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Research on the Impact of Digital Technology Application on Households

——Calculation Based on Household Digital Penetration Index

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Abstract: With the widespread popularization of digital technology and its continuous penetration into family life, the impact of digital technology on the national economy and residents' lives has gradually emerged. Based on the CFPS database, this article uses the A-F model to measure the household digital penetration index, explores the popularity and application of digital technology in households, and uses an empirical model to analyze the impact of the household digital penetration index on household income, consumption and income gaps. Research results show that digital technology has increasingly penetrated households from 2010 to 2020. The household digital penetration index can effectively increase household income and stimulate consumption, but it also widens the household income gap to a certain extent. At the same time, the impact of household digital penetration index on residential households shows obvious spatial heterogeneity.

Keywords: digital technology, A-F model, household digital penetration index, household income, income gap

1. Research Background

The digital economy is playing an increasingly important role in national economic development, economic structural transformation and labor structure optimization. With the vigorous development of the Internet industry, digital technology and applications, digital transactions, e-commerce and other fields, the digital economy continues to grow. At the same time, these emerging industries have also created a large number of new job opportunities for the country, increased residents' income, and laid a solid foundation for sustained and stable economic growth. According to statistics, the added value of my country's digital economy industry was 2.6 trillion yuan in 2005, and has grown to 50.2 trillion yuan in 2022, with an average annual growth rate of 119%, which is significantly higher than the nominal growth rate of GDP in the same period. The proportion of the digital economy in the national economy has also continued to rise. It has now reached 41.5% of GDP, which is equivalent to the proportion of the secondary industry in the national economy. The contribution of the digital economy to GDP growth continues to increase.

The development of digital technology has an important impact on residents' income, consumption and income gaps. With the vigorous development of digital technology, more and more platforms

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and applications have emerged, broadening residents' channels for information acquisition and information exchange, and also promoting the rapid rise of the gig economy in the country. The gig economy connects service providers with the demand side through online platforms, creating a new work model that provides more employment opportunities and flexibility for self-employed workers. The digital economy provides residents with a more convenient way of consumption. According to statistics, my country's total e-commerce transactions in 2022 will reach 43.83 trillion yuan, of which online retail sales and online retail sales of physical goods will be 13.79 trillion yuan and 11.96 trillion yuan respectively. However, the development and popularization of digital technology may also lead to a further widening of the income gap. The income of high-skilled jobs grows significantly faster than that of low-skilled jobs, which may exacerbate the problem of social income inequality.

Digital technology has become one of the important driving forces for China's economic development. It has made positive contributions to creating new job opportunities, changing consumption patterns, promoting economic structural transformation and labor structure optimization. However, the development of digital technology still faces challenges such as regional disparities and income inequality, which require continued attention and resolution. This article uses the A-F model to construct a household digital penetration index evaluation model, and deeply explores the impact of the development and popularization of digital technology on household income, consumption and income gaps.

2. Literature Review

In recent years, the impact of the development and application of digital technology on households has been the focus of academic attention. Digital technology not only changes the macroeconomic growth model, but also brings huge changes to the lifestyle of residents and families. In terms of residents' income, Chen and Wu[1] believe that the development level of the digital economy has a positive role in promoting residents' income. They also point out that regional differences in the development level of the digital economy will, to a certain extent, affect individuals or families' investment in digital services such as the Internet. The extent of technology use, thereby increasing household income. Zang and Kang[2] pointed out that the digital economy reduces wage income and increases operating income, property income and transfer income. On the one hand, the digital economy promotes the formation and expansion of flexible employment. Internet-based platforms give individuals more independent choices and create more part-time, freelance and remote work opportunities [3]. On the other hand, the "digital dividend" brought by the digital economy has also had a positive impact on residents' income. It reduces search costs, copy costs, transportation costs, tracking costs and verification costs, reducing operating costs for enterprises, allowing more value to be converted into residents' income. PSheorey et.al[4] believes that the digital economy has played an important role in national economic development, driving the growth of employment for people around the world by supplementing people's primary income.

In terms of household consumption, there is relatively little research on the consumption effects of digital technology in the existing literature. For example, scholars such as Ren Baoping and Ma Yue have explored the characteristic changes in household consumption behavior during the development of digital technology from the perspective of economic theory.[5] proposed a digital economy driven by digital technology, put forward new connotations for the concept of resident consumption, and used the dialectical materialist methodology of Marxist economics to demonstrate the dialectical unity of production and consumption in the digital economy. Cultivate the consumption power of the digital economy to drive digital consumption. The digital economy provides more and more convenient ways to shop. The rise of e-commerce platforms allows consumers to browse, compare and purchase products anytime and anywhere, promoting the popularity of online shopping. At the same time, the popularity of digital payment methods has also brought greater convenience to

