

# Research on the impact and mechanism of digital economy on the development of new quality productivity: an empirical analysis based on provincial panel data from 2012 to 2022

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**Abstract.** With the continuous advancement of science and technology and the profound development of globalization, the conventional mode of economic growth and productivity's developmental trajectory have become inadequate to meet the demands of modern society. Consequently, innovation has emerged as a pivotal driving force for promoting economic and social progress, with new quality productivity being a significant outcome in this context. Drawing on provincial panel data from 2012 to 2022, this study explores the influence of the digital economy on new quality productivity's development and its underlying mechanisms. The findings demonstrate that the digital economy substantially fosters the advancement of new quality productivity, which remains valid even after conducting endogeneity tests. Mechanism analysis reveals that housing prices and social consumption levels exert notable regulatory effects on how the digital economy promotes new quality productivity's development: housing prices negatively regulate such promotion while social consumption levels play a positive adjusting role in their causal relationship. Heterogeneity analysis indicates that at both ends of China (Eastern and Western regions) as well as within industries characterized by medium-level structures, higher levels of digital economy significantly promote local advancements in new quality productivity. This investigation contributes to enhancing our understanding regarding the impacts, mechanisms, and regional disparities associated with developing new quality productivity through leveraging the potential offered by digital economy.

**Keywords:** Digital Economy, New Quality Productivity, Social Consumption Level, Housing Prices.

## 1. Introduction

The concept of "new quality productivity" was first introduced by the Chinese president during his visit to Heilongjiang in September 2023. At the 11th group study session of the Political Bureau of the CPC Central Committee in January 2024, he emphasized that developing new quality productivity is essential for promoting high-quality development. Digital economy is a new economic form based on digital technology, realizing production, distribution, exchange and consumption through information network [1]. In the technological and industrial revolution, data elements have become new strategic resources, and digital technologies are increasingly playing an enabling role in strategic emerging industries and future industries, promoting the transformation of production modes and the development of new quality productive forces. Driven by technologies such as Internet of Things, the digital economy is expanding in scale, increasing the added value of productivity, competitiveness and sustainable development capacity.

The detailed examination of how the digital economy affects new quality productivity development is essential for accelerating its formation and vital for achieving high-quality economic growth in China. Current research on this topic remains at an early stage, primarily concentrating on their logical relationship, characteristics, and formation process [2]. However, existing studies are excessively theoretical without sufficient empirical evidence or case analysis. This paper aims to comprehensively analyze how housing prices and social consumption levels contribute to the impact of the digital economy on new quality productivity development. Such an analysis plays a significant role in utilizing the potential of the digital economy to drive forward new quality productivity development.

The marginal contribution of this paper is reflected in the following aspects: (1) This paper empirically tests the role of digital economy in promoting the development of new quality productivity, and deepens relevant theoretical research. (2) It is theoretically and empirically verified that the promotion effect of digital economy on new-quality productivity can be strengthened by reducing housing price and improving the level of social consumption. (3) Through heterogeneity analysis, this paper compares the impact of digital economy on new quality productivity under different geographical locations and fiscal structures, which provides an empirical basis for formulating differentiated development of new quality productivity policies.

## **2. Literature review and research hypotheses**

### **2.1. Digital economy and new quality productivity**

The digital economy enhances the ability of the "invisible hand" to allocate resources efficiently, promoting the development of new-quality productivity to some extent. It has inherent advantages in data aggregation and processing capabilities, facilitating seamless exchanges and connections between upstream and downstream enterprises. This strengthens China's industrial chain competitiveness and lays a foundation for high-quality economic development. Relying on digital economy and technology to drive new quality productivity is not only a trend but also an essential choice for promoting rapid high-quality economic growth. Therefore, as shown in Figure 1, hypothesis 1 is proposed: H1 - Digital economy development promotes improved new-quality productivity.

