# The Impact of Population Aging on Fiscal Revenue and Expenditure and Local Government Debt: An Empirical Analysis Based on Panel Data

**Erjiang Wu[1], Yunfeng Li[2], Zhao Zhang[2], Shaomei Lu[1*]**
*[1]Guangxi Academy of Oceanography, Nanning, China*
*[2]The National University of Malaysia, Economics and Management Fuaculty, Kuala Lumpur, Malaysia*
**Corresponding Author*

**Abstract:Amid the global trend of aging, this study focuses on the multifaceted impact of population aging on the economy and society, which is of significant theoretical and practical importance. The study uses panel data from multiple regions between 2011 and 2020, sourced from authoritative institutions such as the United Nations Population Division and the World Bank. Using panel data models, and controlling for variables such as regional GDP and savings levels, the study explores the relationship between population aging and tax revenue, local government debt, social security, and employment expenditure.**

**The results show that there is a long-term stable cointegration relationship between the variables. Population aging has an insignificant impact on tax revenue, which is mainly due to the combined effects of factors such as industrial structure, economic policy, labor market changes, and tax policy adjustments, which obscure or weaken its effect on tax revenue. However, population aging has a significant positive impact on local government debt, social security, and employment expenditures. As aging deepens, the demand for pension, healthcare, and other services for the elderly drives the government to increase investment in social security and healthcare. When fiscal revenue is insufficient, local governments expand their debt issuance. At the same time, the growing elderly population directly pushes up social security expenditures, and the difficulties in re-employing elderly workers also increase employment expenditures. Additionally, factors such as regional GDP, savings levels, and total population also have varying degrees of impact on fiscal revenue and expenditure, as well as debt size.**

**Keywords: Population Aging; Fiscal Revenue and Expenditure; Local Government Debt; Panel Data Model; Cointegration Relationship**

## 1. Research Background

Globally, population aging has become a significant socioeconomic phenomenon that cannot be ignored. With advancements in medical technology and improvements in living standards, life expectancy has continually increased, while fertility rates have steadily declined, leading to a rapid rise in the proportion of elderly people in the total population. According to relevant data from the United Nations, the proportion of the population aged 65 and above has been on a sharp upward trend in several developed countries over the past few decades. Some developing countries are also gradually entering the aging society, with the aging wave sweeping across the globe.

In terms of the domestic situation, since the implementation of the family planning policy, fertility rates have been effectively controlled, and with significant improvements in healthcare, the aging process has accelerated. Regionally, there are significant differences in the degree of aging. Economically developed regions often face more prominent aging issues due to population inflows and lower fertility rates. On the other hand, some economically underdeveloped regions, due to labor outflow, also face significant aging challenges. This major demographic shift is profoundly changing the operation of the socioeconomic system. In the labor market, the proportion of elderly workers is increasing while the supply of young workers is relatively decreasing, which has a profound impact on labor productivity and industrial structure adjustments. In the consumption sector, the unique consumption preferences and capacities of the elderly population are reshaping market demand.

 

In the social welfare area, the demand for social security services such as pensions and healthcare is experiencing explosive growth, putting immense pressure on government finances. These changes have driven the need for in-depth exploration of the intrinsic relationship between population aging and various aspects of the economy and society, to better address the challenges posed by aging.

## 2. Methodology and Data Collection

### 2.1 Data Collection

We selected data from 2011 to 2020 to capture relevant trends during the significant period of population aging and economic transformation. This study adopts a quantitative research approach, using panel data analysis to explore the complex relationships between population aging and various economic and social indicators. Panel data combines both cross-sectional data and time-series data, offering numerous advantages.

The data used in this study come from several authoritative international databases and institutional publications. For population-related data, including the proportion of elderly population, total population, and demographic trends, we rely on data from the United Nations Population Division. These data provide a comprehensive and standardized perspective on the demographic structure of different countries at different times.

### 2.2 Model Specification

We use a fixed-effects panel data model to estimate the relationship between population aging and the dependent variables. The fixed-effects model is specified as follows:

$$Yit=\beta_0+\beta_1 Agingit+\beta_2 GDPit+\beta_3 Savingsit+\beta_4 Industrialit+\beta_5 Populationit+\alpha_i+\epsilon_{it}$$

In the above formula:

*Yit* represents the dependent variable (tax revenue, local government debt, social security and employment expenditures) for region *i* at time *t*.

*Agingit* represents the degree of population aging in region *i* at time *t*, measured as the proportion of the population aged 65 and above relative to the total population.

*GDPit* represents the gross domestic product (GDP) of region *i* at time *t*, used to control for the overall economic scale and development level of the region.

*Savingsit* represents the savings level of region *i* at time *t*, reflecting the reserve and liquidity of funds in the economy.

*Industrialit* represents the degree of industrial structure rationalization in region *i* at time *t*, measured by the Theil index.