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consumption, accelerated the formation of purchasing decisions, and thus stimulated the growth of consumer activities. Research shows that the development of the digital economy can improve the relationship between consumers and sellers, thereby promoting an increase in consumption [6]. Domestically, the digital economy enables the consumption level to change from developmental to sharing and service-oriented, the consumption structure changes from material needs to spiritual sustenance, and the consumption mode changes from traditional offline to new online, thereby realizing the consumption level from low-end to The transition to high-end levels promotes consumption upgrades. There is an obvious spatial autocorrelation between the digital economy and consumption upgrade. The spatial agglomeration characteristics of consumption upgrade in the east are more obvious, the spatial agglomeration level of consumption upgrade in the central part is relatively low, and the spatial agglomeration level of consumption upgrade in the west shows a declining process [7].

In terms of the impact of digital technology applications on household income gaps, in the context of efforts to achieve equitable income distribution, the development of the digital economy may have an important impact on household income gaps. On the one hand, the digital economy creates more opportunities for entrepreneurship and employment, especially for those seeking flexible employment opportunities [8]. This will help to increase the income level of some people and reduce the economic pressure of some people, thereby narrowing the income gap to a certain extent. On the other hand, after the development of the digital economy reaches a certain stage, it may also become a positive force in reducing the urban-rural income gap, because the popularization of digital technology in some rural areas may bring new economic opportunities [9]. Cheng and Zhang[10] empirically analyzed the impact of my country's Internet penetration rate on the urban-rural income gap from the perspective of my country's Internet penetration. The research results show that the popularity of the Internet in my country has a significant impact on residents' income, and as the Internet penetration rate increases, the income gap between urban and rural residents in my country shows an inverted U-shaped characteristic. DS Zeng [11] proposed that the digital economy can effectively promote economic development, industrial structure adjustment and industrial upgrading, increase the disposable income of urban and rural residents, and theoretically help narrow the urban-rural income gap. Guellec & Paunov[12] took developed countries in Europe and the United States as the research object and believed that the development of digital technology and digital economy has exacerbated income inequality to a certain extent. Zhang [13] explored the relationship between digital technology and income inequality from the perspective of Internet diffusion. The results show that there is a significant negative correlation between income inequality and the slope of the Internet diffusion curve. Zhang et al.[14] believe that the development of digital finance has inhibited the expansion of the digital divide and its negative impacts. The digital divide generated by the new round of global technological revolution has generally widened the gap between the rich and the poor in society. Wang and Zhao[15] further subdivided my country's residents into poor households and non-poor households. The research results pointed out that the uneven development of my country's digital finance has led to obvious Matthew effects between different residents. From the perspective of regional differences, the urban-rural income gap at the provincial level in my country continues to shrink, and generally presents a geographical pattern of "high in the west and low in the east". In recent years, the development level of digital technology and digital economy in my country has grown rapidly, but at the same time there are obvious regional differences. Generally speaking, it shows the spatial characteristics of "high in the east and low in the west, high in the south and low in the north".

To sum up, the development of the digital economy has had a broad and far-reaching impact on residents' income, consumption and income gaps. These impacts include both positive factors, such as increasing income, promoting consumption, and reducing income gaps, as well as potential

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challenges, such as regional differences that may be caused by unbalanced development. Therefore, further research and policy development need to consider the complex interaction of various factors.

3. Theoretical Analysis

The rapid development of digital technology has brought about profound economic changes and has had a significant impact on residents' income, consumption and income gaps. Driven by digital technology, emerging industries are booming, providing residents with more job opportunities. The rapid growth of emerging fields such as the Internet, artificial intelligence, and e-commerce has given residents more sources of income, while also creating new opportunities for personal entrepreneurship and promoting diversification of income generation. In addition, digital technology has also promoted the popularization of online education. Residents can learn new skills online and improve their competitiveness, thus further increasing their income levels.

In terms of household consumption, digital technology has also brought about many changes. The rise of e-commerce has provided residents with a convenient way to shop and consume anytime and anywhere. At the same time, through the application of digital technology, companies can better understand consumer needs and launch personalized recommendations and customized products, promoting consumption. upgrade. Digital technology has also promoted the popularity of mobile payments and provided more convenient payment methods, further promoting the growth of consumption.

However, the development of digital technologies has also exacerbated income disparities. The lack of skills and education restricts the application of digital technology by some families to a certain extent. Highly technical jobs pose challenges to those who lack relevant skills and education. In developing countries and poor areas, the existence of the digital divide also limits people from fully utilizing the opportunities brought by digital economic technologies. In addition, some digital platform models, such as sharing economy platforms, online labor markets, and the digitization of traditional industries, have a crowding-out effect on some jobs to a certain extent, leaving some employees with low incomes or at risk of unemployment. These factors have led to the widening of income gaps.

