



Fixed Effects Model-Analysis of the Influence of Population Aging on Different Levels of Education Under the Digital Background

Xinzhu Zeng and Shiming Zhao^(✉)

School of Management, Tianjin University of Technology, Tianjin, China
zhaoshiming@email.tjut.edu.cn

Abstract. Based on the background of the aggravation of population aging in China, and the development of education as an important measure to deal with population aging, this paper selects the panel data from 2007 to 2019, digitizes the educational information, uses Python software for data visualization analysis, establishes a fixed effect model, and deeply discusses the impact of population aging on the level of higher education and basic education. The study found that population aging has a significant positive effect on the development level of basic education and higher education, and this promotion effect is more obvious at the level of basic education. This paper argues that fully understanding the correlation between aging and the level of education development is helpful to realize the fairness of education, ensure the fairness of education starting point, process and result, and lay a solid foundation for the high-quality development of education in China.

Keywords: Fixed effect model · digital analysis · high-quality development of education · population aging

1 Introduction

The high-quality development of education is the development of comprehensive transformation of education development mode, optimization of education structure and transformation of growth momentum. The optimizing development in its connotation is to give full play to the factor potential of existing educational resources and maximize the input-output benefits of various types of education. In the process of promoting the balanced development of basic education and higher education in China, the lack of clear standards of resource allocation restricts the high-quality development of education. Education as a quasi-public goods, the supply and distribution of resource elements have a direct impact on the level of development. Its supply sources are mainly social input and personal input. Therefore, no matter from the macro national level or the micro family level, economic expenditure is faced with the trade-off and choice between education, welfare and medical expenditure. As of 2020, China's elderly dependency ratio reached 19.7%, an increase of 7.8% from 10 years ago. Aggravated pension burden not

only brings social security, health care, labor supply and other issues, while the aging population will also have an impact on family education investment decisions and public education spending.

In terms of family education investment, some scholars believe that due to the increasing demand for high-quality human capital, Becker's theory of substitution of quantity and quality of children, and the self-interest motivation of future pension security, the deepening of aging is conducive to family education investment [1–3]. However, other scholars hold the opposite view, because the change of population age structure inhibits the consumption expenditure of investing in children's education and tends to invest in consumption savings in the elderly [4, 5]. From the perspective of public education expenditure, increasing government investment in public education can reduce the economic cost of population aging and tap the demographic dividend of the elderly to cope with the problem of population aging [6, 7]; other scholars believe that the financial burden of aging has a certain crowding out effect on public education investment [8, 9].

The existing research has reached a consensus on the impact of population aging on education human capital investment. The research object is mainly around the degree of aging on family education investment and public education investment, and the conclusions are obviously different. Based on this, this paper subdivides the field of educational resource allocation and further explores the impact of population aging on the supply of resources at different educational levels. As an important means to alleviate the negative impact of population structure transformation, the study of the impact of population aging on education level is conducive to weakening its negative impact and strengthening the implementation of its solutions to actively respond to population aging.

2 Model Setting and Data

2.1 Model Setting

This paper uses Stata to establish a fixed effect model to empirically test the data to explore whether the aging of the population will have an impact on the level of education at different levels. After passing the Hausman test, the regression equation is set as follows:

$$Edu_{\alpha} = \beta_0 + \beta_1 Aging_{it} + \beta_2 control_{it} + \varepsilon_{it} \quad (1)$$

where i and t represent province and year, respectively, Edu_{α} represents the level of education, α presents basic education or higher education, $Aging_{it}$ is the aging population; $control_{it}$ for each control variable, ε_{it} is a random disturbance term.

2.2 Data Description

The data sample of this paper is composed of panel data of 31 provinces from 2007 to 2019, with a sample size of 403. The core explanatory variable is population aging, the explained variables are the level of higher education (edu_h) and the level of basic education (edu_p), and the other are control variables. The significance and source of the main variables are shown in Table 1, and descriptive statistics are shown in Table 2. The correlation analysis between aging and different levels of education is shown in Fig. 1 and Fig. 2

