

# ***The Impact of Digital Economy on the Upgrading of Industrial Structure: Based on the Perspective of Consumption Structure and Technological Innovation***

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**Abstract:** With the continuous changes in the structure of consumer demand and the rapid development of scientific and technological innovation, the digital economy is increasingly becoming an important driving force to promote industrial upgrading. This article explores the impact of it on industrial upgrading and the interaction of mechanism factors based on panel data from 31 provinces from 2014 to 2021. The empirical results indicate that: (1) The progression of the digital economy has obviously promoted the upgrading of China's industrial structure; (2) The digital economy provides consumers with more diversified and personalized consumption choices, and promotes the transformation of traditional industries to high value-added and high-quality directions; (3) The digital economy has promoted the continuous breakthrough and use of technology, changing the industrial production and business model, and promotes the development of the industry; (4) There is a two-way feedback between consumption upgrading and technological innovation, which jointly promote industrial upgrading. After robustness testing, the above conclusion is still valid. Finally, this article summarizes the positive influence of the digital economy on industrial upgrading and proposes policy recommendations from the supply and demand.

**Keywords:** industrial structure, technological innovation, consumer upgrading, digital economy.

## **1. Introduction**

In recent years, with the rapid development of digital technologies, the digital economy has become a new engine for global economic growth. The digital economy not only changes people's lifestyles and business models, but also benefit for upgrading of industrial structures and economic transformation in various countries. The development of the digital economy has many remarkable characteristics: the wide application of digital technologies, the deepening of industrial integration and the rise of innovative enterprises. Meanwhile, the consumer market that breaks through the geographical and information restrictions will rely more on digital systems, providing a new development path for enterprises.

Previous studies on digital economy and industrial structure have ignored the other end regardless of whether they focus solely on the demand side or the supply side. The influence of the digital economy on the actual variables is extensive and diversified. The change of consumption structure

does not entirely come from the progress of the digital economy, and technological change is not entirely equivalent to upgrading the industrial structure. Consumption upgrading often have an impact on industrial structure through changes in each other. It is also more realistic to analyze multiple pathways. Therefore, the innovation point of this paper is to concentrate on the interaction of two perspectives and test the transmission path of digital economy affecting industrial upgrading. Besides, the paper further improves the relevant model framework and improves the interpretation and prediction ability of the model.

In short, only by guiding residential consumption, stimulating the enthusiasm of technological innovation, applying innovative technologies, and stimulating residents' consumption upgrading, can we fully grasp the dynamic operation of the economy, grasp the main contradiction of the market economy, and realize the upgrading of traditional industries.

## 2. Literature review

Chi Mingyuan et al. believe that digital economy-related industries are highly permeable and transform traditional industries through the Internet and e-commerce[1]. From the perspective of demand, Liu Guo-wu and Li Junhua believe that it can promote the transformation and upgrading of industrial structure through three mechanisms: per capita income effect, marketization degree effect and urbanization effect[2]; Yan Se et al. utilized the multi-sector general equilibrium model and argued that the change of demand structure had a significant impact on China's industrial structure transformation and productivity improvement[3]; Long Yun 'an et al. mentioned in the article that the entry of high-end products with higher demand by residents into the market will promote the acceleration of the derivation of new business forms[4].

From the perspective of supply, the study of Gao Yuelin et al. shows that technological innovation is a key factor indirectly affecting and promoting the upgrading of industrial structure [5]; Liu Yang and Chen Xiaodong built the digital economy indicator system based on three dimensions and found that human capital are also factors that promote significant upgrading of industrial structure in the digital economy[6]. According to the study of Petersen et al., multinational corporations help enterprises innovate digital products and processes and develop profitable customer-level strategies in the digital economy environment[7]. Omoge et al., using the banking industry as an example, found that the use of new technologies has a positive direct impact on consumer behavior[8].

By summarizing the existing literature, it can be seen that the existing studies have the following points to be supplemented and improved: First, the existing studies on the digital economy, technological innovation, consumption upgrading, and industrial structure mostly focus on the relationship between any two, which means the question about how the supply side or demand side affects the industrial structure in a single thread. There are relatively little literature that link them together and establish an analytical framework based on national data. Second, the interaction between supply and demand is ignored.

## 3. Theoretical analysis and research hypothesis

### 3.1. The transmission role of consumption upgrading and technological innovation

The progression of the digital economy has led to an increase in online consumption among people, and more luxury brands are using social media to increase brand recognition and develop customer relationships[9]. The transformation of digital consumption channels online, preference intelligent, model service has changed the driving mechanism of consumption on industrial development, and has exerted a unique function in accelerating the transformation of industrial structure[10].