*Populationit* represents the total population of region *i* at time *t*, which affects the scale of economic activity and demand for public services.

$\alpha i$ represents the region-specific fixed effects, capturing unobserved, time-invariant characteristics unique to each region.

$\epsilon it$ represents the error term, accounting for the random unobserved component in the model.

## 3.Empirical Analysis

### 3.1 Panel Regression

3.1.1 Hypothesis 1

**Table 1. Hypothesis 1 FE Model Analysis**

| Intermediate process value of FE model | | | | | |
|---|---|---|---|---|---|
| Item | Coef | Std. Err | *t* | *p* | 95% CI |
| Intercept | 11049.422 | 3499.102 | 3.158 | 0.002** | 4191.309 ~ 17907.535 |
| Population Aging | -234.866 | 167.591 | -1.401 | 0.161 | -563.338 ~ 93.606 |
| Regional Gross Domestic Product (GDP) | 0.000 | 0.000 | 17.956 | 0.000** | 0.000 ~ 0.001 |
| Savings Level | 0.000 | 0.000 | 22.616 | 0.000** | 0.000 ~ 0.000 |
| Industrial Structure Rationalization | 7.033 | 44.529 | 0.158 | 0.875 | -80.242 ~ 94.308 |
| Total Population | -17.269 | 7.357 | -2.347 | 0.019* | -31.689 ~ -2.849 |
| $F$ (5,2114)=1320.879,$p$=0.000 | | | | | |
| $R^2$=0.828,$R^2$(within)=0.758 | | | | | |
| * $p$<0.05 ** $p$<0.01 | | | | | |

It can be observed that for population aging, no significant relationship is found (t=-1.401, p=0.161 > 0.05), indicating that population aging does not have an impact on tax revenue. For GDP, a significant positive relationship is found at the 0.01 level (t=17.956, p=0.000 < 0.01), with a regression coefficient of 0.000 > 0, meaning GDP has a significant positive impact on tax revenue. For savings level, a significant positive relationship is also found at the 0.01 level

(t=22.616, p=0.000 < 0.01), with a regression coefficient of 0.000 > 0, indicating that savings level significantly positively affects tax revenue. For industrial structure rationalization, no significant relationship is found (t=0.158, p=0.875 > 0.05), meaning industrial structure rationalization does not affect tax revenue. For population size, a significant negative relationship is found at the 0.05 level (t=-2.347, p=0.019 < 0.05), with a regression coefficient of -17.269 < 0, indicating that population size has a significant negative impact on tax revenue.

3.1.2 Hypothesis 2

**Table 2. Hypothesis 2 FE Model Analysis**

| Intermediate process value of FE model | | | | | |
|---|---|---|---|---|---|
| Item | Coef | Std. Err | *t* | *p* | 95% CI |
| Intercept | -617.143 | 49.838 | -12.383 | 0.000** | -714.825 ~ -519.462 |
| Population Aging | 9.326 | 2.387 | 3.907 | 0.000** | 4.647 ~ 14.004 |
| Regional Gross Domestic Product (GDP) | 0.000 | 0.000 | 20.120 | 0.000** | 0.000 ~ 0.000 |
| Savings Level | 0.000 | 0.000 | -5.819 | 0.000** | -0.000 ~ -0.000 |
| Industrial Structure Rationalization | 0.058 | 0.634 | 0.091 | 0.927 | -1.185 ~ 1.301 |
| Total Population | 0.831 | 0.105 | 7.929 | 0.000** | 0.626 ~ 1.036 |
| $F$ (5,2114)=414.844,$p$=0.000 | | | | | |
| $R^2$=-2.491,$R^2$(within)=0.495 | | | | | |
| * $p$<0.05 ** $p$<0.01 | | | | | |

For the variable of population aging, it exhibits significance at the 0.01 level (t=3.907, p=0.000<0.01), with a positive regression coefficient of 9.326>0, indicating that population aging has a significant positive impact on local government debt. For regional GDP, it shows significance at the 0.01 level (t=20.120, p=0.000<0.01), with a positive regression coefficient of 0.000>0, indicating that regional GDP has a significant positive impact on local government debt. Regarding savings levels, it shows significance at the 0.01 level (t=-5.819, p=0.000<0.01), with a negative regression coefficient of -0.000<0, indicating that savings levels have a significant negative impact on local government debt. For industrial structure rationalization, it does not show significance (t=0.091, p=0.927>0.05), suggesting that industrial structure rationalization does not affect local government debt. As for the total population, it exhibits significance at the 0.01 level (t=7.929, p=0.000<0.01), with a positive regression coefficient of 0.831>0, indicating that the total population has a significant positive impact on local government debt.

