

# *The Influence of the Digital Economy on Scale of Employment: From the Perspective of Population Aging*

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**Abstract:** The digital economy serves as a vital engine for addressing the employment challenges posed by an aging population. By enhancing the digital skills of older individuals and creating more flexible employment opportunities, it can significantly alleviate labor supply pressures and pave the way for high-quality economic growth. This study analyzes panel data from various provinces in China between 2012 and 2022, employing both fixed-effect and threshold models to examine the influence of the digital economy on employment scale in the context of demographic aging. The findings indicate that the advancement of the digital economy positively impacts employment scale, with a marginally increasing nonlinear effect as population aging progresses. Additionally, the effects of digital economy development on employment expansion vary across regions. To effectively increase employment scale, it is essential to strengthen regional coordination mechanisms and foster collaborative efforts between government and enterprises.

**Keywords:** digital economy, the scale of employment, population aging

## 1. Introduction

Amid significant global economic shifts and an aging population, digital transformation has become a key driver of social progress. Since the 18th National Congress of the Communist Party of China, the digital economy has grown remarkably, expanding from 11.2 trillion yuan in 2012 to 53.9 trillion yuan in 2023—an increase of nearly 3.8 times in a decade. Notably, after surpassing 10 trillion yuan, it took only six years to reach 30 trillion yuan and just four more years to exceed 50 trillion yuan, reflecting accelerated growth. In 2023, with continued policy support, the digital economy is projected to expand by an additional 3.7 trillion yuan, signaling a transition to high-quality development. The 20th National Congress report emphasizes the need to accelerate digital economic growth, integrate it with the real economy, and build a competitive digital industrial cluster, providing strategic direction for modernization.

As a major force in job creation, the digital economy has reshaped employment by enabling flexible work models, such as e-commerce, and generating new opportunities. To enhance its positive impact, it is crucial to align talent cultivation with digital development needs, utilize policy and market mechanisms, and establish an employment security system suited to this evolving landscape. This paper explores the relationship between the digital economy and employment through empirical analysis, offering theoretical and practical insights for policy formulation.

## 2. Literature review

As digital technology continues to advance and demographic shifts intensify, changes in employment scale and population aging have emerged as critical dimensions for observing China's economic and social development. Population aging, characterized by a systematic transformation in age structure, involves a steady increase in the proportion of elderly individuals alongside a relative decline in the working-age population. Currently, scholars are increasingly focused on how the “creative destruction” effect of the digital economy is reshaping the traditional employment landscape amid the ongoing decrease in the working-age population and the rising dependency ratio of the elderly [1].

### 2.1. Digital economy and employment

The digital economy relies on data as a key production factor and advances in digital technology as its driving force. This transformation reshapes production methods, influences employment growth, and drives the emergence of new industries [2-3]. In the short term, the substitution effect is significant, with research by Acemoglu and Restrepo showing that it can reduce labor demand in equilibrium [4]. Domestic studies further reveal that a 1% increase in industrial machinery adoption by firms leads to a 0.18% decline in employment demand [5], contributing to short-term job reductions.

In the long run, the digital economy positively impacts employment by increasing total employment, optimizing job structures, and enhancing job quality. Qi et al. found that digital platforms and shared service models have integrated many workers transitioning from traditional industries, aligning with Acemoglu and Restrepo's theory that while automation displaces jobs initially, it eventually creates new tasks that offset employment losses. Regarding job structure, Goos et al. analyzed employment trends across 16 Western European countries from 1993 to 2010, identifying “job polarization”—a decline in middle-skilled roles alongside growth in high- and low-skilled positions [6]. In contrast, domestic research suggests digital advancements have increased demand for middle- and high-skilled workers while helping displaced low-skilled workers transition into service roles, fostering employment servitization and structural optimization. Additionally, Autor's “task model” theory highlights a skill-biased impact on job quality. High-skilled workers benefit from income premiums and greater autonomy due to technological complementarity, whereas low-skilled workers maintain stable demand for manual services but face wage stagnation. This dynamic ultimately contributes to improved employment quality [7].

