

Research on the Impact of Digital Economy on Residents' Consumption Upgrading

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Abstract: The deep integration of digital technology and the real economy has injected new power into the consumer market, and the role of digital economy in promoting residents' consumption upgrading is especially obvious in the post epidemic era. Panel data from 2014-2020 of 30 provinces in China except Tibet are selected to examine the driving role of digital economy on residents' consumption upgrading based on the perspective of technological innovation intermediary. The results of the study show that: from the overall level, the digital economy significantly promotes the upgrading of residents' consumption, but there is obvious regional heterogeneity; from the perspective of the mediation effect, the digital economy promotes the optimization of the residents' consumption structure through the channel of technological innovation; however, the technological innovation path of the digital economy to promote the level of residents' consumption is not significant, due to the impact of the two types of technological innovation, namely, product innovation and technological innovation, which are offsetting the impact of the two types of technological innovation on the level of residents' consumption. significant. Therefore, we should accelerate the breakthrough of digital technology innovation, fill the gap of digital economy development between regions, promote the coordinated development of East, Middle East and West China, and promote the upgrading of residents' consumption.

Keywords: Digital economy, Consumption upgrading, Technological innovation, Mediation effect.

1. Introduction

Consumption has long been a topic of greater academic interest. Stimulating residents' consumption potential has become the key to transforming China's economic growth mode and improving the quality of economic development (Yang Weiming, Su Lin, 2021). 2020 epidemic outbreak, affected by the recurrence of the epidemic and the downward pressure of the economy and other factors, the release of consumer demand still has a greater potential, but the status of consumption as the first driver of economic growth has not changed. 2021 began to weaken the impact of the epidemic, with the prevention and control work into normalization, China's consumer market fully established a good trend of recovery. work into normalization, China's consumer market has established a comprehensive recovery trend. According to the National Bureau of Statistics, the total retail sales of consumer goods reached 440,823 billion yuan in 2021, and the contribution rate of final consumption expenditure to China's economic growth was 65.4%, and exceeded the pre-epidemic level, with the resilience and endogenous dynamics of the consumer market further emerging and expanding.

Digital innovation has become an important driving force for the recovery and expansion of the consumer market. The digital consumption mode brought about by the development of the digital economy has gradually become the mainstream of investment and consumption of China's residents, and its generation and development have an extremely strong driving effect on the consumption level and consumption behavior of China's residents (Xing Genius, Zhang Xi, 2019). The importance of online consumption in all avenues of residents' consumption has been further highlighted, playing the role of a stabilizer in this response to the impact of the new crown epidemic. The "house economy" and "house consumption" have emerged, and new online consumption innovations such as vertical e-commerce, live streaming, and e-tailing have become more active, while digital technology has accelerated

its empowerment to the offline sector, further accelerating online and offline consumption innovations. The digital economy industry has effectively responded to market demand and created economic growth against the trend, and in the case of the national total retail sales of consumer goods showing negative growth, online consumption still maintains high growth, and the data from the National Bureau of Statistics shows that the annual online retail sales of physical goods in 2021 will reach 108,042 billion yuan, an increase of 12.0% compared with 2020, and account for the proportion of total retail sales of consumer goods in the whole society to reach 24.5%, and has become the main driver of consumption growth. In view of this, this paper attempts to use the digital economy development index, matched with provincial consumption data to construct panel data, to analyze the relationship between the development of the digital economy and the consumption of residents in various regions. It explores whether the digital economy drives consumption upgrading and in what path it works, assesses the role of technological innovation in the path of the digital economy affecting consumption upgrading, and provides useful reference for exploring new consumption growth points and stabilizing economic growth in the post epidemic era.

2. Literature Review

Digital economy boosts residents' consumption. The digital economy is a new economic form based on the development of the Internet and its corresponding emerging technologies in the context of economic slowdown (Jing Wenjun, Sun Baowen, 2019). Thanks to the Internet revolution, the digital economy has developed rapidly, especially since the new crown epidemic, the development of the digital economy has accelerated in all aspects and continued to maintain growth against the trend, becoming an important force to hedge against the impact of the epidemic and promote the stabilization of the economy. The continuous emergence of new business models and new forms of business, consumers

are no longer limited to offline physical consumption, but also ease the liquidity constraints in consumption and optimize the payment environment (Huang Kainan, Hao Xiangru, 2021). The development of the digital economy has brought about new industrial forms, boosted consumption and injected a source of power for economic growth.

