



The Impact of Population Aging on Digital Economy: A Perspective on Market Competition

Zishan Jiang*

Beijing Technology and Business University, Beijing 102488, China

*13811729237@163.com

Abstract. Population aging and digital economic development are two major issues facing the contemporary transformation of China's economy and society. Based on the panel data of 30 provinces in China from 2012 to 2022, this paper starts from the perspective of market competition and uses the mediation effect model to empirically test the impact of population aging on digital economic development and its mechanism. The research results show that population aging has a significant positive promoting effect on digital economic development; market competition plays a mediating role in the process of population aging influencing the development of the digital economy, and population aging indirectly promotes the development of the digital economy by alleviating the degree of market competition; the impact of population aging on the development of the digital economy is significantly positive in the eastern and central regions, but there is a significant inhibitory effect in the northeastern region. Therefore, in order to promote the high-quality development of the digital economy, the government should take a series of measures to fully leverage the impelling effect of population aging, continuously optimize the market competition environment, and implement differentiated regional development strategies for different regions.

Keywords: Population Aging, Digital Economy, Market Competition, Mediating Effect

1 Introduction

Population aging is one of the major challenges faced by human society in the 21st century. By the end of 2023, the population aged 60 and above in China reached 297 million, accounting for 21.1% of the total population. Population aging not only profoundly affects the structure of labor supply, the social security system, and consumption patterns, but also has a far-reaching impact on the economic growth model and social development pattern [1]. At the same time, the position of the digital economy in the national economy is increasingly prominent [2]. There is a complex interaction relationship between population aging and the digital economy. On the one hand, population aging affects the development of the digital economy through factors such as reduced labor supply and changes in consumption demand; on the other hand,

the rapid development of the digital economy also provides new ideas and tools to address the challenges of population aging. Market competition serves as an important link connecting population aging and the digital economy, which is also an important external environment for enterprise innovation [3].

2 Literature Review

Most literature suggests that population aging has a promoting effect on the development of the digital economy. From an empirical perspective, population aging has a promoting effect on the development of the digital economy because it can stimulate the improvement of digitalization levels to promote high-quality economic development, but this direct promoting effect may decrease in the order of the west, central, northeast, and east [4]. However, some studies suggest that population aging has a significant negative impact on the development of the digital economy [5]. From a longer time span, the relationship between population aging and the digital economy is not a simple linear one, but presents complex interactive characteristics. The research finds that there is an inverted U-shaped relationship between population aging and the level of digital technology innovation [6].

When scholars study digital economy, they often also mention market competition. The complex and changing market competition environment promotes enterprises to apply digital technologies, enabling them to effectively overcome time and space limitations and more efficiently integrate internal and external resources [7]. Some scholars believe that when the degree of market competition is higher, the management of enterprises will more likely learn from industry benchmarks to improve their own innovation levels [8]. In addition, some studies have found that there is an inverted U-shaped relationship between market competition and enterprise digital transformation [9]. Few studies have systematically integrated these three elements into a single research analysis framework to explore the complex nonlinear relationships among them. Based on this, this paper takes the perspective of market competition as the starting point, constructs an intermediary effect model to analyze the internal mechanism by which population aging affects the digital economy.

3 Theoretical Model and Research Hypothesis

According to the factor substitution theory, when the supply of labor decreases and labor costs rise, enterprises and markets tend to seek technological substitution, promoting labor-saving technological innovations. At the same time, although population aging reduces the number of eligible labor force, it can also expand the digital consumption demand of the elderly group. Based on the above analysis, this paper proposes research hypothesis 1.

H1: Population aging has a promoting effect on the development of digital economy.

According to the supply and demand theory, the degree of market competition is a key factor affecting the efficiency of resource allocation. In the context of population aging, the reduction in labor supply leads to a decrease in the number of new enterprises

and a relative increase in market entry barriers, resulting in a more moderate degree of market competition [10]. In a moderately competitive environment, enterprises are more motivated to enhance their competitiveness through digital transformation. Based on this, this paper proposes hypothesis 2.