3.1.3 Hypothesis 3

**Table 3. Hypothesis 3 FE Model Analysis**

| Intermediate process value of FE model | | | | | |
|---|---|---|---|---|---|
| Item | Coef | Std. Err | *t* | *p* | 95% CI |
| Intercept | -5553.244 | 537.614 | -10.329 | 0.000** | -6606.947 ~ -4499.541 |
| Population Aging | 554.945 | 25.749 | 10.391 | 0.000** | 212.830 ~ 313.765 |
| Regional Gross Domestic Product (GDP) | 0.000 | 0.000 | 14.351 | 0.000** | 0.000 ~ 0.000 |
| Savings Level | 0.000 | 0.000 | 0.939 | 0.000** | 0.000 ~ 0.000 |
| Industrial Structure Rationalization | 30.726 | 6.842 | 0.939 | 0.348** | 17.317 ~ 44.136 |
| Total Population | -7.360 | 1.130 | -3.139 | 0.002** | 1.218 ~ 5.650 |
| $F$ (5,2114)=1900.087,$p$=0.000 | | | | | |
| $R^2$=0.701,$R^2$(within)=0.818 | | | | | |
| *$p$<0.05 **$p$<0.01 | | | | | |

From the table above, it can be observed that regarding population aging, it shows significance at the 0.01 level (t=10.391, p=0.000<0.01), and the regression coefficient is 554.945>0, indicating that population aging has a significant positive impact on social security and employment expenditures. Regarding GDP, it shows significance at the 0.01 level (t=14.351, p=0.000<0.01), and the regression coefficient is 0.000>0, indicating that GDP has a significant positive impact on social security and employment expenditures. Regarding savings levels, it shows significance at the 0.01 level (t=15.468, p=0.000<0.01), and the regression coefficient is 0.000>0, indicating that savings levels have a significant positive impact on social

 

security and employment expenditures. However, industrial structure rationalization does not show significance (t=0.939, p=0.348>0.05), indicating that it does not have an impact on social security and employment expenditures. Lastly, regarding total population, it shows significance at the 0.01 level (t=-3.139, p=0.002<0.01), and the regression coefficient is -7.360<0, indicating that total population has a significant negative impact on social security and employment expenditures.

## 4. Results Interpretation and Conclusion

The insignificant impact of population aging on tax revenue: Tax revenue is influenced by a variety of factors, including industrial structure, economic policies, business performance, and income levels. In terms of industrial structure, different industries contribute differently to tax revenue, and new and traditional industries have different tax policies. The impact of population aging on tax revenue varies across industries, and its effect may be masked by other factors. From the labor market perspective, although aging changes the labor force structure, technological advances and improvements in labor productivity help to offset the economic impact of a shrinking workforce, thus weakening its effect on tax revenue.

The positive impact of population aging on local government debt: As the aging population increases, the demand for elderly care, healthcare, and other services rises. To meet these demands, governments need to increase spending on social security and healthcare. When fiscal revenue cannot cover these expenses, local governments often resort to borrowing. For example, to build more elderly care facilities, raise pension standards, or improve healthcare systems, local governments issue bonds to increase their debt. Additionally, aging may suppress economic growth and reduce fiscal revenue, further increasing the debt burden.

The positive impact of population aging on social security and employment expenditures: With the expansion of the elderly population, there is a significant increase in demand for pensions, healthcare, social welfare services, and other forms of social security, which drives the growth of social security expenditures. In terms of employment, older workers face difficulties in re-entering the workforce, prompting the government to implement policies that promote their employment or provide employment subsidies, vocational training, and other measures, thus increasing employment-related expenditures.

## References

[1]Auerbach, A. J., Gale, W. G., & Harris, B. H. (2017). How will aging affect U.S. fiscal policy? [J]National Tax Journal, 70(4), 703-732. https://doi.org/10.17310/ntj.2017.4.01

[2]Bloom, D. E., Canning, D., & Fink, G. (2015). Implications of population aging for economic growth. [J]Oxford Review of Economic Policy, 26(4), 583-612. https://doi.org/10.1093/oxrep/grq038

[3]Börsch-Supan, A. (2013). Myths, scientific evidence and economic policy in an aging world. [J]The Journal of the Economics of Ageing, 1-2, 3-15. https://doi.org/10.1016/j.jeoa.2013.07.002

[4]Braun, B., & Joerges, B. (2019). Local government debt and population aging: Evidence from Germany.[J]Public Finance Review, 47(6), 1036-1065. https://doi.org/10.1177/1091142119858986

[5]Cutler, D. M., Poterba, J. M., Sheiner, L. M., & Summers, L. H. (1990). An aging society: Opportunity or challenge? [J]Brookings Papers on Economic Activity, 1990(1), 1-73. https://doi.org/10.2307/2534505

[6]Gruber, J., & Wise, D. A. (2012). Social security programs and retirement around the world: Micro estimation.[J]University of Chicago Press. https://doi.org/10.7208/chicago/9780226310137.001.0001

 