

The Impact of Population Aging on Consumption Structure: A Perspective on Digital Economy

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Abstract. With the ageing of the Chinese population, the type of consumption among people in China has also changed. A relatively strong panel data set of 31 Chinese provinces from 2011 to 2022 is used to employ both fixed-effects and threshold regression models in this study to explore the triangle formed by digital integration, aging trends and consumption changes. Based on the above analysis, although the general trend of population aging is to increase consumption, this momentum may be reduced by the gradual aging of the digital infrastructure in areas. Enclaves with a high level of saturation in the digital economy have generally seen little or no improvement in consumption at present. The distribution of geography is also different; The central and eastern corridors are positively correlated with those in the central area and show a more significant increase in consumption elasticity, but there has been no substantial rise in consumption due to changes in the demographic structure in the western frontier area. Therefore, these results show that a local non-monolithic policy will be required. To make good use of the advantages of a silver economy in the future, change the plan for local-level development and build diversified technological and demographic conditions.

Keywords: Population aging, Consumption structure, Digital economy, Threshold model

1. Introduction

Under the changes in recent years, China's population structure has been changing; this situation has created problems. By 2024, the silver wave will have reached 310 million people aged 60 and over, accounting for 22 per cent of the total in the country, and the 65-plus group will be as high as 15.6 per cent. Projections indicate that by about 2035, the country will reach the end of the period of severe atmospheric aging [1]. A substantial change in the structure of the population will be evident in an increase in numbers and will also cause considerable changes in all sectors of the consumer economy, shift the demand for daily necessities, and fundamentally reform the entire system of domestic demand. As consumption provides the "ballast" for high-quality economic reform and development, we must now uncover the reasons why ageing affects changes in consumption; otherwise, this endeavor will be in vain.

At the same time, the rise of the digital economy has provided a new set of factors for such behavior change. According to the recent data in the "Digital Consumption Development Report (2025)", about 117 million older people, or roughly 12.2% of the digital marketplace, are now active

participants in the virtual economy. Their patterns show that most people have shifted from a focus on necessity to seeking higher-quality life and health products. However, the dividends of this digital revolution are also not evenly distributed. Regional differences in infrastructure, as well as varying educational levels and technological literacy, have left many older people behind in the digital age. Technological isolation has reduced the convenience of daily life for older adults and has caused a loss of purpose among them; thus, it may hinder the development of the silver economy [2]. Therefore, this paper will investigate how the three-way interaction of digitalization, ageing populations, and changes in consumption concepts has developed to some extent.

2. Literature review

2.1. Population aging and consumption structure

With the decline in the working-age population and the aging of the populace across the world, the academic community has recently paid more and more attention to how consumers are changing. Research has shown that, at present, there is no single result; many schools of thought and experiments have diverged. One well-known school of thought is that the silver wave provides the foundation for structural optimization. Proponents of this view, such as Zhang et al., used longitudinal data to show that an increasing proportion of older adults in the dependency ratio is positively associated with higher consumption refinement [3]. The foundation of this change is often a forced adjustment of household finances; as the need for elderly care and medical services increases, people's traditional consumption patterns have been reshaped, and this is particularly severe in rural areas [4]. In addition, this "aging-induced upgrading" is also subject to socio-economic thresholds and has a higher elasticity for households with strong financial liquidity and good health [5]. Based on the multi-wave panel analysis of the CFPS, Zhang and others believe that a large number of older people may be inhibiting changes in household consumption patterns, especially in rural communities [6]. The logic here is one of necessity-driven crowding out: the rising costs of survival-oriented needs for older adults often consume the resources that would otherwise be allocated to developmental or hedonistic consumption, thus constraining the consumption structure to a more basic equilibrium [7]. Given the above extremes, recent studies have found that the impact of aging is neither entirely positive nor negative. Zhao and Wang's grey correlation model shows that the "aging-consumption" connection is influenced by both differences in regions and the urban-rural divide [8]. Probably the most convincing is the inverted U-shaped hypothesis. At present, ageing is to reduce expenses for food and drink, so more money can be spared for education and healthcare. However, with the increase in age, the cumulative load of all these reasons eventually causes a collapse in the structure [9].

Population ageing alters the structure of consumption in the following three ways for research. First, Demand Factors. Due to various reasons, such as aging and ill health, the elderly have increased their demand for medical care, culture and leisure, and thus, corresponding industries have developed; as a result, the pattern of changing consumption structures has been emerging. Second, economic resources. In addition to basic consumption, the elderly population needs certain economic resources to bear their higher-level consumption demands. Personal income and savings, social security, etc. are important factors affecting the change in the consumption structure of the elderly population. Third, information channels. The elderly population obtains information about their new demands for goods and services through a series of information channels such as the Internet and their own social networks, converting potential demands into actual consumption, and thus having an impact on the consumption structure [10].

