid development of high-tech manufacturing industry, promote the flow of resources between industries, and continuously optimize and upgrade the industrial structure. Based on the above analysis, the study hypothesis 3 is proposed here. Hypothesis 3: There is an intermediary effect in the impact of digital economy on industrial structure upgrading.

4. Model setting and data description

4.1 Model setting

4.1.1 Benchmark regression model

Based on the above theoretical analysis, in order to explore the impact of digital economy on the upgrading of industrial structure, the benchmark regression model is established as follows:

$$upgit = \beta_0 + \beta_1 deit + \beta_2 X_{it} + \varepsilon_{it} \quad (1)$$

I represents region, t represents time, upgit and deit represent the level of industrial structure and digital economy development in t period, X_{it} is a series of control variables, ε it is a random disturbance term, and β_0 is a constant term.

4.1.2 The threshold effect model

According to the analysis of the above theory part, there is a threshold effect of digital economy to promote the upgrading of industrial structure. In order to investigate the non-linear relationship of digital economy on the upgrading of industrial structure, this paper establishes the following threshold model:

$$upgit = \beta_0 + \beta_1 deit (\eta < \gamma) + \beta_2 deit (\eta \geq \gamma) + \beta X_{it} + \varepsilon_{it} \quad (2)$$

Where $deit()$ is an indicator function with a value of 1 or 0, the value is 1 when the condition is met, and the value is 0. This mode is a single threshold model, of course, it can also be expanded to the multiple threshold model through the threshold regression test. η represents the threshold variable, and γ is the threshold value to be estimated.

4.1.3 Mediation effect model

In this paper, household consumption is taken as the intermediary variable. Drawing on the research of Wen Zhonglin et al. The specific formula construction of the model is formula (3) - (5):

$$upgit = \beta_0 + c deit + \beta X_{it} + \varepsilon_1 \quad (3)$$

$$C_{uit} = a_0 + a deit + \beta X_{it} + \varepsilon_2 \quad (4)$$

$$upgit = C_0 + c' deit + b C_{uit} + \beta X_{it} + \varepsilon_3 \quad (5)$$

Where, C_u is the mediating variable, c is the total effect, and $c = ab + c'$. The ab indicates the mediation effect, the indirect effect and c' indicates the direct effect. X is a set of control variables.

The gradual regression method is used to test the intermediary effect: the first step, the total effect of digital economy on the industrial structure upgrading in formula (3), whether the measurement coefficient c is significant; the second step, the effect of digital economy on the degree of the mediation variable in formula (5), and whether the measurement coefficient a and b are significant; if both are significant, the mediation effect is proved.

4.2 Variable selection

4.2.1 Interpreted variables

Upgrading of industrial structure (upg): The upgrading of industrial structure is defined as the process or trend of the transformation from the low form to the high form, which refers to the continuous transformation of the industrial structure to the service industry, that is, the transformation from the traditional industry to the tertiary industry.

4.2.2 The explanatory variables

Development level of digital Economy (de): There are various kinds of research on the construction and measurement of digital economy indicators. The application of digital technology permeates every aspect of industrial development. Therefore, does not reflect the influence of digital economy on social structure transformation, draw lessons from Wang Xiaowen (2023).The evaluation index system of the development level of digital economy is shown in Table 1.

Table 1. Evaluation index system of digital economy development level measurement

	Level 1 indicators	Level 2 indicators	unit
figure economy develop horizontal	digital economy infrastructure	Total telecom business	Ten thousand yuan
		The Internet broadband access port	Ten thousand
		Cable line length	KM
		Mobile phone base station	Ten thousand households
	digital economy Application degree	Website number	Ten thousand
		Mobile phone penetration rate	%
		Express business revenue	Ten thousand yuan
		Internet broadband access to the users	Ten thousand households
	digital economy development degree	R & D input strength	Ten thousand yuan
		Revenue from software products	Ten thousand yuan
		Information employment personnel	thousands of people

4.2.3 Mediation variables

Upgrading of residents 'consumption structure (cu), based on the practice of Du Peng and Lou Feng (2023), this paper uses the sum of the expenditure of rural residents' daily necessities and services, transportation and communication, education, culture, entertainment and health care projects to measure the consumption upgrading level of rural residents.

