Analyzing the Impact of Digital Economy Development of Consumer Spending: An Empirical Study Based on VAR Modeling in City A, China

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Abstract. As the leading city in the economic development of Guangdong Province, City A has closely follows the pace of digital economic development. This study hypothesizes that the digital economy can drive urban industrial structure upgrading, create employment for urban residents, increase residents' income, and promote urban residents' consumption. The paper selects data on the digital economy and residents' consumption level in City A from 2013 to 2022 and uses a vector autoregression (VAR) model for derivation and analysis. The result demonstrate that both the digital economy development index and disposable income of residents have an impact on residents' consumption, with the digital economy development index having a more significant impact.

Keywords: Digital Economy, Consumer behavior, Industrial Upgrading

1 Introduction

A unified national market refers to a nationwide system characterized by unified institutional rules, seamless market connectivity, and standardized regulatory practices. This framework aims to enhance production efficiency and unleash consumption potential. The report of the 20th National Congress of the Communist Party of China emphasizes the need to "strengthen the fundamental role of consumption in economic development." Against this backdrop, the digital economy has emerged as a critical driver of high-quality growth, particularly through its integration with the real economy.

The digital economy exhibits inherent inclusiveness. Its role in boosting consumption manifests in five dimensions: (1) reshaping consumption concepts and habits, (2) stimulating developmental and enjoyment-oriented consumption, (3) reducing transaction costs, (4) expanding online sales boundaries, and (5) mitigating information asymmetry. Emerging trends—such as live-streaming commerce and digital currency adoption—exemplify how digital transformation reshapes consumption patterns. Furthermore, industrial upgrading driven by digitalization generates higher-quality employment, thereby increasing residents' income and indirectly promoting consumption up-

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grading. The development of the digital economy has brought new types of consumption patterns. For example, people transfer online shopping from traditional platforms like Taobao and JD.com to Douyin. The rise of live-streaming sales increases rapidly, and the emergence of digital currency becomes popular. Consumers' consumption behaviors and habits have also changed. The development of the digital economy will also lead to industrial upgrading, provide more high-quality job opportunities, increase residents' income, expand regular sources of income, and thereby indirectly promote the upgrading of residents' consumption.

2 Institutional Background and Research Progress

2.1 Institutional Background

[1] On March 5, 2024, the "2024 Government Work Report of the State Council" proposed accelerating the construction of a unified national market. [2] On April 10 of the year, the "Opinions of the CPC Central Committee and the State Council on Accelerating the Construction of a Unified National Market" were issued. [2] On May 19, 2024, the executive meeting of the State Council studied and implemented the overall work plan for the construction of a unified national market. [3] The "Notice of the State Council on Issuing the 14th Five-Year Plan for the Development of the Digital Economy," released by the State Council of the People's Republic of China on January 12, 2022, clarified the promotion of the healthy development of the digital economy during the 14th Five-Year Plan period. The National Development and Reform Commission and the National Data Bureau issued the "Implementation Plan for Promoting Common Prosperity through the Digital Economy" in December 2023 to deeply integrate digital technology with the real economy and achieve common prosperity through digital means in high-quality development.

2.2 Research Progress in Existing Literature

Cohan(2000) observed that technological diffusion has ushered in an entirely new business ecosystem.The digital economy is generally divided into digitalization of industries and industrialization of digital technology. The digitalization of industries emphasizes the digital upgrade of all elements in the upstream and downstream of the industrial chain, while the industrialization of digital technology emphasizes the importance and scale of the digital industry. Lu Yuxiu (2023) combined the concepts of the two based on previous research and summarized that the industrialization of digital technology is the core development of the information and communication technology (ICT) industry driven by information science and technology innovation, while the digitalization of industries is the process of using information technology to upgrade and transform the business of traditional industries. The development of the digital economy plays a role in promoting the consumption of urban and rural residents. Yang Junxia (2023) empirically found that China's digital economy level is gradually increasing but with regional differences. Liu Hong (2023) discovered a positive correlation between the digital economy and residents' consumption, with a higher impact coefficient

