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# Can Industrial Digitalization Boost a Consumption-Driven Economy? An Empirical Study Based on Provincial Data in China

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**Abstract:** A consumption-driven economy refers to an economic growth model primarily driven by domestic consumption and is a common goal for the economic growth of various countries. To explore the impact of industrial digitalization on a consumption-driven economy, this paper conducts an empirical study based on data from 31 provinces in China from 2013 to 2021. The empirical test results indicate: first, industrial digitalization significantly promotes the development of a consumption-driven economy, mainly reflected in the improvement of economic foundation and consumption levels, but shows no significant effect on improving the consumption structure. Second, mechanism analysis results show that industrial digitalization can promote the development of a consumption-driven economy by fostering innovation and advancing the industrial structure. Third, heterogeneity analysis results reveal that the promotion effect of industrial digitalization on the consumption-driven economy exists only in eastern and central China but not in western China, indicating that industrial digitalization in underdeveloped areas cannot exert a positive effect on the consumption-driven economy.

**Keywords:** industrial digitalization; consumption-driven economy; industrial structure; consumption level



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## 1. Introduction

A consumption-driven economy refers to a growth model primarily driven by domestic consumption, that is, by expanding domestic demand, especially household consumption, to promote sustained economic growth. National economic growth is generally considered to be propelled by four factors: private sector consumption, investment, government spending, and net exports. The contributions of these components to economic growth can vary across countries and different stages of economic development. China's early economic growth was primarily driven by exports and investment, a model suitable for developing economies in the early stages of industrialization. This is because the weak infrastructure in the early stages of industrialization provides possibilities for investment-driven economic growth. However, after reaching a certain stage, the marginal effect of investment diminishes, reducing its pulling effect on the economy. At this point, the economy needs to seek other factors to drive growth. Empirical evidence suggests that after completing the industrialization process, developed countries gradually shift to an endogenous growth model led by domestic consumption demand, transitioning from an investment-driven economy to a consumption-driven economy. The difference between a consumption-driven economy and an investment-driven economy lies in the different driving forces of economic growth. An investment-driven economy mainly relies on investment to drive economic growth, while a consumption-driven economy relies more on residents' consumption demand. The investment-driven economy has problems such as insufficient consumption and excessive dependence on external demand. Compared to the consumption-driven economy, it is more susceptible to the impact of the international economic situation, which is not conducive to the long-term stable development of the country.

In recent years, China has been committed to promoting the transition of economic growth from an investment-driven model to a consumption-driven one, achieving certain results. However, problems such as unstable consumption and insufficient release of consumption potential still exist. In the past five years, the average contribution rate of China's final consumption expenditure to GDP growth was 46.4%, with a maximum range of 89.3%. In terms of both the contribution rate and stability, China's consumption economy lags far behind developed countries like the United States and Japan. How to steadily transition the economic growth model to a consumption-driven one is a crucial issue for China and other developing economies to consider.

Since entering the 21st century, digital technology has flourished, and "digitization" has become an unavoidable wave, with the world gradually stepping into the era of the digital economy. In the theory of endogenous economic growth, technological progress is the decisive factor in ensuring sustained economic growth. The digitalization behavior of enterprises is a comprehensive technological progress in production and operation, so the digitalization of enterprises can promote economic growth. Existing research indicates that the digitalization of enterprises has positive effects in reducing costs and improving efficiency, which are beneficial for economic growth. The inherent advantages of digitalization, such as smarter and more convenient production processes, can help enterprises enhance their production efficiency and capacity, thereby improving their competitiveness [1–3]. Furthermore, digital technology can provide enterprises with more precise business insights, supporting innovation in production processes and operational models [4,5]. Consequently, production costs and management costs decrease [6]. On this basis, digitalization can reduce the carbon emission intensity of enterprises and improve their carbon emission efficiency [7]. In summary, most studies, except for a few, demonstrate that enterprise digitalization brings higher economic and social benefits to enterprises [8–10]. It is worth noting that every industrial revolution has a disruptive impact on the economy and society, and driving economic growth is only one of the impacts of the industrial revolution. The first industrial revolution changed the mode of production, greatly improved production efficiency, and greatly increased the contribution of industry to economic growth. The second industrial revolution extensively promoted electricity and internal combustion engines, promoting the development of heavy industry and chemical industry, and had a disruptive impact on the industrial structure. The third industrial revolution led to rapid growth in the service industry, becoming one of the pillars of economic growth. The fourth industrial revolution, centered around digital technologies such as artificial intelligence and the Internet of Things, has driven the development of the digital economy and achieved large-scale digitization. This also raises the question of what impact industrial digitization will have on economic models.

Industrial digitization is the process of large-scale application of digital technologies such as big data and artificial intelligence. Utilizing digital technology to achieve intelligent and automated production can also help enterprises provide personalized services based on big data and artificial intelligence technologies. These characteristics are in line with the development conditions of a consumption-driven economy; that is, industrial digitization can provide a better environment for the development of a consumption-driven economy. Specifically, industrial digitization can improve the production efficiency of various industries, endow them with stronger competitiveness, and may also give rise to new technological innovations, all of which are beneficial for the development of a consumption-driven economy. Zhang et al. [11] conducted an empirical study based on data from China between 2015 and 2022. Their results show that industrial digitalization can effectively improve the carbon emission efficiency of various sectors, achieving both emission reduction and efficiency improvement. This effect is more pronounced in highly energy-consuming and highly polluting industries such as mining, electricity, heating, and gas. Zhao and Lin [12] conducted a study using agricultural data, also confirming the carbon reduction effect of industrial digitalization. Hao et al. [13] argued that industrial digitalization can effectively promote green technological innovation and empirically demonstrate the marginal increasing characteristic of this effect. From an international competitiveness perspective, the digitalization of a country's industries can enhance its position in the global value chain [14]. Overall, industrial digitalization enhances production efficiency and fosters innovation, which undoubtedly provides the market with a richer and more diverse supply of products. Additionally, the burgeoning development of industries empowered by digital technologies, such as intelligent marketing, e-commerce, mobile payments, and consumer finance, offers consumers a more convenient consumption environment and conditions [15]. Therefore, it is evident that industrial digitalization might promote the development of a consumption-driven economy.

To verify whether industrial digitalization can promote the development of a consumption-driven economy, this paper conducts an empirical study based on China's provincial data between 2013 and 2021. A comprehensive index of industrial digitalization and a comprehensive index of a consumption-driven economy are constructed for regression analysis. Furthermore, the paper explores the mechanisms through which industrial digitalization affects the consumption-driven economy. The main contributions of this paper are as follows: Firstly, previous studies have rarely quantified the development level of a consumption-driven economy as an economic growth model or simply estimated it based on a single indicator such as the proportion of total consumption. This article constructs a comprehensive indicator system to measure the development level of a consumption-driven economy, providing a reference for subsequent research and a basis for policy formulation. Secondly, this article provides new ideas for promoting the development of a consumption-driven economy. After completing the basic industrialization process, an economic growth model dominated by domestic demand is a common goal pursued by all countries. This article verifies the promoting effect of industrial digitization on a consumption-driven economy, providing new ideas for countries to develop a consumption-driven economy. Thirdly, the Fourth Industrial Revolution is still ongoing, and timely clarification of the economic impact of industrial digitization can provide a reference for the government to formulate industrial development policies and promote the healthy and sustainable development of the national economy.

The subsequent sections of this paper are arranged as follows: The second section presents the research design, including the theories and basic hypotheses on how industrial digitalization affects the development of a consumption-driven economy, besides, model design, descriptions of relevant variables, and data are elaborated in this section. The third section conducts econometric tests on the impact of industrial digitalization on the consumption-driven economy; including analyses of the impact of industrial digitalization on the consumption-driven economy and its various dimensions and robustness tests. The fourth section provides further analysis of the impact of industrial digitalization on the consumption-driven economy; including analyses of the impact mechanism and heterogeneity analysis. The fifth section concludes the paper.