2.2. Digital economy and consumption structure

With the ongoing development of information and communication technology, the digital economy has begun to play a larger and larger role in altering the structure of household consumption in China and promoting high-quality development of the economy. It has expanded the scope of consumption and changed the preferences and purchasing behavior of the people living here over time. As a result, people's consumption behavior has also changed, and the structure of consumption has been gradually advanced [11, 12]. At the same time, as the digital economy develops, people have been using online shopping and live-streaming commerce for consumption more and more often, moving away from traditional offline shopping. This change has promoted the opening up of information, helped consumers obtain high-quality goods and services, met the rising demand for high-end consumption, and thus accelerated the shift from goods-driven consumption to service- and experience-oriented consumption [13, 14]. In recent years, as the digital economy has grown rapidly, many people's incomes have risen, increasing their ability to spend and improving the overall purchasing power in society. On the one hand, as the Internet industry has developed, more and more jobs have been created through entrepreneurship and innovation, increasing household income and thus raising the amount of disposable income. At the same time, the development of the digital economy has reduced the uncertainty of household income and consumption, eased liquidity constraints, and indirectly improved income expectations [15]. As the digital economy is developing around the world, many of the linguistic and geographical barriers of traditional economic activities have been overcome; at the same time, transaction costs have dropped significantly and higher-level international consumption has been promoted [16].

3. Theoretical model and research hypotheses

According to the life cycle framework [17], total market demand is the sum of individual choices at each life stage that aim to maximize lifetime utility. With an older population, there has been a change in the dual structure of expenditures: expenses on life-sustaining necessities such as clothes and food are declining, but at the same time, the demand for medical and aged-care services has risen due to a loss of physical independence. The shift from goods to services is driving changes across the board in consumption at present [18]. Therefore, we put forward the following:

H1: Population ageing is promoting a change in consumption structure.

According to the theory of the digital divide, some groups in society are more or less able to use the Internet. The Development of the digital economy has also created a digital divide. Because of the digital divide, older people have trouble living independently in old age; for instance, they cannot purchase food, wear clothes, buy homes or use public transport. Specifically, the digital divide strengthens the negative cognition of ageing among older adults, increases their negative attitude towards ageing, thus affects the psychological mechanism of elderly consumption, and consequently suppresses their consumption demand and restricts the optimisation of consumption structure [2]. Thus, the following hypothesis is proposed.

H2: The extent to which the promotion effect of population ageing on the structure of consumption decreases with higher levels of the regional digital economy.

According to the theory of resources, the distinct resources in different areas will be consumed differently by residents there. As a result, the pressures or stimuli of population ageing on consumption will not be the same for everyone. Generally speaking, the economically developed area has better facilities and jobs; people live better here too. Together with the development of urbanization, these reasons will be able to boost the economic benefits for older adults. Therefore,

the silver economy can serve as a strong driving force to promote a new structure of regional consumption. Based on the above reasoning, we put forward the following.

H3: The promotional effect of population ageing on the consumption structure varies by region.

4. Model setting and description of variables

4.1. Research design

In order to demonstrate the relationship among the digital economy, population aging and consumption structure, this paper constructs a regression model as shown in Equation (1).

$$ConStr_{it} = \beta_0 + \beta_1 PopAge_{it} + \theta Controls + \eta_i + \varepsilon_{it} \quad (1)$$

In model (1), i and t represent the province and year respectively, $ConStr_{it}$ represents the optimization of consumption structure, $PopAge_{it}$ represents the level of population aging, Controls represent a series of control variables, β is the parameter to be estimated, η_i is the province-fixed effect, and ε_{it} is the random error term.