The development of the digital economy has brought new business models that have revolutionized consumption and promoted the further upgrading of consumption. Research on the impact of the digital economy on residents' consumption upgrading is relatively rich, and relevant literature has carried out a lot of discussion and research in both theory and empirical evidence. In terms of theory, Quiet (2020), based on the perspective of the Internet industry, points out that Internet finance has generated new consumer demand through innovative supply, which has substantially changed the consumption pattern of residents, not only increasing the convenience of consumption, but also lowering the threshold of access for the use of the population. Ma Xiangpin (2020) unfolded from the new characteristics of residents' consumption, in the age of informationization, the development of digital economy accompanied by technological progress and innovation promotes the cyclic upgrading between the mode of production and residents' consumption. Based on the perspective of consumer behavior, Liu Rongting (2019) analyzed and found that the consumption behavior of China's residents under the network economy will appear new characteristics such as the locking of consumption information and the self-expansion of the consumption scale, indicating that the network economy has a promotional effect on consumption. Empirically, Yi Xingjian and Zhou Li (2018), from the micro perspective, found that China's digital HPF significantly promotes residents' consumption by alleviating liquidity constraints and facilitating payments. Zhu Zhongkun (2020), based on CSS2015 data, empirically examined whether the consumption potential is released and whether the consumption structure is optimized at two levels, and found that Internet skills have a significant role in promoting the consumption upgrading of rural residents.

There have been many explorations by scholars on the mechanism and path of the digital economy to promote residents' consumption upgrading. First, the digital economy promotes consumption upgrading by reducing consumption costs. Compared with the traditional business model, the Internet financial consumption model avoids the information asymmetry between the supply and demand sides, thus effectively reducing the cost of sales and the final transaction price (Li Xuyang, Li Tongping et al., 2019). Second, the demand side aspect promotes consumption upgrading. The Internet has an impact on traditional consumer behavior by changing consumer behavioral decisions (He Zongyue, Song Xuguang, 2020). Li Jikai and Yin Yuting (2020) argue that the digital economy provides direction for changes in residential consumption by influencing changes in the dominant level of the demand side. Thirdly, it promotes consumption upgrading from the supply side. The digital transformation of traditional industries and the deepening of China's supply-side structural reform have effectively solved the problems of massive overcapacity, excessive competition and ineffective supply in low segments. With the deepening of supply-side structural reform, the products and services provided by enterprises can effectively meet consumer demand, realizing the precise matching of supply and demand, thus promoting consumption

upgrading and realizing a virtuous cycle of economic operation (Lv Tie, 2019). Shi Bo (2020) believes that artificial intelligence will accelerate green consumption and intelligent consumption to guide industrial upgrading, improve the quality of education and medical consumption, create conditions for cultivating high-end factors of production, drive consumption upgrading and help high-quality development.

In summary, research on the impact of digital economic development on residents' consumption upgrading has been relatively abundant, but no consensus has been reached on how the digital economy promotes residents' consumption. This paper tries to empirically test whether the development of digital economy promotes residents' consumption upgrading from the perspective of technological innovation, and further analyzes the transmission mechanism of this impact by using the mediation effect model. The marginal contribution is mainly reflected in the following aspects: first, it empirically explores the marginal effect of the impact of digital economic development on the upgrading of residents' consumption in different regions, which provides a theoretical basis for realizing the upgrading of residents' consumption in different regions; second, it explores from the perspective of technological innovation whether there is a mediation effect in the impact of the digital economy on the level of residents' consumption with technological innovation as the mediating variable. By revealing the intrinsic mechanism of the digital economy's influence on residents' consumption upgrading, it deepens the research on the relationship between the digital economy and consumption, and further provides empirical reference and policy inspiration for promoting the stable and high-speed development of China's economy.

3. Theoretical Analysis and Research Assumptions

Before studying the impact of digital economy on residents' consumption upgrading, we first define the measurement of residents' consumption upgrading. Existing indicators for measuring consumption upgrading vary due to different scholars' research methods and research purposes. For example, the income demand elasticity is calculated through the AIDS model or the ELES model, etc., and then the residents' various consumptions are divided into different levels according to the expenditure elasticity to determine whether consumption upgrading occurs and whether the upgrading effect is significant (Shi Mingming, 2019; Zeng Jiehua, 2019; Liu Xiangdong, 2020). Wei Yong and Yang Mengyu (2017) used the extended linear expenditure model to classify high-grade consumption and regarded the change in the total consumption of high-grade goods as a reference for residents' consumption upgrading. Combining the existing views, this paper argues that consumption upgrading should include two aspects. One is the rise of the consumption level, and the other is the optimization of the consumption structure. The increase in consumption rate and consumption level is the main basis for residents' consumption upgrading.