## 2. Research Design

### 2.1. Theoretical Analysis and Research Hypotheses

Industrial digitization refers to the process of applying digital technology to traditional industries, which not only means technological innovation but also has a profound impact on the transformation of economic growth models. Firstly, the Solow growth model points out that technological innovation is the main driving force of economic growth. Industrial digitization is a process of technological innovation where the application of technology reduces production costs and improves production efficiency for enterprises [16], ultimately reflected in the growth of economic scale. The sustained and healthy economic growth has created a favorable environment for the development of a consumption-driven economy, which is conducive to the development of a consumption-driven economy. Secondly, from the perspective of consumer behavior and demand theory, industrial digitization stimulates consumer desire and drives the development of a consumption-driven economy by increasing product diversity, facilitating consumption, and promoting the development of personalized services. The digitization of industries has given rise to platform economies centered on digital technology, such as e-commerce and online services [17], breaking down the consumption barriers caused by geographical distance, expanding the market boundaries faced by consumers, and providing them with a wider range of product choices. This diversity drives consumers to try new products and promotes the development of the consumer economy. The digitization of industries has driven innovation in payment methods and financial products, such as mobile payments, online consumer credit, and other consumer-friendly products [18], Created convenient consumption conditions for consumers and further promoted the development of a consumption-driven economy. Industrial digitization endows enterprises with stronger information collection and processing capabilities, enhances their targeted marketing and personalized service capabilities [19], enables consumers' needs to be captured by enterprises in a timely and accurate manner, increases the likelihood of consumption, and promotes the development of a consumption-driven economy. Finally, from the perspective of supply chain management, industrial digitization is a revolution for the entire industry chain, which can promote the optimization and integration of the supply chain and improve the efficiency of supply chain management [20]. With the support of digital technology, the process of transmitting demand signals from consumers to the upstream of the supply chain has become faster, enabling manufacturers to respond to market demand at the fastest speed possible. This not only reduces the operating costs of supply chain enterprises but also accelerates the cycle of production and consumption, promoting the development of a consumption-driven economy.

Overall, combining the Solow growth model, consumer behavior and demand theory, supply chain management theory, and scholars' research, it can be seen that industrial digitization can promote healthy and sustained economic growth, create a favorable consumption environment and conditions, stimulate consumer demand, accelerate production and consumption cycles, and ultimately promote consumption-driven economic growth. Based on the above analysis, this article proposes research Hypothesis 1:

**Hypothesis 1:** *Industrial digitalization can drive consumption-driven economic development.*

According to the theory of innovation diffusion, technological innovation has a feedback effect after going through a wide range of application stages; that is, the widespread application of technology and economic development will further stimulate new technological innovation and application, forming a positive feedback loop. Industrial digitalization is both a process of promoting the application of digital technologies and a process of technology application driving further technological innovation. In the process of industrial digitalization, digital technologies such as artificial intelligence and the Internet of Things are widely applied in various industries [21], meaning that industrial digitalization will promote the adoption rate of new technologies. At the same time, to make digital technologies more suited to their needs, practitioners in different industries need to conduct a new round of research and development based on their specific requirements, forming a virtuous cycle of technology application-technology innovation-technology application. That is, in the process of industrial digitalization, actual demand drives the continuous iteration of digital technologies, which will significantly enhance the level of innovation in the region [22,23]. Continuous innovation can create new consumer demands and stimulate market vitality, which is a key factor in the development of a consumption-driven economy. Based on the above analysis, this paper proposes Hypothesis 2.

**Hypothesis 2:** *Industrial digitalization can promote technological innovation, thereby driving consumption-driven economic development.*

Through the application of advanced digital technologies, industrial digitalization can drive the industrial structure towards a more advanced and complex form, providing a favorable environment for the development of a consumption-driven economy. Advancement of industrial structure refers to the process where the industrial system of a country or region evolves towards higher levels, higher quality, and higher added value. According to the theory of industrial structure upgrading, with the development of the economy, the industrial structure will gradually undergo a process of evolution from low-end to high-end. Industrial digitalization promotes the digital upgrading of all elements across the entire industrial chain, enhancing the production efficiency and quality of the entire industrial chain [24], and significantly improving the productivity and market competitiveness of traditional industries. On this basis, the upstream and downstream of the industrial chain will jointly develop towards high-tech, high-intensity, and high-value-added directions, with digital technologies providing support for this process. Therefore, industrial digitalization can drive industrial upgrading [25]. An advanced industrial structure means an improvement in the quality of products and services, which may also lead to an upgrade in social consumption concepts, making consumers pursue not only the basic functions of products and services but also design and brand, thus shifting the economic growth model towards a consumption-driven economy. Based on the above analysis, this paper puts forward Hypothesis 3.

**Hypothesis 3:** *Industrial digitization can promote the development of a consumption-driven economy by promoting an advanced industrial structure.*

### *2.2. Model Design and Variable Descriptions*

#### 2.2.1. Model Design

The research sample for this paper consists of 31 provinces in China from 2013 to 2021, requiring the use of a panel data model for the study. Given the substantial development disparities among different provinces and the varying development backgrounds in different years, some factors that might influence consumption-driven economic development cannot be quantified as control variables. Therefore, this study employs a two-way fixed effects model to examine the impact of industrial digitalization on consumption-driven economic development. The fixed effects model can minimize the problem of omitted variable bias as much as possible compared to the random effects model. However, compared to dynamic panel models, fixed effects models may have endogeneity issues. Therefore, this article will use a fixed effects model for benchmark regression and a dynamic panel model for endogeneity testing.

The benchmark regression model for this article is set as follows:

$$\mathrm{cde}_{i,j} = \alpha_0 + \alpha_1 \mathrm{indig}_{i,t} + \sum_{j=1}^{n} \delta_j \mathrm{Control}_{j,i,t} + \mu_t + \sigma_i + \varepsilon_{i,t} \quad (1)$$

In Equation (1), $\mathrm{cde}_{i,j}$ represents the level of consumption-driven economic development; $\mathrm{indig}_{i,t}$ represents the level of industrial digitalization; $\sum_{j=1}^{n} \delta_j \mathrm{Control}_{j,i,t}$ represents a series of control variables; $\mu_t$ and $\sigma_i$ represents year dummy variables and individual dummy variables, respectively, and $\varepsilon_{i,t}$ represents the random disturbance term.

#### 2.2.2. Variable Explanation

(1) The explained variable in this paper is the level of consumption-driven economic development, which is a highly comprehensive variable. Therefore, an indicator system is constructed to measure this variable using the index system method.

A consumption-driven economy primarily has three characteristics: a good economic foundation, high consumption levels, and a reasonable consumption structure. Therefore, this paper measures the level of consumption-driven economic development from three dimensions: economic foundation, consumption level, and consumption structure, selecting 11 indicators. The economic environment is a comprehensive evaluation of the level and balance of regional economic development, mainly considering aspects such as economic scale, urban–rural income balance, and income level. Consumption level is evaluated from four aspects: per capita consumption expenditure, the proportion of consumption expenditure to GDP and its contribution to economic growth, and the gap between economic growth driven by consumption and that driven by investment. Additionally, a consumption-driven economy not only implies a high level of consumption but also requires a reasonable consumption structure. There are two aspects to a reasonable consumption structure: a lower proportion of expenditure on essential needs and a higher proportion of expenditure on non-essential needs such as education and entertainment; and an economic cycle driven by consumption that can be completed domestically. Therefore, this paper selects Engel's coefficient, the proportion of education, culture, and entertainment expenditure, and the dependence on foreign trade as three indicators to evaluate the consumption structure. The specific indicator system is as follows (Table 1):

**Table 1.** Indicator System for Measuring Consumption-Driven Economic Development.

| Primary Indicators | Secondary Indicators | Calculation Method | Indicator Attributes |
|---|---|---|---|
| Economic Foundation | Economic Scale | GDP | + |
| | Economic Development Level | Per capita GDP | + |
| | Economic Development Balance | Urban-rural income gap | - |
| | Income Level | Per capita disposable income | + |
| Consumption Level | Consumption Expenditure | Per capita consumption expenditure | + |
| | Consumption Rate | Proportion of consumption expenditure to GDP | + |
| | Consumption-Investment Rate | Consumption growth rate—Investment growth rate | + |
| | Consumption Contribution Rate | Consumption expenditure growth rate/GDP growth rate | + |
| Consumption Structure | Engel's Coefficient | (Food consumption expenditure/Consumption expenditure) × 100% | - |
| | The proportion of Education, Culture, and Entertainment Expenditure | (Education, culture, and entertainment expenditure/Consumption expenditure) × 100% | + |
| | Dependence on Foreign Trade | Proportion of total imports and exports to GDP | - |

The data for this indicator system can be directly obtained from the National Bureau of Statistics of China. This study uses the entropy method to process the collected data, ultimately deriving the level of consumption-driven economic development for the 31 provinces and municipalities in China from 2013 to 2021.