4.2.4 Control variables

To prevent missing variables model estimation deviation, draw lessons from zhen-hua wang (2022), wang fang (2022), this paper also joined a number of control factors, and analyzes the influence of the transformation and upgrading of industrial structure: (1) government intervention (gov): government funding can effectively promote the optimization of regional industrial structure optimization and promotion. (2) Per capita GDP (pgdp): the industrial structure will be affected by the regional economic development level, and select the regional per capita GDP to measure the regional economic development level.(3) Urbanization (urb): The urbanization rate will affect the process of industrial structure upgrading, which is expressed by the proportion of urban population in the total population.(4) Urban-rural gap (urg), the urban-rural income gap is an external factor

affecting the industrial structure, which is measured by the ratio of urban per capita disposable income to rural per capita disposable income.

4.3 Data sources

This paper aims to study the impact of digital economy and household consumption on the upgrading of industrial structure. The data derived from China Statistical Yearbook over the years use linear interpolation method to supplement the missing data. Table 2 shows the descriptive statistical results of the variables.

Table 2: Descriptive statistical results

variable	unit	sample number	mean value	standard deviation	Mix	Max
upg	%	310	0.903	0.052	0.689	0.998
de		310	0.125	0.127	0.033	0.746
cu	%	310	8.091	0.375	7.550	11.099
pgdg	Ten thousand yuan	310	5.791	2.895	1.971	18.398
urb	%	310	58.598	12.793	22.750	89.600
gov	%	310	0.284	0.206	0.107	1.379
urg	Yuan	310	2.026	0.610	0.916	4.821

5. Empirical test

5.1 Benchmark regression

In this paper, empirically test the impact of digital economy on industrial structure upgrading. Stepwise regression was used to avoid the effect of multicollinearity on the results. In Table 3, model (1) included only the core explanatory variables for regression, and model (2) to model (5) added control variables for analysis.

Table 3: Test results of digital economy gradually returning to the upgrading of industrial structure.

variable	upg				
	(1)	(2)	(3)	(4)	(5)
de	.216*** (.022)	.111*** (.021)	.068*** (.022)	.046** (.021)	.078*** (.024)
urb		.002*** (0)	.002*** (0)	.001** (0)	.001*** (0)
urg			.029*** (.006)	.01 (.007)	.004 (.007)
pgdp				.009*** (.002)	.008*** (.002)
gov					.042*** (.014)
_cons	.876*** (.004)	.759*** (.011)	.734*** (.012)	.788*** (.016)	.755*** (.019)
Observations	310	310	310	310	310
R-squared	.248	.469	.51	.543	.557
Standard errors are in parentheses					

*** p<.01, ** p<.05, * p<.1

5.2 Threshold inspection

As shown in table 4, table 5, according to the inspection of the threshold effect, digital economy of industrial structure upgrading single threshold effect, threshold value of 0.248, there is no double threshold and triple threshold effect, namely the digital economy on the influence of industrial structure upgrading has two differentiation stage, assuming 1b validation, and in the digital economy through the threshold of 0.248, the influence of digital economy on industrial structure upgrading from 0.237 to 0.094, digital economy of industrial structure upgrading with the development of digital economy to flat.

Table 4: The threshold estimates

The variable	threshold	Threshold estimate	The 95% confidence interval
de		First threshold value 0.248	[0.207 0.257]

Table 5 : The threshold model estimation results

variable	Single threshold model
de	
de (de<0.248)	0.237***
de (de ≥ 0.248)	0.094***
constant term	0.735***
controlled variable	control
Year effect	control
Province effect	control
R2	0.513

5.3 Mediation effect test

Table 6 in the regression results show that in the model (1), the digital economy has a significant positive impact on industrial structure, on the basis of the model (2), the digital economy has significant positive impact on household consumption, hypothesis 2 verified, in the model (3), the digital economy and consumption has significant positive effect on industrial structure upgrading, coefficient a=0.215, coefficient b=0.007, measurement coefficient a and b significant and coefficient c is positive, so consumer consumption is indirect transmission mechanism, 3 hypothesis 3.

