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The impact of population structure change on economic growth in Shanxi Province

Duan Bujing

School of Economics and Management, Guangxi Normal University, Guilin, China

Abstract: *The problem of population structure is related to the speed and efficiency of economic growth and affects the sustainable and healthy development of economic society. This paper selects the data of 31 years from 1990 to 2020 in Shanxi Province to conduct an empirical study on the impact of population structure changes on economic growth. Through multiple regression analysis, this paper discusses the influence mechanism of specific variables in the population structure on economic growth, and verifies it with stability test, providing suggestions for the adjustment of the population structure in Shanxi Province.*

Keywords: *population structure; Economic growth; Multiple regression; robustness check*

1. Introduction

In recent years, the economic growth of Shanxi Province has made a series of new progress, but the problems of unbalanced and uncoordinated economic development and relatively backward overall development level will inevitably affect the further improvement of the economic structure and economic development of Shanxi Province. Reasonable population structure promotes regional economic development and improves regional development potential. At present, the population development of Shanxi Province is facing problems such as aging, which will inevitably have a negative effect on the economic growth of Shanxi Province. Therefore, it has certain guiding and practical significance to comprehensively analyze the current situation and problems of the population in Shanxi Province, and deeply explore its impact, so as to provide policy suggestions for the coordinated development of population and economy in Shanxi Province, and promote the positive role of population structure in economic growth.

In view of the impact of demographic changes on economic growth, scholars at home and abroad have made rich research results.

In terms of population age structure, the population of different age groups has different effects on economic growth. It is generally believed that the population aged 15-64 is the working population, the main contributor to economic growth [1], and has a significant role in promoting economic growth [2]. The population aged 0-14 and over 65 years old are the main dependent population of the society, and the increase in their proportion increases the social support burden. In particular, the increase in the dependency ratio of the elderly will seriously hinder economic growth.

In terms of population gender structure, a reasonable gender ratio is particularly important. Once formed, it will have a huge impact on social development and people's lives. The imbalance between men and women will not only have a negative impact on our politics and economy, but also have a negative impact on the establishment of families and social stability. Only by reducing gender imbalance can we promote economic development and stabilize the macro economy [3].

In terms of population structure in urban and rural areas, economic development must be accompanied by the rise and prosperity of cities and towns. With the development of economy, the contribution of population urbanization is increasing [4]. The change of urban and rural structure causes the change of population structure, and then drives the consumption upgrading [5]. Promoting urbanization, reducing rural population and improving urbanization level are conducive to promoting economic development.

In terms of population industrial structure, industrial structure refers to the impact of labor changes on economic growth [6]. The growth mode of modern economy is basically structurally dominated economic growth characterized by changes in industrial structure. The adjustment of industrial

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structure can effectively promote economic growth. Accelerating the change of industrial structure can promote the development of new urbanization and provide new growth points for economic growth.

In terms of the structure of population's cultural level, population quality is the technology and production knowledge that human beings possess, and is a permanent rare resource. Investing in population can improve population quality and then increase productivity. Knowledge plays the most important role in economic growth in all economic and social factors. Increasing investment in education in human capital can significantly promote economic development [7].

To sum up, there are many literatures at home and abroad that have systematically studied the impact of population structure on social and economic growth, and have made a series of important achievements. However, there are few literatures that have in-depth studied the impact of population structure on economic growth from the perspective of age, gender, urban and rural areas, industry and cultural level, and few scholars have comprehensively studied the economic growth of Shanxi Province from the above aspects. Therefore, the author takes Shanxi Province as the research object, studies the impact of population structure on economic growth, constructs an econometric model, and conducts empirical analysis.