(2) Core Explanatory Variable

The core explanatory variable in this paper is the level of industrial digitalization. Industrial digitalization starts with the adoption of digital technologies by enterprises and gradually expands to the entire industrial chain, ultimately changing the economic operating model. A single indicator cannot fully capture the level of industrial digitalization. Based on this connotation, this paper constructs an indicator system for the level of industrial digitalization in China from three dimensions: industrial transformation, enterprise digitalization, and industrial chain resilience.

In the dimension of industrial transformation, indicators include two aspects: one is the integration level of the entire industry with digital forms, including indicators such as "e-commerce penetration rate" and "e-commerce sales volume"; the other is the scale of the digital industry, measured by the value added of the digital industry. The dimension of enterprise digitalization focuses on the degree of digital transformation of enterprises in the region, including indicators such as the digital transformation level of listed companies and digital-related assets. The dimension of industrial chain resilience considers the regional autonomy, penetration level, and output efficiency of the digital industry, measured by interregional input–output tables. The detailed indicator system is shown below:

Among the 11 indicators in Table 2, four indicators—e-commerce penetration rate, e-commerce sales volume, total software business volume, and website coverage rate of enterprises—are sourced from the National Bureau of Statistics of China, with calculation methods detailed in Table 2. Due to space constraints, the calculation methods for four indicators—value added of the digital industry, degree of enterprise digitalization, digital assets of enterprises, and industrial chain resilience—are provided in Appendix A.

**Table 2.** Indicator System for the Level of Industrial Digitalization.

| Primary Indicators | Secondary Indicators | Calculation Method | Indicator Attribute |
|---|---|---|---|
| Industrial Transformation | E-commerce penetration rate | Number of enterprises with e-commerce transactions/Total number of enterprises | + |
| | E-commerce sales volume | Total e-commerce sales | + |
| | Total software business volume | Software business revenue | + |
| | Value added to the digital industry | Defined based on the "National Economic Industry Classification (2017)" and "Statistical Classification of the Digital Economy and Its Core Industries (2021)" | + |
| Enterprise Digitalization | Degree of enterprise digitalization | The proportion of digital-related terms in the "Management Discussion and Analysis" section of annual reports of listed companies; regional average digital attention of listed enterprises | + |
| | Digital assets of enterprises | Total digital intangible assets of listed enterprises | + |
| | The website coverage rate of enterprises | Number of websites per 100 enterprises | + |
| Industrial Chain Resilience | Autonomy of the digital industry chain | The portion of intermediate inputs in the digital core industry from the same region/Intermediate inputs of the digital core industry | + |
| | Output efficiency of the digital industry chain | Value added of the digital core industry/Intermediate inputs of the digital core industry | + |
| | Penetration of the digital industry chain | The portion of intermediate inputs from the regional digital core industry in non-digital core industries/Intermediate inputs of non-digital core industries | + |
| | Spillover of the digital industry chain | The portion of intermediate uses of the digital core industry flowing to other regions/Total intermediate inputs of other regions | + |

(3) Control Variables

The consumption-driven economy is influenced by multiple factors. To minimize estimation errors caused by omitted variables, this paper selects nine control variables from four aspects: economic structure, investment situation, government intervention, and social environment.

In terms of the economic structure, considering that the consumption economy mainly relies on the tertiary industry and develops more easily in urban environments, this paper selects the proportion of the tertiary industry (*service*) and the level of urbanization (*citization*) as control variables. The proportion of the tertiary industry refers to the percentage of GDP contributed by the tertiary industry, and the level of urbanization refers to the proportion of the urban population to the total population.

In terms of the investment situation, the paper considers the impact of infrastructure and foreign direct investment on the consumption-driven economy. Well-developed infrastructure is more conducive to the development of a consumption-driven economy. The paper uses the length of highways as a proxy variable for infrastructure (*infrastructure*). Foreign direct investment (*lnfdi*) is also an important factor in promoting regional production and consumption development. The paper uses the actual utilization amount of foreign direct investment as a proxy variable for FDI.

In terms of government intervention, the paper considers tax burden (*taxl*) and government efficiency (*eff*). High tax burdens are not conducive to the development of a consumption-driven economy. The paper measures tax burden by the ratio of tax revenue to GDP. Higher government efficiency facilitates smoother market operations, which is beneficial to the development of a consumption-driven economy. The paper uses the ratio of fiscal expenditure to GDP as a proxy variable for government efficiency.

In terms of social environment, the paper mainly considers employment situation (*employ*), dependency ratio (*dependency*), and financial development level (*finance*). Adequate employment rates can promote the development of a consumption-driven economy. Excessive aging is not conducive to consumption development. A well-developed financial sector is crucial for the prevalence of consumer credit in a consumption-driven economy.

### *2.3. Data Sources and Descriptive Statistics*

The study sample consists of annual data from 31 provinces (autonomous regions and municipalities) in China (excluding Hong Kong, Macau, and Taiwan) for the period 2013–2021. Data for the various indicators of the industrial digitalization level index were obtained from the National Bureau of Statistics, provincial statistical yearbooks, annual reports of listed companies publicly available from the Shanghai Stock Exchange and Shenzhen Stock Exchange, regional input–output tables, the China Economic Census Yearbook, and the China multi-region input–output table. Data for the indicators of the consumption-driven economic development index and control variables were sourced from the National Bureau of Statistics of China. The main descriptive statistics of the variables are presented in Table 3.

**Table 3.** Descriptive Statistics.

| Variable | Obs | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| cde | 279 | 0.203 | 0.060 | 0.044 | 0.441 |
| indig | 279 | 0.107 | 0.097 | 0.025 | 0.705 |
| citization | 279 | 0.599 | 0.124 | 0.239 | 0.896 |
| service | 279 | 49.393 | 9.010 | 32.00 | 83.900 |
| infrastructure | 279 | 11.707 | 0.838 | 9.444 | 12.896 |
| lnfdi | 279 | 14.145 | 1.805 | 8.123 | 16.932 |
| taxl | 279 | 0.082 | 0.029 | 0.044 | 0.200 |
| eff | 279 | 0.282 | 0.192 | 0.107 | 1.334 |
| employ | 279 | 96.815 | 0.633 | 95.390 | 98.790 |
| dependency | 279 | 39.097 | 7.080 | 22.700 | 57.786 |
| finance | 279 | 1.580 | 0.465 | 0.743 | 2.996 |

From Table 3, we can observe that the standard deviation of the consumption-driven economic development level (*cde*) is only 0.06, indicating that the values are generally close to the mean with small fluctuations. However, the range is 0.396, suggesting that there are still some provinces with extremely low or high levels of consumption-driven economic development. The industrial digitalization level (*indig*) has a maximum value of 0.705 and a minimum value of only 0.107, indicating significant disparities. Nevertheless, the standard deviation of the industrial digitalization level is only 0.097, suggesting that the distribution of industrial digitalization levels may be relatively close to a normal distribution. Among the control variables, the standard deviation of the tertiary industry ratio (*service*) is relatively large, indicating substantial differences in industrial structure across different regions of China. Similarly, the standard deviation of the old-age dependency ratio (*dependence*) is 7.080, indicating that there may be significant differences in population structure across provinces due to factors such as labor mobility. Although other control variables do not exhibit extremely high standard deviations, their extreme values are also large, indicating substantial developmental disparities across provinces. These differences may influence the relationship between industrial digitalization and consumption-driven economic development.