for rural residents than urban residents. Huang Ren (2023) used the entropy weight method to prove that the digital economy can provide diverse digital services for different income groups, thereby improving residents' consumption levels, stimulating domestic demand, and promoting supply-side structural reform. Zhang Wenwen (2023) believed that the digital economy, which continuously permeates production and life, promotes the upgrading of traditional industries and has an important impact on people's consumption behavior, decision-making, and habits. Foreign research on the digital economy is mostly focused on other aspects of society, and there are few studies on its relationship with residents' consumption. Cohen et al. (2000) argued that modern network information and communication technology has changed the world and explicitly defined the digital economy as information and communication technologies (ICTs)[4]. Zhang Yun et al. (2024) concluded that the development of the digital economy brings uncertainty to poor families in the labor market, such as unemployment due to the inability to adapt to new technological jobs, which in turn reduces their family consumption, especially for poor families.Hyunbae Chun et al. (2024) found that the expansion of online consumption amplifies intergenerational consumption inequality[5].

3 Research Design

3.1 Selection of Digital Economy Indicators and Measurement

The designed indicators are shown in the figure below. To clarify the logic, all positive indicators are chosen. In the construction of digital economy indicator systems, existing research has gradually evolved from a single-dimensional approach to a multi-dimensional comprehensive assessment. For example, Zhang Wenwen (2023) developed an indicator system based on four dimensions: digital infrastructure, digital industrialization, industrial digitalization, and digital technology innovation. Huang Ren (2023) further introduced market-oriented indicators such as the penetration rate of e-commerce. Building on the existing indicator system, this paper supplements two secondary indicators: "the proportion of e-commerce transaction volume to GDP" and "the number of Internet users per ten thousand people." The digital economy development index is recalculated by combining principal component analysis and entropy method to enhance the comprehensiveness and robustness of the indicator system (see Table 1 for specific results).

Table 1. Indicator System for the Level of Digital Economy Development

Primary Indicator	Secondary Indicator	Unit	Indicator Nature
Digital Infrastructure	Number of Internet broadband access ports	10K Units	Positive Indicator
	Number of mobile phone base stations	10K Units	Positive Indicator
	Mobile phone penetration rate		

Digital Industrialization		Units per hundred people	Positive Indicator
Industrial Digitalization	Degree of digital inclusive finance	/	Positive Indicator
Digital Technology Innovation	Amount of employees in information transmission, software, and information technology industries	10K Units	Positive Indicator
Digital Market Penetration	E-commerce Transaction Volume/GDP	(%)	Positive Indicator
Digital Application Popularity	Number of Internet Users per Ten Thousand People (Households)	10K people	Positive Indicator

The data source is the statistical yearbook of City A and China Internet Information Center from 2013 to 2022. The data results are shown in the Fig.1. It can be seen that the level of digital economy development in City A from 2013 to 2022 is above 0.2 and shows a good development trend with the increase of years.

Fig. 1. City A Digital Economy Department Index.

3.2 VAR Model Specification

The Vector Auto regression (VAR) model is a commonly used econometric model for analyzing and forecasting the dynamic relationships among multiple time series variables. By using Eviews,This paper selects the time series data of City A from 2013 to 2022 and determines the optimal lag order through unit root tests. The empirical process of VAR regression, Granger causality test, impulse response, and variance decomposition is carried out to derive the conclusion that the improvement of the level of digital economy development can promote the level of residents' consumption.

3.2.1 Data Variables.

In order to simpleminded the process, the levels of residents' consumption, digital economy development index, residents' disposable income, and financial development level are arithmetically transformed. The model takes the level of residents' consumption as the dependent variable, the digital economy development index as the core explanatory variable, and residents' disposable income and financial development level as control variables.

3.2.2 Model Specification-Algorithms and Parameters.

The model is set as follows:

$$Yt=A_0+A_1Yt\text{-}_1+...+ApYt\text{-}p+\mathcal{E}t \quad (1)$$

It is a vector containing the level of residents' consumption, digital economy development index, and residents' disposable income, represents the intercept term. We set t as the observation year, p as the lag order, and $\mathcal{E}$ is the disturbance term.