2. Theoretical analysis and research hypothesis

The impact of population of different age groups on economic growth is different due to their different supply of labor. The increase of the working population can effectively promote the social division of labor and improve labor productivity; Its proportion increases, reducing the dependency ratio, and benefiting saving and investment. The population of non-working age directly causes the relative shortage of social working-age labor force, which limits the improvement of social productivity. And its ability to create social wealth is relatively weak, which lowers the savings rate [8]; The population consumption level is low, which compresses the space of total social consumption demand and weakens the driving mechanism for economic growth [9]. Based on this, this paper proposes hypothesis 1: the working-age population plays a role in promoting economic growth, that is, the proportion of working-age population to economic growth has a positive direction.

The gender ratio is deeply influenced by people's ideas and national policies. The existence of some gender biases leads to the imbalance of the gender ratio, which is not conducive to the reproduction of the population, and directly affects the marriage problem, resulting in the phenomenon of "marriage squeeze" [10]. Different sex ratios of men and women affect the population size and age structure of the economy by affecting fertility and death, the supply of labor and the cost of employment of enterprises, and the consumption structure and industrial layout [11]. The rationality of population gender structure affects the stability of economic growth. Based on this, this paper proposes hypothesis 2: the more reasonable the gender structure of the population, the faster the economic growth, and the positive relationship between the two.

The development of population urbanization forms a agglomeration effect, which can significantly promote regional economic growth. Population urbanization indirectly promotes economic growth through factor accumulation and structural change [12]. The effect and main path of population urbanization on economic growth in different regions are also different [13]. In the end, a part of the rural surplus labor force will flow into the city, increase the labor supply of the city, promote the development of the urban economy, indirectly promote the level of rural consumption, accelerate the upgrading of rural consumption, and in turn promote the process of urbanization. Based on this, this paper puts forward hypothesis 3: the closer the urban-rural structure of population is to urbanization, that is, the higher the level of population urbanization, the more it can promote economic growth.

The population industrial structure develops new productivity through restructuring and optimizing low level productivity, mainly through the flow of input factors from low productivity level or low production growth rate sectors to high productivity level or high production growth rate sectors. A part of the labor force transits from the primary industry to the secondary and tertiary industries. When it develops to a certain degree, the labor force is redistributed, and the labor force transferred to the tertiary industry increases, driving economic development [14]. Based on this, this paper proposes hypothesis 4: the better the industrial structure of the population, that is, the greater the ratio of the number of employees in the third and second industries [15], the more conducive to economic growth.

The higher the cultural level of a region's population, the stronger its comprehensive strength and competitiveness. The high-quality population culture optimizes the division of labor and employment

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population structure, and improves social labor productivity; Promote the research and development of new products, promote technological innovation and industrial restructuring, strengthen the technical barriers of enterprises, improve the competitiveness of enterprises, and facilitate the transformation and upgrading of enterprises [16]. In addition, the level of population and cultural structure directly affects the consumption structure. High-quality people often have high incomes, which can stimulate more consumption, especially the consumption of spiritual enjoyment. Based on this, this paper proposes hypothesis 5: the higher the education level of the population, the more it can promote economic growth, and there is a positive relationship between the two.

3. Empirical results and analysis

According to the characteristics of population structure changes in Shanxi Province, the population structure is divided into the following main aspects: (1) age structure; (2) Gender structure; (3) Urban and rural structure; (4) Industrial structure; (5) Cultural level structure.

According to the research purpose of this paper, the per capita GDP deflator (y) is selected to represent economic growth; Select the proportion of population aged 15-64 in Shanxi Province (X1) as the representative variable to represent the population age structure [16]; Select the gender ratio (X2) as the representative variable to represent the gender structure of the population [17]; The population urbanization rate (X3) is selected as the representative variable to represent the urban-rural structure of the population; Select the ratio of the number of employees in the third and second industries (X4) as the representative variable to represent the population industrial structure [15]; The proportion of the number of students in colleges and universities to the total population (X5) is selected as the representative variable to represent the structure of population education level.

In order to avoid the omission of indicator selection, policy and system (U1), total import and export (U2), technological progress (U3), investment in scientific research (U4), investment in fixed assets (U5) and foreign direct investment (U6) are added as control variables. See Table 1 for the indicator system.