### 2.2. Digital economy and aging

Research on the relationship between China's digital economy and population aging remains limited. Existing studies suggest that aging's supply-side effects on industrial structure optimization outweigh its demand-side effects, resulting in a net negative impact. However, digital economy growth has significantly aided industrial optimization, mitigating aging-related challenges [8]. As aging progresses, its impact on employment begins with low-skilled labor, then medium-skilled, and finally high-skilled workers. Enhancing human capital and promoting industrial upgrades are key strategies for improving employment structures in this context [9]. Japan, facing similar demographic shifts, demonstrates how aging can lead to financial constraints, reduced labor efficiency, and weakened digital economy-linked industries. To counter these effects, emphasis should be placed on the “silver hair industry,” which arises from declining birth rates and an aging population. Digital empowerment and tailored products for the elderly can strengthen this sector's competitiveness. Additionally, restructuring the digital industry to align with an aging workforce can further support economic growth [10].

While existing research has explored the digital economy, employment, and population aging, the impact of the digital economy on employment within the context of an aging population remains underexamined. Building on previous studies, this paper investigates how the digital economy influences employment scale amid population aging, aiming to provide targeted policy recommendations for alleviating structural employment pressures and optimizing workforce allocation across all age groups.

### 3. Theoretical models and research hypotheses

In recent years, the rapid growth of the digital economy has significantly benefited the job market. This paper examines its impact on employment scale through the lens of endogenous growth theory and labor market search-matching theory. According to endogenous growth theory, knowledge spillovers in the digital economy, a knowledge-intensive sector, create a self-reinforcing employment mechanism that promotes job expansion. Additionally, labor market search-matching theory suggests that digital platforms reduce information asymmetry and enhance job-matching efficiency, thereby lowering frictional unemployment. Based on this analysis, hypothesis 1 is proposed.

H1: The level of development of the digital economy has a positive effect on the scale of employment.

Population aging has led to structural shifts, including a rising elderly population and a shrinking labor force. According to the theory of demographic dividend reconstruction, aging erodes traditional demographic dividends, while the digital economy generates new ones, such as the digital dividend and the silver economy, contributing to employment expansion. From a structural transformation perspective, as aging deepens, societal demand shifts toward healthcare, elder care, and related services. The digital economy facilitates the growth of these industries, further increasing employment scale. Thus, hypothesis 2 is proposed.

H2: The promotion effect of the development level of digital economy on the scale of employment has a nonlinear effect under the influence of population aging.

The digital economy in China has developed at different sequences, stages, and economic foundations, leading to regional disparities. Resource-based theory attributes these differences to variations in resource availability. Economically advanced regions typically possess stronger digital industries, infrastructure, human resources, and policy support, allowing for better alignment with labor market demands. This fosters new occupations, enhances skill matching, and drives employment growth and structural upgrades. Based on this, hypothesis 3 is proposed.

H3: The role of the development of the digital economy on the expansion of employment scale is regionally heterogeneous.

### 4. Model setting and variable description

#### 4.1. Model settings

In order to demonstrate the relationship between digital economy and employment, this paper constructs a regression model as follows (1).

$$\ln EMP_{it} = \alpha_0 + \alpha_1 \ln DEI_{it} + \theta X_{it} + \mu_i + \omega_t + \varepsilon_{it} \quad (1)$$

Among them,  $EMP$  represents the employment scale,  $DEI$  represents the digital economy development level index,  $X_{it}$  represents a series of control variables,  $i$  represents the province,  $t$  represents the year,  $\alpha$  represents the coefficient to be determined,  $\mu_i$  is the province fixed effect,  $\omega_t$  is the time fixed effect, and  $\varepsilon_{it}$  is the random error term.

In order to further discuss the influencing mechanism of employment under different population aging levels, the threshold effect model is constructed based on (1) and the aging level is used as a threshold variable, as shown in (2).

$$\begin{aligned} \ln EMP_{it} = & \alpha_0 + \alpha_1 \ln DEI_{it} \times I(\ln OLD_{it} \leq \gamma) + \\ & \alpha_2 \ln DEI_{it} \times I(\ln OLD_{it} > \gamma) \\ & + \theta X_{it} + \mu_i + \omega_i + \varepsilon_{it} \end{aligned} \quad (2)$$

*OLD* represents the aging level of the population,  $I(\cdot)$  represents the indicator function with a value of 0 or 1, and  $\gamma$  is the threshold value to be estimated in the threshold model.