In the post epidemic era, the digital economy has gradually become the focus of global industrial layout for economic recovery. The digital economy overcomes the dependence of traditional finance on physical outlets, expands residents' consumption channels, and provides support for the improvement of the consumption rate as well as the consumption hierarchy of residents (Nan Yongqing, Song

Mingyue, 2020). Secondly, the development of the digital economy is conducive to improving production efficiency, accelerating the innovation of products and services, and promoting the enhancement of the consumption level of residents from the supply side. The penetration of the digital economy into all fields of social and economic activities can not only improve production efficiency, but also expand the scale and improve the quality of employment, which in turn promotes the adjustment of the income distribution structure, reduces the urban-rural income gap, and enhances the consumption level of residents. Based on this, we hypothesize that the development of digital economy in the post-epidemic era can influence the upgrading of residents' consumption. Therefore, the following hypotheses are proposed based on the above analysis:

Hypothesis 1: The development of digital economy in the post epidemic era has a significant role in promoting the upgrading of residents' consumption.

Overall, it seems that the economy of China's regions has entered a period of rapid growth, but the central and western regions still show obvious imbalances. Although the digital economy can break through the traditional geographical limitations to a certain extent, its activities still depend on the real economic development of the region. Not only in the scale of the real economy, there are significant differences in the digital resources, geographic location and historical conditions of the regions, which provide different fundamental elements for the development of the digital economy, leading to an imbalance in the development of the digital economy among the regions.

In addition, the consumption habits and preferences of residents in the eastern, central and western regions of China have significant regional characteristics, and residents' consumption preferences determine the derivation and development of new local consumption patterns, so the impact of the digital economy on residents' consumption upgrading in the three major regions of China may also differ. The study found that residents' consumption itself has a demonstration effect, and the level of residents' consumption in each region shows a significant positive spatial correlation. Eastern coastal cities, especially the Yangtze River Delta and the Pearl River Delta region, are mostly characterized by the phenomenon of high-high aggregation, and eastern coastal cities and central provincial capitals with higher levels of consumption also show higher consumption capacity in their surrounding cities. The low-low aggregation phenomenon is mainly distributed in the northeast and central cities, and the prefecture-level cities in the central and western regions, which are relatively backward in terms of economic development, are usually surrounded by cities with lower consumption capacity. And the development of the digital economy also shows a clear ladder from the southeast coast to the inland (Guo Feng, 2020). From this, we make reasonable assumptions:

Hypothesis 2: There are regional differences in the role of the digital economy in promoting residents' consumption upgrading.

Humanity has entered the age of informationization and intelligence. As far as the retail industry is concerned, China's e-commerce accounts for more than 50%. In other words, online consumption has gradually become mainstream, and the proportion of digitalization is becoming more prominent in various fields. In terms of society in general, the development of the digital economy has promoted

technological innovation, enabling the accelerated expansion of new consumer businesses and easing the consumption slump. In the process of economic growth, technological innovation has a very prominent position. Technological innovation is categorized into product innovation and process innovation. Product innovation refers to the improvement or creation of products, which triggers new consumer demand and opens up new consumer markets, and this kind of innovation will also greatly improve supply efficiency and increase employment. Process innovation, on the other hand, refers to the modification of existing production processes or the invention of new production processes, with the aim of reducing production costs and increasing production efficiency. Such innovations generally do not create demand for new products, but simply make the production of existing products more efficient and less costly, with a concomitant reduction in employment, which offsets the effect of product innovations on the level of consumption.

Second, digital technology continues to innovate, opening up entirely new areas and horizons of consumption for consumers. New technologies and modes provide consumers with a broader space for choice. Microscopically speaking, the digital economy provides support for consumers to advance to higher levels of consumption demand through scientific and technological innovation, and expands residents' development and enjoyment-oriented consumption expenditure (Zhao Baoguo, Gainian, 2020). The innovation and application of digital technology gradually opens up the channels of consumers' self-needs, and consumers' consumption desires are no longer satisfied with material needs such as food and clothing, but are replaced by the spiritual level of sustenance, which promotes the optimization of the residents' consumption structure. From a macro point of view, the digital economy breaks down regional and urban-rural market segmentation, expands the scope of the flow of goods and services, and better meets the consumption needs of residents. In addition, the new service capacity created by the digital economy is also expanding, and virtual services such as online consumption are increasingly favored by consumers, realizing the transformation of physical-type consumption to virtual service-type consumption. Therefore, based on the above analysis, the following hypothesis is proposed:

Hypothesis III: The digital economy may not have an impact on the level of consumption of residents through technological innovation.

Hypothesis 4: The digital economy may realize the optimization of residents' consumption structure through technological innovation.

