Demographic Structure and Economic Growth

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Keywords: Demographic Structure, Economic Growth, China;

Abstract: In this paper, I analysed the relationship between demographic structure and economic growth with several potential influential factors based on the Solow model and Cobb-Douglas function, I assume that the Population Burden Coefficient, the quantity of Labour and Summation of Population Growth and Depreciation Will influence Gross Domestic Product (GDP) in China, to prove that, I analysed the 17 years' panel data of 31 provinces in China. my result shows that Population Burden Coefficient and Summation of Population Growth and Depreciation influence economic growth negatively, and quantity of labour influences economic growth positively, Population Burden Coefficient influences economic growth significantly.

1. Introduction

After the economic reform, China has been focusing on the economic growth for 40 years, and China has made a great achievement on that. At the same time, China also faces the population pressure and large population leads to the birth control policy 40 years ago, and it is also in the constitution of the people's republic of China. It is indeed effective and decreases the fertility rate immediately, but it also changed the aging structure of the Chinese population. the consequence is that the population of the younger generation is less than the expected amount, and the burden on young people is heavier, which might influence the economic growth. Base on this situation, my research focus on the relationship between economic growth and aging structure in last 17 year, this period reflects the current relationship between population and economic growth under the fluence of general consequence of the birth control policy.

2. Literature Review

In 2018, Maja Bengtsson studied Age Structure and Economic Growth of Sri Lanka, and the aging structure, Sri Lanka faces aging situation, the elders are increasing, and he concluded that the prime working labor group has a positive significant influence on economic growth. In 2016, Qi Song studied how the changing economic effects influence the age structure, the growth of population will improve economic growth, but the problem that aging issue has influence economic growth positively or negatively is still unknown. He considers a lot of factors including economic growth effect, labor supply effect, consumption and saving effect, social security effect concluded that the lower dependency ratio, sufficient labor supply do have a positive influence on economic growth, especially dependence ratio, contribution of dependence ratio is 26% on the total economic growth. In 2012, Klaus Prettner, David Canning studied the influence of growing life expectancy on retirement optimization. They analysed optimal retirement decisions with lifetime, saving behavior, and technology growth, concluded that consumption of capital to consumption decrease the longevity and increase technology growth. In 2009, Brunow Stephan and Hirte Georg studied how Regional age structure and economic growth influence each other in German regions with the Solow model and the neoclassical growth model, and conclude that Population Growth and

Depreciation in the Solow model influence demographic the structure does influence economic growth. In 2007, Alexia Prskawetz, Thomas Fent, Werner Barthel studied how Demographic Change influences Economic Growth in the European Union, and conclude that demographic factors matter for economic growth, dependent variables represent demographic structure.

3.Research Design

3.1 methodology

Analytical methods are quantitative analysis, data description, chart analysis, and empirical analysis. In the process of empirical analysis, the data is processed by the approach of panel data analysis.

In statistics and econometrics, panel data is the multi-dimensional data involving measurements over time. Panel data contains observations of multiple phenomena obtained over multiple time periods for the same firms or individuals. Time-series and cross-sectional data can be thought of as special cases of panel data that are in one dimension only (one-panel member or individual for the former, one-time point for the latter). I use the 17 years data from 31 provinces to estimate the relation between demographic structure and Chinese economic growth.

There are also some tests to examine the model fitness. the Panel Data Regressions are based on LS-methods, T-test and F test to examine the significance and overall significance. And use the Durbin-Watson test and studentized Breusch-Pagan test to test the series correlation. After that, I use the F test for individual effects, Hausman Test and Lagrange Multiplier Test to select the most accurate model to fit it accurately.

3.2 Theoretical Framework

The main theories of my research are Cobb-Douglas production function and Solow model. the Cobb-Douglas production function is as follows

$$Y=AL^{\alpha}K^{\beta} \tag{1}$$

A is the total factor production, L is the labor, K is the capital accumulation, α and β are the output elasticities of capital and output elasticities of labor. According to this function, it separates the capital, labor, and other factors that might influence the total output.