## 3. The Impact of Industrial Digitalization on Consumption-Driven Economy

### *3.1. Baseline Regression*

To test the impact of industrial digitization on the consumption-driven economy, this paper uses the data of 31 provinces in China from 2013 to 2021 to regress Equation (1), considering the impact of industrial digitization on the consumption-driven economy without adding control variables and fixed effects, and with adding control variables but without adding fixed effects at the same time.

As shown in Table 4, industrial digitalization significantly enhances the level of consumption-driven economic development. Column (1) of Table 2 shows the regression results of industrial digitalization on consumption-driven economic development without adding control variables and fixed effects. Column (2) shows the results without adding control variables but with fixed effects. Column (3) presents the results with both control variables and fixed effects included. It can be seen that, in all three cases, the coefficient of the industrial digitalization level (*indig*) on the consumption-driven economic development level (*cde*) is significantly positive at the 1% level. This confirms Hypothesis 1 of this study. Specifically, for every one-unit increase in the industrial digitalization level, the consumption-driven economic development (*cde*) will increase by 0.152 units.

**Table 4.** The Impact of Industrial Digitalization on Consumption-Driven Economic Development.

| | **(1)**<br>**cde** | **(2)**<br>**cde** | **(3)**<br>**cde** |
|---|---|---|---|
| indig | 0.391 *** | 0.191 *** | 0.152 *** |
| | (6.191) | (4.590) | (3.143) |
| citization | | 0.390 ** | 0.173 |
| | | (2.582) | (0.779) |
| service | | 0.001 | 0.002 |
| | | (1.270) | (0.981) |
| infrastructure | | 0.023 ** | 0.039 |
| | | (2.628) | (0.763) |
| lnfdi | | −0.005 | −0.027 *** |
| | | (−0.825) | (−2.922) |
| taxl | | −0.296 | −0.862 ** |
| | | (−1.277) | (−2.421) |
| eff | | 0.031 | 0.054 |
| | | (0.738) | (0.410) |
| employ | | 0.005 | 0.014 ** |
| | | (0.642) | (2.124) |
| dependency | | 0.001 | −0.001 |
| | | (1.498) | (−0.512) |
| finance | | 0.019 | 0.016 |
| | | (1.197) | (0.513) |
| cons | 0.162 *** | −0.851 | −1.338 * |
| | (22.604) | (−1.082) | (−1.699) |
| Individual effect | No | No | YES |
| Time effect | No | No | YES |
| N | 279 | 279 | 279 |
| Adj. $R^2$ | 0.3975 | 0.6537 | 0.8250 |

Note: *, **, *** denote significance levels of 10%, 5%, and 1%, respectively; values in parentheses are t-values.

Regarding the control variables, the coefficient for foreign direct investment (*lnfdi*) on consumption-driven economic development is significantly negative. This may be because foreign investment can have a disruptive impact on domestic industries and lead to profit outflows, which hampers the healthy development of local industries. While foreign investment can promote economic growth in the short term, it is detrimental to the development of a consumption-driven economy in the long run. The tax level (*taxl*) also has a significantly negative impact on the consumption-driven economy, indicating that excessively high taxes are not conducive to the development of the consumption-driven economy. Conversely, the employment rate (*employ*) has a significantly positive impact on the consumption-driven economy (*cde*), as full employment is a prerequisite for the development of a consumption-driven economy. Low employment rates can lead to a loss of consumer confidence, hindering the growth of the consumption-driven economy.

### *3.2. Impact of Industrial Digitalization on Various Dimensions of the Consumption-Driven Economy*

A consumption-driven economy is multidimensional, and the impact of industrial digitalization on each dimension may vary. To better understand the mechanisms through which industrial digitalization influences a consumption-driven economy, this paper further examines its effects on the three dimensions of economic foundation, consumption level, and consumption structure.

From Table 5, it is evident that the impact of industrial digitalization on various dimensions of a consumption-driven economy differs significantly. Specifically, industrial digitalization has a significantly positive effect on the economic foundation and the consumption level, while its impact on the consumption structure is negative and insignificant.

**Table 5.** Impact of Industrial Digitalization on Various Dimensions of a Consumption-Driven Economy.

| | **(1)**<br>**Basis** | **(2)**<br>**Consume** | **(3)**<br>**Structure** |
|---|---|---|---|
| indig | 0.151 *** | 0.070 *** | −0.068 |
| | (5.583) | (3.051) | (−1.567) |
| citization | −0.186 ** | 0.036 | 0.323 * |
| | (−2.221) | (0.492) | (1.794) |
| service | −0.001 ** | 0.002 ** | 0.001 |
| | (−2.051) | (2.285) | (0.466) |
| infrastructure | −0.023 | 0.042 * | 0.020 |
| | (−0.992) | (1.733) | (0.490) |
| lnfdi | −0.000 | −0.003 | −0.024 ** |
| | (−0.222) | (−0.822) | (−2.680) |
| taxl | −0.053 | −0.525 ** | −0.285 |
| | (−0.371) | (−2.323) | (−1.302) |
| eff | −0.093 * | 0.055 | 0.092 |
| | (−1.808) | (0.954) | (0.924) |
| employ | 0.004 | 0.006 | 0.005 |
| | (1.615) | (1.542) | (0.887) |
| dependency | 0.001 *** | 0.000 | −0.002 ** |
| | (2.923) | (0.500) | (−2.155) |
| finance | 0.009 * | 0.020 ** | −0.013 |
| | (1.969) | (2.687) | (−0.484) |
| cons | 0.144 | −1.061 ** | −0.421 |
| | (0.401) | (−2.064) | (−0.829) |
| Individual effect | YES | YES | YES |
| Time effect | YES | YES | YES |
| N | 279 | 279 | 279 |
| Adj. $R^2$ | 0.9832 | 0.4827 | 0.7571 |

Note: *, **, *** denote significance levels of 10%, 5%, and 1%, respectively; values in parentheses are t-values.

For every one-unit increase in the level of industrial digitalization (*indig*), the economic foundation (*basis*) improves by 0.151 units, indicating a positive impact of industrial digitalization on the economic foundation. This suggests that industrial digitalization positively affects the economic development level and residents' income within a region, consistent with previous research findings [25]. Additionally, for every one-unit increase in the level of industrial digitalization (*indig*), the consumption level (*consume*) increases by 0.07 units, indicating a positive impact of industrial digitalization on the consumption level. This is primarily because industrial digitalization optimizes supply chain management, strengthens upstream and downstream linkages in the supply chain, reduces production costs for enterprises, and accelerates their response to market demands through the application of digital technologies such as data analytics. These factors collectively create a favorable consumption environment and stimulate consumer desire, effectively enhancing the regional consumption level. However, the impact coefficient of industrial digitalization (*indig*) on consumption structure is negative but insignificant, indicating that the current level of industrial digitalization does not significantly affect China's consumption structure. This may be due to the relatively low level of industrial digitalization, where productivity improvements driven by industrial digitalization precede its stimulation of consumption, promoting the development of China's digital trade [26], and further increasing China's dependence on foreign trade.

### *3.3. Endogeneity and Robustness Tests*

To further validate the reliability of the baseline regression, this paper employs multiple methods for endogeneity and robustness tests.

To avoid reverse causality affecting the accuracy of the estimates, all explanatory variables and control variables are lagged by one period. Additionally, to address endogeneity issues such as omitted variable bias, the means of the industrial digitalization level index of other regions in the same year are used as instrumental variables for 2SLS and GMM model estimations. At the same time, in order to verify whether the selection of instrumental variables is appropriate, we also used the Durbin Wu Hausman test for weak instrumental variable testing during the 2SLS model regression. The results are shown in Table 6.