In the era of digital economy, optimizing residents' income and consumption structure and narrowing the income gap is a complex task. It requires multi-party cooperation, focusing on education and training, digital infrastructure construction, and support for small businesses, in order to achieve social sustainability and inclusiveness. sexual development. Only in this way can the vigorous development of the digital economy truly benefit every resident and allow them to share the dividends brought by the digital economy.

4. Calculation of household digital penetration index and Empirical Analysis

4.1. Data source

This article uses the China Family Panel Survey database (CFPS), which covers 25 provinces/municipalities/autonomous regions, with a target sample size of 16,000 households. This article uses panel data from 2010 to 2020. Due to the serious lack of relevant indicators in the 2012 data, and in order to reduce data bias, the data from 2012 will be eliminated from this article.

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4.2. Calculation of household digital penetration index

4.2.1. Calculation model of household digital penetration index

This article adopts the Alkire-Foster (A-F) method, which usually takes an individual or family as a unit to assess the deprivation status of various dimensional indicators. The methods and steps for measuring household digital penetration index using the A-F method are as follows:

(1) Construct an indicator matrix of digital penetration index. This article evaluates the application and penetration of household digital technology from different index dimensions. It is assumed that the number of dimensions of the household digital penetration index is d. Each dimension indicator $x_{ij} \geq 0$ represents the value of the i th sample household ($i = 1,2,\cdots,n$) on the j th dimension indicator ($j = 1,2,\cdots,d$). The larger the value, the higher the penetration level of the ith sample household in the jth dimension indicator, thus forming the indicator matrix of the digital penetration index:

$$X = \begin{bmatrix} x_{11} & \cdots & x_{1d} \\ \vdots & \ddots & \vdots \\ x_{n1} & \cdots & x_{nd} \end{bmatrix} \tag{1}$$

(2) Set the thresholds of indicators in each dimension to establish a household digital penetration index discrimination matrix. According to the dependence of households on digital technology and the Internet, thresholds for identifying penetration conditions are set as $z_j > 0$ for different dimensional indicators. That is, when $x_{ij} < z_j$, the i th sample household is deemed to be "penetrated" in the jth dimension, represented by an indicator function:

$$I_{ij} = \begin{cases} 1 & x_{ij} < z_j \\ 0 & x_{ij} \geq z_j \end{cases} \tag{2}$$

I_{ij} is the indicator function, when $I_{ij} = 1$, the ith sample household is in the "penetrated state" at the jth dimension indicator, otherwise it is in the "uninfiltrated state". Therefore, a household digital penetration index discriminant matrix I is constructed.

$$I = \begin{bmatrix} I_{11} & \cdots & I_{1d} \\ \vdots & \ddots & \vdots \\ I_{n1} & \cdots & I_{nd} \end{bmatrix} \tag{3}$$

(3) Set corresponding weights for each dimensional indicator and calculate the weighted digital penetration index.

By weighting each dimensional indicator selected in this article w_j, the weighted household digital penetration matrix can be obtained:

$$I^* = \begin{bmatrix} w_1 I_{11} & \cdots & w_d I_{1d} \\ \vdots & \ddots & \vdots \\ w_1 I_{n1} & \cdots & w_d I_{nd} \end{bmatrix} \tag{4}$$

Based on this, the household digital penetration index of the ith sample household is c_i:

$$c_i = \sum_{j=1}^{d} w_j I_{ij}$$

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4.2.2. Selection of household digital penetration index indicators

In this article, in order to examine the impact of digital technology development on residents' income and expenditure, a household digital penetration index evaluation model is constructed using the A-F method. The dimensions, indicators, thresholds and weights of the household digital penetration index are shown in Table 1. In the digital device dimension of the household digital penetration index, this article selects whether mobile Internet access, whether computer Internet access, and the time spent online on mobile devices and the time spent online on computers are indicators, in which mobile Internet access is recorded as 1, and no mobile Internet access is recorded as 0; using a computer to access the Internet Recorded as 1, Internet use without a computer was recorded as 0; daily use of mobile device for Internet access for more than 120 minutes was recorded as 1, and less than 120 minutes was recorded as 0; daily computer Internet use for more than 120 minutes was recorded as 1, and daily computer Internet use was recorded as 1, and less than 120 minutes was recorded as 0. , the weight of each indicator is 1/12. In the work dimension, this article selects the importance of the Internet to work, the importance of the Internet to learning, the importance of the Internet as an information channel, and whether to study online. The importance of the Internet to work is scored as 1 if it exceeds 4 and is scored as 1 if it is less than 4. is 0; if the importance of the Internet to learning is greater than 4, it is scored as 1, and if it is less than 4, it is scored as 0; if the importance of the Internet as an information channel is greater than 4, it is scored as 1, and if it is less than 4, it is scored as 0; if online learning is used, it is scored as 1, and if it is not used, it is scored is 0, and the weight of each indicator is 1/12. In the life dimension, this paper selects whether to shop online, the importance of the Internet to leisure and entertainment, and the importance of the Internet to daily life as indicators, in which online shopping is recorded as 1 and not online shopping is recorded as 0; the impact of the Internet on leisure and entertainment The importance of the network to daily life is scored as 1 if it is greater than 4, and 0 if it is less than 4. The weight of each indicator is 1/9.

