Exploring the Impact of China's Labor Force Changes on Economic Growth: A Quantitative Study

Xiaochen Han(✉)

Public Utilities Management, Yantai Research Institute, China Agriculture University, Yantai 264003, China
hanxiaochen@cau.edu.cn

Abstract. Trends in labour force changes can have a powerful impact on macroeconomic growth. The persistently low population growth rate in China has become a matter of immediate concern for policymakers and academics. Based on the data of the communiqué of the seventh population census of China and the National Bureau of Statistics, this article uses the historical growth accounting method and regression analysis to explore the changes in the labour force. It is decomposed into three contributing factors through deduction by the formula: growth in labour productivity, growth in the size of the working-age population and in the efficiency of labour utilisation, which can lead to the exploration of its impact on economic growth. The Change characteristics, rates and trends of the three factors can reveal their contribution and effects on GDP growth from 2001 to 2020. On this basis, using linear analysis can prove the correlation and coefficient of each factor and GDP growth rate. The results demonstrate that all three factors can influence China's economic growth. The increase in labour productivity has been the main driver of China's economic growth over the past 20 years. Its growth has reduced in recent years, which indicated a slowdown in China's future economic development. While the effect of labour utilization efficiency is negative. The downward tendency of labour utilization efficiency in the future may be caused by the reduction of labour force participation rate and working hours, which is relevant to the size of the working-age population. The above findings of this article can be used to assist shape future policy recommendations.

Keyword: Labor Force Population · Economic Growth · Historical Growth Accounting Method

1 Instruction

The population has long been a key concern in China's development. As the most basic content in demography, labor force change profiles and growth trends are the core of the study of population reproduction and economic growth, as well as major concerns of population change and population security. Although China's population is still growing, the inertia of negative growth has been accumulating. The general declining trend of

© The Author(s) 2023
G. Guan et al. (Eds.): ICBDSS 2022, AHCS 8, pp. 247–257, 2023.
https://doi.org/10.2991/978-94-6463-064-0_29

population growth in the future has been set. This will continue in the second decades of the 21st century, which will affect the size of the population. It has a huge impact on structure, economic and social development. In this context, this paper will study the change characteristics and trends of China's GDP growth and various contributing factors from 2001 to 2020 to explore the impact of labor force changes on economic growth. The negative population growth and the transformation of the labor structure will inevitably bring unprecedented new challenges and problems. Therefore, it is of great significance to explore the changing ways and development prospects of the labor force structure.

This paper adopts the historical growth calculation method to decompose economic growth into three contributing factors. After descriptive statistical analysis, this article uses regression analysis to verify their significant correlation with GDP growth rate. Their contribution to China's economic growth over two decades is analyzed as well. By results this paper will roughly judge the changing trend of the labor force in the future, discusses its impact on China's development, and puts forward brief policy recommendations.

2 Theoretical Foundation

The impact of population on the economy is the topic of the majority of population studies undertaken by experts from various countries. In this topic, a small number of scholars choose qualitative research, but it should be noted that qualitative research has relatively strong subjectivity. Most scholars choose quantitative research. They build models and use the results to determine how variables interact with each other. However, since the results depend on the model, how the variable relationship is selected and how the variable relationship is defined in each study will be very different, which means that results will vary greatly. The effectiveness of repeated testing will be dissimilar as well, which means that accuracy can also be low. While the advantage of the growth accounting theoretical framework adopted in this paper is that it does not rely on special assumptions about behavioral and technical functions, which can lead to a more stable result.

Based on Solow's growth accounting model, referring to the GDP growth accounting framework of Maddaloni and Qi Mingzhu, this paper decomposes GDP growth into three elements, namely, increase in labor productivity, growth of the working-age population, and growth in the efficiency of labor utilization [1–3]. On such basis, this article investigates the changing characteristics and trends of China's GDP growth, as well as the factors that contribute to it, from 2001 through 2020.

The data used in this article are provided by 2021 National Bureau of Statistics. Employed population is calculated from labor force and unemployment rate data, in which the unemployment rate is missing in some years and supplemented by data from 2020 China Labor Statistics Yearbook.