Variable selection: Due to the limited number of years in this paper, the variables are chosen based on the ideas of Yang Junxia (2023) and Huang Ren (2023), and the appropriate variables for this paper are selected as follows:

Dependent variable: The level of residents' consumption (lny) is an indicator to measure the living standard of residents in a country or region. This paper selects per capital consumption expenditure as the measure.

Core explanatory variable: The level of digital economy development index (lnx), calculated by the entropy method.

Control variables: Residents' disposable income (lna) refers to the income that residents in a region can freely dispose of on an annual basis. Income is the main factor determining consumption. This paper selects the disposable income of residents in City A, and the data comes from the statistical yearbook of City A. Financial development level (lnb) refers to the ratio of the loan balance of financial institutions in a region to the region's GDP. The detail code is in the Appendix.

4 Empirical Results

1.The first step of the empirical analysis is the unit root test. All variables are differenced, and after the first-order difference, all variables are in a stable state.

2.Determine the optimal lag order. The data used are the first-order differenced data. The results are shown in Table 2. below. Therefore, the optimal lag order selected in this paper is 3.

Table 2. Determine the Optimal Lag Order

lag	AIC	HQIC	SBIC
0	-15.91	-16.75	-16.23
1	-286.00	-286.00	-287.57
2	-293.76	-297.95	-295.32

3	`-296.60*	`-300.79*	`-298.16*
4	0	0	0

Note: *, **, *** indicate significance levels

3.Granger Causality Test

Table 3. Granger Causality Test

Null Hypothesis	F-value	P-value	Test Result
lnx is not a Granger cause of lny	.30	.58	Accept null hypothesis
lny is not a Granger cause of lnx	147.37	.00	Reject null hypothesis
lna is not a Granger cause of lny	.22	.64	Accept null hypothesis
lny is not a Granger cause of lna	1.09	.30	Accept null hypothesis
lnb is not a Granger cause of lny	.32	0.57	Accept null hypothesis
lny is not a Granger cause of lnb	.40	0.53	Accept null hypothesis

Note: lny represents the level of residents' consumption, lnx represents the level of digital economy development, lna represents residents' disposable income, and lnb represents the level of financial development.

From the Granger causality test results in Table 3, it can be seen that the improvement in the level of residents' consumption in City A has an impact on the level of digital economy development, while the impact on residents' disposable income and financial development level is relatively insignificant. However, since the digital economy is a relatively new type of economy that has not been developing for a long time and there are relatively few years of data available through public channels, this leads to a small sample size, which brings certain limitations. For example, it does not timely reflect the impact of the explanatory variable, the level of digital economy development, and the control variables, residents' disposable income and financial development level, on the level of residents' consumption.

4.VAR Unit Root Test

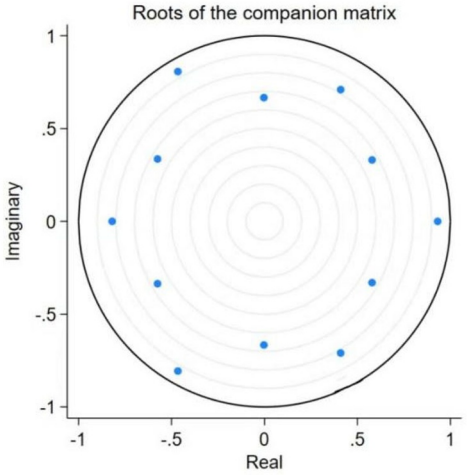

Fig. 2. VAR Unit Root Test

From Figure 2, it can be seen that the characteristic roots of the VAR model are evenly distributed within the circle and do not exceed the range of the circle, indicating that the established VAR model is stable.