Table 1. Variable meanings and sources

Variable name	Variable meaning	Data sources
Higher education level (edu_h)	Average number of students in higher education institutions per 100,000 population to measure the level of regional higher education	<i>China Statistical Yearbook</i>
Primary education level (edu_p)	The ratio of the number of applicants for college entrance examination to the number of 18-year-old population reflects the educational situation of the school-age population	College entrance examination data published by provinces and cities over the years
Population aging (aging)	Old-age dependency ratio (ratio of elderly population to working-age population)	<i>China Statistical Yearbook</i>
Urban-rural ratio (urban)	Proportion of urban and rural population control education gap between urban and rural areas	<i>China Statistical Yearbook</i>
Rate of population growth (population)	Measuring the rate of population growth in China	<i>China Statistical Yearbook</i>
Education level of employed persons (labor)	Measuring parental education	<i>China Labor Statistics Yearbook</i>
Economic openness (openness)	Measuring the degree of national openness	<i>China Statistical Yearbook</i>
Children's dependency ratio (childtio)	Measuring parenting stress	<i>China Statistical Yearbook</i>
Per capita gdp (GDP)	Representing the level of regional economic development	<i>China Statistical Yearbook</i>
Number of universities per capita (school)	Measuring the per capita higher education resources in the region	<i>China Statistical Yearbook</i>
Family education investment (family)	Measuring the importance of family education for children	<i>China Family Panel Studies</i>

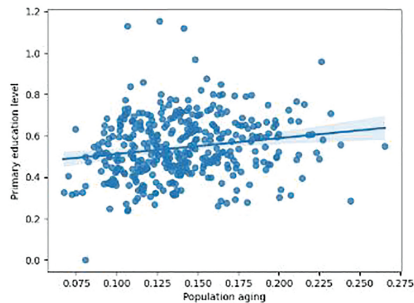
(continued)

Table 1. (continued)

Variable name	Variable meaning	Data sources
Public education investment (public)	Measuring the relationship between population aging and public education investment at the level of public expenditure	<i>China Statistical Yearbook</i>

Table 2. Variable statistical description

Variable	observation	Average	Standard deviation	Minimum	Maximum
<i>aging</i>	403	0.139	0.034	0.067	0.266
<i>edu_h</i>	403	0.250	0.089	0.097	0.675
<i>edu_p</i>	403	0.542	0.137	0.285	0.821
<i>urban</i>	403	0.161	0.161	0.027	0.862
<i>population</i>	403	0.054	0.028	-0.010	0.118
<i>labor</i>	403	9.501	1.329	4.144	13.900
<i>openness</i>	403	0.443	0.982	0.013	8.808
<i>child</i>	403	0.240	0.072	0.096	0.515
<i>GDP</i>	403	4.370	2.638	0.778	16.460
<i>infrastructure</i>	403	16.670	8.752	1.528	39.030
<i>family</i>	391	0.098	0.068	0.000	0.560
<i>public</i>	403	0.858	0.223	0.493	1.368
<i>school</i>	403	0.020	0.007	0.009	0.048

**Fig. 1.** The correlation analysis between aging and primary education level

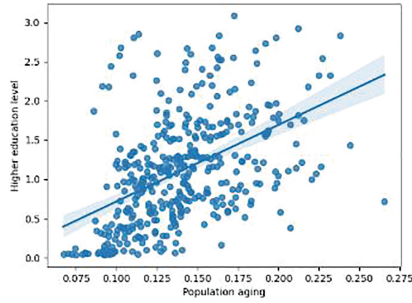


Fig. 2. The correlation analysis between aging and higher education level

3 Empirical Analysis

3.1 Regression Analysis

The empirical test of this paper aims to explore the correlation between population aging and different levels of education in China. The ordinary least squares model (OLS), individual fixed effect regression model (FE) and least squares dummy variable model (LSDV) are used to estimate the impact of population aging on higher education level and basic education level. As shown in Table 3. The results of the LSDV model show that the dummy variables of the provinces are significant, and it can be considered that there are obvious individual effects in each province. Under different models at the national level, population aging has a promoting effect on both higher education and basic education, and is significant at the level of 1%. For the impact of basic education level, the correlation coefficients of the elderly dependency ratio are 0.66 and 1.50, respectively, indicating that the correlation coefficient obtained after controlling the regional effect is doubled, indicating that the positive effect of population aging on basic education level is enhanced after the confounding factors are controlled. This shows that population aging is beneficial to the development of basic education and can promote the improvement of basic national quality. The resulting trend of low birth rate and prolonged life expectancy may make families and governments pay more attention to the development of education, extending from the beginning of education and laying a solid foundation for improving the quality of the whole nation.