In order to further discuss the influence mechanism of population aging under different levels of digital economy development, the level of digital economy development is taken as the threshold variable, and a threshold effect model as shown in Equation (2) is constructed. Here, γ represents the threshold value, and I is an indicator function taking the value of 0 or 1.

$$ConStr_{it} = \beta_0 + \beta_1 PopAge_{it} * I(Digit \leq \gamma_1) + \beta_2 PopAge_{it} * I(\gamma_1 < Digit \leq \gamma_2) + \beta_3 PopAge_{it} * I(Digit > \gamma_2) + \theta Controls + \eta_i + \varepsilon_{it} \quad (2)$$

4.2. Variable selection

For this study, our main focus is how the consumption structure actually improves (ConStr). To pin this down, we followed the framework used by Wang et al. [19]. First, we sorted consumer spending into three distinct buckets: basic, intermediate, and advanced. To make this concrete, we picked the most representative expenses for each level: food, housing, and then transportation and communication. After calculating what percentage each of these takes up in a typical budget, we used a weighting system to come up with a final score that shows the overall upgrade rate. The math behind it looks like this:

$$Constr = Food\% \times 1 + House\% \times 2 + Commu\% \times 3 \quad (3)$$

In Equation (3), Food%, House%, Commu% respectively represent the proportion of primary consumption in total consumption, the proportion of intermediate consumption in total consumption, and the proportion of advanced consumption in total consumption. Constr is a positive indicator, and the larger the indicator value, the more obvious the optimization of the consumption structure.

The core explanatory variable is population aging (PopAge). This paper uses the elderly population dependency ratio to measure the level of population aging, that is, the ratio of the number of elderly people to the number of working-age population. The higher the elderly population dependency ratio, the more severe the degree of population aging.

In this paper, the threshold variable is the level of digital economic development (Dig). Drawing on Zhao et al. [20], Dig is measured from two dimensions: internet development and digital

financial inclusion. The level of internet development is evaluated using four indicators, namely broadband internet users per 100 people, the share of employees in the computer service and software industry among urban unit employees, per capita telecommunications business volume, and mobile phone users per 100 people [21]. The level of digital financial inclusion is measured by the China Digital Inclusive Finance Index [22]. Finally, principal component analysis is applied to combine these indicators into a composite measure of digital economic development.

Based on existing studies, this paper selects economic development level (eco - per capita GDP), employment scale (emp - urban unit employment personnel), and infrastructure level (ninf - railway mileage in logarithmic form) as control variables.

4.3. Data source and descriptive statistics

This paper selects the panel data of 31 provinces in China (excluding Hong Kong, Macao and Taiwan regions) from 2011 to 2022. The data is sourced from the annual "China Statistical Yearbook" and the statistical yearbooks of each province and region. The descriptive statistics of each variable are shown in Table 1.

Table 1. Descriptive statistics of variables (N=372)

Variable	Mean	Std. Dev.	Min	Max
constr	110.328	9.490	86.597	131.500
PopAge	15.350	4.582	6.710	28.770
eco	5.803	3.042	1.602	18.999
emp	0.551	0.404	0.023	2.111
ninf	8.089	0.753	6.134	11.044
Dig	0.711	0.098	0.600	1.000

5. Analysis of empirical results

5.1. Benchmark regression

The first set of empirical evidence in Table 2, Model (1), shows that with an aging population, consumption patterns have changed accordingly. In the absence of external controls, the older-aged years are still positively correlated with health. As we add more control variables in Models (2) through (4), this persistent statistical significance of a positive correlation serves as supporting evidence for Hypothesis 1. The above indicates that the structure of expenses for older people will be healthier and more leisurely. In addition, according to the data, systematic improvements in the economic output of the region, labor force participation, and physical infrastructure provide auxiliary support for the modernization of consumption structures.

Table 2. Baseline regression results (N=372)

VARIABLES	(1)	(2)	(3)	(4)
PopAge	1.452*** (0.119)	0.277* (0.148)	0.559*** (0.169)	0.392** (0.180)
eco		2.817*** (0.350)	2.154*** (0.366)	1.793*** (0.420)
emp			23.465*** (7.769)	21.616** (8.156)
ninf				7.648* (3.771)
Constant	88.040*** (1.828)	89.734*** (1.223)	76.322*** (4.827)	20.142 (29.095)
Zone fixed		Yes		
R ²	0.393	0.440	0.468	0.496

Note: Robust standard errors are in parentheses; ***, **, and * denote significance levels of 1%, 5%, and 10%, respectively, as in the table below.

5.2. Robustness test analysis

To further verify the reliability of the empirical regression results presented above, the following three robustness tests will be conducted in this paper. The first way is to replace the main explanatory variable and use the proportion of the elderly population in the total population as a substitute for the elderly dependency ratio in the regression analysis. The second is a change in the sample. Given that there may be special features of the administrative divisions affecting the regression results, these four municipalities directly under the central government have been excluded from the sample in this paper. The third way is tail trimming. Since the baseline regression process may be affected by potential problems such as outliers, tail trimming at the 5th and 95th percentiles, and then a stability test has been conducted. Table 3 is the result of the above estimation. The three ways of study have produced the same results, and therefore, all of them can serve as the foundation for this study.