In the stationary status of the Solow model, the average capital per person and average out per person maintain at a certain level. but Solow model set total factor effective as a fixed parameter. And the elders usually have low income, which might lead to the low saving rate, high mortality rate, and low fertility rate, these trends will shift the saving curve down and move the stationary point to the lower level. In China, it might have the aging population situation and low fertility will change the aging structure, the current young generation will have more burden, so based on this current the situation, my research will find relation between Demographic Structure and Economic Growth with the several indicators that might fluence the current economic growth, and also how significantly it will influence economic growth and demography.

So, I will make a further separation for Cobb-Douglas production function model. Dependent variables represent demographic structure.

$$Y=A(P\times a\times 1/(1+1/b))\alpha \tag{2}$$

The The a represents that the proportion of the total amount of population that is in the proper age to the product, usually it is people who are between 15- 64 years old. b is the Population Burden Coefficient, which the proportion of no-working people to the working population, b is different with the dependency ratio in the demographic science, which is more accurate than the dependency ratio, the dependency ratio divides the population by age.

Based on the formula above, there are several factors that might influence economic growth

significantly.

Product (GDP) mainly including the following factors: labor, Population Burden Coefficient and summation of population growth and depreciation and research empirically estimates the relationship between the factors above and Gross Domestic Product (GDP) by constructing an econometric model.

$$Log(Y)=\beta_0+\beta_1 X_2+\beta_2 log(X_3)+\beta_4+\mu \tag{3}$$

The model contains 6 parts. The model contains 3 variables and 1 dependent variable, Gross Domestic Product (GDP) is the explanatory variable Y, Population Burden Coefficient is explanatory variable X_1, labor is the explanatory variable X_2, summation of population growth and depreciation is the explanatory variable X_3, stochastic error term is μ. β_0、 β_1、 β_2、 β_3 are undetermined coefficient. u is stochastic error term.