Economic growth is represented by GDP growth. The working-age population is 15–64 years old. Labor productivity is calculated by dividing real GDP by the number of employed population. The employed population divided by the working-age population yields labor utilization efficiency.

So there is the following formula:

$$GDP = (GDP/EW) * (EW/WAP) * (WAP/TP * TP) \tag{1}$$

Among them, EW (Employed Workers) represents the number of employed population. LP (Labor Productive) represents labor productivity. EW (Employed Workers) represents the number of employed population. WAP (Working Age Population) represents the working age. LU (Labour Utilization) represents labor utilization efficiency. TP (Total Population) represents the total population and DF (Demographic Factor) represents the population factor. In the analysis of Maddaloni et al., Labor Utilization divides the total working time by the working-age population [2]. Since the total working time in China cannot be obtained, the actual working population is used here instead.

DF, as the population factor, can be decomposed as follows:

$$dr = \frac{TP - WAP}{WAP} = \frac{TP}{WAP} - 1, \text{thereby} \frac{WAP}{TP} = \frac{1}{1 + dr} \tag{2}$$

That is:

$$GWAP = GTP + G\frac{1}{1 - dr} \approx GTP - \Delta dr \tag{3}$$

G_{WAP} represents the annual growth rate of the working-age population. GTP represents the annual growth rate of the total population and the real GDP growth rate can be decomposed into:

$$G_{GDP} = G_{LP} + G_{LU} + G_{DF} \approx G_{LP} + G_{LU} + G_{TP} - \Delta dr \tag{4}$$

Here, GGDP represents the annual growth rate of GDP. GLP represents the annual growth rate of labor productivity. GLU represents the annual growth rate of labor utilization efficiency. Thus, the following formula is obtained:

$$G_{GDP} = G_{LP} + G_{LU} + G_{WAP} \tag{5}$$

This formula means that if the real GDP growth of a country or region is examined in the medium and long term, the average annual growth rate of GDP is approximately equal to the sum of the average annual growth rates of the three contributing factors. Growth accounting models are particularly useful for analyzing the development and variations of real GDP and its contributing components over the medium and long term, which has drawn policymakers' attention [3]. Through such a formula, past economic growth can be clearly decomposed into different contributing factors, so as to understand the influence of population change factors on economic growth [4].

3 Method

This paper adopts a quantitative approach, which uses existing data to perform a regression analysis to test whether changes in the labour force affect the economy. According to foreign historical accounting methods and the three elements determined by China's

actual situation, relevant variables are selected from the data publicly released by the National Bureau of Statistics of China for sorting, which crosses 20 years (2001–2020).

These data come from the National Bureau of Statistics of China and are also combined with multiple World Bank databases. The data directly selected in this paper include GDP, total labour force, labour force size and unemployment rate. The number of employed people is calculated by multiplying the total number of the working population and the unemployment rate. In addition, the unemployment rate in some years is missing, which is supplemented by the data of the "China Labor Statistics Yearbook".

In addition, labor productivity is usually calculated by dividing real GDP by the total number of hours worked in relevant foreign studies. The stability of data is relatively low, given the changes in statistical caliber in 2006. More importantly, the number of primary industry working hours is not used as a statistical basis, which accounts for nearly 40% of the total labor force. So this article uses GDP (RMB) divided by the number of employed people to define labor productivity. The implicit assumption here is that the per capita working hours of the employed population remain the same. But in fact, the global per capita labor time has a tendency to decrease. Maddaloni et al. proved that from 1980 to 2005, the average annual growth rate of average working hours per worker in Europe was -0.5%, which is consistent with the average annual decline in average working hours per worker in China's non-agricultural industries [5]. In order to account for changes in labor productivity over time, this article predicts a 0.5 percent yearly reduction in working hours between 2001 and 2020. Similarly, labor efficiency is typically assessed by dividing total hours worked by the population of working age. Because of the foregoing, the real labor scale is also employed to replace the entire working time in this case.

After selecting the contributing factors as the growth of the working-age population, the growth of labour productivity and the growth of labour utilization efficiency, this paper chose the descriptive analysis using the data in LP, LU, WAP and GDP changing rate in 20 years. So it's more convenient to observe the changes in LP, LU, WAP and GDP in 20 years and the growth rate of each factor.

