

# Study on the Impact of Population Aging on Regional Economic Growth: A Case Study of Beijing-Tianjin-Hebei

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**Abstract.** The impact of population aging on regional economic growth is an important issue to improve the quality of economic development and avoid economic risks. A case study of Beijing-Tianjin-Hebei region shows that there is a large proportion of the elderly population in Beijing-Tianjin-Hebei region and a large regional disparity in population aging. Through the establishment of a double-panel variable coefficient fixed effect model and panel co-integration test, it is found that there is a long-term and stable equilibrium relationship between population aging and regional economic growth. Whether or not there is a time effect, the aging of the population has a positive effect on the economic growth of Beijing and Tianjin, and has a negative impact on the economic growth of Hebei Province.

**Keywords:** Beijing-Tianjin-Hebei; population aging; regional economic; fixed effect model.

## 1. Introduction

Population aging is a major realistic problem facing mankind in the 21st century. It is related to the overall situation of economic and social development and involves many aspects of social economy, family life and personal life cycle. China has entered an aging population society in 2000. The problem of population aging has begun to emerge and will have a significant impact on China's on economic and social development. Beijing-Tianjin-Hebei region includes two municipalities directly under the Central Government of Beijing and Tianjin, as well as 11 prefecture-level cities of Shijiazhuang, Baoding, Langfang, Tangshan, Chengde, Cangzhou, Hengshui, Zhangjiakou, Qinhuangdao, Xingtai and Handan in Hebei Province. The level of population aging in Beijing, Tianjin and Hebei is higher than that in most provinces of China, and the problem of population aging is becoming increasingly prominent. Based on the example of Beijing-Tianjin-Hebei, the study of how population aging affects regional economic growth has become a "proactive" strategy to improve the quality and level of economic development in Beijing-Tianjin-Hebei and to avoid long-term economic development risks.

## 2. Summary of Research

The impact of population aging on economic growth is extensive and far-reaching. From the effect of population aging on economic growth, scholars at home and abroad hold different views, which can be attributed to the positive, negative and positive effects of population aging on economic growth.

On the one hand, the increasing effect of population aging on per capita output is greater than the decreasing effect of per capita output caused by the decrease of birth population, indicating that over time, aging will promote economic growth[1]. The increase of government and residents' health expenditure caused by aging will play a significant positive role in economic growth by increasing the total consumption[2]. Aging will help to increase human capital investment, improve the quality of labor force, and promote the formation and development of the elderly market[3]. On the other hand, China has the existing situation of "getting old before getting rich", which will hinder its economic development[4]. Aging society will hinder economic growth through the decline of working age population and savings rate[5]. Aging will lead to the decline of labor participation rate in the future and have a negative impact on economic growth[6].

In addition, based on the extended Solow model, we find that aging has a dual effect on China's economy, and the two effects are different in magnitude. Aging will increase its negative impact on

the economy[7].Some scholars believe that aging will have a moderate negative impact on the macro-economy,and at the same time,it will also have a positive impact [8].

To sum up,the research on population aging covers all aspects of economic growth and is more comprehensive.Generally speaking,there are few empirical studies on the impact of population aging and economic growth in the existing literature,and relatively few studies on the medium-level of a certain region.At the same time,the establishment of economic growth model is relatively single.Therefore,this paper summarizes the shortcomings of existing literature,studies the impact of population aging on regional economy in Beijing-Tianjin-Hebei region, chooses the main indicators of population aging and economic growth,considers the impact of time effect on economic growth,and tries to measure the impact of population aging on economic growth scientifically and accurately,so as to promote the coordinated and high-quality development of Beijing-Tianjin-Hebei economy.

### 3. The Impact of Population Aging on Regional Economic Growth in Beijing-Tianjin-Hebei

Based on the population aging and economic data from 2002 to 2016,this paper analyzed the impact of population aging on regional economic growth in Beijing-Tianjin-Hebei.

#### 3.1 Data Selection and Model Construction

In order to reflect the level of population aging more truly and comprehensively,the proportion of the elderly population in Beijing- Tianjin-Hebei is selected to measure the level of population aging,and GDP per capita is selected as the index to measure the economic growth of Beijing,Tianjin and Hebei.On this basis,fixed assets investment is added as the control variable.In order to make the model more scientific and effective to measure the impact of population aging on economic growth, two models including time effect and non-time effect were established to explore.The econometric models are as follows:

$$\text{Model 1: } PGDP_{it} = \alpha + \beta_1 PEP_{it} + \beta_2 IFA_{it} + \delta_i + \varepsilon_{it} (i=1,2,3; t=1,2,3\cdots 15)$$

$$\begin{aligned} \text{Model 2: } PGDP_{it} = & \alpha + \beta_1 PEP_{it} + \beta_2 IFA_{it} + \beta_3 D_{2002-2006} + \beta_4 D_{2007-2011} \\ & + \beta_5 D_{2012-2016} + \delta_i + \varepsilon_{it} (i=1,2,3; t=1,2,3\cdots 15) \end{aligned}$$