### **2.2. Digital economy, housing prices and new-quality productivity**

Due to the rapid rise in housing prices and the development of the real estate market, capital is driven by profit. The highly profitable real estate sector has obtained significant funds, which hinders research and development in other sectors and impedes technological progress. This further inhibits high-quality economic development. In comparison to cities with low housing prices, high housing prices in cities accelerate the diffusion effect of digital economy on manufacturing agglomeration while weakening geographical agglomeration in the manufacturing industry [3]. Rising housing prices divert funds that real enterprises need for production, operation, and innovation into the real estate market. This seriously damages their ability for technological innovation, thus hindering the promoting effect of digital technology on new quality productivity. Therefore, as shown in Figure 1, hypothesis 1 is proposed: H1 - Housing price negatively regulates the promoting effect of digital economy on new-quality productivity.

### **2.3. Digital economy, social consumption level and new-quality productivity**

With the development of the digital economy, people's consumption level is rising. The application of digital technology can improve operation efficiency and production efficiency, reduce production costs, help enterprises to expand their scale, improve labor productivity, and thus create more employment opportunities [4]. Traditional transactions need to consume a lot of costs, while the digital economy uses high-tech means to realize cross-regional and timely transactions, which makes the transaction channels and communication methods in the market more convenient, can reduce the cost of market transactions, and provides the possibility for residents to have a higher level of consumption [5]. Therefore, as shown in Figure 1, hypothesis 3 is proposed in this paper. H3: The level of social consumption positively regulates the promoting effect of digital economy on new quality productivity.



**Figure 1.** Mechanism analysis diagram

### 3. Empirical design

#### 3.1. Model setting

In order to study the impact of digital economy on new quality productivity, the following two-way fixed effect model is constructed:

$$\text{newprod}_{it} = \alpha_0 + \alpha_1 \text{digital}_{it} + \gamma \text{control}_{it} + \mu_i + \nu_t + \varepsilon_{it} \quad (1)$$

In Equation (1),  $i$  denotes province,  $t$  denotes year,  $\text{newprod}_{it}$  denotes the development level of new quality productivity in province  $i$  in period  $t$ ,  $\text{digital}_{it}$  denotes the development level of digital economy in province  $i$  in period  $t$ , which is the core explanatory variable of the model. Represents the control variables that may affect the development of new quality productivity, mainly including the level of population size, the degree of opening to the outside world, the level of labor force and the level of economic development;  $\mu_i$  is the province fixed effect,  $\nu_t$  is the year fixed effect, and  $\varepsilon_{it}$  is the random error term.

#### 3.2. Variable selection

##### 3.2.1. Explained variable

Explained variable is new quality productivity (newprod). This paper builds the evaluation index system of new quality productivity on the basis of three secondary indicators of scientific and technological productivity, green productivity and digital productivity, and further subdivides the three secondary indicators into 13 tertiary indicators according to the reference range of indicators, and uses the entropy method to measure [6]. The specific index system is shown in Table 1 below.

**Table 1.** New quality productivity level measurement index system

| First-level indicators   | Secondary indicators                      | Tertiary indicators                        | Explanation                                                         | Units               | Attributes |
|--------------------------|-------------------------------------------|--------------------------------------------|---------------------------------------------------------------------|---------------------|------------|
| New quality productivity | Scientific and technological productivity | Innovative research and development        | Number of patents granted by region                                 | a                   | +          |
|                          |                                           | Innovative industries                      | Business income from high-tech industries                           | Ten thousand yuan   | +          |
|                          |                                           | Innovative products                        | Regulation of industrial innovation funds of industrial enterprises | Ten thousand yuan   | +          |
|                          |                                           | Technology research and development        | Standard industrial enterprise R&D personnel full-time equivalent   | h                   | +          |
|                          | Green productivity                        | Energy intensity                           | Energy consumption/gross domestic product                           | %                   | -          |
|                          |                                           | Energy mix                                 | Fossil energy consumption/gross domestic product                    | %                   | -          |
|                          |                                           | Intensity of water use                     | Industrial water consumption/gross domestic product                 | %                   | -          |
|                          |                                           | Waste utilization                          | Comprehensive utilization/production of industrial solid waste      | %                   | +          |
|                          |                                           | Wastewater discharge                       | Industrial wastewater discharge/gross domestic product              | %                   | -          |
|                          |                                           | Exhaust emissions                          | Industrial SO <sub>2</sub> emissions/gross domestic product         | %                   | -          |
|                          | Digital productivity                      | Electronic information manufacturing       | Integrated circuit production volume                                | Ten thousand pieces | +          |
|                          |                                           | Telecommunications business communications | Total amount of telecommunications services                         | Ten thousand yuan   | +          |
|                          |                                           | Internet penetration                       | Number of Internet broadband access ports                           | a                   | +          |
|                          |                                           | Software services                          | Software business revenue                                           | people              | +          |
|                          |                                           | Digital information                        | Cable line length/area area                                         | m                   | +          |
|                          |                                           | E-commerce                                 | E-commerce sales                                                    | Ten thousand yuan   | +          |