5.Impulse Response Analysis

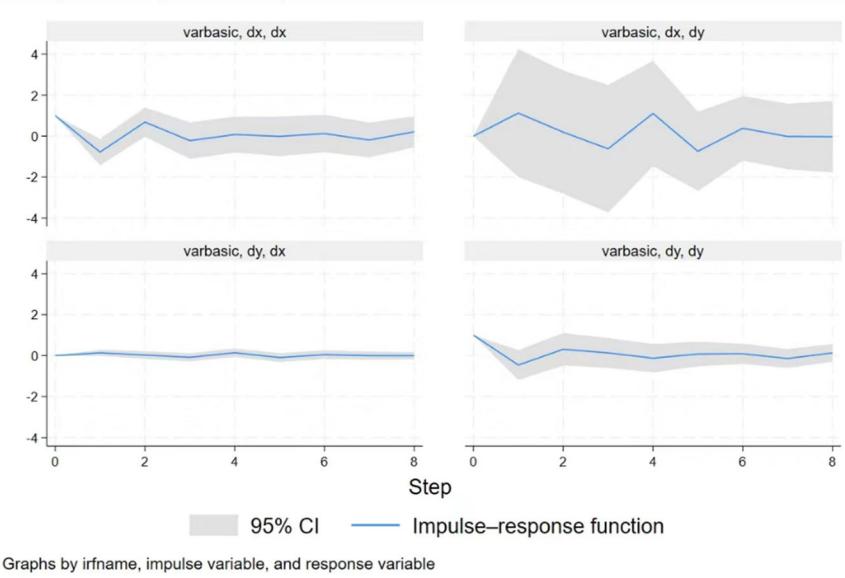

Fig. 3. Impulse Response of Residents' Consumption Level and Digital Economy Development Level

From Figure 3, it can be seen that there is a mutual impact between the level of digital economy development and the level of residents' consumption in City A. In the upper-left figure, the impact of the digital economy on residents' consumption peaks at period 2, then decreases to period 3, reaches a peak again at period 4, and then decreases to period 5. It begins to rise from period 5 and finally converges towards zero. The negative values at periods 3 and 5 can be attributed to the fact that although City A has achieved significant results in the development of the digital economy, there is still a digital divide. For example, the elderly and low-income groups, due to the unavailability of digital devices or the lack of relevant skills, cannot fully enjoy the convenience brought by the digital economy, which in turn reduces consumption.The negative shock in Period 3 may reflect the technological adaptation barriers faced by certain groups (such as middle-aged and elderly individuals and low-income earners) during the early stages of digital transformation, leading to a suppression of consumption. However, with the advancement of digital inclusion policies (such as the "Implementation Plan for Promoting Common Prosperity through Digital Economy" in 2023), the shock turned positive after Period 5, indicating that policy interventions have effectively alleviated structural contradictions.

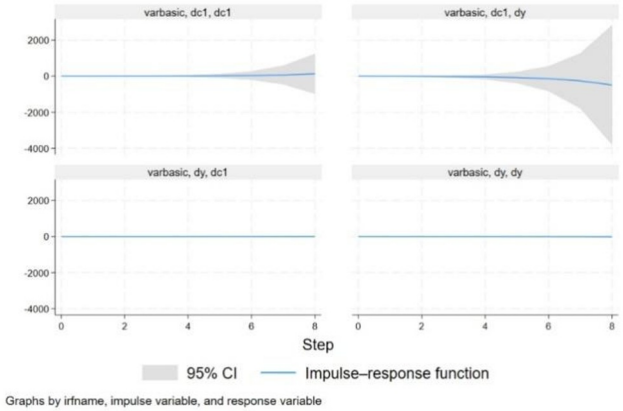

Fig. 4. Impulse Response of Residents' Disposable Income and Residents' Consumption Level

Figure 4 shows the mutual impact between residents' disposable income and residents' consumption in City A. The impact of residents' consumption level on residents' disposable income is positive and converges towards zero later. The impact of residents' disposable income on residents' consumption level is generally positive and also converges towards zero later. The positive impact on both sides can be explained as follows: An increase in residents' disposable income leads to an increase in consumption, and an improvement in residents' economic capacity brings an increase in consumption capacity.