Table 1: Indicator system

Be explained variable	Economic growth	Per capita GDP deflator y	During the reporting period the price of per capita GDP/base price calculation of per capita GDP by 100% (in 1990) for the base period
Explanatory variables	The population age structure	15-64 - year - old population proportion X1	The population aged 15-64 / population
	The population sex structure	Gender ratio X2	The number of the number of male/female
	The population of urban and rural structure	Population urbanization rate X3	Total urban population/total population
	The population of the industrial structure	The ratio of the tertiary industry and workers secundiparity employs X4	Number of employees in the third industry/number of employees in the second industry
	The degree of population culture structure	The number of students of institutions of higher learning and the proportion of the total population X5	Number of college students/total population
Control variables		Policy system (U1)	The local finance general budget expenditure/GDP
		The total import and export (U2)	The total import and export
		Technological advances (U3)	An application for a patent for grant
		Scientific research funds investment (U4)	Research and experimental development spending
		Fixed asset investment (U5)	The whole society fixed asset investment
		Foreign direct investment (U6)	The actual use of foreign direct investment

This paper selects the data of Shanxi Province from 1990 to 2020 for a total of 31 years as the research object. For a few missing values in the control variables, interpolation method is used to supplement. In order to eliminate the variance problem, the logarithm of GDP deflator per capita (y) is taken as the explained variable. In order to keep the above variables in the same measurement unit, divide U2, U5 and U6 by 10000 as the new variables. Statistical analysis of basic description of variables is shown in Table 2.

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Table 2: Descriptive statistical results of variables

variable	The mean	The standard deviation	The minimum value	The Maximum
lny	6.587445	1.122248	4.60517	8.114036
X1	70.90774	3.817016	65.64	75.8
X2	106.541	1.921301	103.63	109.51
X3	42.57065	11.32162	28.9	62.53
X4	125.8923	39.5244	73.71	206.23
X5	1.128065	0.8090794	0.18	2.41
U1	17.86645	6.610889	9.72	28.92
U2	82.87762	74.69501	9.72	28.92
U3	4691.871	6243.66	380	27296
U4	55.78796	59.44191	0.68	211.0549
U5	0.4129272	0.4530046	0.012341	1.419798
U6	9.443261	10.15002	0.034	29.5186

The mean value in the statistical description can reflect the overall level of the variable, but individual extreme values may have interference, and the standard deviation represents the discrete trend of the data. The logarithm of GDP deflator per capita is the explained variable in this model, with the average value of 6.587445 yuan in the whole study range. At the current stage, the economic growth of Shanxi Province is relatively slow, and the per capita GDP even showed negative growth in 2009 and 2015, with a growth rate of nearly - 2%. Compared with the eastern region, it is far behind and also at the end of the middle region. The economic development of Shanxi Province should be accelerated. The floating range of X1, X2 and X5 is small, and the maximum value of X3 and X4 is about 3 times of the minimum value, with a small fluctuation range. For the control variable U1-U6, the maximum value is a large multiple of the minimum value, with a large fluctuation, and the standard deviation of U2, U3, and U4 are high, especially U3, with a large degree of dispersion.

3.1. Multiple linear regression analysis

Considering the collinearity between the explanatory variables, a multiple linear regression equation is constructed one by one between the explanatory variables and the explained variables, as shown below:

$$lny=\alpha1+\beta1X1+\gamma1U1+\gamma2U2+\gamma3U3+\gamma4U4+\gamma5U5+\gamma6U6+\varepsilon1 \quad (1)$$

$$lny=\alpha2+\beta2X2+\delta1U1+\delta2U2+\delta3U3+\delta4U4+\delta5U5+\delta6U6+\varepsilon2 \quad (2)$$

$$lny=\alpha3+\beta3X3+\eta1U1+\eta2U2+\eta3U3+\eta4U4+\eta5U5+\eta6U6+\varepsilon3 \quad (3)$$

$$lny=\alpha4+\beta4X4+\lambda1U1+\lambda2U2+\lambda3U3+\lambda4U4+\lambda5U5+\lambda6U6+\varepsilon4 \quad (4)$$

$$lny=\alpha5+\beta5X5+\mu1U1+\mu2U2+\mu3U3+\mu4U4+\mu5U5+\mu6U6+\varepsilon5 \quad (5)$$