## 4.2. Variable selection

This paper uses employment scale (EMP) as the dependent variable, drawing data from provincial statistical yearbooks (2012–2022). From 2012 to 2019, employment figures include urban unit employees, private enterprises, and self-employed individuals [11]. Data from 2020 to 2022 reflect total employment from the Chinese Population and Employment Statistical Yearbook.

The Digital Economy Growth Index (DEI) serves as the core explanatory variable. Following Zhao et al., this paper evaluates the digital economy's development using five key indicators: Internet penetration rate, Internet-related employment, output, mobile Internet users, and digital financial inclusion [12].

The threshold parameter (OLD) quantifies population aging through the old-age dependency ratio. This metric calculates the proportion of elderly individuals (beyond working age) relative to the economically active population cohort, with non-workers aged over 65 compared against working-age adults (15-64 years) in demographic assessments [13-15].

Drawing from established research frameworks, this study incorporates five key regulatory factors: capital formation (K), sectoral composition (IND), technological advancement (TEC), urban development (URB), and market reform progress (MAR), following methodological approaches in [11,16].

## 4.3. Data sources and descriptive statistics

This paper utilizes panel data from 29 provinces in China (excluding Xinjiang, Tibet, Hong Kong, Macao, and Taiwan) from 2012 to 2022, primarily sourced from the China Statistical Yearbook and Chinese Population and Employment Statistical Yearbook. To ensure data stability, all values are logarithmically transformed, with descriptive statistics presented in Table 1. The data in Table 1 reveal that China's overall digital economy development remains at a relatively low level, while industrial structure and technological advancement exhibit significant regional and temporal disparities, highlighting unbalanced development. Additionally, the aging population is substantial, with pronounced variations across different regions and time periods.

Table 1: Descriptive statistics of variables

| Variable      | Mean   | Std. dev. | Min   | Max    |
|---------------|--------|-----------|-------|--------|
| <b>ln EMP</b> | 7.276  | 0.871     | 4.874 | 9.125  |
| <b>ln DEI</b> | 2.999  | 0.600     | 1.590 | 4.605  |
| <b>ln IND</b> | 4.631  | 0.919     | 1.831 | 6.564  |
| <b>ln TEC</b> | 15.159 | 17.267    | 0.382 | 92.821 |
| <b>ln MAR</b> | 2.077  | 0.232     | 1.271 | 2.442  |
| <b>OLD</b>    | 16.145 | 4.361     | 9.110 | 28.770 |

## 5. Analysis of empirical results

### 5.1. Benchmark regression analysis

The baseline regression results on the impact of the digital economy on employment scale are presented in Table 2. Columns (1)-(4) show the regression results as control variables are gradually added. Column (1) includes only the core explanatory variable, while columns (2)-(4) incorporate control variables step by step. The findings indicate that the digital economy has a significantly positive effect on employment scale, with the coefficient remaining statistically significant at the 1% level even after adding control variables. Specifically, a 1% increase in digital economy development leads to a 25.0% increase in employment scale, confirming hypothesis 1. Regarding control variables, technological advancement has a significant inhibitory effect on employment scale. This is likely due to automation reducing demand for low-skilled jobs and capital crowding out labor, thereby constraining employment growth. In contrast, industrial structure and marketization level both show positive coefficients, indicating that higher levels in these areas are associated with larger employment scales.