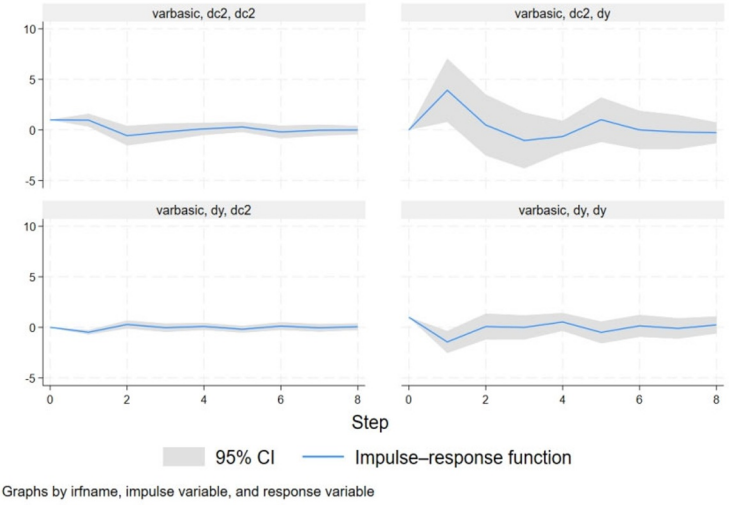

Fig. 5. Impulse Response of Residents' Disposable Income and Financial Development Level.

From the upper-left part of Figure 5, it can be seen that the impact of residents' consumption level on the financial development level in City A peaks at period 1, then

decreases, reaches the lowest point at period 3, and then steadily rises to period 5, finally converging towards zero, and is generally positive. The lower-right figure shows that the impact of financial development level on residents' consumption level is relatively flat and still positive overall. It can be concluded that there is a positive relationship between residents' consumption level and financial development level.

6.Variance Decomposition

Variance decomposition is used to list the contribution rate of each potential factor to the variation of the explained variable, residents' consumption level, so as to better understand the impact of the level of digital economy development, residents' disposable income, and financial development level on the change in residents' consumption level.

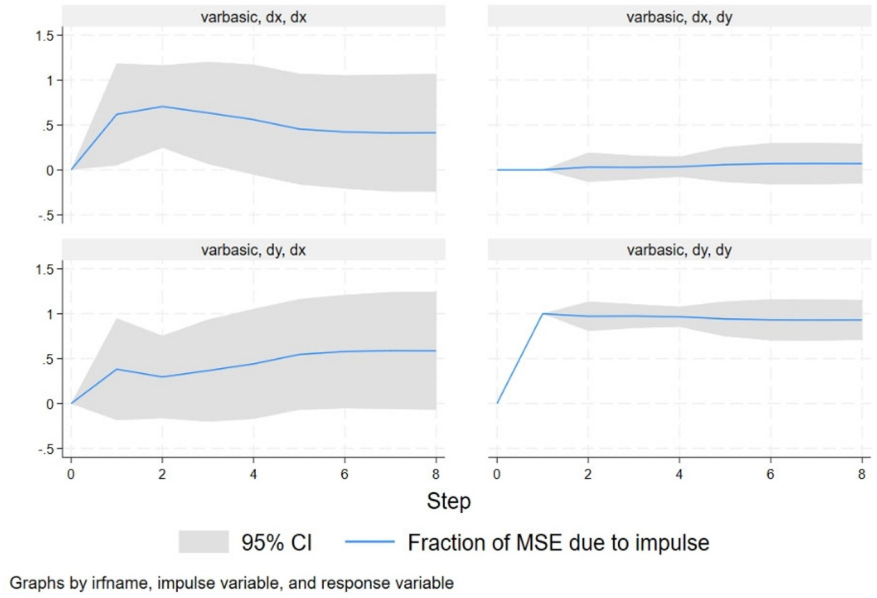

Fig. 6. Variance Decomposition of Residents' Consumption Level and Digital Economy Development Level

Note: Y represents residents' consumption level, x represents the level of digital economy development, c1 represents residents' disposable income, and c2 represents the level of financial development.

From Figure 6, it can be seen that the level of digital economy development in City A has an upward trend and reaches a peak in period 1, and then begins to rise steadily later. It can be concluded that the contribution of the level of digital economy development in this region to residents' consumption is increasing.