Table 1: Dimensions, indicators, and weights of household digital penetration index

Dimension	Indicator	Threshold	Weight
Digital devices	mobile Internet access	yes=1;no=0	1/12
	computer Internet access	yes=1;no=0	1/12
	Duration of mobile Internet access(minutes)	duration≥120 equals 1; duration<120 equals 0	1/12
	Duration of computer Internet access(minutes)	duration≥120 equals 1; duration<120 equals 0	1/12
work	importance of the Internet to work	importance≥ 4 equals 1;importance<4 equals 0	1/12
	importance of the Internet to learning	Importance ≥ 4 equals 1; importance<4 equals 0	1/12
	importance of the Internet as an information channel	Importance ≥ 4 equals 1; importance <4 equals 0	1/12
	Online learning	yes=1;no=0	1/12
Daily life	Online shopping	yes=1;no=0	1/9
	importance of the Internet to leisure and entertainment	Importance ≥ 4 equals 1; importance <4 equals 0	1/9
	importance of the network to daily life	Importance ≥ 4 equals 1; importance <4 equals 0	1/9

4.3. Descriptive statistical analysis

Table 2 shows the descriptive statistics of the relevant variables involved in this article. It can be seen that the penetration of the Internet into families is increasing year by year, and the importance of the Internet to family work, study, and life is gradually increasing. Among them, the importance of the Internet to work increased from 3.174 in 2010 to 4.428 in 2020, the importance to learning increased

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from 3.375 in 2010 to 3.773 in 2020, and the importance to daily life increased from 2.043 in 2010 to 2020 Year 3.534. The household digital penetration index calculated according to the A-F method generally shows a deepening trend year by year, rising from 0.312 in 2010 to 0.493 in 2018. However, the household digital penetration index in 2020 is only 0.462, a decrease of 0.031 from 2018. It may The reason is that due to the impact of the epidemic, the digitalization process of families has been impacted, which to a certain extent affects the further penetration of digital technology into families. From the perspective of family situation, family income shows a rapid growth trend. The average total family income was 33,174 yuan in 2010, and increased to 96,762 yuan in 2020, an increase of approximately 2.9 times. From the perspective of consumption, household expenditure increased from 34,105 yuan in 2010 to 47,705 yuan in 2018. Due to the impact of the epidemic, household consumption expenditure dropped significantly in 2020, only 40,320 yuan.

Table 2: Descriptive statistics of main variables

	2010	2014	2016	2018	2020
Mobile Internet access (1 = yes)	0.553	0.519	0.585	0.985	0.992
Computer Internet access (1 = yes)	0.308	0.454	0.382	0.973	0.981
Duration of mobile Internet access(minutes)	19.591	34.121	114.3	147.68	165.68
Duration of computer Internet access(minutes)	69.530	51.220	46.74	44.207	49.593
Importance of the Internet to work	3.174	3.809	3.954	4.242	4.428
Importance of the Internet to learning	3.375	3.505	3.606	3.799	3.773
Importance of the Internet as an information channel	1.693	1.974	2.347	2.727	3.151
Online learning (1 = yes)	0.349	0.436	0.852	0.642	0.498
Online shopping (1 = yes)	0.219	0.243	0.655	0.447	0.622
Importance of the Internet to leisure and entertainment	3.166	3.204	3.129	3.377	3.447
Importance of the network to daily life	2.043	2.697	3.011	3.150	3.534
Household Digital Penetration Index	0.312	0.352	0.442	0.493	0.462
Household income	33174	55614	75958	82639	96762
Household expenditure	34105	36579	41345	47705	40320
Average household education level	2.492	2.475	2.499	3.716	3.249
Average household age	46.938	47.345	48.23	47.920	49.408
Family size	3.816	3.752	3.759	3.699	3.908
urban (1) vs. rural (0)	0.481	0.513	0.525	0.506	0.508

4.3.1. Through the Lens of Family Characteristics

Table 3 shows the average digital penetration index for households with different incomes. From 2010 to 2018, the digital penetration index showed a continuous growth trend, especially between 2016 and 2018, the increase was even more obvious. Before 2018, there were large differences between different income ranges. However, between 2016 and 2018, the penetration rate of China's mobile Internet increased rapidly. A large number of people have begun to use smartphones, creating a broad market for the development of the digital economy. As a result, by 2018, the differences between various income brackets decreased. Taking 2010 and 2018 as examples, the digital penetration index of households with a household income in the 0-20% range in 2010 was 0.065,

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while that of households with a household income in the 81-100% range was 0.341. In 2018, the digital penetration index of households with a household income in the 0-20% range increased to 0.676, and that of households with a household income in the 81-100% range increased to 0.693. It is worth noting that from 2018 to 2020, the digital penetration index of households with household income levels below 80% dropped significantly. The reason may be the impact of the new crown epidemic. The average digital economy penetration index of households with an income level of 81-100% continues to increase, and has increased to 0.544 in 2020, indicating that high-income households have a higher ability to resist risks.