4. Model Setting and Variable Selection

4.1. Econometric Model Setting

In order to study the impact of digital economy on residents' consumption upgrading, the basic test model set in this paper is as follows:

$$\text{Consume1}_{it} = \alpha_0 + \alpha_1 \text{LnIndex}_{it} + \alpha_2 \text{Control}_{it} + \mu_{it} \quad (1)$$

$$\text{Consume2}_{it} = \beta_0 + \beta_1 \text{LnIndex}_{it} + \beta_2 \text{Control}_{it} + \mu_{it} \quad (2)$$

In model (1) (2), the subscripts i and t denote province and time respectively, the explanatory variable $Consume1_{it}$ is a measure of consumption level, and $Consume2_{it}$ is a measure of consumption structure, and $LnIndex_{it}$ is the core explanatory variable of this paper, which indicates the level of digital economy development. $Control_{it}$ indicates other control variables that may affect residents' consumption upgrading. μ_{it} is the error correction term.

Mechanism analysis, in order to explore the mechanism of the digital economy affecting residents' consumption upgrading this paper uses the mediation effect model to further study.

$$LnInnovation_{it} = \gamma_0 + \gamma_1 LnIndex_{it} + \gamma_2 Control_{it} + \mu_{it} \quad (3)$$

$$Consume1_{it} = \theta_0 + \theta_1 LnIndex_{it} + \theta_2 LnInnovation_{it} + \theta_3 Control_{it} + \mu_{it} \quad (4)$$

$$Consume2_{it} = \sigma_0 + \sigma_1 LnIndex_{it} + \sigma_2 LnInnovation_{it} + \sigma_3 Control_{it} + \mu_{it} \quad (5)$$

Where $Innovation_{it}$ in model (3), (4), (5) is the measure of technological innovation.

4.2. Variable Selection and Data Source

4.2.1. Variable Selection and Processing

Explained variable: residents' consumption upgrading index. It is mainly examined from two dimensions: firstly, the improvement of residents' consumption scale, which is measured by residents' per capita consumption expenditure ($Consume1$); secondly, the optimization degree of consumption structure ($Consume2$); the measurement of consumption structure index is divided into three categories, namely, survival consumption expenditure, development consumption expenditure and enjoyment consumption expenditure, in accordance with the classification standard of National Bureau of Statistics (NBS). Consumption structure indicators are measured according to the classification standards of the National Bureau of Statistics. Survival-type consumption expenditure includes food, clothing and housing consumption expenditure; development-type consumption expenditure includes household equipment and transportation and communication consumption expenditure; and enjoyment-type consumption expenditure includes culture, education and recreation and medical care consumption expenditure. The proportions of survival-type, development-type, and enjoyment-type consumption in the total consumption of the population are calculated separately, and consumption is considered to be upgraded when the

proportions of development-type and enjoyment-type consumption in the total consumption increase.

Core explanatory variable: the level of digital economy. In this paper, Peking University's Digital Inclusive Finance Index is used as an indicator to measure the development of digital economy. The Digital Financial Inclusion Index (Index) is constructed by three dimensions: the breadth of digital financial coverage, the depth of digital financial use, and the degree of digitization of inclusive finance, which is available and reliable.

Mediating variable: technological innovation. Technological progress has prospered the economic market and stimulated the rapid expansion of people's consumption desire. Therefore, this paper portrays technological innovation through technology market turnover.

Control variables: per capita disposable income ($Income$), according to the theory of income and consumption, residents' consumption is mainly affected by per capita disposable income; social security (ss), using the social insurance participation rate of each province to reflect the impact of social security on consumption; the level of openness to the outside world ($open$), using the amount of import and export trade and the exchange rate of the current year to convert to the yuan and take the logarithm of the expression; the unemployment rate (ur), using the unemployed population turnover to characterize the unemployment rate ($Innovation$), (ur), expressed as the ratio of the number of unemployed people to the total number of employed people. The data come from local statistical bureaus.

4.2.2. Data sources and descriptive statistics of indicators

The data used in this paper mainly come from the local statistical yearbooks of past years. China's digital economy started relatively late, and it was only with the popularization of 3G mobile communication networks and the emergence of mobile smart terminals in 2008 that China's digital economy began to enter a stage of rapid development, and it was not until after 2012 that the development of China's digital economy stabilized. Since 2013, the National Bureau of Statistics (NBS) has carried out statistics and surveys on residents' online consumption. In order to ensure the consistency and availability of data, this paper selects the panel data of 30 provinces, autonomous regions and municipalities directly under the central government in China (excluding Tibet) for the period of 2014-2020. In addition, the digital economy-related indicators are derived from the Peking University Digital Financial Inclusion Index (2011-2020). The descriptive statistics of each variable are shown in Table 1.