The digital economy has promoted technological R&D and innovation. The development of the digital economy has brought huge amounts of data. New technologies like AI and blockchain are

emerging and enable more extensive technological innovation in various industries and fields, and promoted the improvement of total factor productivity[11]. Promote the upstream and downstream industry chain relationship has been a single linear model into a network of cooperation between multiple suppliers industry chain relationship[12].

Hypothesis 1. In the transmission of digital economy and industrial upgrading, both the upgrading of consumption structure and technological innovation have a positive impact.

### 3.2. Two-way feedback mechanism of consumption upgrading and technological innovation

On the one hand, consumption upgrading can stimulate the demand for technological innovation. In a market with a certain stock, when a reasonable consumer demand is stronger, the fierce competition between enterprises will accelerate the technological change and innovation, and drive the development of related industries, so that the industrial structure will develop in high-level rationalization. A good example is that under the rapid development and replacement of smart phones, users want more diversified functions and convenience, which encourages manufacturers to constantly develop new features.

On the other hand, technological innovation can promote the realization of consumption upgrading. In order to expand the market and increase profits, enterprises will compete to develop new services and new industrial chains[13]. The digital technology has enhanced the industrial production efficiency and promoted the organizational structure reform and optimization, and the cost and capital turnover rate of the industry have decreased, and the price has decreased, so as to stimulate consumption. At the same time, technological innovation has an income effect, which can improve residents' current income and expected income, and also directly determines the degree of consumption upgrading[14].

Hypothesis 2. The bidirectional feedback between consumption structure upgrading and technological innovation drives industrial upgrading.

## 4. Model design and data description

### 4.1. Empirical model design

Based on provincial panel data, a multi-line regression model with interactive terms is established. To solve the endogenous issues caused by missing variables, control variables are the level of foreign asset investment, per capita GDP and government intervention level. Build a fixed effects model based on these variables:

$$Is_{it} = \beta_0 + \beta_1 De_{it} + \beta_2 Inv_{it} + \beta_3 Gdp_{it} + \beta_4 Gov_{it} + u_{it} \quad (1)$$

Among them,  $Is$  represents the upgrading of industrial structure;  $De$  represents the development level of digital economy;  $Inv$  is the level of foreign investment;  $Gdp$  is the level of GDP per capita and  $Gov$  is the level of government intervention;  $u_{it}$  is a random error term, and logarithmic treatment is performed on continuous variables with larger values. In addition, two mechanism variables of consumption structure upgrading and technological innovation are added to the model, and another interaction item is constructed: digital economy and consumption structure upgrading ( $DeCons$ ), digital economy and technological innovation ( $DeInnov$ ), and consumption structure upgrading and technological innovation ( $ConsInnov$ ). The model is as follows:

$$Is_{it} = \beta_0 + \beta_1 De_{it} + \beta_2 DeCons_{it} + \beta_3 Cons_{it} + \beta_4 Innov_{it} + \beta_5 Inv_{it} + \beta_6 Gdp_{it} + \beta_7 Gov_{it} + u_{it} \quad (2)$$

$$Is_{it} = \beta_0 + \beta_1 De_{it} + \beta_2 DeInnov_{it} + \beta_3 Cons_{it} + \beta_4 Innov_{it} + \beta_5 Inv_{it} + \beta_6 Gdp_{it} + \beta_7 Gov_{it} + u_{it} \quad (3)$$

$$Is_{it} = \beta_0 + \beta_1 De_{it} + \beta_2 ConsInnov_{it} + \beta_3 Cons_{it} + \beta_4 Innov_{it} + \beta_5 Inv_{it} + \beta_6 Gdp_{it} + \beta_7 Gov_{it} + u_{it} \quad (4)$$

## 4.2. Variable selection and data source

### 4.2.1. Explained variable

Industrial structure upgrading (Is). According to the Petty-Clark theorem combined with today's economic context, the transformation to capital and technology intensive industries also reflects the upgrading of industrial structure. The advanced level of structure indicates that the correlation between industrial structures is increasing, and the degree is positively related to that of coordination between industries. With reference to the practice of Fan Decheng and Xiao Wenxue, the article uses the calculation method of the ratio of output value between the secondary and tertiary industries[15].

### 4.2.2. Core explanatory variable

Digital economy development level (De). This index refers to the construction standard of Zhao Tao, and adopts five data indicators of Internet development (including the Internet users per 100 people, mobile phone users per 100 people, and the software industries) and digital financial inclusion index[16], Principal component analysis was used to fill in the missing parts of each year by using the linear trend of data. The value of the digital economy indicator is positively related to the development level of the digital economy.