As far as the level of higher education is concerned, population aging has a significant promoting effect on its development level. After controlling the regional effect, the promoting effect is further enhanced when the regression coefficient rises from 0.26 to 0.49. This conclusion reveals that the current stage of population aging not only has no crowding-out effect on higher education, but also plays a role in promoting its level of development, contrary to common perception. This paper argues that under the background of great pressure brought by getting old before getting rich', China vigorously develops education in order to increase the output of high-quality specialized talents, promote economic growth, weaken the negative impact of population structure change on education development, and finally the level of higher education has a positive net effect. Other control variables, such as the educational level of employees (labor_edu) and the level of higher education, show a positive correlation at the level of 5%, and the

Table 3. Regression results

Variable	Primary education level			Higher education level		
	OLS	FE	LSDV	OLS	FE	LSDV
<i>aging</i>	0.66*** (2.90)	1.50*** (3.96)	1.50*** (5.15)	0.26*** (3.01)	0.49*** (3.32)	0.49*** (6.21)
<i>urban</i>	0.08* (1.72)	0.71* (1.94)	0.71*** (3.26)	0.21*** (4.83)	0.02 (0.13)	0.02 (0.34)
<i>population</i>	0.68* (1.78)	-1.17 (-1.47)	-1.17** (-2.28)	-0.38*** (-2.84)	0.14 (0.82)	0.14 (1.05)
<i>labor</i>	0.03*** (3.50)	-0.02 (-1.35)	-0.02** (-2.22)	0.02*** (6.43)	0.01** (2.17)	0.01*** (4.55)
<i>child</i>	-0.44** (-2.55)	-0.99*** (-3.98)	-0.99*** (-5.14)	-0.19*** (-3.10)	-0.34*** (-3.50)	-0.34*** (-7.01)
<i>family</i>	0.16* (1.83)	0.08 (1.26)	0.08 (1.22)			
<i>openness</i>				0.00 (0.53)	-0.01 (-1.02)	-0.01*** (-3.09)
<i>public</i>				0.02* (1.76)	-0.01 (-0.69)	-0.01 (-0.66)
<i>constant</i>	0.17* (1.65)	0.72*** (4.82)	0.58*** (4.62)	0.04 (1.35)	0.17*** (3.06)	0.41*** (10.47)
<i>Observations</i>	391	391	391	403	403	403
<i>District effects</i>	NO	YES	NO	NO	YES	NO
<i>Adj-R2</i>	0.244	0.165	0.625	0.682	0.386	0.937
<i>F</i>	32.82	7.173	19.02	66.70	9.280	161.6

Note: 1. The standard error based on heteroscedastic robustness standard error method is estimated in brackets. 2. *, **, *** represent the regression coefficients are significant at the level of 10%, 5% and 1% respectively.

coefficient of child dependency ratio(*child_tio*) is negative at the level of 1%, indicating that the improvement of educational level per capita can promote the development of higher education, while the pressure of raising children will crowd out their children's access to higher education, which is consistent with existing research and theoretical expectations. At the same time, compared with the regression results of higher education and basic education, the marginal impact of population aging on the level of basic education is greater than the marginal impact on the level of higher education, reflecting that the aging trend has a stronger role in promoting the protection of national basic education.

Table 4. Robustness test results

Variable	Changing variable		2SLS	
	Primary education level	Higher education level	Primary education level	Higher education level
<i>aging_lag</i>	1.96*** (3.85)	0.38** (2.45)	0.01* (1.96)	0.01*** (5.22)
<i>constant</i>	0.47***	0.13**		
<i>Control variable</i>	YES	YES	YES	YES
<i>Observations</i>	391	403	391	403
<i>Adj-R2</i>	0.166	0.342	0.232	0.683
<i>F</i>	8.10	8.30	8.44	31.95

Note: 1. The standard error based on heteroscedastic robustness standard error method is estimated in brackets. 2. *, **, ***represent the regression coefficients are significant at the level of 10%, 5% and 1%respectively.

3.2 Robustness Test

In order to verify the universality of the conclusion and the endogenous problems such as control model setting bias, this paper conducts a robustness test on the conclusion by replacing the core explanatory variables and replacing the model.

Robustness test1: In this paper, the proportion of 65-year-old population in the total population (*aging_*) is selected to replace the old-age dependency ratio to characterize the aging population. The explained variables and control variables remain unchanged, and regression analysis is performed. The results are shown in Table 4. It can be seen that population aging has a positive effect on the level of basic education and higher education, which is significant at the level of 1%and 5%respectively, which is consistent with the previous results, and there is no significant difference in the coefficient size. The robustness of the results is verified.