Table 3: Average digital penetration index of households by income group

Total household income	2010	2014	2016	2018	2020
0 - 20 %	0.295	0.288	0.346	0.467	0.376
21 – 40 %	0.309	0.328	0.395	0.473	0.388
41 – 60 %	0.322	0.356	0.433	0.483	0.422
61 – 80 %	0.331	0.391	0.471	0.497	0.453
81 – 100 %	0.352	0.440	0.520	0.521	0.544

Table 4 shows the changing trend of the average household digital penetration index at different education levels. Across all education levels, the digital penetration index has shown an increasing trend year by year from 2010 to 2020. There is a correlation between education level and digital penetration index. Generally speaking, the higher the level of education, the higher the digital penetration index. This may be because families with higher levels of education are more likely to understand and apply digital technologies, thereby integrating into the digital society more quickly. From 2016 to 2018, the growth in the digital penetration index was evident across all education levels. This shows that the digital economy has become more widely used and popularized at different levels of education during this time period. The penetration index of these two education levels is relatively high in each year, especially after 2018. This may be because people with these educational levels are more likely to master and apply advanced digital technologies.

Table 4: Average household digital penetration index by education level

Education Level	2010	2014	2016	2018	2020
Elementary school and below	0.301	0.326	0.414	0.477	0.394
Junior high school	0.343	0.426	0.519	0.501	0.466
High school	0.368	0.490	0.584	0.523	0.532
Junior college	0.369	0.526	0.632	0.542	0.636
University and above	0.439	0.522	0.683	0.521	0.672

4.3.2. Through the Lens of Regional Differences

From the perspective of urban-rural differences, Table 5 shows the urban-rural differences in household digital penetration index. In all years, the digital penetration index was higher in urban areas than in rural areas. In 2010, the digital penetration index of households in rural areas was 0.301, and that of households in urban areas was 0.324, which was 0.023 higher than that in rural areas. By 2020, the digital penetration index of households in rural areas has increased to 0.431, and that of urban households is 0.492, a difference of 0.061. It shows that the degree of digitalization of households in urban areas is higher than that in rural areas, and the gap in digital penetration index between urban and rural areas is constantly widening. This may be because cities and towns have greater access to advanced digital technologies and internet connectivity, but also as a result of the

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growing urban-rural divide. Whether in rural or urban areas, the digital penetration index is constantly rising. This may mean that digital technology is increasingly used in these regions.

Table 5: Average household digital penetration index in urban and rural areas

Urban and rural areas	2010	2014	2016	2018	2020
Rural areas	0.301	0.319	0.405	0.481	0.431
Urban areas	0.324	0.383	0.476	0.505	0.492

Looking at different regions, Table 6 shows the differences and changing trends in the average household digital penetration index in the east, central and west. The eastern region has the highest digital economy penetration index in all years, followed by the central region, while the index in the western region is relatively low. This may reflect the eastern region's leading position in digital technology penetration and economic development, while the western region lags behind. The digital penetration index in the eastern, central and western regions increased from 0.322, 0.312, and 0.305 in 2010 to 0.476, 0.466, and 0.449 in 2020 respectively, but the growth rate may vary between different regions. The growth rate in the eastern region is faster, while the growth rate in the western region is relatively slower. The reason may be that the eastern region generally has a better economic and technological foundation, which may help increase the digital economy penetration index.

Table 6: Average household digital penetration index in the Eastern, Central and Western China

Region	2010	2014	2016	2018	2020
Eastern	0.322	0.372	0.461	0.498	0.476
Central	0.312	0.355	0.447	0.491	0.466
Western	0.305	0.335	0.424	0.491	0.449