Table 1. Statistical description of the variables

variant	maximum values	minimum value	average value	standard deviation	observed value
Consume1	10.7278	9.1381	9.7755	0.3245	210
Consume2	0.4005	0.2568	0.3297	0.0322	210
LnIndex	6.0683	4.9831	5.5632	0.2354	210
Innovation	17.9612	8.7833	14.2264	1.7828	210
LnIncome	11.1876	9.4079	10.1118	0.3574	210
ss	0.5748	0.0306	0.3476	0.1349	210
open	11.3293	3.0629	8.0674	1.6127	210
ur	4.6100	1.3000	3.2026	0.6288	210

5. Empirical Estimation and Analysis of Results

5.1. Empirical analysis of the impact of digital economy development on residents' consumption structure and residents' consumption level

Table 2 reports the results of the benchmark regression of

the digital economy on the upgrading of residents' consumption, respectively, the empirical test of the impact of the digital economy on the level of residents' consumption and the empirical test of the impact of the digital economy on the structure of residents' consumption. After Hausman test, the model setting of this paper should be in fixed effect mode.

Table 2. The impact of digital economic development on residents' consumption upgrade

explanatory variable	(1)	(2)
LnIndex	0.182*** (0.0324)	0.0920*** (0.0257)
LnIncome	0.561*** (0.0576)	0.0832** (0.0359)
ss	0.204 (0.206)	0.0458 (0.0752)
open	0.0487*** (0.0172)	0.000199 (0.00696)
ur	-0.0252** (0.0118)	-0.0113*** (0.00346)
constant term	2.707*** (0.444)	0.678*** (0.209)
R ²	0.9573	0.3216
N	210	210

Note: "***, **, *" represent 1%, 5%, and 10% significance levels, respectively. The parentheses represent the standard error, and FE and RE represent the fixed effect model and random effect model, respectively.

According to the estimation results in Table 2, it can be concluded that there is a significant positive relationship between the increase in the level of residents' consumption and the optimization of the consumption structure and the level of development of the digital economy. Every 1% increase in the development indicator of the level of digital economy will bring about 0.182 percentage point increase in the level of residents' consumption and 0.0920 percentage point improvement in the consumption structure. This finding proves that hypothesis one is valid and that digital economy development significantly promotes residents' consumption upgrading. From the significance of the control variables, there is a significant positive relationship between per capita disposable income and both the level of residents' consumption and consumption structure. Every 1% increase in disposable income brings about a 0.561% increase in the level of residents' consumption and a 0.0832% improvement in residents' consumption structure. At the same time, the degree of regional openness also has a significant contribution to the increase in the level of consumption of residents, and every 1% increase in the degree of openness will lead to an increase in the level of consumption of residents by 0.0487%. On the contrary, there is a significant negative relationship between the unemployment rate and the consumption level of residents. Every 1% increase in the unemployment rate will lead to an average decrease of 0.0252% in the level of consumption.

From the results of the empirical analysis of the variables on the level of residents' consumption as well as the consumption structure. First, the level of the digital economy

has a significant positive impact on the level of residents' consumption and consumption structure. This result is in line with the objective reality, in the special period of epidemic prevention and control, the development and wide application of the digital industry has broadened residents' consumption channels and promoted the emergence of new consumption patterns. These new consumption modes have the characteristics of convenience and quickness, which stimulate residents' consumption demand and enhance their consumption level, thus bringing about the improvement of residents' consumption level and the optimization of consumption structure. Secondly, there is a significant positive correlation between per capita disposable income and residents' consumption level and structure. Income is the most important factor influencing residents' consumption. With control variables, the more disposable income residents have, the more they consume various goods and services, and they will pursue higher levels of consumption while food and housing are satisfied. Thirdly, the degree of regional openness has a significant role in promoting the level of residents' consumption. From the perspective of the consumer market, people's demand for high-quality goods is growing, and effects such as the facilitation of import trade have gradually emerged. Therefore, expanding the degree of opening up to the outside world and promoting the upgrading of the supply product structure from the supply side can better satisfy residents' consumption demand and raise the level of consumption. Fourth, there is a clear negative relationship between the unemployment rate and the level of residents' consumption. The increase of the unemployment rate

indicates that the number of unemployed people within the measured range will show a certain magnitude of growth trend, and to a certain extent, it also indicates that the employment situation is not too optimistic, and even those who are not unemployed are unlikely to have a too sizable income. Lower disposable income per capita will bring about a downturn in the overall demand market, leading to a significant reduction in the consumption rate of the population.