Robustness test2: In order to control the possible endogeneity problems in the model, this paper uses the two stage least square (2SLS) method to identify the model. This paper selects the reference D Acemoglu [10] approach, and selects old-age dependency ratio lagging five periods as the instrumental variable of the model Estimate the model. The chi-square statistic P value of the calculation result is less than 0.01, and it can be considered that there is no weak instrumental variable. As shown in Table 4, it proves that population aging still has a promoting effect on both basic education and higher education, and satisfies the statistical significance judgment, which guarantees the accuracy of the original model setting and the robustness of the conclusion.

4 Conclusion

This paper studies the impact of population aging on the level of basic education and higher education by using Stata software to establish fixed effect model, dummy variable OLS regression model and two-stage least squares method. The study found that China

's population aging has a positive impact on the level of basic education and higher education, the marginal impact on the level of basic education is significantly greater than the marginal impact on the level of higher education.

At present, China is in an important period of demographic transformation and economic model transformation. As a necessary process of cultivating talents, education is of great significance to explore its development level from the perspective of investment and distribution of educational resources. It can provide a reference for taking effective measures to rationalize the allocation of education investment before the overall aging. At the same time, based on the different product attributes of basic education and higher education, the different influence of aging degree also provides a theoretical basis for the choice of government allocation of educational resources. Reduce the negative impact of population aging on education development and talent training in China.

Based on the above analysis, this paper puts forward policy recommendations from two aspects: First, adhere to education equity, according to the different levels of education needs and status, to achieve the rational allocation of educational resources, to ensure the continuity of education in order to fully implement the high-quality development of education; second, improve the social pension system, reduce the burden of social pension and personal pension pressure, while extending the retirement age. Excavate the dividends of longevity.

There are still shortcomings in this paper, which need further study. In this paper, only provincial macro data are used for regression analysis, and individual data such as individual education willingness and education motivation are not well reflected. In the future, micro sampling data can be used for empirical test to improve the accuracy and scientificity of experimental results.

Acknowledgment. The authors gratefully acknowledge the financial supports by The National Social Science Fund Planning Project 'Research on the Mechanism and Path of Low Birth Rate Aging and Sustainable Development' numbers 19BRK020.

References

1. Maxime Fougère, Marcel Mérette. Population ageing and economic growth in seven OECD countries [J]. *Economic Modelling*, 1999.
2. Zhao Chunyan, Lyu Zhaohe, Li Fan. Bilateral effects of population aging on human capital accumulation: estimates based on a bilateral stochastic frontier model[J]. *Population and development*. 2021, (4):37–50.
3. Liu Yongping, Lu Ming. Can the Aging Chinese Economy Continue to Grow from the Perspective of Family Support[J]. *World Economy*. 2008, (1):65-77.
4. Feenberg D R, Poterba J M. The Income and Tax Share of Very High Income Households, 1960–1995[J]. *Nber Working Papers*, 2000.
5. Brsch-Supan A H, Winter J K. Population Aging, Savings Behavior and Capital Markets[J]. *Social Science Electronic Publishing*, 2001.
6. Qiu Muyuan, Wang Tianyu, Liang Run. Delayed retirement, human capital investment and pension financial balance [J]. *Economic research*. 2020, (9):122–137.

7. Wang Yunduo. Prediction of the impact of population aging on labor supply, human capital and output [J]. *Population and economy*. 2014, (3):69–75.
8. Guo Xibao, Li Tongping, Yuan Bei. Persistent effects of population aging on Chinese economy and its countermeasures [J]. *Economic theory and management*. 2013, (2):43–50.
9. Wang Yunduo. Population aging, public expenditure bias and human capital growth[J]. *Journal of Social Sciences of Hunan Normal University*. 2019, (5):79–86.
10. Acemoglu D, Restrepo P. Demographics and Automation[J]. Pascual Restrepo, 2018.

Open Access This chapter is licensed under the terms of the Creative Commons Attribution-NonCommercial 4.0 International License (<http://creativecommons.org/licenses/by-nc/4.0/>), which permits any noncommercial use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license and indicate if changes were made.

The images or other third party material in this chapter are included in the chapter's Creative Commons license, unless indicated otherwise in a credit line to the material. If material is not included in the chapter's Creative Commons license and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder.