4.4. Empirical analysis

4.4.1. Model selection

With the development of the economy and society, digital technology in households continues to popularize, and the household digital penetration index continues to grow. In order to eliminate the impact of time factors and regional differences on the empirical results, this article uses a time-point and region fixed effects model to explore the household digital penetration index. Impact on household income, expenditure and income gap. The time point and region fixed effects model is a model with different intercepts for different sections (time points) and different time series (regions). The point-in-time regional formula model established in this article is as follows:

$$y_{it} = \lambda_i + \gamma_t + \sum_{k=2}^{k} \beta_k x_{kit} + u_{it}$$

4.4.2. Empirical results

Table 7 shows the empirical results of the impact of household digital penetration on residential households. Model 1 shows the impact of household digital penetration index on household income. The results show that household digital penetration has a significant positive relationship with household income. Its impact coefficient is 0.229, and it is significant at the 1% level of significance. It shows that the penetration of household digital technology can effectively increase the income level of households. Model 2 shows the impact of household digital penetration index on household expenditure. The results show that household digital penetration has a significant positive impact on

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household expenditure. Its impact coefficient is 0.287, and it is significant at the 1% level of significance. It shows that the development of digital technology not only broadens residents' consumption channels, but also stimulates residents' consumption tendencies, which can effectively promote consumption. Model 3 shows the impact of household digital penetration index on household income gap. The results show that household digital penetration has a significant positive impact on household income gap. Its impact coefficient is 0.370 and is significant at the 1% level of significance. It shows that the development of digital technology has further widened the income gap among households. The possible reason is that different families have different acceptance and application of digital technology. It should be noted that the urban-rural gap is not significant in Model 2, but has a significant impact in both Models 1 and 3, indicating that the urban-rural gap continues to expand in terms of household income.

Table 7: Empirical results on the impact of household digital penetration on residential households

	Model 1	Model 2	Model 3
	Household income	Household expenditure	Family income gap
Household Digital Penetration Index	0.229***	0.287***	0.370***
	(0.0356)	(0.0607)	(0.0660)
Average family education level	0.0212***	0.0477***	0.0292**
	(0.00452)	(0.0167)	(0.0117)
Urban (vs. rural)	0.0820***	0.0146	0.0799*
	(0.0224)	(0.0305)	(0.0441)
Family size	0.188***	0.100***	0.189***
	(0.00506)	(0.00682)	(0.00995)
Average household age	-0.00998***	-0.00643***	-0.00681***
	(0.000719)	(0.00113)	(0.00136)
Constant	9.473***	9.520***	8.652***
	(0.0693)	(0.127)	(0.121)
Observations	55,520	38,115	29,050
R-squared	0.279	0.055	0.199
Number of fid	15,999	15,831	11,989
Year FE	YES	YES	YES
Region FE	YES	YES	YES

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Due to the large differences in natural endowments, economic development levels, digital technology development and other aspects between different regions. In order to further explore the differences in the impact of household digital penetration on households in different regions, Table 8, Table 9, and Table 10 conduct empirical analysis on households in the eastern, central and western regions respectively. The results show that the impact of household digital penetration index on households in different regions is quite different.

Table 8 shows the impact of household digital penetration on household income in different regions. The results show that the household digital penetration index has a significant positive impact on household income in the eastern, central and western regions. The impact coefficients are 0.279, 0.198, and 0.193 respectively, and they are all significant at the 1% level of significance. It can be

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seen that the household digital penetration index improves the income of households in the eastern region much more than that in the central and western regions, while there is no big difference between the central and western regions. It shows that households in the eastern region are better able to apply digital technology to production to increase household income.

Table 9 shows the impact of household digital penetration on household expenditures in different regions. The results show that the household digital penetration index has a significant positive impact on household expenditures in the eastern, central and western regions. The influence coefficients are 0.309, 0.349, and 0.181 respectively. The eastern and central regions are both significant at the 1% level of significance, while the western region is significant at 1%. Significant at the 10% level of significance. It can be seen that the household digital penetration index has the highest stimulating effect on household consumption in the central region, which is not only much higher than that in the western region, but also exceeds that of households in the eastern region by 0.04 percentage points. This shows that the central region is more inclined to use digital channels for consumption, while digital consumption channels in the western region are relatively weak.

Table 10 shows the impact of household digital penetration on household income gaps in different regions. The results show that the household digital penetration index has a significant positive impact on the household income gap in the eastern, central and western regions. The influence coefficients are 0.282, 0.314, and 0.459 respectively, and both the east and west are significant at the 1% level of significance, while the central Significant at the 5% level of significance. It can be seen that the household digital penetration index has the greatest impact on expanding the household income gap in the western region, followed by the central region, and has a smaller impact on the eastern region.