PGDP is the explanatory variable, PEP is the proportion of the elderly population, IFA is the explanatory variable, IFA is the fixed assets investment,  $D_{2002-2006}$ ,  $D_{2007-2011}$  and  $D_{2012-2016}$  are the time fictitious variables,setting 2002-2006 to 1 and the rest to 0.Similarly,set 2007-2011 and 2012-2016, Alpha is a constant term or intercept term, $\delta_i$  is the fixed effect of the some province, and  $\varepsilon_{it}$  is the random perturbation term on cross section I and time t. The panel data of Beijing, Tianjin and Hebei are used in the study. The data mainly come from the National Statistical Bureau and (China Statistical Yearbook), and refer to (Tianjin Data 2016).

#### 3.2 Testing of Model

Because there may be false regression in time series,unit root test is needed for each variable before panel data analysis,and unit root test for model 1 will be carried out.In order to improve the reliability of the test, LLC test and Fisher test will be used to verify the stationarity of the data.The unit root test results of model panel data are shown in Table 1.

Table 1. Unit Root Test Results of Variables in Model

	variable Statistic	LLC test	Fisher ADF test	stable
Unit root test results of original value	LNPEP	-0.02042	7.43788	no
	LNP GDP	1.21946	0.56913	no
	LNIFA	1.94789	0.43603	no
The result of the first order difference unit root test	$\Delta$ LNPEP	- 5.17141***	21.8055***	yes
	$\Delta$ LNP GDP	- 4.95199***	20.5323***	yes
	$\Delta$ LNIFA	- 3.26479***	20.4741***	yes

Note: \*\*\* denies the original assumption of unit root at 1% significance level.

The results of Table 1 show that the original assumption with unit root is rejected after the first-order difference of each variable is 1% significant level, that is, the variables LNPEP, LNP GDP and LNIFA are stationary series, which shows that pseudo-regression can be effectively avoided in the following panel data model. The first-order difference terms of variables in the model are stationary series, so the cointegration test can be carried out. Table 2 shows the results of panel co-integration Pedroni test. There are differences in the test results. Because group ADF, panel ADF and group PP test are effective, and the three statistics reject the original hypothesis that there is no co-integration relationship at the level of 1% significance, it can be concluded that there is co-integration relationship among variables, namely, per capita GDP, the proportion of the elderly population and fixed assets investment. The long-term equilibrium relationship can be estimated by panel model.

Table 2. Pedroni cointegration test results for panel data

Statistic	Constant term	Constant term and trend term
Panel V	0.681212	-0.629258
Panel rho	0.415139	1.606545
Panel pp	-1.571876*	-0.237578
Panel ADF	-4.490539***	-3.591159***
Group rho	1.095420	2.259955
Group pp	-3.311396***	-1.018100
Group ADF	-5.815966***	-3.795192***

Note: \* \* and \*\*\* respectively deny the original hypothesis without co-integration at the level of 10% and 1% significance.

Before constructing the panel equation, it is necessary to identify whether the mixed cross-section model, the variable intercept model or the variable coefficient model are selected, and to verify whether the model set above is reasonable. The research decides which model to choose by constructing F statistic, which is tested by constructing F1 Statistic and F2 statistic. The calculated values of F1 Statistic and F2 statistic are 1070.6 and 42.5 respectively, which are larger than their corresponding critical values. Therefore, the mixed cross section model and the variable intercept model are rejected. The variable coefficient model is adopted, and the time effect is taken into account in model 2 on the basis of model 1. The time dummy variable is added, and the fixed effect model with variable coefficients is still adopted.

### 3.3 Panel Empirical Results and Explanations

The estimated results of panel data are shown in Table 3. The goodness of fit of model 1 and model 2 is higher, and model 2 has better goodness of fit, and the F statistics of the two models are 926.1629 and 480.1394, respectively, which have passed the 1% significance level test, and the model as a whole is remarkable. From model 1, population aging has a positive effect on the economic growth of Beijing and Tianjin, and the positive impact of population aging on Beijing is greater than that of Tianjin. The proportion of the elderly population increases by 0.01, its contribution to Beijing's economic growth is 0.25, and its contribution to Tianjin's economic growth is 0.15. The corresponding regression coefficient test is not significant. The population aging in Hebei has a negative effect on economic growth, reflecting the elasticity of -0.33. The regression coefficient is not statistically significant, indicating that the population aging has a negative impact on the economy of Hebei.