Among them, the logarithm of GDP deflator per capita in lny table; α 1- α 5 is the constant term of each regression equation; X1 represents the proportion of population aged 15-64; X2 represents the gender ratio of men and women; X3 represents the population urbanization rate; X4 represents the ratio of the number of employees in the third industry to the number of employees in the second industry; X5 represents the proportion of the number of students in colleges and universities to the total population; β 1- β 5 is the regression coefficient of each regression equation; U1 represents the policy system; U2 represents the total import and export volume; U3 represents technological progress; U4 represents scientific research investment; U5 represents fixed asset investment; U6 represents control variable; γ 1- γ 6、 δ 1- δ 6、 η 1- η 6、 λ 1- λ 6、 μ 1- μ 6 represents the coefficients of the control variables of each regression equation; ε 1- ε 5 represents the random perturbation term of each regression equation.

Based on the empirical model setting, multiple linear regression analysis is conducted. The results are as follows:

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Table 3: Analysis of regression results

Explanatory variables	Model 1	Model 2	Model 3	Model 4	Model 5
X1	0.2552278*** (4.02)				
X2		-0.3059672*** (-4.90)			
X3			0.1442856*** (6.33)		
X4				0.0195878*** (5.17)	
X5					1.927145*** (4.72)
U1	-0.0524053 (-1.41)	-0.0353453 (-1.13)	-0.0813245** (-2.70)	-0.0415726 (-1.34)	-0.0754843** (-2.07)
U2	0.0042945 (1.01)	0.0049412 (1.31)	0.00012 (0.03)	0.0040278 (1.09)	-0.0012919 (-0.29)
U3	0.0001126* (1.73)	-0.0000379 (-1.05)	-0.0000918*** (-3.18)	-0.00017*** (-4.86)	-0.0000182 (-0.47)
U4	0.0057722 (-0.63)	0.0068399 (0.95)	0.0086335 (1.41)	0.0220297*** (3.13)	0.0032444 (0.43)
U5	-0.0973828 (-0.19)	0.5482606 (1.17)	0.2105667 (0.53)	0.3918391 (0.87)	-0829098 (-0.18)
U6	0.0007176 (0.04)	-0.0006088 (-0.03)	-0.0152149 (-1.00)	-0.0239386 (-1.40)	0.0051053 (0.27)
cons	-11.10252** (-2.74)	38.98291*** (5.64)	1.893843*** (3.25)	4.163486*** (11.24)	5.759476*** (15.81)
N	31	31	31	31	31
R^2	0.9453	0.9545	0.9660	0.9570	0.9528
F value	56.79	68.92	93.48	73.08	66.27

Note: The values in brackets are t, and *, * * and * * indicate that they are significant at the level of 10%, 5% and 1% respectively

In Table 3, X1-X5 has passed the significance test, and the significance level is at a high level, indicating that there is a significant linear relationship between X1-X5 and lny respectively. The R2 of the above five equations is greater than 0.94, close to 1, indicating that the goodness of fit of the model is high.