Table 3. Robustness test results

VARIABLES	(1) Replacing measurement method of core variable	(2) Excluding cities directly under control	(3) Winsorize
PopAge	0.813*** (0.277)	0.445** (0.188)	0.545*** (0.189)
Constant	18.983 (29.294)	21.983 (33.592)	-31.349 (27.025)
Controls		Yes	
Zone fixed		Yes	
N	372	324	372
R ²	0.627	0.622	0.661

5.3. Threshold effect analysis

Next, it was determined whether there is a threshold asymmetry. As shown in Table 4, the test for a single threshold in the digital economy system is statistically significant, but higher-order threshold effects are not. As shown in Table 5, the corresponding estimates indicate a change in regime due to the level of digitalization. In areas with a digital development level of less than 0.697, an ageing population will have a substantial upward effect on consumption upgrades. On the other hand, if the above limit is exceeded, there will be a relatively small impact, and the coefficient will drop to 0.285. The above evidence indicates that the link between ageing and consumption structure is positively correlated but diminishes incrementally as digital ecosystems develop; thus, it supports Hypothesis 2.

Table 4. Test of threshold effect

Threshold Variable	Threshold Number	Value	F-statistics	P-value	BS	Critical value		
						1%	5%	10%
Dig	Single	0.697	16.890	0.057	300	20.738	17.263	14.013
	Double	0.659	8.570	0.143	300	17.225	12.111	9.807
	Triple	0.634	2.640	0.787	300	16.341	12.002	10.003

Table 5. Regression results of threshold model

Threshold Variable	Value	$I(\text{Dig}_{it} \leq \gamma_1)$	$I(\text{Dig}_{it} > \gamma_1)$	Period	Provinces
Dig	0.697	0.491*** (0.147)	0.285** (0.147)	12	31

5.4. Heterogeneity analysis

Based on the regional division model proposed by He [23], the 31 provincial-level units in this study have been divided into three tiers: Eastern, Central and Western. As shown in Table 6 below, the subsequent group-specific regressions show different spatial patterns of the ageing-consumption phenomenon. The Eastern and Central cohorts reached the 5% and 10% significance levels, respectively, but not the Western Area. Notably, the positive elasticities were as follows: 0.519 for the East and a relatively higher 0.775 for the Central Area; that is to say, ageing of the population in these regions has promoted consumption upgrading. The increased sensitivity of the Central region shows a more severe structural change and, thus, provides empirical support for the verification of Hypothesis 3.

Table 6. Heterogeneity analysis

VARIABLES	(1) Eastern	(2) Middle	(3) Western
PopAge	0.519** (0.185)	0.775* (0.334)	-0.404 (0.351)
Constant	26.625 (45.736)	48.482*** (12.930)	-42.172** (18.143)
Controls		Yes	
Zone fixed		Yes	
N	132	96	144
R ²	0.649	0.594	0.716

6. Conclusion and recommendation

6.1. Conclusion

Research has been conducted in this paper to explore the connections among digital development, an older population, and changes in consumption patterns at the provincial level over the past twelve years (2011-2022). Empirical diagnostics show that an aging population has been driving the modernization of consumption patterns and this effect persists after adding multiple control variables. However, the two are not directly correlated; with the development of the digital economy, the promotional effect will gradually decline, and an increase in technological integration may also reduce the benefits derived from age-based optimisation. Based on the above, China has shown a dispersed pattern of development. The change in the age structure is most pronounced in the central area and still relatively stable in the east; on the other hand, the western area has not experienced this change and is at a lower level. Therefore, this paper presents a large number of various technological transitions in regional consumption structures.

6.2. Recommendation

Based on the above results, the following policy recommendations are proposed. First, the government can use the consumption-upgrading effect of population ageing to actively promote the development of the elderly consumer market. Place more emphasis on the supply of healthcare, leisure and entertainment for older people, as well as cultural and educational services for older people. Improvement of the Pension Security System and Financial Insurance System at the demand side. Second, make efforts to narrow the digital divide of older people. Increase broadband coverage in rural and remote areas, simplify digital products and improve accessibility, and strengthen the construction of community service and activity centers for older adults. Thirdly, policies to promote the consumption of older adults need to be customized for the different situations in various areas. Further advance the market-oriented reform of elderly care services in the eastern and central areas,

and strengthen the construction of elderly care and medical security systems in the western region, while promoting industrial transfer from the eastern and central areas.

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