5.2. Regional heterogeneity analysis of the impact of the development of digital economy on residents' consumption upgrade

Based on the results of the empirical analysis of the impact

of the digital economy on residents' consumption upgrading, it is concluded that the development of the digital economy can help promote residents' consumption upgrading. However, due to the differences in economic development and cultural level across China, there are significant differences in the development of digital economy and consumption habits between regions. In order to further study the regional heterogeneity of the impact of digital economy development on residents' consumption upgrading, this paper, based on the methodology of the China Bureau of Statistics, divides the 30 provincial-level administrative regions in the full sample into three regions: eastern, western and central. Then it continues to use the provincial panel data from 2014-2020 for empirical analysis. The results of the empirical analysis are shown in Table 3.

Table 3. The impact of the sub-regional digital economy on residents' consumption upgrading

explanatory variable	(1)			(2)		
	the east(FE)	central part (RE)	western part (FE)	the east (FE)	central part (FE)	western part (FE)
Index	0.154* (0.0700)	0.0654 (0.0915)	0.178** (0.0674)	0.103* (0.0492)	0.0834* (0.0372)	0.0916** (0.0324)
LnIncome	0.600*** (0.0997)	0.864*** (0.147)	0.577*** (0.0892)	-0.119 (0.0663)	-0.0278 (0.0659)	-0.0334 (0.0473)
ss	0.447 (0.603)	-0.341 (0.219)	0.225 (0.253)	0.491* (0.193)	-0.369 (0.210)	-0.209 (0.103)
open	-0.00121 (0.0414)	0.00897 (0.0313)	0.0437* (0.0209)	-0.0297 (0.0178)	-0.0224 (0.0126)	0.00113 (0.00902)
ur	-0.0609** (0.0220)	-0.0164 (0.0147)	-0.00632 (0.0150)	-0.0234** (0.00741)	-0.00666 (0.00386)	-0.00897* (0.00487)
constant term	3.006*** (0.892)	0.792 (0.867)	2.630*** (0.617)	1.147** (0.427)	0.461 (0.431)	0.274 (0.253)
R ²	0.9449	0.9756	0.9617	0.2649	0.4551	0.6046
N	77	56	77	77	56	77

Note: Same as Table 2.

According to the results of the empirical analysis in Table 3 above, it can be seen that the impact effect of the digital economy on residents' consumption upgrading, both from the dimension of consumption level and from the dimension of consumption structure, there are more obvious regional differences. From the perspective of residents' consumption level, the development of digital economy has the greatest impact on the consumption level of residents in the western region, followed by the eastern region. For every 1% rise in the level of the digital economy, the consumption level of residents in the western region will increase by 0.178% on average, while that of the eastern region will rise by 0.154%. There is still a gap between the digital infrastructure and informatization in the western region and the eastern region. This also shows that the driving effect of the digital economy on the consumption demand of residents in the western region still has a lot of room for development. Observe the impact of the level of the digital economy on the consumption structure of residents, the level of the digital economy on the east, central and west of the three regions of the consumption structure of residents have a significant positive role, and the impact on the eastern region is significantly greater than the central and western regions. Every 1% increase in the level of the digital economy will bring about a 0.103% increase in the

consumption structure of residents in the eastern region, a 0.0834% increase in the consumption structure of residents in the central region and a 0.0916% increase in the consumption structure of residents in the western region. It shows that the driving effect of the digital economy on the consumption structure of residents in the eastern region is greater than that in the central and western regions. Therefore, based on the above findings, it is concluded that hypothesis two is valid, and there are regional differences in the promotion effect of digital economy on residents' consumption upgrading.

5.3. Robustness Test

In order to test the reliability of the above research results, this paper realizes the robustness test by replacing the relevant indicators. On the basis of the original model, the proportion of enterprises with e-commerce transaction activities in the total number of enterprises (cov) is selected as an alternative explanatory variable for regression, and the test results are shown in Table 4. The significance and direction of the coefficient of the explanatory variable cov are consistent with the previous regression results. Therefore the conclusion that the level of digital economy has a positive impact on residents' consumption upgrade is considered significant.

Table 4. Robustness regression results

explanatory variable	(1)	(2)
cov	0.00411** (0.00166)	0.00222*** (0.000718)
LnIncome	0.772*** (0.0252)	0.0222** (0.0109)
ss	0.210 (0.176)	0.0509 (0.0762)
open	0.0538*** (0.0168)	0.00322 (0.00728)
ur	-0.0282*** (0.00807)	-0.0129*** (0.00349)
constant term	1.514*** (0.179)	0.0829 (0.0772)
R ²	0.9565	0.3098
N	210	210

Note: Same as table 2.