Table 6: Test results of the intermediary effect of household consumption

variable	(1)	(2)	(3)
	upg	cu	upg
de	.078***	.215*	.077***
	(.024)	(.12)	(.024)
cu			.007*
			(.011)
urb	.001***	.016***	.001***
	(0)	(.002)	(0)
urg	.004	.081**	.003
	(.007)	(.037)	(.007)
pgdp	.008***	.009	.008***
	(.002)	(.01)	(.002)
gov	.042***	-.024	.042***
	(.014)	(.069)	(.014)

cons	.755***	7.751***	.703***
	(.019)	(.098)	(.091)
Observations	310	310	310
R-squared	.557	.696	.558
Standard errors are in parentheses			
*** p<.01, ** p<.05, * p<.1			

5.4 Stability and endogeneity test

In order to further ensure that the previous empirical regression results are reliable, referring to the practice of Zhang Chi (2023), this paper also makes the following robustness tests: First, replace the explained variables. According to Clark's law, the increase of the proportion of non-agricultural industry output value is an important symbol of industrial upgrading, so the weight of one, two and three industrial structures are 1,2,3 respectively, so as to comprehensively measure the upgrading of

industrial structure. The specific formula is: $gj = \sum_{i=1}^3 cy_i \times i$. The regression results after excluding the extreme values are shown in Table 7 (4) (5) (6). The regression results are basically consistent with the previous empirical results, indicating that the previous study results are robust.

Table 7: The robustness test

	Change of the explained variable			Extracts were removed		
	(1)	(2)	(3)	(4)	(5)	(6)
	upgiv	cu	upgiv	upg	cu	upg
de	.075*	.215*	.070*	.079***	.177**	.079***
	(.043)	(.12)	(.044)	(.028)	(.079)	(.028)
cu			.023*			.003*
			(.021)			(.021)
urb	.007***	.016***	.006***	.001***	.017***	.001***
	(.001)	(.002)	(.001)	(0)	(.001)	(.001)
urg	.1***	.081**	.098***	.006	.125***	.006
	(.013)	(.037)	(.014)	(.008)	(.021)	(.008)
pgdp	-.003	.009	-.003	.008***	.003	.008***
	(.004)	(.01)	(.004)	(.002)	(.006)	(.002)
gov	.207***	-.024	.208***	.044**	-.135***	.043**
	(.025)	(.069)	(.025)	(.018)	(.052)	(.019)
cons	1.746***	7.751***	1.571***	.746***	7.673***	.769***
	(.036)	(.098)	(.167)	(.019)	(.057)	(.164)
Observations	310	310	310	281	281	281
R-squared	.723	.696	.724	.572	.883	.566
Standard errors are in parentheses						
*** p<.01, ** p<.05, * p<.1						

In order to overcome the possible endogeneity problems in the model, the lag-phase lupg of industrial structure was taken as the explained variable, and the systematic GMM method was used to test the endogeneity of the benchmark model, and the fitting results were obtained as shown in Table 8. The results of the endogeneity test are basically consistent with the benchmark fit.

Table 8 shows the endogeneity test

	(1)	(2)	(3)
	lupg	cu	lupg
de	.107***	.142*	.107***
	(.033)	(.181)	(.033)

cu			.001*
			(.009)
urb	-.002***	.014***	-.002***
	(0)	(.003)	(.001)
urg	-.041***	-.001	-.041***
	(.01)	(.069)	(.01)
pgdp	.01***	.023	.01***
	(.003)	(.017)	(.003)
gov	-.069***	-.09	-.069***
	(.014)	(.272)	(.014)
_cons	1.034***	7.976***	1.041***
	(.021)	(.126)	(.073)
Observations	279	279	279
R-squared	.202	.496	.202
Standard errors are in parentheses			
*** p<.01, ** p<.05, * p<.1			

5.5 Further inspection

In order to test the regional differences of digital economy on the upgrading of industrial structure, this paper estimates the subsamples of 31 provinces (cities) in the total sample according to the eastern, central and western regions according to the division of the National Bureau of Statistics. The regression results are listed in Table 9 (3) (4) (5). The reason is that the development level of digital economy in the central and western regions lags far behind that in the eastern region, so the marginal effect of digital economy on the upgrading of residents' consumption is stronger.