This paper calculates the specific values of the three elements in 20 years. Then the detailed data and 20 years of GDP values were analyzed in suitable ways. Factor regression analyses are performed to confirm whether the growth of each contributing factor has a significant correlation with GDP growth, which means to prove what kind of positive and negative correlation and the size of the contribution. Finally, the presented results are discussed and final conclusions and recommendations are made.

4 Result

4.1 Descriptive Statistics

Using the growth accounting model, this paper can examine the impact of changes in various factors on mid-term and long-term GDP growth. The data changes of GDP and its influencing factors from 2001 to 2020 will be descriptively shown by Fig. 1, Fig. 2, Fig. 3, Fig. 4.

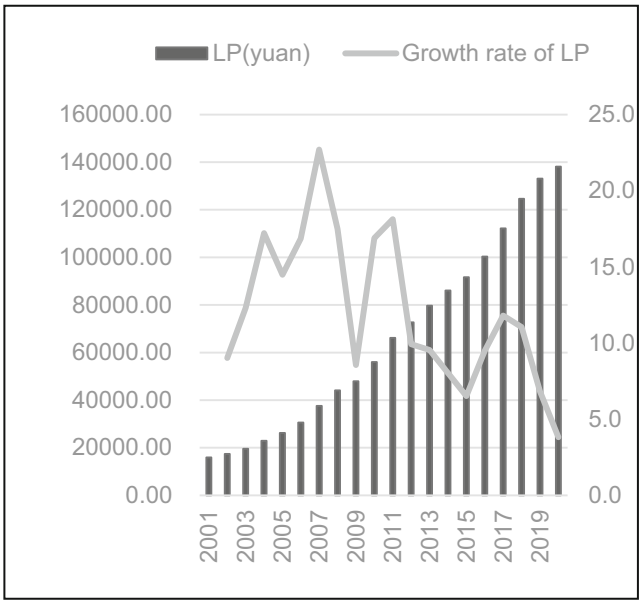

Fig. 1. Changes in China's LP and growth rate from 2001 to 2020 [6]

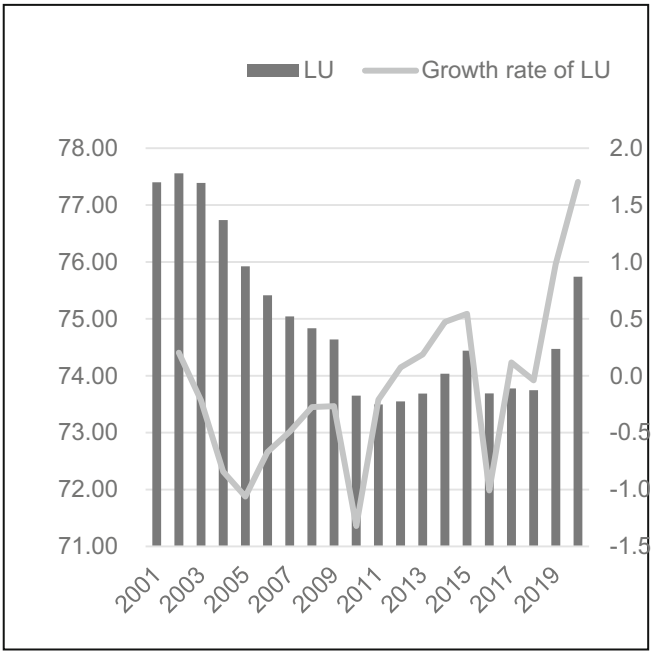

Fig. 2. Changes in China's LU and growth rate from 2001 to 2020 [7]