### 3.2.2. Core explanatory variables

The core explanatory variable is digital economy (digital). In order to quantitatively describe the development level of digital economy in all provinces of China as completely and accurately as possible, this paper takes the three dimensions of digital infrastructure, digital industry development and digital inclusive finance as the secondary indicators to describe the development level of digital economy at provincial level. The paper constructs the index system of digital economy development level and calculates it through entropy method, as shown in Table 2 below [7].

**Table 2.** Measurement index system of digital economy development level

| First-level indicators | Secondary indicators         | Tertiary indicators                                            | Units                 | Attributes |
|------------------------|------------------------------|----------------------------------------------------------------|-----------------------|------------|
| Digital economy        | Digital infrastructure       | Number of domain names                                         | Ten thousand yuan     | +          |
|                        |                              | Number of IPv4 urls                                            | Ten thousand          | +          |
|                        |                              | Number of Internet broadband access ports                      | Ten thousand          | +          |
|                        |                              | Mobile phone penetration                                       | Ministry / 100 people | +          |
|                        |                              | Cable length per unit area                                     | Km/km <sup>2</sup>    | +          |
|                        | Digital industry development | Number of information-based enterprises                        | a                     | +          |
|                        |                              | Number of websites per 100 enterprises                         | a                     | +          |
|                        |                              | E-commerce transaction volume                                  | Billion               | +          |
|                        |                              | Proportion of enterprises with e-commerce transaction activity | %                     | +          |
|                        |                              | Revenue from software business                                 | Ten thousand yuan     | +          |
|                        | Digital Universal Finance    | Breadth of Coverage Index                                      | -                     | +          |
|                        |                              | Using the Depth index                                          | -                     | +          |
|                        |                              | Digitization degree index                                      | -                     | +          |

### 3.2.3. Mechanism variables

The moderating variables are houseprice and social consumption level. Referring to the method of Qian Hongsen (2023), for the purpose of data comparability, the logarithm of the average sales price of commercial housing is used to calculate; The level of social consumption refers to the sum of various expenditures used by consumers to meet their daily living expenses in a certain period of time [8].

### 3.2.4. Control variables

In order to analyze the impact of digital economy on new quality productivity more comprehensively, the control variables that may have an impact on the development of new quality productivity are set. The specific control variables cited in this paper are as follows: population size level (population), which is represented by the logarithm of permanent resident population; The degree of opening up to the outside world (open) is reflected by the ratio of the import and export value of goods to the regional GDP; The level of labor force (labor) is measured by the logarithm of the number of employed persons; The level of economic development (lngdp) is measured by taking the logarithm of per capita GDP.

### 3.3. Data sources

The data in this paper are panel data of 30 provinces and autonomous regions in China (excluding Tibet, Hong Kong, Macao and Taiwan) from 2012 to 2022. The data mainly come from China Statistical Yearbook, China Energy Statistical Yearbook and statistical yearbooks of various provinces, etc. The missing data are supplemented by linear interpolation method.

## 4. Empirical analysis

### 4.1. Benchmark regression

The results of the impact of digital economy on the level of new quality productivity are shown in Table 3. After the control variables are added to column (6), the coefficient of the development level of digital economy is 0.334, which is significantly positive at the level of 1%, indicating that the digital economy has a role in promoting the development of new quality productivity. By improving

the ability of data processing and analysis in various industries, digital economy promotes the intelligence and refinement of production process, and its role in promoting the new quality productivity cannot be ignored. Therefore, Hypothesis 1 is established. In addition, the coefficient of the level of economic development is also significantly positive, indicating that the level of economic development will also significantly promote the development of new quality productivity.