Based on the current research, the factors that can affect Gross Domestic

If the Population Burden Coefficient increase, the public will cost more resource for the elders, which usually decreases the Gross Domestic Product (GDP).
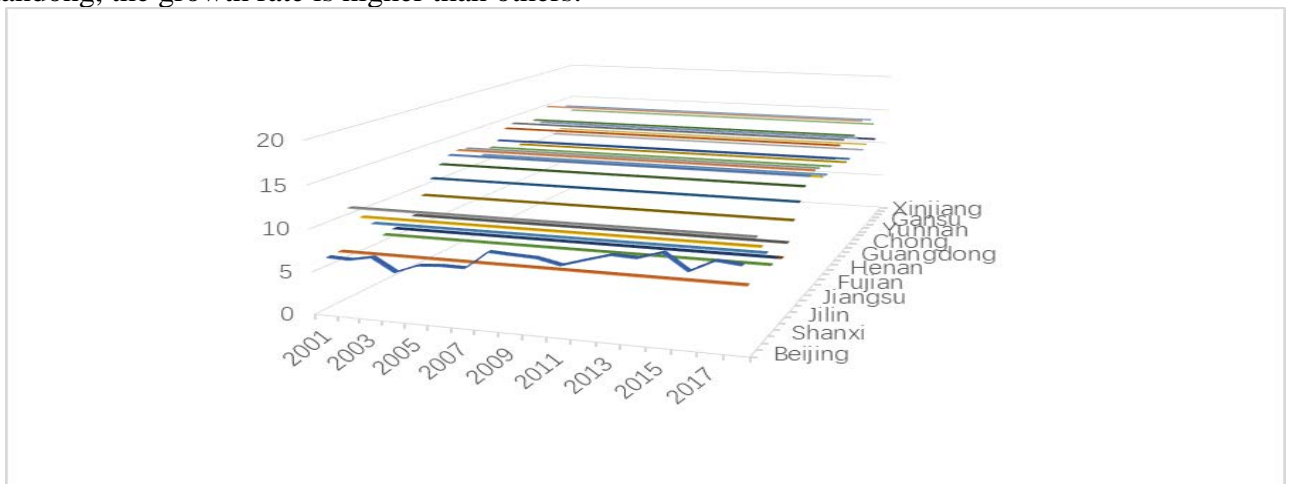
If the summation of population growth and depreciation increase, it will accelerate the depreciation of current capital, it also influences the stationary point in the Solow model, it also will influence the GDP.
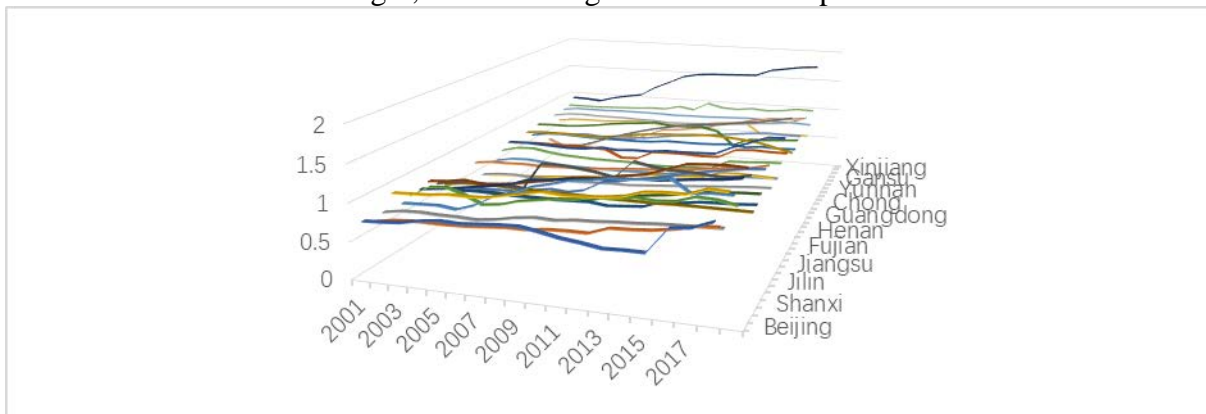
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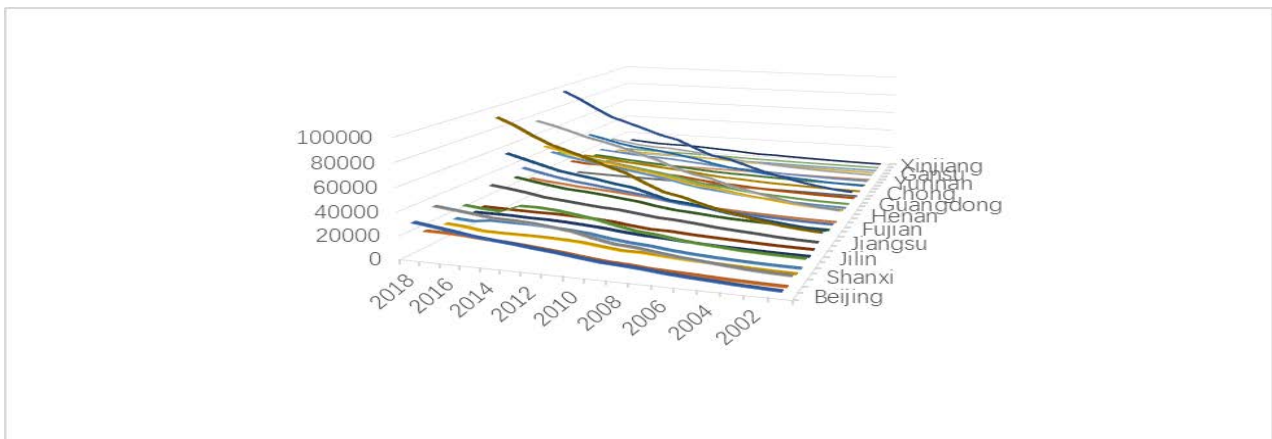
Figure 1. GDP (billion yuan)