H2: Population aging indirectly promotes the development of the digital economy by alleviating the degree of market competition.

According to the resource-based theory, the level of regional economic development, the completeness of digital infrastructure, and the concentration of innovation factors determine its ability to utilize the backward-pressure mechanism of population aging to promote the development of the digital economy. Different regions in China have different resource endowments and infrastructure, and the development of the digital economy is unbalanced [11]. Therefore, this paper proposes hypothesis 3.

H3: The effect of population aging on the development of the digital economy shows regional heterogeneity.

4 Model Setting and Descriptive Statistics

4.1 Research Design

To examine the relationships among the digital economy and population aging, this study constructs the following regression model.

$$DigEco_{it} = \alpha_0 + \alpha_1 PopAge_{it} + \alpha Controls_{it} + \delta_i + \varepsilon_{it} \quad (1)$$

In Model (1), *DigEco* represents the level of digital economic development, and *PopAge* represents the degree of population aging. *Controls* represents a series of control variables, *i* represents the province, *t* represents the year, α is the coefficient to be estimated, δ_i is the province-fixed effect, and ε_{it} represents the random error term.

To explore the moderating and mediating role of market competition in the impact of population aging on digital economic development, this paper constructs Model (2) and (3) based on Model (1), where *Com_{it}* represents the degree of market competition.

$$Com_{it} = \beta_0 + \beta_1 PopAge_{it} + \beta Controls_{it} + \delta_i + \varepsilon_{it} \quad (2)$$

$$DigEco_{it} = \gamma_0 + \gamma_1 PopAge_{it} + \gamma_2 Com_{it} + \gamma Controls_{it} + \delta_i + \varepsilon_{it} \quad (3)$$

4.2 Variable Selection

The level of digital economy development (*DigEco*) is the dependent variable and is constructed from two aspects: the development of the Internet and the accessibility of digital finance. The core explanatory variable is the degree of population aging (*PopAge*), using the proportion of people aged 65 and above in the total population. The mediating variable in this article is market competition. Considering that market competition has a certain lag, the measurement indicator of the intensity of market competition (*Com_{it}*) is approximately described by the ratio of the number of enterprises in each region in the previous year to the industrial output value of that

region. Furthermore, this paper selects the output proportion of the primary industry is (represented by the proportion of the primary industry's added value in the gross domestic product), the average years of education AYS (referring to the average number of years of formal education received by each resident of a country or region), and the per capita GDP growth AGdpGrowth (the average increase in wealth created by each individual) as control variables.

4.3 Data Source and Descriptive Statistics

The data sources include the China Statistical Yearbook, the China Fiscal Yearbook and the statistical yearbooks of each province, etc. The descriptive statistics of each variable are shown in Table 1.

Table 1. Descriptive Statistics of Variables (N=330)

Variable	Mean	Std. Dev.	Min	Max
DigEco	0.714	0.097	0.600	1.000
PopAge	11.409	2.854	6.368	20.016
is	0.096	0.052	0.002	0.251
AYS	8.768	0.294	8.160	9.787
AGdpGrowth	0.081	0.041	-0.039	0.285
Com	1.121	0.376	0.370	2.435

5 Empirical Results

5.1 Benchmark Regression

The columns (1)-(4) in Table 2 represent the regression results of the impact of population aging on digital economic development when control variables are gradually added. The results show that the estimated coefficient of the degree of population aging is always positive and has passed the 5% significance test. During the process of continuously adding control variables, the impact coefficient of population aging on digital economic development remains stable at 0.003, and the significance level has not changed, indicating that population aging has a stable and significant positive promoting effect on digital economic development, verifying Hypothesis 1.