Table 8: Empirical results on the impact of household digital penetration on household income in different regions

Household income	Model 4 Eastern region	Model 5 Central region	Model 6 Western region
Household Digital Penetration Index	0.279***	0.198***	0.193***
	(0.0603)	(0.0678)	(0.0581)
Average family education level	0.0245**	0.0182*	0.0189***
	(0.00980)	(0.00933)	(0.00613)
Urban (vs. rural)	0.0695**	-0.000699	0.134***
	(0.0337)	(0.0446)	(0.0375)
Family size	0.180***	0.197***	0.189***
	(0.00892)	(0.00910)	(0.00829)
Average family age	-0.00867***	-0.00886***	-0.0114***
	(0.00126)	(0.00133)	(0.00115)
Constant	9.690***	9.196***	9.206***
	(0.0856)	(0.0851)	(0.0751)
Observations	16,523	15,280	23,717
R-squared	0.297	0.273	0.272
Number of fid	5,275	4,322	6,683
Year FE	YES	YES	YES

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

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Table 9: Empirical results on the impact of household digital penetration on household expenditure in different regions

Household expenditure	Model 7 Eastern region	Model 8 Central region	Model 9 Western region
Household Digital Penetration Index	0.309***	0.349***	0.181*
	(0.106)	(0.113)	(0.0977)
Average family education level	0.0777***	0.0607**	0.0234
	(0.0259)	(0.0278)	(0.0300)
Urban (vs. rural)	0.111*	0.0134	-0.00586
	(0.0607)	(0.0512)	(0.0478)
Family size	0.0948***	0.104***	0.103***
	(0.0117)	(0.0127)	(0.0109)
Average family age	-0.00408*	-0.00717***	-0.00732***
	(0.00208)	(0.00215)	(0.00172)
Constant	9.456***	9.384***	9.500***
	(0.152)	(0.154)	(0.129)
Observations	11,334	10,423	16,358
R-squared	0.082	0.052	0.046
Number of fid	5,091	4,232	6,612
Year FE	YES	YES	YES

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 10: Empirical results on the impact of household digital penetration on household income gaps in different regions

Family income gap	Model 10 Eastern region	Model 11 Central region	Model 12 Western region
Household Digital Penetration Index	0.282***	0.314**	0.459***
	(0.103)	(0.131)	(0.115)
Average family education level	0.0342*	0.0480*	0.0110
	(0.0179)	(0.0258)	(0.0193)
Urban (vs. rural)	0.0726	-0.0722	0.198**
	(0.0695)	(0.0878)	(0.0815)
Family size	0.213***	0.182***	0.164***
	(0.0153)	(0.0189)	(0.0186)

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Table 10: (continued).

Family income gap	Model 10 Eastern region	Model 11 Central region	Model 12 Western region
Average family age	-0.00898***	-0.00631**	-0.00494**
	(0.00207)	(0.00270)	(0.00240)
Constant	8.878***	8.527***	8.360***
	(0.152)	(0.183)	(0.173)
Observations	10,547	7,717	10,786
R-squared	0.275	0.170	0.150
Number of fid	4,236	3,188	4,757
Year FE	YES	YES	YES
Region FE			

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

5. Conclusions and Policy Recommendations

5.1. Research Conclusion

To sum up, with the development of digital technology, the household digital penetration index has shown an upward trend year by year. The application and popularization of the Internet and digital technology in our country's households have increased significantly, which has a significant effect on improving the living standards of households. However, at the same time, it also Have certain negative impacts. On the one hand, the application of household numbers has increased residents' income and stimulated residents' consumption. The empirical results in Table 7 show that household digital penetration has a significant positive relationship with household income, its impact coefficient is 0.229, and is significant at the 1% level of significance, and it also has a significant positive impact on household expenditure, with its impact coefficient is 0.287, and is significant at the 1% level of significance. On the other hand, the development and application of digital technology has also widened the income gap among households to a certain extent. Empirical results show that household digital penetration has a significant positive impact on the household income gap, with an impact coefficient of 0.370 and significant at the 1% level of significance.

Due to the obvious huge differences in natural endowments and economic development levels between the east, middle and west of my country, the problem of imbalance in the development and popularization of digital technology is prominent, resulting in obvious heterogeneity in the penetration and impact of digital technology on families. In terms of household income, the household digital penetration index has a significantly higher effect on increasing household income in the eastern region than in the central and western regions, and has the weakest effect on increasing household income in the western region. The possible reason is that the digital technology level, economic activity, population density and related infrastructure in the eastern region are much higher than those in the central and western regions. In terms of household consumption, the household digital penetration index has a greater stimulating effect on household consumption in the central region than in the eastern and western regions. Empirical results show that the household digital penetration index has a significant positive impact on household expenditures in the eastern, central and western regions. The impact coefficient on household consumption in the central region is 0.349,

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0.04 higher than that in the eastern region, while the impact coefficient on household consumption in the western region is 0.349. Only 0.181. In terms of income disparity, the household digital penetration index has the most obvious impact on household income disparity in the western region, while it is the weakest in the eastern region. Empirical results show that the household digital penetration index has a significant positive impact on the household income gap in the eastern, central and western regions. The impact index on the household income gap in the western region is 0.459, which is 0.145 higher than the central region and 0.177 higher than the eastern region.