Table 2: Results of the impact of digital economy on employment scale

| Variable             | ln EMP              |                     |                      |                      |
|----------------------|---------------------|---------------------|----------------------|----------------------|
|                      | (1)                 | (2)                 | (3)                  | (4)                  |
| <b>ln DEI</b>        | 0.250***<br>(0.053) | 0.248***<br>(0.056) | 0.223***<br>(0.059)  | 0.209***<br>(0.065)  |
| <b>ln IND</b>        |                     | 0.011<br>(0.025)    | 0.034<br>(0.261)     | 0.032<br>(0.025)     |
| <b>ln TEC</b>        |                     |                     | -0.011***<br>(0.003) | -0.011***<br>(0.003) |
| <b>ln MAR</b>        |                     |                     |                      | 0.146<br>(0.144)     |
| Constant             | 5.920***<br>(0.239) | 5.877***<br>(0.211) | 6.389***<br>(0.273)  | 6.148***<br>(0.338)  |
| Time fixed           |                     |                     |                      |                      |
| Province fixed       |                     |                     | Yes                  |                      |
| <b>R<sup>2</sup></b> | 0.872               | 0.872               | 0.905                | 0.906                |
| <b>N</b>             | 319                 | 319                 | 319                  | 319                  |

Note: The brackets are robust standard errors: \*\*\*, \*\*, and \* represent the significance levels of 1%, 5%, and 10%, respectively, and the following table is the same.

### 5.2. Robustness test

To ensure the reliability of the conclusions, the robustness of the data was tested using three methods, with results presented in Table 3. First, to address potential outliers, the benchmark regression was adjusted by shrinking the data at the 1% and 99% quantiles, eliminating extreme values to minimize their impact on the results. Second, given the significant economic and social disruptions caused by the global public health emergency in 2020, data from that year was excluded. Finally, recognizing that China's municipalities—Beijing, Tianjin, Shanghai, and Chongqing—have distinct digital economy development levels compared to other regions, they were removed from the analysis. Results remained consistent across all three robustness tests, confirming the stability of the benchmark regression findings.

Table 3: Robustness test results

| Variable         | Tail Reduction      | Exclusion of Special<br>Years | Change of Sample    |
|------------------|---------------------|-------------------------------|---------------------|
| <i>ln DEI</i>    | 0.230***<br>(0.060) | 0.177***<br>(0.067)           | 0.215***<br>(0.061) |
| Control variable |                     | Control                       |                     |
| Constant         | 6.092***<br>(0.303) | 6.252***<br>(0.355)           | 0.000<br>(0.000)    |
| Time fixed       |                     | Yes                           |                     |
| Province fixed   |                     |                               |                     |
| $R^2$            | 0.903               | 0.894                         | 0.928               |
| $N$              | 319                 | 290                           | 275                 |

### 5.3. Threshold effect test

This paper further conducts a panel threshold test to examine the impact of the digital economy on employment scale from the perspective of population aging. Table 4 shows that the aging threshold variable passes the 1% significance test for a single-fold threshold but fails the double and triple threshold tests. As seen in Table 5, when the aging level is below 17.770, the digital economy positively influences employment growth. Above this threshold, the impact coefficient rises from 0.187 to 0.290, exhibiting a significant positive and increasing marginal effect. Thus, Hypothesis 2 is confirmed.

Table 4: Test results of employment size threshold effect under the background of population aging

| Threshold variables | Number of thresholds | Thresholds | F-statistic | P-value | BS times | Critical Value |        |        |
|---------------------|----------------------|------------|-------------|---------|----------|----------------|--------|--------|
|                     |                      |            |             |         |          | 1%             | 5%     | 10%    |
| Level of ageing     | Single threshold     | 17.770     | 62.180      | 0.007   | 300      | 56.528         | 40.341 | 34.688 |

Table 5: Results of employment scale threshold under the background of population aging

| Variable Name                                                              | Variable Symbol                                            | Threshold variables<br>Level of Aging<br><i>OLD</i> |
|----------------------------------------------------------------------------|------------------------------------------------------------|-----------------------------------------------------|
| The degree of aging is less than or equal to the threshold value of 17.770 | $\alpha_1 \ln DEI_{it} \times I(\ln OLD_{it} \leq \gamma)$ | 0.187**(0.073)                                      |
| The degree of aging is greater than the threshold value of 17.770          | $\alpha_2 \ln DEI_{it} \times I(\ln OLD_{it} > \gamma)$    | 0.290*** (0.073)                                    |
| Industrial Structure                                                       | <i>ln IND</i>                                              | 0.235*** (0.043)                                    |
| Technological Level                                                        | <i>ln TEC</i>                                              | 0.005*** (0.002)                                    |
| The Degree of Marketization                                                | <i>ln MAR</i>                                              | 0.843*** (0.202)                                    |
| Constant                                                                   | <i>constant</i>                                            | 3.691*** (0.374)                                    |
| Thresholds                                                                 | $\gamma$                                                   | 17.770                                              |
| Number of Samples                                                          | $N$                                                        | 319                                                 |
| $R^2$                                                                      | $R^2$                                                      | 0.608                                               |