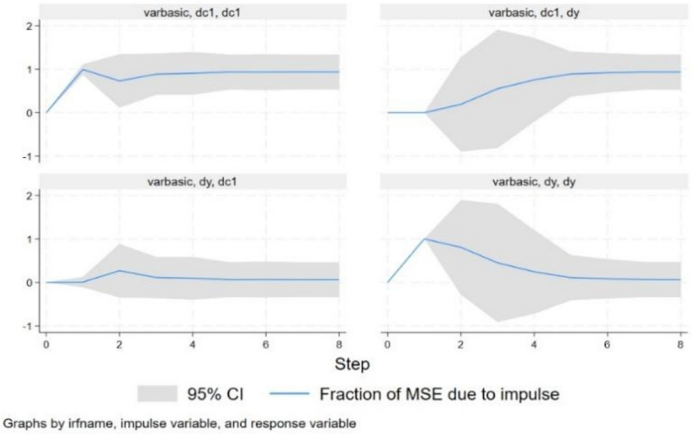

Fig. 7. Variance Decomposition of Residents' Consumption Level and Residents' Disposable Income

Note: Y represents residents' consumption level, x represents the level of digital economy development, c1 represents residents' disposable income, and c2 represents the level of financial development.

From the lower-left figure of Figure 7, it can be seen that the contribution of residents' disposable income to residents' consumption level reaches a peak in period 2, then decreases and remains in a slow positive state later. It can be concluded that the contribution rate of residents' disposable income to residents' consumption is positive.

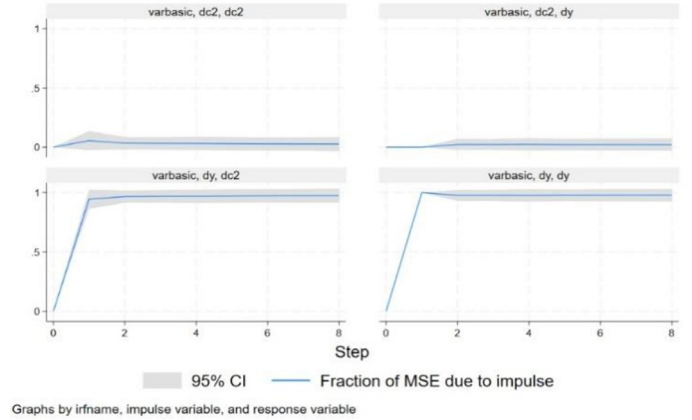

Fig. 8. Variance Decomposition of Residents' Consumption Level and Financial Development Level

Note: Y represents residents' consumption level, x represents the level of digital economy development, c1 represents residents' disposable income, and c2 represents the level of financial development.

From the lower-left figure of Figure 8, it can be seen that the contribution rate of financial development level to residents' consumption reaches a peak around period 1, and then extends steadily at the peak state. It can be concluded that the financial development level has a higher contribution to the local residents' consumption level. The higher the regional financial development level, the richer the residents' lives.

From the three variance decomposition figures, it can be seen that the explanatory power of the three variables on the level of residents' consumption basically shows an increasing trend. The contribution of financial development level to residents' consumption is the largest, followed by the contribution of the level of digital economy development.

In summary, this paper uses three criteria, AIC, SBIC, and HQIC, to select the optimal lag order for the three variables of digital economy, residents' disposable income, financial development level, and residents' consumption level in City A, and the optimal lag order is 3. Before conducting impulse response analysis, Granger causality test was performed. However, due to the limited number of years selected in this paper, the effect of Granger causality test was not significant. But Granger causality analysis is only a kind of prediction, not a true causal relationship. After the impulse response analysis, the mutual impact relationship between residents' disposable income and residents' consumption level in City A was found. Finally, variance decomposition was conducted to judge the impact of digital economy, residents' disposable income, and financial development level on the level of residents' consumption in City A. The empirical results show that the impact of digital economy, residents' disposable income, and financial development level on the level of residents' consumption in City A is positive, and the index of digital economy development has a greater impact on residents' consumption.