Table 9: Results of the heterogeneity analysis

	east	middle	west
	(3)	(4)	(5)
	upg	upg	upg
de	.014*	.185*	.203**
	(.045)	(.2)	(.085)
urb	.009***	.009***	.004***
	(.001)	(.002)	(.001)
urg	.096***	.11***	.041*
	(.014)	(.03)	(.024)
pgdp	-.005	-.039***	.001
	(.004)	(.015)	(.005)
gov	.157	-1.221***	.121***
	(.107)	(.42)	(.023)
_cons	1.64***	2.19***	.544***
	(.036)	(.19)	(.073)
Observations	110	80	120
R-squared	.811	.402	.44

6. Conclusions and suggestions

Based on the panel data of 10 provinces in China from 2022 to 2023, this paper uses the panel data regression model, panel threshold model and intermediary effect model respectively to study the linear and non-linear effects of digital economy on the upgrading of industrial structure, as well as the intermediate transmission mechanism of household consumption in this effect. The study found that: (1) the development of digital economy has a significant positive impact on the upgrading of industrial structure, and the endogenous problems and one system are excluded.

Based on the above research conclusions, the following suggestions are made: Focusing on consumption upgrading and changes in demand, we will vigorously foster digital emerging industries and business models and promote the upgrading of industrial structure. Third, steadily promote the construction of supporting facilities for digital economy in the central and western regions, and make full use of the opportunities brought by digital economy for the upgrading of industrial structure.

References

- [1] CAI Ning, Fu Jianhua, Qiao Shuchen. The influence and function mechanism of digital economy development on the upgrading of industrial structure [J]. Business Economics Research, 2022 (23): 182-184.
- [2] Dai Kuizao, Huang Zi, Wang Simin. Has the digital economy promoted the upgrading of China's service industry structure?[J]. Quantitative economy, Technical and economic Research, 2023,40 (02): 90-112.
- [3] Du Peng, Lou Feng. The influence of digital development level on rural residents' consumption upgrading: theoretical analysis and empirical test [J]. Business Economics Research, 2023, No.860 (01): 47-50.
- [4] Hu Haiyang, Yao Chen. Digital economy, technological innovation and advanced industrial structure —— Empirical analysis based on provincial panel data [J]. Research on Technical Economics and Management, 2023 (02): 7-11.
- [5] Yang Liu. Optimization of consumption structure and industrial structure upgrading of digital economy [J]. Economics and Management, 2023,37 (02): 68-75.
- [6] Long Yunan, Kong Deyuan, Huang Yi. Research on the influence mechanism and countermeasures of digital economy in promoting the upgrading of industrial structure —— Based on the analysis of energy node, financial structure and household consumption structure [J]. Scientific Management Research, 2023,41 (01): 80-89.
- [7] Liu Hedong, Ji Ran. Research on the mechanism and effect of digital Economy in promoting the upgrading of industrial structure [J]. Scientific and technological Progress and Countermeasures, 2023,40 (01): 61-70.
- [8] Shen Yufeng, Liao Dongsheng. Research on China's Digital Economy Development in Promoting the Transformation and Upgrading of Industrial Structure —— Empirical test based on provincial panel data [J]. Regional Finance Research, 2022 (12): 79-86.
- [9] The Wang's family, Yuan Chunlai, Ma Ning. The impact of digital economy development on industrial structure and industrial efficiency: empirical evidence from the provincial level [J]. China Science and Technology Forum, 2022 (12): 117-127.
- [10] Wang Xiaowen, Chen Mingyue, Chen Nanxu. Green technology innovation and upgrading of industrial structure in the digital economy [J]. Economic problems, 2023 (01): 19-28.