## 5.4. Heterogeneity test

Regional disparities in development stages create significant heterogeneity in employment scale and digital economy growth across China. This study categorizes 29 provincial-level regions into eastern, central, western, and northeastern groups, with regression results shown in Table 6. The digital economy's impact on employment is insignificant in the eastern and northeastern regions. However, the central region shows a strong positive effect, with a coefficient of 0.348, passing the 1% significance test, indicating a 1% increase in digital economy development leads to a 34.8% rise in employment. The western region also exhibits a positive effect, though with a lower coefficient of 0.195, suggesting its digital economy needs more time to strengthen its influence. These findings confirm Hypothesis 3.

Table 6: Results of heterogeneity analysis

| Variable         | <i>ln EMP</i>       |                     |                     |                   |
|------------------|---------------------|---------------------|---------------------|-------------------|
|                  | East                | Central             | West                | Northeast         |
| <i>ln DEI</i>    | -0.147<br>(0.273)   | 0.348***<br>(0.071) | 0.195*<br>(0.100)   | -0.016<br>(0.334) |
| Control variable |                     |                     | Control             |                   |
| Constant term    | 7.814***<br>(1.478) | 7.665***<br>(0.720) | 5.841***<br>(0.307) | 0.000<br>(0.000)  |
| Time fixed       |                     |                     | Yes                 |                   |
| Province fixed   |                     |                     |                     |                   |
| $R^2$            | 0.874               | 0.977               | 0.941               | 0.905             |
| $N$              | 110                 | 66                  | 110                 | 33                |

## 6. Conclusions and policy recommendations

### 6.1. Conclusions

As the digital economy continues to evolve alongside rising population aging, both have become key drivers of employment expansion. Understanding how to leverage digital economy growth in an aging society to enhance employment has become a crucial research topic. Based on panel data from China's provinces, this paper examines the relationship between the digital economy, population aging, and employment, leading to the following conclusions:

First, the digital economy significantly boosts employment and serves as a major engine for job growth. Second, its impact on employment follows a nonlinear pattern, with an increasing marginal effect under population aging. In the early stages of aging, the digital economy moderately promotes employment, but as aging intensifies, its positive effect becomes more pronounced. Third, the influence of the digital economy on employment expansion varies across regions. In particular, the central region has developed a virtuous cycle of digital economy growth and employment expansion, driven by cost advantages, industrial transformation, policy support, and market demand, making its impact especially significant.

### 6.2. Suggestions

Firstly, accelerate digital innovation to diversify employment opportunities. The growth of the digital economy requires both policy support and market-driven mechanisms. Governments should enhance digital infrastructure and promote digital transformation through incentives like tax breaks, fostering more technical and operational job opportunities. Additionally, strengthening school-enterprise

collaboration and integrating practical courses—such as e-commerce operations—into education will equip workers with the skills needed to seize digital employment opportunities.

Secondly, unlock the potential of senior human resources and expand elderly employment. In aging regions, governments should lead efforts to improve digital skills training for the elderly, enabling them to engage in roles such as live-streaming sales and online household services. Businesses can create accessible job opportunities, such as community group-buying coordinators or digital application testers for seniors. Expanding the silver economy by encouraging active seniors to earn service credits for eldercare benefits can foster a positive cycle between employment and retirement support.

Finally, enhance regional cooperation and optimize resource allocation to maximize employment potential. The eastern region should leverage its digital technology leadership to drive regional industrial coordination and technology diffusion. The central and western regions should accelerate digital infrastructure development, align training with local industry needs, and support the digital transformation of traditional sectors. Meanwhile, the Northeast can capitalize on its resource advantages to stimulate localized employment growth and mitigate brain drain.

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