**Table 3.** Benchmark regression results

| Variables of interest                                                                                                                                      | (1)      | (2)      | (3)      | (4)     | (5)      | (6)      |
|------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|----------|----------|---------|----------|----------|
| digital                                                                                                                                                    | 0.671*** | 0.515*** | 0.267*** | 0.204** | 0.433*** | 0.334*** |
|                                                                                                                                                            | (5.33)   | (4.22)   | (3.86)   | (2.60)  | (3.62)   | (3.96)   |
| population                                                                                                                                                 |          | 0.104*   |          | 0.251   |          | 0.156    |
|                                                                                                                                                            |          | (1.66)   |          | (1.31)  |          | (0.81)   |
| open                                                                                                                                                       |          | 0.003    |          | 0.103*  |          | 0.080    |
|                                                                                                                                                            |          | (-0.06)  |          | (-1.77) |          | (-1.28)  |
| labor                                                                                                                                                      |          | 0.011    |          | 0.047   |          | 0.007    |
|                                                                                                                                                            |          | (-0.22)  |          | (0.83)  |          | (-0.12)  |
| lngdp                                                                                                                                                      |          | 0.180*** |          | 0.017   |          | 0.139*** |
|                                                                                                                                                            |          | (4.39)   |          | (-0.51) |          | (3.10)   |
| Province                                                                                                                                                   | NO       | NO       | YES      | YES     | YES      | YES      |
| Year                                                                                                                                                       | YES      | YES      | NO       | NO      | YES      | YES      |
| Observations                                                                                                                                               | 330      | 330      | 330      | 330     | 330      | 330      |
| Number of provinces                                                                                                                                        | 30       | 30       | 30       | 30      | 30       | 30       |
| R-squared                                                                                                                                                  | 0.248    | 0.315    | 0.163    | 0.254   | 0.260    | 0.331    |
| Note: The figures in parentheses are robust t statistics; *, ** and *** indicate significance at the level of 10%, 5% and 1%, respectively, the same below |          |          |          |         |          |          |

## 4.2. Endogeneity analysis

In the empirical process, due to mutual causality and the existence of omitted variables may lead to potential endogeneity problems, this paper introduces the interaction term between the number of Internet users in the previous year (2011-2021) and the number of fixed telephones per 10,000 people in each province in 1984 as instrumental variable, which is used as the instrumental variable of the provincial digital economy index in this year. The 2SLS method is used for regression to alleviate the endogeneity problem.

As shown in the regression results of instrumental variables in Table 4, columns (1) and (2) are the first-stage regression results, which show that instrumental variables are significantly positively correlated with the development level of digital economy, satisfying the correlation; The second-stage regression results in columns (3) and (4) show that the coefficient of the development level of digital economy is positive and significant at the level of 5%, which is consistent with the benchmark regression results, and the research hypothesis 1 is verified again.

**Table 4.** Regression results of instrumental variables

| Variables           | (1)     | (2)      | (3)     | (4)     |
|---------------------|---------|----------|---------|---------|
|                     | digital |          | newprod |         |
| phone               | 0.017** | 0.015*** |         |         |
|                     | (2.70)  | (3.48)   |         |         |
| digital             |         |          | 0.361** | 0.362** |
|                     |         |          | (1.97)  | (2.30)  |
| Control             | NO      | YES      | NO      | YES     |
| Province            | YES     | YES      | YES     | YES     |
| Year                | YES     | YES      | YES     | YES     |
| Observations        | 330     | 330      | 330     | 330     |
| Number of provinces | 30      | 30       | 30      | 30      |
| R-squared           | 0.793   | 0.864    | 0.864   | 0.331   |

### 4.3. Moderating effect

#### 4.3.1. Model construction

In order to investigate the effects of housing price and social consumption level on digital economy and new quality productivity, this paper introduces interactive variables between digital economy and housing price, digital economy and social consumption level on the basis of benchmark regression, and further analyzes the regulating effects of housing price and social consumption level [9]. The moderating effect model is as follows:

$$\text{newprod}_{it} = \delta_0 + \delta_1 \text{digial}_{it} + \delta_2 \text{moderator}_{it} + \delta_3 \text{digial}_{it} \times \text{moderator}_{it} + \gamma \text{control}_{it} + \mu_i + \nu_t + \varepsilon_{it} \quad (2)$$