**Table 6.** Endogeneity Test.

| | **FE (1) cde** | **2SLS (2) cde** | **GMM (3) cde** |
|---|---|---|---|
| l.cde | | | 0.410 *** |
| | | | (10.431) |
| indig | 0.162 ** | 0.152 *** | 0.119 *** |
| | (2.142) | (3.081) | (7.973) |
| citization | 0.141 | 0.173 | 0.271 ** |
| | (0.571) | (1.165) | (2.304) |
| service | −0.000 | 0.002 ** | −0.001 |
| | (−0.257) | (2.116) | (−0.779) |
| infrastructure | 0.074 | 0.039 | −0.001 |
| | (1.298) | (1.138) | (−0.141) |
| lnfdi | −0.029 *** | −0.027 *** | −0.004 |
| | (−2.929) | (−6.763) | (−0.975) |
| taxl | −1.123 ** | −0.862 *** | 0.451 ** |
| | (−2.053) | (−3.391) | (2.217) |
| eff | 0.076 | 0.054 | 0.075 ** |
| | (0.428) | (0.687) | (2.559) |
| employ | 0.020 * | 0.014 *** | 0.019 *** |
| | (1.786) | (2.865) | (2.803) |
| dependency | 0.001 | −0.001 | 0.003 *** |
| | (1.264) | (−0.588) | (4.945) |
| finance | 0.011 | 0.016 | −0.030 *** |
| | (0.392) | (1.147) | (−2.807) |
| cons | −2.251 * | | −1.895 *** |
| | (−1.824) | | (−3.145) |
| Individual effect | YES | YES | YES |
| Time effect | YES | YES | YES |
| N | 248 | 279 | 248 |
| Adj. $R^2$ | 0.7991 | | |
| F (1,268) | | 21.9781 | |

Note: *, **, *** denote significance levels of 10%, 5%, and 1%, respectively; values in parentheses are t-values.

Column (1) of Table 6 shows the fixed effects model regression results with explanatory variables and control variables lagged by one period. Columns (2) and (3) present the estimation results under the 2SLS and GMM models, respectively. As seen in Table 6, after considering endogeneity issues, the coefficient of industrial digitalization level on consumption-driven economic development remains significantly positive, indicating that the main regression conclusions are robust. In addition, from column (2), it can be seen that the F-value is 21.9781, which is greater than 10, indicating that the Durbin Wu Hausman test has been passed and that the instrumental variable is not a weak instrumental variable. That is, the instrumental variable is effective. Since the number of instrumental variables is consistent with the number of endogenous variables, there is no need for excessive instrumental variable testing.

To further ensure the robustness of the conclusions, we conducted robustness tests using methods such as reducing sample years, changing the main variable measurement method, changing the control variable group, and changing the model. Firstly, reduce the sample year. In special years, the relationship between various economic variables may change. The years 2020 and 2021 are in the period of COVID-19. The global economic situation has undergone major changes, and economic growth is slow or even stagnant, which may affect the accuracy of estimates. Therefore, this paper will remove the samples in 2020 and 2021 and conduct a regression again. Secondly, changing the measurement method of the dependent variable, considering that although the indicator system method can reflect the comprehensive evaluation of the consumption-driven economy, the mutual influence between various indicators may lead to inaccurate results, this article directly selects the consumption level as the proxy variable for the consumption-driven economy for regression. Thirdly, increase the control variables. This article adds education level (*education*) and medical level (*medical*) as control variables for regression to test whether there are omitted variables that affect the accuracy of the regression results. Fourth, replace the regression model. This article replaces the fixed effects model in benchmark regression with a random effects model and quantile model for regression to avoid interference caused by model selection. The results are shown in the following table:

From Table 7, it is evident that after excluding the special years, changing the measurement method of the dependent variable, and increasing the control variables, industrial digitalization still exhibits a significant positive impact on the consumption-driven economy, indicating the robustness of the study's conclusions.

**Table 7.** The first part of Robustness Test.

| | **(1)**<br>**cde** | **(2)**<br>**Consume_Rate** | **(3)**<br>**cde** |
|---|---|---|---|
| indig | 0.220 *** | 5.515 ** | 0.129 ** |
| | (3.298) | (2.244) | (2.600) |
| citization | 0.107 | 11.173 | 0.391 |
| | (0.486) | (1.518) | (1.380) |
| service | 0.001 | 0.218 *** | 0.002 |
| | (0.932) | (6.052) | (1.608) |
| infrastructure | 0.055 | 3.298 * | 0.027 |
| | (1.453) | (1.956) | (0.592) |
| lnfdi | −0.008 | −0.234 | −0.023 *** |
| | (−1.148) | (−1.162) | (−2.957) |
| taxl | −1.184 *** | 13.224 | −0.958 ** |
| | (−3.085) | (1.047) | (−2.440) |
| eff | 0.223 * | 6.313 | 0.095 |
| | (1.991) | (1.613) | (0.742) |
| employ | 0.008 | −0.179 | 1.366 ** |
| | (1.000) | (−0.749) | (2.188) |
| dependency | 0.000 | 0.010 | −0.001 |
| | (0.609) | (0.219) | (−0.727) |
| finance | 0.018 | 3.858 *** | 0.013 |
| | (1.289) | (5.505) | (0.484) |

**Table 7.** *Cont.*

| | (1)<br>cde | (2)<br>Consume_Rate | (3)<br>cde |
|---|---|---|---|
| education | | | −6.821 ** |
| | | | (−2.406) |
| medical | | | 0.000 |
| | | | (0.507) |
| cons | −1.217 | −13.214 | −1.287 |
| | (−1.361) | (−0.407) | (−1.609) |
| Individual effect | YES | YES | Yes |
| Time effect | YES | YES | Yes |
| N | 217 | 279 | 279 |
| Adj. $R^2$ | 0.8430 | 0.9328 | 0.8356 |

Note: *, **, *** denote significance levels of 10%, 5%, and 1%, respectively; values in parentheses are t-values.

In Table 8, column (1) shows the regression results of the random effects model, while columns (2) and (3) represent the quantile model regression results at the 25% and 50% quantiles, respectively. From Table 3, it can be seen that after replacing the model, industrial digitization (*indig*) still shows a significant impact on the consumption-driven economy (*cde*), which proves the robustness of the conclusions in this paper.

**Table 8.** The second part of Robustness Test.

| | (1)<br>RE<br>cde | (2)<br>Q25<br>cde | (3)<br>Q50<br>cde |
|---|---|---|---|
| indig | 0.203 *** | 0.206 *** | 0.214 *** |
| | (5.539) | (69.430) | (12.928) |
| citization | 0.461 *** | 0.150 *** | 0.188 *** |
| | (6.752) | (20.344) | (3.730) |
| service | 0.002 *** | 0.001 *** | 0.003 *** |
| | (3.215) | (32.598) | (5.271) |
| infrastructure | 0.033 *** | 0.013 *** | 0.004 |
| | (4.118) | (43.695) | (1.036) |
| lnfdi | −0.016 *** | −0.000 | −0.009 *** |
| | (−4.755) | (−0.283) | (−5.616) |
| taxl | −0.532 *** | −0.438 *** | −0.784 *** |
| | (−3.215) | (−25.042) | (−5.628) |
| intervention | −0.013 | −0.038 *** | −0.039 ** |
| | (−0.328) | (−6.951) | (−2.433) |
| employ | 0.012 *** | 0.003 *** | 0.011 *** |
| | (2.728) | (6.394) | (3.618) |
| dependency | 0.000 | −0.000 ** | −0.002 ** |
| | (0.165) | (−1.967) | (−1.997) |
| finance | 0.017 | 0.021 *** | 0.000 |
| | (1.429) | (18.050) | (0.107) |
| cons | −1.503 *** | | |
| | (−3.523) | | |
| Individual effect | NO | YES | YES |
| Time effect | NO | YES | YES |
| N | 279 | 279 | 279 |

Note: **, *** denote significance levels of 5%, and 1%, respectively; values in parentheses are t-values.

## 4. Further Research on the Impact of Industrial Digitalization on the Consumption-Driven Economy

### *4.1. Mechanism Tests*

According to previous analysis, industrial digitalization may promote the development of a consumption-driven economy by advancing industrial upgrading and fostering technological innovation. There may be strong endogeneity issues such as omitted variables when using the three-step mediation model for mechanism testing [27,28].To verify whether this mechanism holds, this study draws on the works of Dell [29] and Liu and Yi [30] to further test the impact of industrial digitalization on industrial structure advancement and technological innovation, based on the validity of Model (1). For variable selection, the study uses the industrial upgrading index as a proxy for the advancement of industrial structure (AIS), calculated as follows: AIS = (First industry's GDP/GDP) ×1 + (Second industry's GDP/GDP) ×2 + (Third industry's GDP/GDP) ×3. The proportion of technology market transaction volume to GDP is used as a proxy for technological innovation (*inno*). The estimation results are as follows:

From Table 9, it can be seen that the coefficients for the impact of industrial digitalization level (*indig*) on industrial structure advancement (*AIS*) and technological innovation (*inno*) are significantly positive. This indicates that industrial digitalization promotes the development of a consumption-driven economy by advancing industrial structure and technological innovation, thereby validating Hypotheses 2 and 3 of this study.