The above results show that the proportion of the population aged 15-64, the urbanization rate of the population, the ratio of the number of employees in the tertiary industry to the number of employees in the secondary industry, and the proportion of the number of students in colleges and universities to the total population are positively correlated with the logarithm of the per capita GDP deflator, which has a certain promoting effect on economic growth, and has a significant promoting effect on economic growth, of which the proportion of the number of students in colleges and universities to the total population has the greatest impact on economic growth. However, there is a negative relationship between the gender ratio of men and women and the logarithm of the GDP deflator per capita, that is, the gender ratio of men and women has a certain inhibitory effect on economic growth, indicating that at the level where the gender ratio of men and women in Shanxi Province has been greater than 1 for a long time, the lower the ratio, the more significant the inhibitory effect on economic growth. And the goodness of fit is high, indicating that the regression results are good, and there is a certain correlation between population structure and economic growth.

3.2. Robustness check

Use the logarithm (r) of fiscal revenue of Shanxi Province to reflect the economic growth of Shanxi Province, replace the explained variable y above, and conduct regression analysis again. To some extent, the higher the level of fiscal revenue, the faster the growth and the larger the scale, the stronger the financial strength of the region, the higher the level of economic development and the better the economic growth. The regression results are as follows:

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Table 4: Regression results of robustness test

Explanatory variables	Model 1	Model 2	Model 3	Model 4	Model 5
X1	0.2213687*** (5.68)				
X2		-0.2359776*** (-5.55)			
X3			0.1042309*** (6.18)		
X4				0.0125161*** (4.02)	
X5					1.661618*** (7.14)
U1	-0.0005289 (-0.02)	0.0201757 (0.94)	-0.0100354 (-0.45)	0.0243293 (0.96)	-0.0200258 (-0.97)
U2	0.0039981 (1.54)	0.0201757* (1.98)	0.0018851 (0.73)	0.0052498* (1.72)	-0007866 (-0.31)
U3	0.0000533 (1.34)	-0.0000834*** (0.002)	-0.0001255*** (-5.87)	-0.0001764*** (-6.14)	-0.0000605** (-2.76)
U4	0.00205 (0.37)	0.0136335*** (0.010)	0.0152568*** (3.36)	0.0242265*** (4.19)	0.0099233** (2.32)
U5	-0.2511879 (-0.81)	0.2666595 (0.413)	0.0012825 (0.00)	0.1086938 (0.29)	-0.2376489 (-0.88)
U6	0.004719 (0.39)	0.0017766 (0.886)	-0.009686 (-0.86)	-0.0155974 (-1.11)	0.0083999 (0.79)
cons	-10.45141*** (-4.20)	29.7349*** (6.31)	1.28707*** (2.98)	3.005644*** (9.88)	4.170313*** (20.07)
N	31	31	31	31	31
R2	0.9867	0.9864	0.9880	0.9813	0.9901
F value	244.59	237.88	271.06	172.55	328.58

Note: The values in brackets are t, and *, * * and * * indicate that they are significant at the level of 10%, 5% and 1% respectively

As shown in Table 4, the significance of explanatory variables is at a high level of 1%. X1, X3, X4, X5 are positively correlated with r, and X2 is negatively correlated with r. It shows that the larger the proportion of the working-age population, the smaller the gender ratio of men and women, the greater the population urbanization rate, the higher the ratio of the number of employees in the third and second industries, the greater the proportion of the number of students in colleges and universities to the total population, the higher the financial income of Shanxi Province, the higher the level of economic growth. It shows that after replacing the explained variables, the regression results still conform to the above hypothesis and empirical test results, and the model passes the robustness test.