5.4. Further analysis

Based on the results of the above analysis, it is concluded that the digital economy promotes residents' consumption upgrading and it has regional heterogeneity. On this basis, we further explore the transmission mechanism of the digital economy affecting residents' consumption upgrading. In this paper, the mediating effect test is conducted, and the mediating variable chosen is the turnover of the technology market (Innovation). The specific test steps of the mediation effect are borrowed from Wen Zhonglin et al. (2014). The first step is to test whether the coefficients α_1 and β_1 of model (1) or (2) are significant, and if they are significant, then proceed to the next step; the second step is to test the coefficients γ_1 of model (3) and the coefficients θ_2 and σ_2 of model (4) and (5), and if both of them are significant, then there is a mediation effect. If at least one of them is not significant, the third step is carried out; in the third step, Bootstrap test is used to further test whether there is a mediation effect.

The results of the mediation effect test are shown in Table 5 below. The first step is the empirical test of the overall impact of the digital economy on the consumption level and consumption structure of residents, and there is a significant positive relationship between the increase in the consumption level of residents and the optimization of the consumption structure and the level of development of the digital economy. The second step is the empirical test of the impact of the digital economy on the development of the technology market. The results show that there is a significant positive relationship between the level of the digital economy and the development of the technology market, and every 1% increase in the level of the digital economy will bring about a 1.330% increase in the level of the development of the technology market; the third step is an empirical test of the impact of the level of development of the digital economy and technology market on the level of residents' consumption and the structure of consumption, the coefficient of the development of the digital economy in the first column of the third step is significant, while the coefficient of the technology market is not significant, the mediation effect model that when there is at least one coefficient is not significant, Bootstrap test is needed to determine whether there is a mediation effect. bootstrap test results show that the mediation effect is not significant as shown in Table 6, indicating that there is no mediation effect in the impact of the

digital economy on the level of consumption of the population with technological innovation as the mediating variable. The coefficients of digital economy development and technology market level in the second column of the third step are both significantly positive, indicating that there is a mediating effect with technological innovation as an intermediary variable in the impact of digital economy on the consumption structure of residents.

Through the test results of the first column of the third step in Table 5 and Table 6, it can be seen that the digital economy does not have an impact on the level of consumption through technological innovation, or the role of the digital economy in promoting the level of consumption through technological innovation is not significant. From the above analysis, it can be seen that technological innovation is divided into two kinds, product innovation and process innovation, and the effects of both on the level of consumption cancel each other out. Product innovation creates new products, triggers new demand and creates new consumer markets. Process innovation improves the productivity of the industry, which reduces total employment and increases unemployment, leading to an increase in the number of low-income groups with low marginal consumption rates. The research conclusion that these two kinds of technological innovations have offset each other's effect on residents' consumption is also confirmed by Yuan Zhigang and Zhu Guolin (2001). Therefore, based on the above analysis it is concluded that hypothesis three is valid.

The test results of the second column of the third step show that the digital economy can significantly promote the optimization of residents' consumption structure through technological innovation. The innovation and development of science and technology has brought about the acceleration of the commercialization process of modern scientific and technological achievements and the change of industrial structure, thus accelerating the rate of product renewal and upgrading, improving the quality and technological content of products, and affecting the consumption structure of residents from the supply side. Secondly, scientific and technological innovation has improved the entire consumer environment, product quality has been improved at the same time reduce transaction costs, prompting unprecedented consumer confidence. After the most basic subsistence consumption needs are satisfied, they begin to chase the consumption in tourism, fitness, culture and health, which brings about the improvement of the residents' consumption structure, and

hypothesis four holds.

Table 5. Intermediary effect test

explanatory variable	(1)		(2)	(3)	
	Consume1 (FE)	Consume2 (FE)	Innovation (FE)	Consume1 (FE)	Consume2 (FE)
Index	0.182*** (0.0324)	0.0920*** (0.0257)	1.330** (0.668)	0.181*** (0.0601)	0.0828*** (0.0255)
Innovation				0.000781 (0.00538)	0.00192*** (0.000706)
LnIncome	0.561*** (0.0576)	0.0832** (0.0359)	0.992 (0.886)	0.560*** (0.0835)	0.0873** (0.0353)
ss	0.204 (0.206)	0.0458 (0.0752)	0.296 (1.570)	0.206 (0.175)	0.0678 (0.0743)
open	0.0487*** (0.0172)	0.000199 (0.00696)	0.489*** (0.146)	0.0483*** (0.0165)	0.00561 (0.00712)
ur	-0.0252** (0.0118)	-0.0113*** (0.00346)	0.0774 (0.109)	-0.0252*** (0.00804)	-0.0120*** (0.00341)
constant term	2.707*** (0.444)	0.678*** (0.209)	-7.499 (5.178)	2.714*** (0.486)	0.703*** (0.205)
R ²	0.9573	0.3216	0.5966	0.9573	0.3492
N	210	210	210	210	210

Note: Same as Table 2.