**Table 9.** Mechanism Tests.

| | **(1)**<br>**AIS** | **(2)**<br>**Inno** |
|---|---|---|
| indig | 0.048 ** | 0.040 *** |
| | (2.204) | (3.115) |
| citization | 0.090 | −0.161 ** |
| | (1.028) | (−2.476) |
| service | 0.011 *** | 0.000 |
| | (19.042) | (1.283) |
| infrastructure | 0.045 * | −0.012 |
| | (1.698) | (−0.821) |
| lnfdi | 0.002 | 0.002 |
| | (1.070) | (1.159) |
| taxl | 0.038 | 0.167 |
| | (0.278) | (1.484) |
| eff | −0.155 * | −0.035 |
| | (−2.019) | (−1.266) |
| employ | −0.001 | −0.000 |
| | (−0.445) | (−0.006) |
| dependency | 0.001 ** | 0.000 ** |
| | (2.349) | (2.208) |
| finance | 0.015 ** | 0.018 ** |
| | (2.286) | (2.549) |
| cons | 1.369 *** | 0.165 |
| | (4.610) | (0.680) |
| Individual effect | YES | YES |
| Time effect | YES | YES |
| N | 279 | 275 |
| Adj. $R^2$ | 0.9951 | 0.9658 |

Note: *, **, *** denote significance levels of 10%, 5%, and 1%, respectively; values in parentheses are t-values.

Industrial digitalization plays a role in promoting technological innovation, but the realization paths of this influence may differ in the early and late stages of industrial digitalization. In the early stages, the promotion of technological innovation by industrial digitalization is mainly brought about by the spillover characteristics of digital technology. When adapting to the production needs of different industries and enterprises, digital technology may give rise to technological innovations, such as different types of enterprises adjusting big data analysis models to suit their own needs. Moreover, new business forms arising from the combination of digital technology and traditional industries, such as digital finance and e-commerce, can also drive innovation [31,32]. In the later stages, as the penetration rate of digital technology becomes higher, the innovation incentive effect brought by technological spillover gradually weakens, replaced by the innovation incentive effect brought by changes in the human capital structure. Industrial digitalization alters the production and management modes of enterprises, requiring them to recruit more technical talents, thus changing the human capital structure of enterprises. With an ample increase in high-level technical talents, innovation behavior becomes more likely. Finally, existing research indicates that innovations brought about by industrial digitalization, such as online payment, have a stimulating effect on consumer spending [33,34], and technological innovation is a key factor in the transformation of economic growth drivers [35,36].

Industrial structure and consumption levels have a certain synchrony; changes in industrial structure can alter consumption levels. Specifically, when the primary industry dominates, consumption goods are mainly agricultural products, resulting in low consumption levels. After industrialization, consumption goods are primarily industrial products, leading to a certain degree of unleashed consumption potential. When the tertiary industry dominates, consumption goods upgrade accordingly, with consumers having a more urgent demand for high-quality services and high-end consumer brands, making consumption a major driving force of economic development. Clearly, under different industrial structures and consumption levels, economic growth models also vary. When achieving an advanced industrial structure, consumption potential is fully unleashed, conducive to the development of a consumption-driven economy. Industrial digitalization promotes the transformation of traditional industries and fosters the integration of various industries, causing the primary and secondary industries to gradually evolve towards the tertiary industry. Additionally, digitalization has given rise to new industries and business models, such as the internet, artificial intelligence, digital payments, and new business models like the sharing economy. The emergence of new industries and business models enhances the efficiency of resource allocation, forming new industrial chains and driving industrial structure upgrades. Therefore, industrial digitalization can promote advanced industrial structures, thereby fostering the development of a consumption-driven economy.

Finally, to avoid endogeneity issues caused by the reverse causal relationship between industrial digitization, industrial structure upgrading, and technological innovation, which may affect the accuracy of the regression, we will regress the explanatory variables with a lag of one order and place the results in Appendix A.

*4.2. Heterogeneity Analysis*

The economic development levels, industrial structures, policy environments, and other factors vary significantly among China's provinces, which may lead to uneven distribution of industrial digitalization and consequently affect its impact on a consumption-driven economy. On one hand, the development of industrial digitalization is influenced by local digital infrastructure, human capital levels, and other factors, which may exhibit considerable regional disparities. On the other hand, the impact of industrial digitalization on a consumption-driven economy is also constrained by factors such as population density and income levels. These factors may vary widely across different regions; hence, the impact of industrial digitalization on a consumption-driven economy may exhibit heterogeneity across regions. To further explore the regional heterogeneity in the impact of industrial digitalization on a consumption-driven economy, this paper divides 31 provinces into eastern, central, and western regions. The eastern region consists of provinces with higher economic development levels, the central region includes economically less developed provinces; and the western region refers to economically underdeveloped areas.

From Table 10, it can be seen that in the eastern and central regions, industrial digitalization has a stimulating effect on a consumption-driven economy, but the magnitude of the impact coefficients varies. In contrast, the impact coefficient of industrial digitalization on a consumption-driven economy in the western region is negative and statistically insignificant.

This indicates that the effect of industrial digitalization on a consumption-driven economy has certain requirements for economic foundations. In underdeveloped regions, industrial digitalization is less likely to promote a consumption-driven economy. The possible reasons are as follows: First, a consumption-driven economy usually occurs in countries or regions with highly developed industrialization, strong industrial production capacity, and high production efficiency. However, the western region of China is still in the developmental stage, with inadequate infrastructure and low levels of industrialization, leading to a slow pace of industrial digitalization [37], which does not provide the preconditions necessary for the development of a consumption-driven economy. Second, the western region is characterized by vast areas with sparse populations, meaning that even if industrial digitalization develops to some extent and provides high-quality products and services, the local consumption market scale is limited, making it difficult to form a consumption-driven economy. Third, due to the siphoning effect among regions, talents, and natural resources in the western region are more likely to be concentrated in the eastern and central regions for development, restricting economic development in the western region.

**Table 10.** Heterogeneity Tests Based on Regional Divisions.

| | **Eastern China cde** | **Central China cde** | **Western China cde** |
|---|---|---|---|
| indig | 0.085 ** | 0.466 * | −0.588 |
| | (2.491) | (1.898) | (−1.369) |
| citization | −0.066 | 1.091 *** | 1.521 |
| | (−0.636) | (5.724) | (1.580) |
| service | −0.007 *** | 0.003* | 0.003 |
| | (−5.056) | (2.034) | (1.380) |
| infrastructure | 0.028 | −0.014 | 0.182 ** |
| | (0.937) | (−0.386) | (2.512) |
| lnfdi | −0.015 | 0.001 | −0.016 |
| | (−1.328) | (0.110) | (−1.640) |
| taxl | 0.299 | −1.989 *** | 0.011 |
| | (1.786) | (−5.652) | (0.015) |
| eff | −0.183 | 0.398 *** | 0.145 |
| | (−1.543) | (4.141) | (0.908) |
| employ | 0.016 *** | 0.004 | 0.024 * |
| | (4.953) | (1.110) | (1.894) |
| dependency | −0.000 | 0.003 | −0.001 |
| | (−0.088) | (1.596) | (−0.517) |
| finance | 0.021 * | 0.031 | −0.028 |
| | (1.882) | (1.208) | (−0.627) |
| cons | −1.037 * | −0.935 | −4.951 ** |
| | (−2.070) | (−1.264) | (−2.646) |
| Individual | YES | YES | YES |
| Time | YES | YES | YES |
| N | 90 | 81 | 108 |
| Adj. $R^2$ | 0.9735 | 0.6781 | 0.7069 |

Note: *, **, *** denote significance levels of 10%, 5%, and 1%, respectively; values in parentheses are t-values.