In Equation (1),  $i$  represents the province,  $t$  represents the year,  $\text{moderator}$  represents the moderating variable, contains house price and consume, where represents the housing price of province  $i$  in period  $t$ , represents the social consumption level of province  $i$  in period  $t$ ; the coefficient of the interaction term represents the impact of the interaction between digital economy and housing price and the interaction between digital economy and social consumption level on the development of new quality productivity respectively, and the definition of other symbols is the same as above.

#### 4.3.2. Moderating effect of housing price

As shown in columns (1) and (2) of Table 5, the coefficient of interaction between digital economy and housing price is significantly negative, indicating that housing price weakens the positive influence of digital economy on the development of new quality productivity. When the housing price is at a low level, the environment of low housing price provides more economic flexibility for enterprises and individuals, and more capital is invested in digital technological innovation and personnel training, thus accelerating the development pace of new quality productivity. The digital economy plays a more significant role in promoting the development of new quality productivity. High housing prices increase the pressure of house purchase and the cost of living, which may lead to enterprises in the field of digital technology and innovation to reduce investment, brain drain and innovation vitality decline, may also lead to the unequal distribution of resources and social equity issues, restricting the development of new quality productivity. Therefore, Hypothesis 2 is approved.

#### 4.3.3. Moderating effect of social consumption level

As shown in columns (3) and (4) of Table 5, the coefficient of interaction between digital economy and social consumption level is significantly positive, which indicates that social consumption level can positively regulate the promotion effect of digital economy on new quality productivity. When the social consumption level is at a high level, consumers are more pursuing the personalized product, digital economy with big data and other advanced technological means, can more effectively meet consumer demand, and then promote the rapid development of new quality productivity; The decline in the level of social consumption often means that the purchasing power of consumers is weakened, and the demand for goods and services will also decrease accordingly. Meanwhile, enterprises will also face greater operating pressure, which makes it difficult for the digital economy to give full play to its potential. Therefore, Hypothesis 3 is accepted.

**Table 5.** Moderating effect of housing price and social consumption level

| Variables           | (1)      | (2)      | (3)      | (4)      |
|---------------------|----------|----------|----------|----------|
| digital             | 0.750*** | 0.742*** | 0.567*** | 0.445*** |
|                     | (4.61)   | (6.90)   | (3.36)   | (3.55)   |
| houseprice          | 0.015    | 0.005    |          |          |
|                     | (-0.60)  | (-0.22)  |          |          |
| consume             | 0.062    | 0.084    | 0.062    | 0.084    |
|                     | (1.24)   | (1.13)   | (1.24)   | (1.13)   |
| houseprice*digital  | 0.169**  | 0.259*** |          |          |
|                     | (-2.41)  | (-3.67)  |          |          |
| consume*digital     |          |          | 2.134**  | 1.576**  |
|                     |          |          | (2.49)   | (2.41)   |
| Control             | NO       | YES      | NO       | YES      |
| Province            | YES      | YES      | YES      | YES      |
| Year                | YES      | YES      | YES      | YES      |
| Observations        | 330      | 330      | 330      | 330      |
| Number of provinces | 30       | 30       | 30       | 30       |
| R-squared           | 0.283    | 0.368    | 0.302    | 0.356    |

#### 4.4. Heterogeneity analysis

##### 4.4.1. Heterogeneity of geographical location

In order to further explore the regional differences of the impact of digital economy on new quality productivity, according to the National Bureau of Statistics, 30 provinces are divided into three regions: eastern, central and western regions.

The results of columns (1) - (3) of Table 6 show that the digital economy in the eastern and western regions has a positive effect on the new quality productivity, while the digital economy in the central region has no significant effect on the new quality productivity. In the eastern region, the economy is more developed, with more universities and research centers, which provides market space and intellectual support for the application of digital economy. The state gives more policy support and capital investment to the digital economy in the western region, so the digital economy has a significant role in promoting the new quality productivity in the eastern and western regions. However, in the central region, the industrial structure is relatively single, mainly dominated by traditional industries, and the application of digital economy is relatively small.