Table 2. Baseline Regression Results (N=300)

Variable	DigEco			
	(1)	(2)	(3)	(4)
PopAge	0.004** (0.002)	0.003** (0.002)	0.003** (0.001)	0.003** (0.001)
is		-0.641***	-0.783***	-0.778***

		(0.180)	(0.184)	(0.182)
AYS			0.043***	0.042***
			(0.013)	(0.013)
AGdpGrowth				-0.049**
				(0.022)
Zone fixed effect			Yes	
Constant	0.670***	0.739***	0.375***	0.390***
	(0.021)	(0.026)	(0.111)	(0.109)
R ²	0.100	0.192	0.254	0.260

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 Tests

This paper verifies the reliability of the above conclusion through three methods. The first method is to exclude the data of the pandemic year 2020. The second method is performing 5% and 95% trimming on all relevant variables and replaces extreme values. The third method is the substitution of core explanatory variables. In the text above, the PopAge is replaced by the elderly dependency ratio (i.e., the proportion of the elderly population in the working-age population). The regression results of the above three methods are shown in Table 3, proving that the benchmark regression results are robust.

Table 3. Robustness Test Results

Variable	(1)	(2)	(3)
	Excluding year2020 samples	Winsorizing	Changing core explan- atory variable meas- urement
PopAge	0.003**(0.001)	0.004**(0.001)	0.002**(0.001)
Controls, Zone fixed ef- fect		Yes	
Constant	0.416*** (0.105)	0.423*** (0.115)	0.390*** (0.106)
N	300	330	330
R ²	0.250	0.244	0.270

5.3 Mechanism Analysis

Based on Equations (2) and (3), the mediating effect of market competition is examined. The regression results are shown in Table 4. Column (1) indicates that population aging can significantly alleviate the degree of market competition. Column (2) indicates that population aging can indirectly promote the development of the digital economy by alleviating the degree of market competition, thus confirming Hypothesis 2.

Table 4. Mechanism Test Results (N=300)

Variable	(1) Com	(2) DigEco
PopAge	-0.022**(0.010)	0.003**(0.001)
Com		-0.026*(0.015)
Controls, Zone fixed effect	Yes	
Constant	-0.281(1.050)	0.394***(0.143)
R ²	0.131	0.319

5.4 Heterogeneous Analysis

Due to the different development stages of various regions, the impact of population aging on digital economy may exhibit regional heterogeneity characteristics. The regression results for each region are shown in Table 5, and indicate that for the eastern and central regions, population aging can promote the growth of the digital economy's development level. While in the western region, the influence is not significant, which might be due to the relatively lagging digital infrastructure. However, population aging has a significant inhibitory effect in the northeastern region, verifying Hypothesis 3.

Table 5. Heterogeneity Analysis

Variable	(1) Eastern	(2) Central	(3) Western	(4) Northeastern
PopAge	0.007***(0.002)	0.009**(0.002)	0.002(0.002)	-0.007**(0.001)
Constant	0.303**(0.115)	0.187*(0.093)	0.464**(0.189)	-0.170(0.274)
Controls	Yes			
Zone fixed effect	Yes			
N	110	66	121	33
R ²	0.331	0.747	0.069	0.615

6 Conclusion and Suggestion

6.1 Conclusion

This paper reaches the following conclusions: Firstly, population aging has a significant positive promoting effect on the development of the digital economy. Secondly, population aging indirectly promotes the development of the digital economy by alleviating the degree of market competition. Thirdly, the impact of population aging on the development of the digital economy shows significant regional heterogeneity. The eastern and central regions show a positive promoting effect, while the impact on

the western region has not yet been manifested. In the northeastern region, it has a significant inhibitory effect.

6.2 Recommendation

Based on this, the following countermeasures and suggestions are proposed in this article: First, the government should actively guide enterprises to increase investment in digital technologies, enhance digital training, improve the digital literacy of the elderly, and narrow the digital divide among the elderly. Second, optimize the market competition environment to promote the digital transformation of enterprises. Sufficient financial support for the digital transformation of enterprises is necessary. Third, implement differentiated regional development strategies to promote the coordinated development of the digital economy. For western and northeastern regions, greater policy support should be provided to address the shortcomings in digital infrastructure.

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