5.2. Policy Recommendations

In order to narrow the income gap, the government, enterprises and society need to work together. First, it is crucial to provide inclusive digital technology education and training to improve the skill level of the workforce so that more people can participate in the digital economy and increase their employment opportunities and income levels. Secondly, the construction of digital infrastructure is necessary to ensure extensive digital infrastructure coverage, including network connections and electronic payment systems, to reduce the digital divide and allow more people to benefit from the digital economy. In addition, the government can support small businesses and start-ups, promote innovation and entrepreneurship, increase job opportunities and market competition, and reduce income gaps. At the same time, we should strengthen the supervision of the platform economy to ensure that the rights and interests of workers are protected, promote the rationalization of wages in the platform economy, provide social security and welfare, and improve the income status of workers.

In the process of achieving these goals, we should also focus on the sustainable development and inclusiveness of the digital economy. The government should formulate targeted policies to avoid excessive concentration of resources and environmental degradation brought about by the digital economy, and ensure that the benefits of the digital economy can be more equitably distributed to more people, not just limited to a small number of wealthy classes. At the same time, regulatory authorities should also strengthen the monitoring and regulation of the digital economy, promote fair competition, prevent the emergence of monopoly and unfair competition, and help reduce the concentration of resources and opportunities, thereby narrowing the income gap.

References

[1] *Chen, W., & Wu, Y. (2022). Shuzi jingji fazhan, shuzi honggou yu chengxiang jumin shouru chaju[J] [Digital economic development, digital divide and income gap between urban and rural residents], Guomin jingji guanli, 2022(4):14.*

[2] *Zang, W., & Kang, N. Shuzi jingji dui chengzhen jumin shouru jiegou de yingxiang[J][The impact of digital economy on the income structure of urban residents], Chengshi fazhan yanjiu, 2023, 30(3):6.*

[3] *Qi, Y. D., Ding, S. L., & Liu, C. H. Shuzi jingji shidai xinzhiye cujin zhuanyehua fazhan he jingji zengzhang de jili yanjiu-jiyu shehui fengong shijiao[J] [Research on the mechanism of new occupations promoting professional development and economic growth in the digital economy era - based on the perspective of social division of labor], Beijing shifan daxue xuebao: shehui kexue ban, 2021(3):12.*

[4] *Behl A, Rajagopal K, Sheorey P, et al. Barriers to entry of gig workers in the gig platforms: exploring the dark side of the gig economy[J]. Aslib journal of information management: New information perspectives, 2022.*

[5] *Han.W.L,The role of the state and the economic development of modern society,China Social Sciences Press,2020*

[6] *Manchanda P, Dube J P, Goh K Y, et al. The Effect of Banner Advertising on Internet Purchasing[J]. Journal of Marketing Research, 2006.DOI:10.1111/j.1365-2818.2003.01254.x.*

[7] *Wang, X. Shuzi jingji yinling xiaofei shengji de bendi xiaoying yu kongjian yichu xiaoying[J][The local effect and spatial spillover effect of digital economy leading consumption upgrade], Shangye shidai, 2022, 000(002):68-71.*

[8] *Maherali A. Financial Inclusion, Digital Payments and Their Impact on Income and Tax Revenue Around the World[J]. 2017.*

[9] *Peng, J. Z., & Zhong, H. Shuzi jingji, shichanghua yu chengxiang jumin shouru chaju[J] [Digital economy, marketization and the income gap between urban and rural residents], Jinrong yu jingji, 2022(12):67-76.*

DOI: 10.54254/2754-1169/74/20241521

[10] *Cheng, M. W., & Zhang, J. P. (2019). Hulianwang puji yu chengxiang shouru chaju: lilun yu shizheng [Internet penetration and urban-rural income gap: theory and evidence], Zhongguo nongcun jingji, 2, 19-41.*

[11] *Zeng D S. Effect of Digital Economy Development on Rural-Urban Income Disparity: Evidence from China [J]. Procedings of Business and Economic Studies, 2022, 5(5):102-109.*

[12] *Guellec D, Paunov C. Digital innovation and the distribution of income[R]. National Bureau of Economic Research Working Paper,2017.*

[13] *Zhang X. Income disparity and digital divide: The internet consumption model and cross-country empirical research[J]. Telecommunications Policy,2013,37 (6-7): 515-529.*

[14] *Zhang, X., Wan, G. H., & Wu, H. T. Suoxiao shuzi honggou: Zhongguo tese shuzi jinrong fazhan[J][Bridging the Digital Divide: Development of Digital Finance with Chinese Characteristics], Zhongguo shehui kexue, 2021, (08) : 35-51 +204-205.*

[15] *Wang, X, H, Zhao, Y, X. Does the Matthew Effect Exist in Digital Finance Development?Empirical Evidence from Poor and Non-Poor Households. Journal of Financial Research, 2020, 481(7): 114-133.*