According to the cumulative contribution rate of 80%, two principal components were selected and the principal component scores f1 and f2 were calculated. The calculated variance contribution rate was taken as the weight. Finally, the formula  $Y=0.6560f1+0.1873f2$  was adopted to establish the comprehensive evaluation criteria, where Y represents the comprehensive score.

### 4.2.3. Mechanism variable

Consumption structure upgrading (Cons). According to the practice of Wang Yifei, Pang Xiaopeng, and Wang Hainan, the total consumption expenditure for the development of hedonic consumption is taken as a factor to measure residents' consumption upgrading. The larger the value, the more residents' hedonic consumption and the higher the upgrading degree of consumption structure[17]. Technological innovation (Innov) is measured by the number of patents granted in each province, reflecting the level of innovation and value creation of enterprises and other social entities in response to market demand.

### 4.2.4. Control variable

Based on the analysis of above factors, the paper selects three indicators, foreign investment level, government intervention level and per capita GDP, as control variables. The level of foreign asset investment (Inv) is measured by the total foreign investment of each province, and the level of government intervention (Gov) is measured by the general public budget expenditure.

Table 1: Descriptive statistics of variables.

| Variable | Sample size | Mean value | Standard deviation | Minimum value | Median value | Maximum value |
|----------|-------------|------------|--------------------|---------------|--------------|---------------|
| Is       | 248         | 1.450      | 0.740              | 0.704         | 1.284        | 5.244         |
| De       | 248         | 0.623      | 0.060              | 0.532         | 0.621        | 0.886         |
| Cons     | 248         | 7744.179   | 2837.256           | 0.432         | 7311.865     | 18051.100     |
| Innov    | 248         | 75881.948  | 1.17e+05           | 146.000       | 37360.500    | 8.72e+05      |

Table 1: (continued).

|     |     |           |           |           |           |           |
|-----|-----|-----------|-----------|-----------|-----------|-----------|
| Gdp | 248 | 61549.297 | 29719.094 | 25100.920 | 52378.000 | 1.88e+05  |
| Gov | 248 | 5751.117  | 3120.102  | 1000.450  | 5107.840  | 18247.010 |
| Inv | 248 | 2.77e+05  | 4.96e+05  | 1328.000  | 95189.000 | 4.53e+06  |

The data are mainly collected from the official website of the National Bureau of Statistics, the Guotai 'an database, the statistical yearbook of each province and the statistical bulletin of national economic development of each province. The time span is from 2014 to 2021, the research object is 31 provinces in China, and finally 248 valid sample data are obtained. Descriptive. Table 1 shows the basic information of the variables.

## 5. Empirical results and relevant tests

### 5.1. Reference regression

Digital economy on industrial structure: the regression coefficient of the variable De is 7.15, indicating that the impact of the digital economy on that is significantly positive. Among the control variables, government intervention level and foreign investment level are significant and positive, and government intervention exerts a more positive function in promoting.

### 5.2. Test of action mechanism

In this paper, the model includes interaction terms between consumption upgrading and the level of digital economy, as well as it between technological innovation. The final regression results were exhibits in Table 2.

1)The interaction coefficients of consumption structure and digital economy are both obviously positive, and the value is 11.38. The interaction coefficient between technological innovation and digital economy is 4.55, and hypothesis 1 is verified. When examining the transmission effect of consumption and technology factors respectively, the effect of consumption in promoting industrial structure upgrading is the most obvious, followed by technological innovation. This may be because although scientific and technological progress can improve productivity, if there is no corresponding market demand, enterprises may not invest enough resources in technological research and development and innovation, and it is impossible to achieve industrial structure upgrading. Meanwhile, according to the study of Zhang Jianhua et al., it may also be caused by the lack of key core technologies in some high-tech fields in China[18].

2)Interaction: When the two factors are added to the model as interaction terms, the regression result is 3.07, indicating that there is a two-way feedback mechanism between consumption and supply, and hypothesis 2 is verified. Consumer demand can guide enterprises to develop in a more high-end and innovative direction, and enterprises can attract consumers to consume in new areas and subtly guide new consumption concepts. In the study of Khalatur et al., as more and more companies continue to provide new technologies to consumers, the local financial sector also takes digital transformation as a strategic priority. To further determine consumer expectations for financial products and services[19]. This bidirectional feedback mechanism enables two key factors to form a virtuous cycle in the demand and supply side, jointly promoting that upgrading process.