The population and labor force in Shanxi Province increased first and then decreased. Since 2010, the average level of labor force in Shanxi Province is higher than that of the whole country, and it is relatively rich on the whole, and can basically meet the social demand for labor force. Therefore, the rich labor resources have a significant role in promoting the economic growth of Shanxi Province. The gender ratio in Shanxi Province is unbalanced, and the deep-rooted gender preference has made the proportion of male population larger than that of female population for a long time, affecting the marriage market, employment market, education investment, and even causing poverty. This is consistent with Liang Chao (2017), reflecting the characteristics that the imbalance of gender structure will have a negative impact on the economy[18]. The urbanization level of Shanxi Province is developing rapidly, and the population urbanization rate is increasing year by year, reaching 62.53% in 2020. On the whole, it has entered a new stage of urbanization development, basically meeting the requirements of economic development in the new era. At present, Shanxi Province is in a critical period of industrial structure transformation and upgrading. The industrial structure is gradually transformed and optimized to the tertiary industry, and the total factor productivity of the society is improved, which is shown as a significant pulling effect on the economy. This is consistent with Gan Chunhui (2011), which reflects the characteristics of the overall inhibition of economic fluctuations and the promotion of stable growth by the upgrading of industrial structure [15]. With the transformation and upgrading of the industrial structure in Shanxi Province, the social division of labor is gradually refined, and the demand for high-quality talents is constantly expanding. Therefore, the role of high-quality labor force in promoting regional economic development is more obvious.

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4. Conclusions and policy recommendations

We should fully understand the specific impact mechanism of population structure change on economic growth, based on the reality of the economic situation in Shanxi Province, and propose corresponding solutions to make the population structure change better adapt to economic growth.

4.1. Increase population dividend

In recent years, the coal resources in Shanxi Province have been exhausted, and the labor force and population have flowed out. By 2020, 12.9% of the permanent residents of Shanxi Province are 65 years old and above, which is far higher than the aging standard. The government needs to: first, increase financial investment to support the smooth progress of employment. Secondly, establish a complete employment mechanism and actively guide from multiple channels. At the same time, we should pay attention to the burden of social support, put the three-child policy into practice, and formulate the labor force extension and retirement policy to ensure the sufficient supply of working-age labor in the future.

4.2. Ensure a reasonable sex ratio

The overall gender ratio of men and women in Shanxi Province has declined year by year, indicating that the awareness of equality between men and women has gradually increased, but it is still in an unreasonable imbalance. The government should pay more attention to the gender ratio: first, strengthen the advocacy of a new fertility culture and eliminate gender bias; Second, improve the social pension system and strengthen the social security system; Third, severely punish the use of advanced methods for gender screening, and curb the imbalance of sex ratio at birth from the source.

4.3. Accelerate the upgrading of population industrial structure

In terms of the overall industrial structure development of Shanxi Province, the tertiary industry has become a pillar industry, surpassing the secondary industry. However, the second industry in some prefecture-level cities is still a pillar industry, and the number of employees in the third industry needs to be improved. The government should promote the upgrading of industrial structure: first, introduce advanced equipment and technology to improve the productivity of the primary industry; Second, optimize the development mode of the secondary industry and improve the development speed of productivity; Third, guide market funds to vigorously support the development of the tertiary industry.

4.4. Vigorously promote population urbanization

In 2020, the population urbanization rate of Shanxi Province was 62.53%, but still lower than the national level. The urbanization development model needs more planning and coordination to follow up the needs of economic growth. First, strengthen the construction of urban infrastructure and improve the carrying capacity; Second, strengthen the overall development of urban and rural areas, and pay attention to the rational design and planning of urban and rural structure; Third, accelerate the development of agricultural industrialization and promote it to move towards a new type of urbanization.

4.5. Improve the cultural level of the population

The educational cause of Shanxi Province is making great progress. The people pursue higher education, and the cultural level of the population is constantly improving. At present, Shanxi Province has made some progress in talent introduction, but due to some institutional obstacles and relatively simple industrial structure, talent introduction is relatively difficult. The government should actively cultivate high-quality talents: first, increase investment in higher education and increase investment in education in backward areas; Second, pay attention to the development of vocational education and improve the comprehensive quality of in-service employees; Third, use all kinds of educational resources efficiently and focus on the long-term training of high-quality talents.

Finally, due to my limited level, although the influence of multiple collinearity is eliminated as far as possible in the process of model selection, there are still some other factors that have not been taken into account and can only be put into the error item; Thirdly, due to the limited data, only the data of

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Shanxi Province in recent 31 years has been selected as the measurement index, which needs to be improved.

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