The empirical results show that the current population aging has a positive impact on Beijing and Tianjin. In the short term, the aging population will not have a negative impact on the supply of Beijing-Tianjin labor force. Beijing and Tianjin have always been important places for population migration in China. Although the registered population of Beijing has declined in recent years, the huge siphon effect produced by the abundant public resources such as education and medical treatment has caused a large number of young people to enter Beijing and Tianjin to work and live. The deepening of the reform of the household registration system has also increased the high-quality human resources in Beijing and Tianjin to meet the needs of enterprises for labor, which keeps the vitality of human capital needed by the city. At the same time, the quality of the elderly population in Beijing and Tianjin is generally high. Although the elderly have reached retirement age, their get mature experience and excellent technology may still be employed by the government or enterprises in the form of expert consultants, so as to give full play to the "waste heat" of the elderly with high knowledge and skills, carry out their old achievements, meet the needs of the society for high-end talents, and make them continue to serve the economic and social development. Aging will promote Beijing-Tianjin economy to "change its mode, adjust its structure", promote capital economic development, and contribute to social progress and cultural prosperity.

Population aging has a negative impact on Hebei Province. Due to the lack of abundant resources such as education and medical treatment, a large number of young laborers in Hebei Province are pouring into big cities such as Beijing and Tianjin, which makes the brain drain in Hebei Province, coupled with the aging of population structure, easily leads to structural unemployment, causes the problem of "difficult recruitment" in Hebei enterprises and hinders economic growth; Hebei has a large elderly population, and the rural aging is serious. According to the life cycle theory, the elderly are from When people quit their jobs, their incomes are low or even no income, which leads to a decrease in savings and consumption, which is not conducive to expanding domestic demand and affecting the improvement of people's income level. The physical fitness of the elderly and their ability to receive new knowledge and skills are lower than those of the young people. Aging has reduced the labor participation rate and per capita output in Hebei Province. The empirical results also show that the degree of population aging in Hebei is not in harmony with economic development, and economic growth lags behind the development of population aging.

Table 3. Panel Estimation of Regional Economic Growth from Population Ageing in Beijing-Tianjin-Hebei

Explanatory variable	parameter estimation	
	Model 1	Model 2
BJ-LNPEP	0.249363	0.410149
TJ-LNPEP	0.146138	0.186377
HB-LNPEP	-0.325932	-0.300939
BJ-LNIFA	0.903816***	0.806893***
TJ-LNIFA	0.583648***	0.591439***
HB-LNIFA	0.595509***	0.586889***
BJ-D <sub>2002-2006</sub>		-0.134016
TJ-D <sub>2002-2006</sub>		0.021512
HB-D <sub>2002-2006</sub>		-0.013587
BJ-D <sub>2007-2011</sub>		-0.029423
TJ-D <sub>2007-2011</sub>		0.029184
HB-D <sub>2007-2011</sub>		0.003696
	Model fitting effect	
R <sup>2</sup>	0.9952	0.9956
F Statistic	926.1629(P=0.0000)	480.1394(P=0.0000)

Note: \*\*\* Indicates a significant level of 1%.

Model 2 adds time effect to model 1. The results show that the aging population in Beijing and Tianjin still has a positive effect on economic growth, and the contribution of aging to economic growth is improved on the basis of model 1. The population aging in Hebei Province still has a negative impact on economic growth, but the negative effect has been reduced. The regression coefficient is - 0.3, which is not statistically significant. The aging population has promoted the economic growth of Beijing and Tianjin through labor force, savings, consumption and so on, and the driving force is more obvious. Since 2002, the elderly population in Beijing, Tianjin and Hebei has increased year by year. The high price of house prices and living costs in Beijing and Tianjin are significantly higher than those in Hebei, which makes many elderly people transfer to Chengde, Qinhuangdao and other cities with better environment and lower cost to provide for the aged, and promotes the development of the local pension industry. To some extent, it offsets the negative impact of population aging on the economy.

The time dummy variable shows different contribution to the per capita GDP of Beijing, Tianjin and Hebei provinces in the model. Before 2006, fictitious variables had weak negative effects on Beijing and Hebei. After 2006, the negative effects of fictitious variables on Beijing were further mitigated, and they had positive effects on Tianjin and Hebei. Controlled variable investment in fixed assets shows a significant positive impact on the per capita GDP of Beijing, Tianjin and Hebei in both models. Increasing investment in fixed assets, such as infrastructure, is bound to help stimulate economic growth.

#### 4. Conclusion

The present situation of population aging in Beijing, Tianjin and Hebei is described and analyzed. It is found that there are correlations and heterogeneities in the aging process in Beijing-Tianjin-Hebei. The proportion of the elderly population in Beijing-Tianjin-Hebei is higher than that in most parts of the country. The proportion of the elderly population is significant, and there are big differences among the aging cities. By building a fixed effect model with double panel variable coefficients and panel co-integration test, it is found that there is a long-term stable equilibrium relationship between population aging and regional economic growth in Beijing-Tianjin-

Hebei. Whether or not there is a time effect, Population aging has a positive impact on economic growth in Beijing and Tianjin, and has a negative impact on economic growth in Hebei Province.

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