Table 2: Results of model parameter estimation.

|           | (1)       | (2)        | (3)        | (4)         |
|-----------|-----------|------------|------------|-------------|
|           | Is        | Is         | Is         | Is          |
| De        | 3.418***  | 7.594***   | 8.917***   | 9.634***    |
|           | (7.15)    | (9.44)     | (9.39)     | (10.12)     |
| lnGDP     | -0.871*** | -0.484***  | -0.527**   | -0.602***   |
|           | (-7.46)   | (-3.51)    | (-3.18)    | (-3.39)     |
| lnGov     | 0.603***  | -0.0287    | -0.00534   | -0.00881    |
|           | (5.74)    | (-0.31)    | (-0.05)    | (-0.08)     |
| LnInv     | 0.0927*** | 0.238***   | 0.206***   | 0.194***    |
|           | (5.09)    | (6.60)     | (4.82)     | (4.45)      |
| DeCons    |           | 0.00114*** |            |             |
|           |           | (11.38)    |            |             |
| Cons      |           | 0.00000847 | 0.0000486* | 0.0000542*  |
|           |           | (0.42)     | (2.04)     | (2.22)      |
| lnInnov   |           | -0.281***  | -0.282***  | -0.269***   |
|           |           | (-5.73)    | (-4.75)    | (-4.18)     |
| DeInnov   |           |            | 1.663***   |             |
|           |           |            | (4.55)     |             |
| ConsInnov |           |            |            | 0.0000220** |
|           |           |            |            | (3.07)      |
| _cons     | 2.654**   | 2.200      | 1.808      | 2.168       |
|           | (3.00)    | (1.61)     | (1.09)     | (1.22)      |
| N         | 248       | 248        | 248        | 248         |

### 5.3. Endogeneity test

To optimize the reliability of regression analysis and alleviate endogenous problems, the number of urban units employed in the software and IT industry (10,000) was taken as the instrumental variable. It was found that, the corresponding P-value is 0.000, and after solving the endogeneity, the coefficient of digital economy is significantly positive at the level of 1%, and proves that the development of the digital economy has promoted the upgrading of industrial structure without doubt.

### 5.4. Robustness test

Change the sample size. The data of all continuous variables were indent by 1% up or down, and then the regression mentioned above was repeated. The results are shown in Table 3 in the appendix. The

positive and negative polarity and significance of the core explanatory variable of the development level of digital economy have not changed significantly, so the model can be considered robust.

Change the measure of the explained variable. Reusing the ratio of the added value of the tertiary industry to the total regional output value as the indicator for regression, as Appendix Table 4. It indicates that the sign of the main regression indicators have not changed significantly, so we can still determine the positive effect of the digital economy, and the model is robust.

## 6. Conclusion and suggestion

### 6.1. Conclusion

This article analyzes the promotion of industrial structure upgrading by the digital economy, verifies that consumption upgrading and technological innovation are internal influencing mechanisms and play a promoting role, and explains the important significance of the digital economy for that upgrading of various provinces in China. The conclusions can be drawn as follows: (1) The digital economy has indeed greatly promoted industrial upgrading and rapid economic progression in the past few years. This effect is particularly evident in the eastern region. (2) The continuous change of consumer demand plays a driving role in the adjustment of industrial structure. (3) Technological innovation has promoted the continuous upgrading of industries and injected new impetus into economic development. (4) The interaction between consumption and technology is an undeniable aspect of the development of the digital economy. The changes in consumer demand have prompted companies to enhance investment in technology innovation to upgrade their products. Conversely, technological innovation has provided consumers with more and better product and service choices, forming a virtuous cycle.

### 6.2. Suggestion

In the digital economy, governments can implement a range of policy initiatives. First of all, for the progression of the digital economy, the government should establish a special fund for digital transformation to enable traditional industries to meet the needs of the digital age. Constructing experimental zones and integrating digital industries[20]. Establish a sound data management system and privacy protection mechanism, and improve the level of regular supervision by improving the anti-monopoly regulation system[21].

Secondly, in terms of upgrading residents' consumption, we will increase residents' disposable income through tax and fee cuts and other policy measures to stimulate residents' consumption potential. Examples include increasing income distribution, establishing a broader social security mechanism and increasing the minimum wage.

Thirdly, in terms of technological innovation, encourage the combination of technological research and development and industrial application. At the early stage of the life cycle of new industries, market demand should be increased through demand-based policy tools such as transfer payments, product outsourcing, and economic subsidies[22].