7.To verify the reliability of the conclusions drawn from the VAR model, this paper employs the following two methods for robustness tests:

Rolling Window Regression: The sample period from 2013 to 2022 is divided into two subsamples (2013–2017 and 2018–2022), and VAR models are established for each subsample. The results show that the positive impact of the digital economy development index on the level of household consumption remains significant in the subsamples, and the coefficient direction is consistent with that of the full sample (see Table A2 in the Appendix).

Model Substitution Method: An autoregressive distributed lag (ARDL) model is used to re-estimate the long-run equilibrium relationship. The bounds test confirms the presence of co integration among the variables ($F = 5.32$, $p = 0.01$). The ARDL estimation results indicate that the long-run elasticity coefficient of the digital economy development index is 0.37 ($p < 0.01$), which further supports the original conclusion.

5 Conclusion

With the comprehensive roll out of 5G technology in China and the development of online transactions, the digital economy has become the main driving force of our consumption. The digital economy has expanded consumption channels, driven industrial

upgrading and transformation, and provided more job opportunities. It has increased residents' income and sources of income. The increase in residents' income has driven consumption. The digital and standardized operations brought by the digital economy can improve enterprises' production efficiency, reduce production costs, reduce information asymmetry, and lower transaction costs to stimulate residents' consumption.

The digital economy breaks geographical and national barriers, expands the sales range of goods, enables consumers to obtain comprehensive product information, and stimulates consumption desires. It improves the experience of consumption. City A actively promotes the construction of smart business districts, uses digital means to improve the consumption environment of business districts and consumer experience, uses artificial intelligence technology to analyze and predict consumer behavior in business districts, and user profiling technology provides merchants with more accurate marketing strategies and personalized services. It improves the convenience and security of electronic payment, such as facial recognition payment, and provides enterprises with efficient capital settlement and risk management tools.

Based on the research conclusions of this paper, the following suggestions can be proposed: (1) Strengthen cybersecurity regulations to bolster digital payment confidence. We can increase the crackdown on online fraud to maintain users' confidence in making payments and settlements with digital currencies. (2) Integrate online-offline platforms for targeted promotions For example, we can distribute festival consumption vouchers through several major APPs, send discount and promotional information of the commercial district to consumers through location tracking, and provide mobile tourism services. (3) Address digital divides via vocational training and elderly-friendly tech education. We should pay attention to vulnerable groups in the Internet age, such as middle-aged and elderly people and low-income groups. Conduct vocational retraining to update the skills of low-income and middle-aged unemployed people, and reduce structural unemployment. We can also use institutions like senior universities to popularize usage methods and application technologies, and improve the ability of the elderly to use mobile payments and online transactions.(4) Establish a multi-dimensional monitoring system for digital economy development. It is recommended that the government establish a multi-dimensional monitoring indicator system that includes infrastructure, industrial integration, technological innovation, and market penetration. The government should also regularly publish white papers on the development of the digital economy to provide a scientific basis for policy-making.

Appendix

Empirical Code for the Study on the Impact of Digital Economy on Resident Consumption in City A:

Note: y represents the level of resident consumption, x represents the digital economy development index, c1 represents disposable income of residents, and c2 represents the level of financial development.

```
tsset year /// Set time series
gen y = resident_consumption_level /// Naming variable
```

```
gen x = digital_economy_development_level
gen c1 = disposable_income_of_residents
gen c2 = financial_development_level
dfuller y /// Unit root test
dfuller d.y
dfuller x
dfuller d.x
dfuller c1
dfuller d.c1
dfuller c2
dfuller d.c2
gen dy = d.y /// Naming variable
gen dx = d.x
gen dc1 = d.c1
gen dc2 = d.c2
varsoc dy dx dc1 dc2 /// Determine the optimal lag order
var dy dx dc1 dc2, lags(3) /// VAR model
varstable, graph /// Unit circle test
vargranger /// Granger causality test
varbasic dy dx, irf /// Impulse response analysis
irf graph fevd /// Variance decomposition
varbasic dy dc1, irf /// Impulse response analysis
irf graph fevd /// Variance decomposition
varbasic dy dc2, irf /// Impulse response analysis
irf graph fevd /// Variance decomposition
```

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