Table 6. Bootstrap test

	Observed Coef.	Bootstrap Std. Err.	z	P> z	Normal-based [95%Conf.Interval]
_bs_1	-0.0065	0.0091	-0.72	0.474	-0.0243 0.0113
_bs_2	0.0117	0.0327	0.36	0.719	-0.0523 0.076

6. Conclusions and Policy Recommendations

6.1. Basic Conclusion

This paper combines the panel data of 30 provinces (except Tibet) from 2014 to 2020 to analyze the impact of the development of the digital economy on residents' consumption upgrading from the dimensions of upgrading the consumption level and optimizing the consumption structure, and conducts empirical tests and regional heterogeneity analysis on the effect of the digital economy on the promotion of China's residents' consumption upgrading. Secondly, the mediation effect model is used to explore the mechanism of the digital economy to promote residents' consumption upgrading. The empirical results show that, firstly, the development of digital economy has a significant promoting effect on both the improvement of residents' consumption level and the optimization of consumption structure. Second, from the perspective of regional differences, the positive promotion effect of digital economy development on residents' consumption upgrading has significant regional differences. Third, from the perspective of mediating mechanism, digital economy can promote the optimization of residents' consumption structure through the channel of technological innovation, but does not have an impact on the consumption level through the channel of technological innovation.

Overall, this paper illustrates from theory and empirical evidence that the digital economy is an important engine to promote the enhancement of the consumption level and optimization of the consumption structure of residents, and the digital economy promotes the optimization of the consumption structure of residents through technological innovation. Especially in the special period of epidemic

prevention and control, digital economy effectively hedges the pressure of economic downturn and shows the advantages of digital economy. Based on the above research conclusions, the following policy recommendations are drawn.

6.2. Policy Recommendations

First, promote the quality and upgrading of consumption in the digital field. The digital economy plays an increasingly important role in releasing consumption vitality, promoting consumption upgrading, and innovating consumption patterns. In the future state of epidemic prevention and control normalization, the government should more intensify the development of the digital economy, deepen and rely on the digital economy to drive the continuous growth of residents' consumption. As a new engine of China's economic growth, the digital economy industry has brought new economic growth points and effectively resisted the negative effects caused by the new crown epidemic. The combination of digital technology and traditional enterprises has led to the transformation and upgrading of traditional enterprises as well as a series of booming new industries. However, the development of the digital economy still needs to rely on government support and social and business cooperation, in order to give full play to the unique advantages of the digital economy, alleviate the pressure of the economic downturn, so that the overall level of social consumption can be ensured, and promote economic recovery.

Second, from China's actual national conditions, increase support for the development of central and western regions, balancing the digital economy development gap between regions. In recent years, with the rapid development of China's digital economy, the imbalance in the development of the scale of the digital economy between regions has become increasingly prominent. The eastern region is more developed,

the digital infrastructure is perfect, and the degree of digitization is significantly higher than that of the central and western regions. In order to promote the construction of digital infrastructure in the central and western regions and coordinate the coordinated development of the eastern, central and western regions, the government, as the coordinator of the development of the digital economy, should improve the incentive system for digital technology innovation, combined with the law of development of each region, to better help the coordinated development of the national digital economy.

Third, improve the incentive system for digital technological innovation to optimize the consumption structure of residents. Technological innovation is an effective conduction path for the digital economy to optimize residents' consumption structure. Therefore, in the ever-changing information age, our government should strive to improve the incentive mechanism for digital technology innovation, encourage the development of new digital industries, and strengthen the integration and innovation of digital technology and related manufacturing fields. On the one hand, we should optimize the layout of technological innovation and key capacity innovation and enhancement; on the other hand, we should further strengthen the support of relevant policies in order to promote the marketing and application of new technologies and new products, and to promote the formation of an innovation and development system that supports the high-quality development of China's information technology.

Fourth, promote the creation strategy of process innovation, give full play to the innovative production effect of process innovation, and generate new consumer demand. Compared with the existing production process for imitation or slightly modified should focus on the creation of technology innovation strategy, according to and to meet market demand, the use of new technologies in society or the original technical advantages of the enterprise to develop new technologies, create new product demand. With the globalization of the economy, enterprises participate in international competition in a wider scope. Therefore, domestic enterprises should innovate their concepts, fully recognize the importance of process innovation for the survival and development of enterprises, and attach great importance to and strengthen the cultivation of the enterprise's technological innovation ability, so as to improve the comprehensive strength of the enterprise's sustainable development.

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