Through the formulation of preferential policies and tax reduction measures to optimize the research and innovation environment for enterprises and clearing obstacles for product innovation. At the same time, to create a "digital university" as the supply, platform services as the support of talent cultivation and development highland[23].

To sum up, with the coordination of policies in the three dimensions, we can integrate Chinese industry into the global development trend, integrate digital technology into economic and financial development, and explore better economic development models.

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## Appendix

Table 3: Parameter estimation results after tail reduction processing.

|           | (1)       | (2)        | (3)        | (4)         |
|-----------|-----------|------------|------------|-------------|
|           | Is        | Is         | Is         | Is          |
| De        | 3.006***  | 7.348***   | 8.676***   | 9.356***    |
|           | (6.37)    | (8.91)     | (8.95)     | (9.61)      |
|           |           |            |            |             |
| lnGDP     | -0.835*** | -0.477***  | -0.532**   | -0.606***   |
|           | (-7.30)   | (-3.39)    | (-3.17)    | (-3.39)     |
|           |           |            |            |             |
| lnGov     | 0.630***  | -0.0297    | -0.0130    | -0.0148     |
|           | (6.11)    | (-0.32)    | (-0.12)    | (-0.13)     |
|           |           |            |            |             |
| LnInv     | 0.102***  | 0.237***   | 0.205***   | 0.194***    |
|           | (5.51)    | (6.38)     | (4.66)     | (4.31)      |
|           |           |            |            |             |
| DeCons    |           | 0.00112*** |            |             |
|           |           | (11.27)    |            |             |
|           |           |            |            |             |
| Cons      |           | 0.0000139  | 0.0000539* | 0.0000602*  |
|           |           | (0.64)     | (2.14)     | (2.33)      |
|           |           |            |            |             |
| lnInnov   |           | -0.284***  | -0.281***  | -0.267***   |
|           |           | (-5.70)    | (-4.65)    | (-4.13)     |
|           |           |            |            |             |
| DeInnov   |           |            | 1.664***   |             |
|           |           |            | (4.60)     |             |
|           |           |            |            |             |
| ConsInnov |           |            |            | 0.0000219** |
|           |           |            |            | (3.10)      |
|           |           |            |            |             |
| _cons     | 2.168*    | 2.280      | 2.024      | 2.387       |
|           | (2.51)    | (1.62)     | (1.20)     | (1.33)      |
| N         | 248       | 248        | 248        | 248         |

Table 4: Regression results after replacing indicators.

|       | (1)        | (2)      | (3)      | (4)      |
|-------|------------|----------|----------|----------|
|       | Is         | Is       | Is       | Is       |
| De    | 0.425***   | 0.527*** | 0.590*** | 0.654*** |
|       | (5.56)     | (6.27)   | (6.67)   | (7.58)   |
|       |            |          |          |          |
| lnGDP | -0.0970*** | -0.00315 | -0.00956 | -0.0266  |
|       | (-5.20)    | (-0.22)  | (-0.62)  | (-1.66)  |
|       |            |          |          |          |

Table 4: (continued).

|           |          |              |              |               |
|-----------|----------|--------------|--------------|---------------|
| lnGov     | 0.121*** | 0.0203*      | 0.0189       | 0.0136        |
|           | (7.23)   | (2.13)       | (1.85)       | (1.31)        |
|           |          |              |              |               |
| LnInv     | 0.00406  | 0.0153***    | 0.0135***    | 0.0124**      |
|           | (1.39)   | (4.07)       | (3.40)       | (3.14)        |
|           |          |              |              |               |
| DeCons    |          | 0.0000805*** |              |               |
|           |          | (7.70)       |              |               |
|           |          |              |              |               |
| Cons      |          | 0.0000111*** | 0.0000138*** | 0.0000145***  |
|           |          | (5.20)       | (6.22)       | (6.56)        |
|           |          |              |              |               |
| lnInnov   |          | -0.0363***   | -0.0344***   | -0.0289***    |
|           |          | (-7.10)      | (-6.20)      | (-4.97)       |
|           |          |              |              |               |
| DeInnov   |          |              | 0.173***     |               |
|           |          |              | (5.09)       |               |
|           |          |              |              |               |
| ConsInnov |          |              |              | 0.00000346*** |
|           |          |              |              | (5.34)        |
|           |          |              |              |               |
| _cons     | 0.236    | 0.152        | 0.177        | 0.319*        |
|           | (1.67)   | (1.06)       | (1.15)       | (1.99)        |
| N         | 248      | 248          | 248          | 248           |