The graph above summarizes the data of GDP (billion yuan) in 31 provinces, as you can see here, all lines show the increasing trend, and there several provinces like Guangdong, Jiangsu, and Shandong, the growth rate is higher than others.
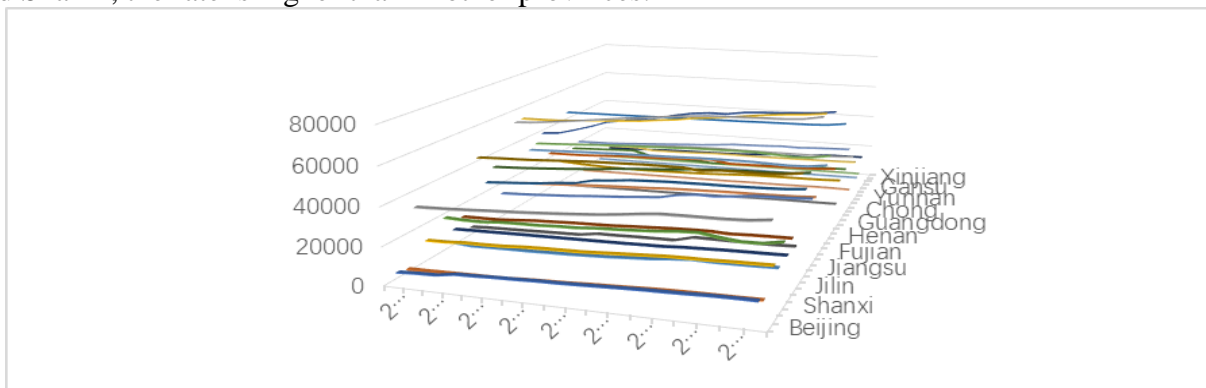

Figure 2. Summation of Population Growth and Depreciation (%)

And the graph above summarizes the data of Summation of Population Growth and Depreciation (%) in 31 provinces, as you can see here, all lines show the growing trend, and there are several provinces like Henan and Guangxi, the rate is higher than in other provinces.

Figure 3. Population Burden Coefficient

And the graph above summarizes the data of the Population Burden Coefficient in 31 provinces, as you can see here, all lines show the growing trend, and there are several provinces like Beijing and Shanxi, the rate is higher than in other provinces.

Figure 4. Population Burden Coefficient

The graph above summarizes the data of labor (thousand) in 31 provinces, as you can see here, all lines show the increasing trend, and there several provinces like Henan and Shandong, the quantities of 2 provinces are higher than others.

5 Model Estimation

5.1 Model Specification

Use 3 kinds of panel models, the Fixed Effect, Random Effect, and Pooling model, the variables are as follows

Y-- Gross Domestic Product (GDP)

X_1 -- Population Burden Coefficient

X_2 -- Labor

X_3 -- Summation of Population Growth and Depreciation

Based on the R analysis, the Fixed Effect panel data model is as follow

GDP intercept Population Burden Coefficient Labor   (N+D)

Model: $\log(Y) = \beta_0 - 0.143X_1 + 4.475\log(X_2) - 0.106X_3 + \mu$ （4）

Standard Deviation   depends   0.32   0.37   0.08

β0 depends because it has individual intercepts for each province. The individual intercepts are in the appendix.

Based on the R analysis, the Random Effect panel data model is as follow

GDP   intercept Population Burden Coefficient Labor   (N+D)

Model: $\log(Y) = 6.107 - 2.59X_1 + 0.90\log(X_2) - 0.16X_3 + \mu$ (4)

Standard Deviation   0.86   0.32   0.37   0.08

Based on the R analysis, the Pooling panel data model is as follow

GDP   intercept Population Burden Coefficient Labor   (N+D)   (5)

Model: $\log(Y) = 5.80 - 1.49X_1 + 0.82\log(X_2) - 0.16X_3 + \mu$

Standard Deviation   0.41   0.32   0.37   0.08

5.2 Model significance

Table 1. Test for significance of Fixed Effect panel data model

β	Estimate	T-Value	Significance
$\beta 0$ (Intercept)	depends	depends	
$\beta 1$ (LBC)	-0.143388	-0.4459	no
$\beta 2$ (Labor)	4.475488	11.8128	yes
$\beta 3$ (n+g)	-0.106908	-1.2086	no

Table 2. Individual intercepts of FE model.