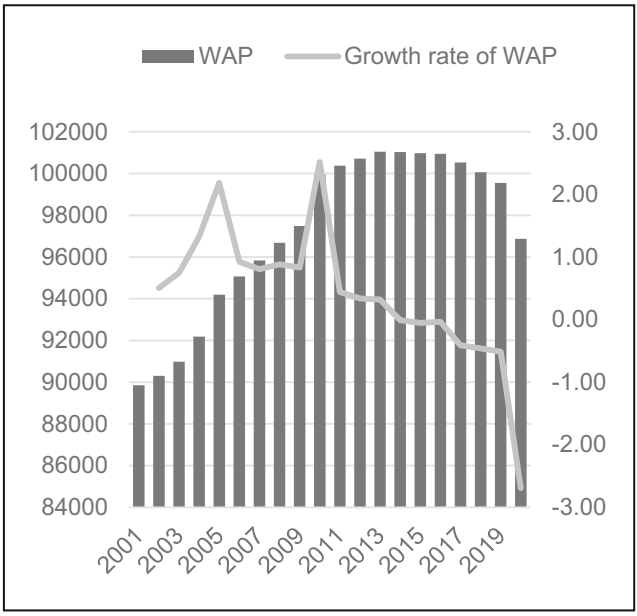

Fig. 3. Changes in China's WAP and growth rate from 2001 to 2020 [7]

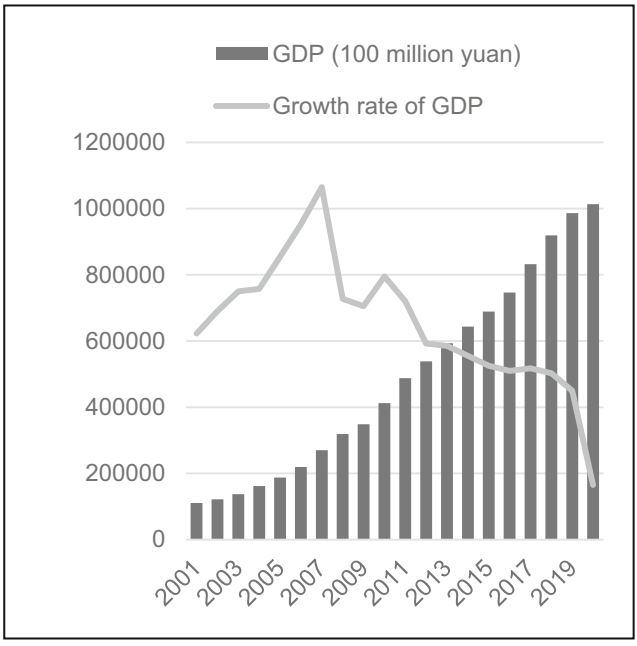

Fig. 4. Changes in China's GDP and growth rate from 2001 to 2020 [6]

It can be seen that China's GDP has continued to increase in the past 20 years. The GDP growth rate has experienced two peaks and a downward trend in the past 10 years. Overall, China's GDP has grown steadily from 11,086.31 billion yuan in 2001 to 101,356.7 billion yuan in 2020, with an increase of more than 9 times. From 2001 to 2020, China's GDP grew at an average annual rate of 8.7%.

Labor productivity has maintained an upward trend for 20 consecutive years, rising from 1594.17 billion yuan in 2001 to 13814.386 billion yuan in 2020. From the perspective of growth rate, it started to rise from the initial 10% and experienced multiple peaks and valleys. It fluctuated up and down but the overall pace of increase was decreasing. In 2020, the growth rate fell below 5% for the first time.

In terms of absolute value, China's labor force utilization efficiency is normally rather high, yet it generally shows a declining trend first and then turns up. From 2001 to 2020, the average labor efficiency in China was 40%. In terms of growth rate, China's labor utilization efficiency only showed positive growth after 2003 and 2010, with negative growth in the rest of the year. The average annual growth rate from 2001 to 2010 was -0.54%. In terms of stages, the growth rate of labor utilization efficiency in China has shown a slow recovery trend. The average annual growth rate of labor utilization efficiency from 2001 to 2010 was -0.2%. The rate from 2011 to 2020 was 0.28%.

From 2001 to 2020, the overall development of China's working-age population revealed an inverted U shape. It has increased from 898.49 million in 2001 to 1,010.41 million in 2013. Then it fell to 968.71 million in 2021. Population growth during this period averaged 0.4%. Over the past decade, the working-age population has grown volatile, experiencing two peaks. In 2010, China's working-age population increased by 2.52% over the previous year, the highest in 20 years. Since 2010, the annual growth rate has decreased year by year. By 2014, the working-age population's yearly growth rate had fallen below zero, and the working-age population had begun to shrink. The total working-age population declined after peaking in 2013, which showed a cliff-like decline in 2019.