## 5. Conclusions and Implications

Industrial digitalization, as the large-scale popularization of digital technology, enhances the production efficiency of traditional industries while driving the emergence of new industries, gradually becoming an important driver of economic growth for various countries. To verify whether industrial digitalization can promote the development of a consumption-driven economy, this paper conducts an empirical study based on interprovincial data from China between 2013 and 2021, constructing comprehensive indices of industrial digitalization and consumption-driven economy for regression analysis. Further, the paper explores the mechanisms through which industrial digitalization affects a consumption-driven economy and its heterogeneity across different regions. The empirical test results indicate: first, industrial digitalization significantly promotes the development of a consumption-driven economy, and this conclusion remains robust after considering endogeneity tests and robustness checks, such as reverse causality and sample selection bias. Additionally, the impact of industrial digitalization on a consumption-driven economy is mainly reflected in the improvement of economic foundations and consumption levels, with no significant effect on consumption structure. Second, mechanism analysis results show that industrial digitalization can promote the development of a consumption-driven economy by fostering innovation and upgrading the industrial structure. Third, heterogeneity analysis results reveal that the promotion effect of industrial digitalization on a consumption-driven economy exists only in the eastern and central regions but not in the western regions, indicating that industrial digitalization in underdeveloped areas cannot exert a positive effect on a consumption-driven economy. This is mainly because most underdeveloped areas have poor industrial foundations, slow industrial digitization processes, and small local consumer markets, making it difficult for basic conditions to support the development of a consumption-driven economy.

Based on the above conclusions, this article draws the following insights: firstly, increase research and development investment in digital technology while improving policies to promote the commercialization of digital technology in order to fully leverage the technology spillover effects in the process of industrial digitization. Secondly, while promoting industrial digitization, attention should be paid to adjusting the consumption structure. This can be achieved by narrowing the income gap between urban and rural areas, providing policy subsidies, and reducing the Engel coefficient of urban and rural residents, as well as increasing their demand for high-end consumer goods. Thirdly, different industrial development policies should be formulated for different regions. In underdeveloped areas, the first step is to improve infrastructure, promote industrialization, accelerate the construction of a sound industrial system, and provide a feasible environment for the digital development of industries and the development of a consumption-driven economy. In developed regions, the focus should be on how to implement the application of digital technology.

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**Data Availability Statement:** The original data used in the study are openly available in the National Bureau of Statistics, provincial statistical yearbooks, annual reports of listed companies publicly available from the Shanghai Stock Exchange and Shenzhen Stock Exchange, regional input–output tables, the China Economic Census Yearbook, and the China multi-region input–output table.

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## Appendix A Description of Industrial Digitalization Indicators

**Table A1.** China's Inter-Provincial Industrial Digitalization Level Indicator System.

| Primary Indicator | Secondary Indicator | Accounting Methodology | Indicator Attributes |
|---|---|---|---|
| Industrial transformation | E-commerce penetration rate | Number of enterprises with e-commerce transactions/total number of enterprises | + |
| | E-commerce sales | Total e-commerce sales | + |
| | Total software business | Software business revenue | + |
| | Value added of digital industries | Define digital industries based on the National Economic Industry Classification (2017) and the Statistical Classification of the Digital Economy and its Core Industries (2021), and measure their value added. | + |

**Table A1.** *Cont.*

| Primary Indicator | Secondary Indicator | Accounting Methodology | Indicator Attributes |
|---|---|---|---|
| Enterprise Digitization | Degree of enterprise digitization | The proportion of digitization-related terms in the "Management's Discussion and Analysis" section of the annual reports of listed companies in the total field length is taken as the degree of enterprise digitization, and the average degree of digital attention of listed enterprises in the region is taken as the degree of enterprise digitization in the region. | + |
| | Enterprise Digital Assets | The total amount of digital intangible assets of listed companies | + |
| | Enterprise Website Coverage Rate | The number of websites owned by every hundred enterprises | + |
| Industry Chain Resilience | Digital Industry Chain Autonomy | The part of the intermediate input from the local area in the digital core industry intermediate input/Total intermediate input of the digital core industry | + |
| | Digital Industry Chain Productivity | The value added of the digital core industry/Intermediate input of the digital core industry | + |
| | Digital Industry Chain Penetration | The part of the intermediate input from the local digital core industry in the intermediate input of non-core digital industries/Total intermediate input of non-core digital industries | + |
| | Digital Industry Chain Spillover | The part of the intermediate input used by the digital core industry flowing to other regions/Total intermediate input of other regions | + |

A total of 11 indicators were selected to measure the level of industrial digitalization. Among them, the e-commerce penetration rate, e-commerce sales, total software business, and enterprise website coverage are derived from the National Bureau of Statistics, with their calculation methods detailed in Table A1. This section will elaborate on the calculation methods for the digital industry value added, degree of enterprise digitalization, enterprise digital assets, and industrial chain resilience.

**(1) Calculation ofthe Digital Industry Value Added**

Digital industry value added mainly includes two aspects: first, the value added of the core digital industry, which primarily comprises the fundamental industries of the digital economy such as computer hardware and software; second, the value added of the digital application industry, which refers to the value added brought by the application of digital production tools in non-core digital industries. Due to incomplete fundamental data related to the digital industry, a comprehensive calculation of the value added of the digital application industry is not feasible. To ensure data accuracy, this paper only considers the value added of industries predominantly characterized by digitalization when calculating the value added of the digital application industry. According to the "Digital Economy and its Core Industry Statistical Classification (2021)", the core digital industries mainly correspond to the "Information Transmission, Software, and Information Technology Services" and "Computer, Communication, and Other Electronic Equipment Manufacturing" categories in the "National Economic Industry Classification (2017)". Calculable digital derivative industries primarily include digital trade and digital content and media. The specific industry classifications are as follows:

**Table A2.** Classification of Digital Industries.

| | Industry Type | Industry Content | Corresponding National Economic Industry | Industry Code |
|---|---|---|---|---|
| Digital Core Industry | Digital Software | Digital software services, such as telecommunications, broadcasting, and satellite transmission services, internet and related services, software and information technology services, etc. | Information Transmission, Software, and Information Technology Services | I-63, I-64, I-65 |
| | Digital Hardware | Digital hardware equipment manufacturing, such as computer manufacturing, communication equipment manufacturing, broadcasting and television equipment manufacturing, etc. | Computer, Communication, and Other Electronic Equipment Manufacturing | C-39 |
| Digital Derivative Industry | Digital Media | Content editing and processing using digital technology, publishing services, and broadcasting, television, film, and sound recording production, which disseminate digital content products via the internet | Journalism and Publishing * | R-86 |
| | | | Broadcasting, Television, Film, and Sound Recording Production | R-87 |
| | Digital Commerce | Internet wholesale and internet retail | Wholesale * | F-51 |
| | | | Retail * | F-52 |

* Indicates that some industries within this category are part of the digital application industry.

After determining the classification of digital industries, the value added of each industry needs to be calculated. Since the value added of each sub-industry cannot be directly obtained from provincial statistical yearbooks, it is necessary to use auxiliary data from sources such as China's regional input–output tables and economic census yearbooks. During the calculation process, tools such as industry value added structure coefficients and digital economy adjustment coefficients are used. The industry *ij* value-added structure coefficient refers to the proportion of industry *ij* value-added in the total value added of industry *j*, while the digital economy adjustment coefficient refers to the proportion of digital economy value added in the total value added of the industry.

**Calculation of the value added of digital core industries.** The digital core industry mainly includes two major parts of I63-65 and C39 from the "National Economic Industry Classification (2017)", which are mapped to the industries in the 2017 China 42-sector regional input–output table. I63-65 represents the information transmission, software, and information technology services industry, corresponding to the "Information Transmission, Software and Information Technology Services" sector in the input–output table; C39 represents the computer, communication, and other electronic equipment manufacturing industry, corresponding to the "Communication Equipment, Computers, and Other Electronic Equipment" sector in the input–output table. This article uses the value added of the corresponding sectors in the 2017 regional input–output tables as the value added of the digital core industry in each region for 2017. Since the input–output table is compiled every five years, the value added of the digital core industry for other years needs to be estimated using the industry value-added structure coefficient. Specifically, the value added of the "Computer, Communication, and Other Electronic Equipment Manufacturing" in each region in 2017 is divided by the industrial value added of the region in that year to obtain the industry value-added structure coefficient. The industrial value added for other years can be obtained by multiplying the industrial value added for other years by this coefficient. Similarly, the value added of "Information Transmission, Software, and Information Technology Services" in each region in 2017 is divided by the service industry value added of the region in that year to obtain the industry value-added structure coefficient, which can then be used to further obtain the value added for other years of "Information Transmission, Software, and Information Technology Services". By adding the calculated value added of "Computer, Communication, and Other Electronic Equipment Manufacturing" and "Information Transmission, Software, and Information Technology Services", the value added of the digital core industry can be obtained.