##### 4.4.2. Heterogeneity of industrial structure

The samples of each province are divided according to the high, medium and low level of industrial structure [10]. The level of industrial structure is measured by the ratio of the added value of the secondary industry to the added value of the tertiary industry.

The test results are shown in columns (4) - (6) of Table 6. In the provinces with medium industrial structure, digital economy can significantly promote the development of new quality productivity, while in the provinces with high and low industrial structure, the effect of digital economy on new quality productivity is not significant. Under the medium-level industrial structure, the market demand and competitive pressure may be more moderate, and the medium-level industrial structure usually has a certain digital foundation, and can more easily accept and apply the technology and tools of the digital economy, so as to improve production efficiency and innovation ability; In the high-level industrial structure, the industrial structure is relatively mature, and the impact of the application of digital economy on productivity is relatively limited; In the low-level industrial structure, due to the limitation of infrastructure and technology level, the development of digital economy may be blocked and cannot promote the development of new quality productivity.

**Table 6.** Heterogeneous regression results

| Variables           | (1)     | (2)    | (3)    | (4)    | (5)     | (6)    |
|---------------------|---------|--------|--------|--------|---------|--------|
|                     | east    | middle | west   | low    | middle  | high   |
| digital             | 0.309** | 6.398  | 0.357* | 0.719  | 0.323** | 0.078  |
|                     | (1.98)  | (0.88) | (1.93) | (1.29) | (2.19)  | (0.39) |
| Control             | YES     | YES    | YES    | YES    | YES     | YES    |
| Province            | YES     | YES    | YES    | YES    | YES     | YES    |
| Year                | YES     | YES    | YES    | YES    | YES     | YES    |
| Observations        | 132     | 99     | 99     | 110    | 110     | 110    |
| Number of provinces | 12      | 9      | 9      | 10     | 10      | 10     |
| R-squared           | 0.654   | 0.109  | 0.66   | 0.274  | 0.746   | 0.528  |

## 5. Policy suggestions

### 5.1. Improve the governance system for the digital economy

The government should strengthen the supervision and law enforcement of the digital economy, establish and improve the supervision mechanism, and ensure the healthy and orderly development of the digital economy. The government should also actively promote the deep integration of the digital economy and the real economy, encourage the digital transformation and upgrading of traditional industries, and enhance the overall competitiveness. Adopt advanced technical means and management measures to ensure data security and privacy, and reduce the impact of information security risks on the development of new quality productivity.

### 5.2. Rationally regulate housing prices and accelerate technological innovation through consumption upgrading.

The government should strengthen the supervision of the real estate market to prevent the housing price from rising or falling too fast, so as to provide stable expectation and guarantee for the development of new quality productivity. By providing preferential policies and convenient conditions, we will encourage consumers to buy high-quality digital products and services, and promote digital consumption to a higher level. Thus, effectively promote the development of new quality productivity.

### 5.3. Promote the open sharing of data resources

First of all, the digital divide between different regions, by promoting information sharing and deep collaboration, ensures that digital resources can achieve comprehensive and efficient regional sharing, promotes the equality and smooth flow of information, so as to maximize the use of information resources. Secondly, the digital divide between different industries, through the establishment of unified data standards and interface specifications, break down industry barriers and information islands, to achieve the free flow and sharing of data in different industries.

## 6. Conclusion

The conclusions are as follows: (1) The improvement of digital economy can significantly promote the development of new quality productivity, and the conclusion is still valid after endogeneity test; (2) Housing price negatively regulates the promotion effect of digital economy on new quality productivity; The level of social consumption positively regulates the promotion effect of digital economy on new quality productivity; (3) The level of industrial structure is heterogeneous among different regions. The study found that in eastern and western regions and provinces with medium level industrial structure, digital economy can significantly promote the development of local new quality productivity. With the continuous expansion of the scale of the digital economy, productivity

has achieved a qualitative leap forward, and promoted the formation of new quality productivity with higher added value, stronger competitiveness and more sustainable development capacity.

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