4.2 Regression Analysis Results

The growth rate of LP, LU and WAP were taken as independent variables. The GDP growth rate was taken as the dependent variable. This paper use SPSS statistical software to carry out regression analysis on them respectively. The results are shown in Table 1.

Table 1. Correlation and Contribution Ratio [6]

	Population Factor		
	LP	LU	WAP
R	0.843[a]	0.743[a]	0.822[a]
R^2	0.711[a]	0.551	0.675
Sig.	0.003[a]	0.000	0.000

[a]Dependent variable: Growth Rate of GDP (100 million yuan)

Table 2. Correlation and Contribution Ratio [6]

		GDP growth rate (%)	Contribution to economic growth
Pearson Correlation	GDP growth rate (%)	1	
	LP growth rate (%)	0.843	1.395
	LU growth rate (%)	−0.743	−0.854
	WAP growth rate (%)	0.822	0.459

It can be seen from Table 1 that after the goodness of fit test and the homogeneity of variance test, the model is apposite. The regression lines of LP, LU and WAP have a high degree of fitting to the observed values, which are 0.711, 0.551 and 0.675, respectively. The significance coefficients of the three are less than 0.05, indicating that the three are significantly related to the dependent variable GDP growth rate. In summary, combined with the results of the R2 test and the homogeneity of variance test, it shows that the energy model can better demonstrate the impact of the three contributing factors on the GDP growth rate.

Then, a specific correlation analysis is carried out on the growth rate of these three contributing factors and the GDP growth rate. The results are demonstrated in Table 2. It is known that the growth rate of labor productivity, the growth rate of the working-age population and the GDP growth rate are positively correlated. The specific coefficient values are 0.843 and 0.822 respectively. The growth rate of labor utilization rate is negatively correlated with the GDP growth rate and the specific coefficient values are − 0.743. Among them, the contribution ratio of the growth rate of the three factors to the GDP growth rate is 139.5%, −85.4% and 45.9% respectively.

The above data shows that the growth of China's labor productivity and working-age population is one of the important driving forces for economic development. While the growth rate of China's labor utilization efficiency is a negative growth in GDP growth. In fact, the continuous decline in the utilization efficiency of labor is caused by people's pursuit of leisure (shorter working hours per capita) and the increase in educational attainment (decreased labor force participation rate) [8]. The decline in labor utilization efficiency is a common trend worldwide and it is likely to further decrease in China in the future. This research conclusion is also consistent with similar international researches. According to a study conducted by Medruni et al. in Europe during the period 1960–2005, it was concluded that the contribution of labor utilization efficiency to economic growth was −22% [2].

5 Discussion

Among the three major population factors, labor productivity is the most important driving force for economic growth, which can be concluded through the contribution ratio. For labor productivity, the initial growth rate was 10%. In addition to the economic crisis in 2008, a series of favorable economic policies, such as reform and opening up, market economic reform and demographic dividends, have brought a series of growth

peaks. In the future, China's economy will transform from high-speed development to high-quality development, which is expected to bring about a new peak in labor productivity growth. But there is a high probability that the general tendency of lowering cannot be completely rescued.

China's labor force utilization efficiency is generally high in absolute terms. However, it has been greatly affected by China's severe aging, industrial transformation and delayed retirement policies, showing a trend of first falling and then rising. The main reasons for this are falling labor force participation, rising unemployment and reduced working hours. Although the growth rate was greater than 0 in the later period, the recovery still was slow [9]. This is not only related to the government's policy guidance, but also to the change of people's work concept and the upgrading of economic development.

The changing trend of the working-age population is closely related to the changing trend of China's population. The low growth of the working-age population precedes the poor growth of the total population. The working-age population in China reached its summit in 2013. The size of the working-age population is shrinking continuously. This means that the contribution of changes in the working-age population to economic growth will transform from positive to negative one day in the future and the Chinese economy must find new growth points [10]. Affected by the Covid-19, the growth rate of the working-age population in 2020 illustrated a cliff-like decline. It is still inconclusive whether it will be able to return to the original growth rate.