1	2	3	4	5	6	7
-20.375	-19.4941	-25.9303	-23.1628	-21.8202	-24.2271	-22.5151
8	9	10	11	12	13	14
-23.879	-20.6683	-26.352	-25.1328	-26.4564	-23.5334	-24.3853
15	16	17	18	19	20	21
-27.264	-27.8556	-25.886	-26.1538	-26.4513	-24.9472	-18.0938
22	23	24	25	26	27	28
-22.914	-27.1117	-24.0293	-25.0702	-15.2663	-23.8375	-23.3262
29	30	31				
-17.015	-17.2013	-20.7827				

Table 3. Test for significance of Random Effect panel data model

β	Estimate	T-Value	Significance
$\beta 0$ (Intercept)	6.10	7.0581	Yes
$\beta 1$ (LBC)	-2.59	-15.3750	Yes
$\beta 2$ (Labor)	0.90	10.1225	Yes
$\beta 3$ (n+g)	-0.16	-5.7104	Yes

Table 4. Test for significance of Pooling panel data model

β	Estimate	T-Value	Significance
$\beta 0$ (Intercept)	5.80	14.090	Yes
$\beta 1$ (LBC)	-1.49	-10.309	Yes
$\beta 2$ (Labor)	0.82	22.709	Yes
$\beta 3$ (n+g)	-0.16	-13.506	Yes

Test for overall significance of the Fixed Effect data model, P-value is smaller than 2.2×10^{-16}, based on the outcome, it is overall significant.

Test for overall significance of the Random Effect panel data model, P-value is smaller than 2.2×10^{-16}, based on the outcome, it is overall significant.

Test for overall significance of the Pooling panel data model, P-value is smaller than 2.2×10^{-16}, based on the outcome, it is overall significant.

5.3 Model Heteroscedasticity Test

Use the studentized Breusch-Pagan test to test the Fixed Effect model, Random Effectmodel, and pooling model, all 3 models' p-value = 0.003023, which means the model does not contain the series correlation.

5.4 Model Selection

Conduct 3 types of tests to select the best model the fitting model perfectly, F- test, Lagrange Multiplier Test.

Firstly, Use the F- test to compare the Fixed Effect model and Pooling model. the p-value is smaller than $2.2\times 10\text{-}16$, reject the Null hypnosis, the Fixed Effect fits the model more accurately.

To test the series correlation, use the studentized Breusch-Pagan test.

At last, Use the Lagrange Multiplier Test to compare the Random Effect model and Pooling model, the p-value is smaller than $2.2\times 10\text{-}16$, reject the Null hypnosis, the Random Effect model fits the model more accurately.

The based on the 5th chapter, set the accurate model.

GDP intercept Population Burden Coefficient Labor   (N+D)

$$\text{Model:} \qquad \log(Y) = 6.107 \quad - 2.59X_1 + 0.90\log(X_2) - 0.16X_3 + \mu \tag{6}$$

Standard Deviation   0.86   0.32   0.37   0.08

6 Conclusion

The based on the 5th chapter, I have set the accurate model.

GDP   intercept Population Burden Coefficient Labor (N+D)

$$\text{Model:} \qquad \log(Y) = 6.107 \quad - 2.59X_1 + 0.90\log(X_2) - 0.16X_3 + \mu \tag{6}$$

Standard Deviation   0.86   0.32   0.37   0.08

Based on the specification, it may conclude that, at a certain level, if the quantity of labor increases by 1%, the GDP increases by 0.9%. If the Population Burden Coefficient increases 0.1, the GDP decreases by 0.259%. If the summation of population growth and depreciation increased by 1%, the GDP increases by 0.08%.

May conclude that the quantity of labor influences economic growth significantly, and the summation of population growth influences the economic growth slightly.

As mentioned above, China is facing the aging problem, although the government change the rule of birth control policy recently, the birth the limitation is improved from 1 child to 2 children, but still, the problem is severe, because the elders are more and more because of the medication and social the security system is improved compared with the situation at 30 years ago.

Thus, if the Chinese government try to maintain the economic growth, the priority is Population Burden Coefficient, the direct measures are to improve the fertility ratio and employment rate, and also, the government could improve the Total Factor Product, like improve the budget of research and development, change the structure of industries.

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