**Calculation of the Value Added of the Digital Derivative Industry.** The digital derivatives industry includes two parts: digital media and digital commerce. Digital media includes part of R-86 journalism and publishing and R-87 broadcasting, television, film, and sound recording production, while digital trade includes part of the wholesale and retail industries. Since the corresponding departments are not directly listed in the 42-sector input–output table, it is necessary to use the digital economy adjustment coefficient for calculation. Specifically, the proportion of "audio-visual products, electronic and digital publications wholesale" main business revenue in "cultural, sports goods, and equipment wholesale" main business revenue from the "China Economic Census Yearbook (2018)" is used as the digital economy adjustment coefficient. This coefficient, combined with the value added of the "cultural, sports goods, and equipment wholesale" industry over the years in each region, is used to calculate the value added of the digital media part of the "journalism and publishing" industry. Similarly, the proportion of the main business revenue of "broadcasting, television, film, and sound recording production" in the "cultural, sports, and entertainment" main business revenue from the census yearbook is used as the digital economy adjustment coefficient. This coefficient, combined with the value added of the "cultural, sports, and entertainment" industry over the years in each region, is used to calculate the value added of "broadcasting, television, film, and sound recording production". Adding these two figures gives the annual value added of digital media in each region. The value added of digital commerce is calculated similarly, using the proportion of internet wholesale and internet retail main business revenue in the total main business revenue of wholesale and retail industries from the census yearbook as the digital economy adjustment coefficient. This coefficient, combined with the value added of "wholesale and retail" over the years in each region, gives the annual value added of digital commerce. Summing the value added of digital media and digital commerce gives the value added of the digital derivatives industry.

**(2) Measurement of the Enterprise Digitalization Level**

The enterprise digitalization level refers to the extent to which enterprises use digital technology in their production activities. Existing research often employs text analysis methods to measure the digitalization level of microenterprises. In this paper, we use the proportion of digital-related terms in the Management Discussion and Analysis (MD&A) sections of annual reports of listed companies to represent the degree of enterprise digitalization. The average digitalization level of listed companies in a region is then used to represent the overall enterprise digitalization level in that region. The specific measurement process is as follows:

Step 1: Constructing the "Digitalization" Lexicon. We searched the websites of the Central People's Government and the Ministry of Industry and Information Technology and manually filtered to obtain 30 significant digital economy-related policies published between 2012 and 2018. Using Python, we performed text segmentation on these policy documents, resulting in a lexicon of 162 digitalization-related terms, such as "information", "network", and "artificial intelligence", each appearing at least five times.

Step 2: Analyzing the MD&A Texts of Listed Companies. We used Python to calculate the frequency of the 162 digitalization-related terms in the MD&A sections of annual reports of listed companies over the years. Financial sector companies and companies designated as Special Treatment (ST) or Particular Transfer (PT) were excluded from the analysis.

Step 3: Calculating the Enterprise Digitalization Level Indicator. The total frequency of digitalization-related terms was divided by the length of the MD&A sections of the annual reports and multiplied by 100 to obtain the annual enterprise digitalization level for each listed company.

Finally, based on the registered locations of the listed companies, the average digitalization level of all listed companies in the same region was used to represent the enterprise digitalization level of that region.

**(3) Measurement of Enterprise Digital Assets**

Enterprise digital assets are often considered another representation of the enterprise digitalization level. In this study, we use the total digital intangible assets of all listed companies in a region to represent the region's enterprise digital assets. The digital intangible assets are identified from the notes of financial reports of listed companies that disclose the year-end details of intangible assets related to the digital economy. Financial sector companies and companies designated as ST or PT were excluded. Specifically, when the details of intangible assets include keywords related to digital economy technologies, such as "software" and "network", and related patents, these items are marked as "digital intangible assets". The digital intangible assets of multiple items in the same company for the same year are summed up. Finally, the digital intangible assets of all listed companies in the same region are aggregated based on their registered locations to obtain the region's enterprise digital assets.

**(4) Measurement of Industrial Chain Resilience**

Industrial chain resilience includes four aspects: digital industrial chain autonomy, digital industrial chain productivity, digital industrial chain penetration, and digital industrial chain spillover. Digital industrial chain autonomy reflects the ability of the local core digital industries to develop independently of other regions. Digital industrial chain productivity reflects the ability of the local core digital industries to create economic value added. Digital industrial chain penetration reflects the support of the local core digital industries for the development of other local industries. Digital industrial chain spillover reflects the support of the local core digital industries for the development of industries in other regions. These four dimensions, respectively, describe the resilience of the regional digital industrial chain from the perspectives of regional autonomy, development level, application level, and economic impact.

The calculation formulas for industrial chain resilience are explained in Table A1, where "core digital industries" refer to information transmission, software, and information technology services, as well as computer, communication, and other electronic equipment manufacturing. We use data from the 31 provinces and 42 departments in the inter-regional input–output table of China for the calculations. Since this table only provides data for 2012, 2015, and 2017, missing years are filled using interpolation and extrapolation methods.

## Appendix B Endogeneity Testing of Mechanism Testing

**Table A3.** Considering endogeneity issues in mechanism testing.

| | (1)<br>cde | (2)<br>Industrial | (3)<br>Technology |
|---|---|---|---|
| L.indig | 0.169 *** | 0.049 ** | 0.046 *** |
| | (2.764) | (2.227) | (3.666) |
| citization | 0.232 | 0.085 | −0.189 *** |
| | (0.824) | (1.069) | (−2.797) |
| service | 0.002 | 0.011 *** | 0.001 |
| | (1.010) | (17.190) | (1.659) |
| infrastructure | 0.035 | 0.042 | −0.012 |
| | (0.621) | (1.646) | (−0.742) |
| lnfdi | −0.031 *** | 0.001 | 0.002 |
| | (−3.119) | (0.710) | (1.349) |
| taxl | −0.998 ** | 0.023 | 0.190 * |
| | (−2.527) | (0.175) | (1.742) |
| intervention | 0.110 | −0.157 ** | −0.032 |
| | (0.771) | (−2.176) | (−1.188) |
| employ | 0.016 ** | −0.003 | −0.000 |
| | (2.117) | (−0.950) | (−0.033) |
| dependency | −0.001 | 0.001* | 0.000 * |
| | (−0.449) | (1.791) | (1.942) |
| finance | 0.005 | 0.019 ** | 0.018 ** |
| | (0.135) | (2.483) | (2.436) |
| cons | −1.504 | 1.548 *** | 0.165 |

**Table A3.** *Cont.*

| | (1) cde | (2) Industrial | (3) Technology |
|---|---|---|---|
| | (−1.590) | (5.610) | (0.692) |
| Individual effect | YES | YES | YES |
| Time effect | YES | YES | YES |
| N | 248 | 248 | 245 |
| Adj. $R^2$ | 0.8006 | 0.9951 | 0.9668 |

Note: *, **, *** denote significance levels of 10%, 5%, and 1%, respectively; values in parentheses are t-values.

Columns (1)–(3) in Table A3 show the regression results of consumption-driven economy (*cde*), industrial structure upgrading (*industrial*), and technological innovation (*technology*) on the lagged terms of industrial digitization (*L.indig*), respectively. From columns (2) and (3), it can be seen that the lag term of industrial digitization has a significantly positive impact coefficient on industrial structure upgrading and technological innovation, indicating that the mechanism testing basis of this article is valid considering the endogeneity problem caused by reverse causality.

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