In addition, China's population will continue to maintain positive growth for a period of time in the future, while the length of the growth period is significantly affected by the fertility level. Although the accurate time of negative population growth under different schemes are slightly different, the arrival of negative population growth is a foregone conclusion. The negative growth of the total population and the positive growth of the elderly population will coexist for a long time in the foreseeable future [11]. The growth that China's population will face in the future can be endogenous negative growth driven by the long-term maintenance of low fertility rates and the aging of the population. The long-term negative population growth is a change unseen in China in a thousand years, which has a huge effect on the entire Chinese society and millions of families. China's population environment and social structure will have undergone profound changes and entered a new era [12].

6 Conclusion

After the calculation of historical growth method and regression analysis method, the following conclusions are drawn. The growth rate of labor productivity is the main driving force for economic growth. The growth of the working-age population can also promote economic growth. However, the continuous downward trend of labor utilization rate in recent years has brought a negative impact on economic development.

First, the importance of labor productivity to economic growth is extraordinary. In the future, China should continue the current policy of improving total factor productivity and insist on high-quality economic development. Promote mass entrepreneurship and innovation. Efforts should be made to improve the technological content in the production

process. At the same time the government are supposed to speed up the transformation of the economic development mode and adjust the economic development structure.

Secondly, with reference to the current downward trend of the working-age population and the status quo of the aging of the internal structure, China should adopt a loose-based fertility policy in the long run. The government should pay attention to the guidance of fertility concept and avoid the "low fertility trap". Keep the fertility rate at a reasonable level and make the total population adapt to the resources, environment, economy and society.

Third, under the pressure of an aging working population and negative growth, China can also expand the number of working-age populations by extending the retirement age. This can not only improve the problem of a sharp decline in the labor force to a certain extent, but also alleviate the dilemma of the shortage of pension insurance funds and improve the self-supporting ability of employees at the retirement age.

It is a feasible option to make assumptions and justify the relationship between the labor force and the economy through the historical growth calculation method. However, there is still much room for improvement in current research. Starting from the research field and direction, this quantitative research method can also be applied to the exploration of the relationship between population aging and economic development in the context of an increasingly serious population aging situation. In addition, predictive modeling can be performed on changes in the working population and future trends in population aging. In terms of accuracy, the mediation effect analysis can be carried out on the three labor force factors and the total GDP to test the relationship more accurately. In terms of detail, a more comprehensive study can be carried out in conjunction with the GDP growth rate.

References

1. R. M. Solow, "Technical Change and the Aggregate Production Function", The Review of Economics and Statistics, vol. 3, 1957.
2. A. Maddaloni, A. Musso, P. Rother. et al, "Macroeconomic Implications of Demographic Developments in the Euro Area", ECB Occasional Paper, 2006, p. 51.
3. M. Z. Qi, "Quantitative research on the impact of population changes on economic growth in China." Population and Economy, vol. 6, 2013, pp. 10–18.
4. S. Y. Zhong, K. Li, "A review of research on the relationship between demographic dividend and economic growth", Population and Economy, vol. 2, 2009.
5. A. Maddison, "The World Economy", Academic Foundation, 2007.
6. Office of the Leading Group for the Seventh National Population Census of the State Council, "Communiqué on Main Data of the Seventh National Population Census in 2020", Beijing: China Statistics Press. 2020.
7. Bureau of Statistics of the People's Republic of China, "China Statistical Yearbook", Beijing: China Statistics Press, 2020.
8. W.W. Kong, Y. S. Lian, C. Liu, "Human capital investment, effective labor supply and high-quality employment", Economic Issues, vol. 5, 2019, pp. 9–18.
9. D. M. He, P. Liu, "Population aging, manufacturing transformation and upgrading and high-quality economic development: Based on the mediation effect model", Economics and Management Research, vol. 41, 2020, pp. 3–20.

10. X. L. Zhang, Z. W. Zhai, T. Tao, "China's negative population growth: current situation, future and characteristics", Population Research, vol. 3, 2020, pp. 3–20.
11. W. G. Wang, F. Liu, C. L. Hu "Fertility policy, optimization of population age structure and economic growth", Economic Research, vol. 54, 2019, pp. 116–131.
12. J. M. Li, "China's new population normal and economic new normal", Population Research, vol. 39, 2015, p. 3

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.