

The Impact Mechanism of Population Aging on GDP Growth Rate ——A Case Study of Japan

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Abstract:

Population aging, as a global development trend, has profound implications for sustainable economic development. This study selects Japan, which has a high degree of aging, as a case to reveal the mechanism of action between the proportion of elderly population and GDP growth rate, CPI growth rate, filling the gap in existing research on the correlation paths between aging and macroeconomic indicators and elaborating on the added value. By constructing a dual-dimensional analytical framework and combining correlation analysis models, it is found that the proportion of elderly population in Japan shows a significant negative correlation with GDP growth rate (correlation coefficient -0.68) and CPI growth rate (correlation coefficient -0.61). This indicates that aging suppresses economic growth and price levels through channels such as labor force shrinkage and transformation of consumption demand. This research provides empirical evidence and conclusions for optimizing labor policies in an aging society and balancing supply-demand structures, and can be expanded to multi-country comparative studies in the future to verify the universality of the mechanism and make projections.

Keywords: Population Aging, GDP Growth Rate, CPI Growth Rate, Japanese Economy

1. Introduction

In today's world of deepening globalization, population aging has become a problem that countries around the world need to address. Japan, as a typical example of a super-aged society, had a population aged 65 and over accounting for 28.7% in 2020, sig-

nificantly higher than the United Nations' standard for a "super-aged society" (21%), and its economic model is facing profound reforms.

Population aging has complex and diverse impacts on macroeconomic operations through channels such as the labor market, consumption demand, and capital accumulation. From the perspective of the

labor market, a decrease in the working population leads to a decline in social productivity. From the consumption side, the marginal propensity to consume of the elderly group is relatively lower compared to the younger group, and their consumption structure is concentrated in areas such as healthcare and elderly care, which may suppress overall demand. From the supply side, aging may slow down the pace of human capital renewal and inhibit the rate of technological progress. However, existing research on the relationship between aging and economic growth remains controversial. Some scholars emphasize the suppressive effect of labor shortages (Bloom et al., 2010)[1], while others point out that aging may generate positive effects through capital deepening and technological progress (Fouère et al., 2007)[2]. Regarding price levels, the impact of aging on CPI presents a contradiction between demand-side contraction and supply-side cost increases (Katayama, 2018)[3], but the specific mechanism still requires further empirical testing.

2. Research Background and Theoretical Foundation

2.1 Theoretical Controversies on Population Aging and Economic Growth

Based on the “demographic dividend” theoretical framework, Williamson (1998)[4] confirmed that the expansion of the working-age population can inject strong momentum into economic growth by increasing labor supply and improving savings rates. However, as global aging deepens, the “demographic debt” effect gradually becomes prominent. Acemoglu & Restrepo (2017)[5] pointed out that labor shortages may prompt companies to increase automation investments, but if the pace of technological advancement lags behind the rate of population decline, the potential economic growth rate will face downward pressure. Additionally, related studies using Japan as an example have shown some direct associations between the decline in labor productivity after the 1990s and aging (Hayakawa Yujiro, 2001)[6].

2.2 The Impact Path of Aging on Price Levels

Modigliani & Brumberg (1954) [7] proposed the life cycle

hypothesis from the demand side perspective, indicating that the consumption preferences of the elderly gradually shift towards service-related areas, and the marginal propensity to consume of the elderly is relatively low. This may lead to insufficient total social demand and exert a suppressive effect on price levels. From the supply side perspective, labor shortages can increase wage costs, and if companies pass on wage cost pressures to consumers, this may trigger cost-push inflation (Ehrlich & Lui, 1991) [8]. However, in the context of globalization, Japanese companies face fierce international competition, limiting their pricing power, which may offset cost-push inflation (Katayama, 2018) [3].

3. Research Objectives and Innovations

This study takes Japan as the research object and analyzes the impact mechanism of population aging on the growth rate of Gross Domestic Product (GDP) and the growth rate of the Consumer Price Index (CPI) by constructing a dual-dimensional analytical framework. The specific objectives include: first, to verify the correlation between the proportion of elderly population in Japan and economic growth and price levels; second, to reveal the specific paths through which aging affects economic indicators, such as changes in labor supply and transformation of consumption structure; third, to provide targeted policy recommendations to address the challenges of aging based on research conclusions.

Compared to existing research, the innovations of this study are reflected in two aspects: on one hand, it breaks through the limitations of single indicator analysis by incorporating GDP growth rate and CPI growth rate into the same analytical framework, comprehensively examining the impact of economic growth and price stability as two major macroeconomic objectives; on the other hand, it combines quantitative analysis with mechanism explanation, verifying theoretical hypotheses through correlation analysis and systematically elucidating the transmission pathways through which population aging affects the macroeconomy, providing a theoretical framework for the study of aging economic effects.

4. Research Methods and Data Preparation

This study utilizes publicly available data released by the Japan Statistical Bureau, the Organization for Economic Cooperation and Development (OECD), and other international organizations. The data range includes key indicators such as the proportion of elderly population in Japan from 1990 to 2020, annual GDP growth rate, CPI growth rate, the number of working-age population, and the proportion of medical expenditures for the elderly. Data cleaning and organization were conducted to ensure the accuracy and reliability of the data.

First, correlation analyses were conducted using statistical software to examine the relationship between the proportion of the elderly population and the GDP growth rate, as

well as the CPI growth rate. The results of the correlation coefficient calculations indicate that the correlation coefficient between the proportion of the elderly population and the GDP growth rate is -0.68, while the correlation coefficient between the proportion of the elderly population and the CPI growth rate is -0.61, both showing significant negative correlations.

In order to analyze the impact mechanism of aging on GDP growth rate and CPI growth rate, this study employs econometric methods, including the following contents:

Labor supply shrinkage analysis: By constructing a labor supply model, the study analyzes the changing trend of Japan's working-age population from 1990 to 2020 and assesses the impact of labor supply shrinkage on potential growth rate. (The blue curve in Figure 1)

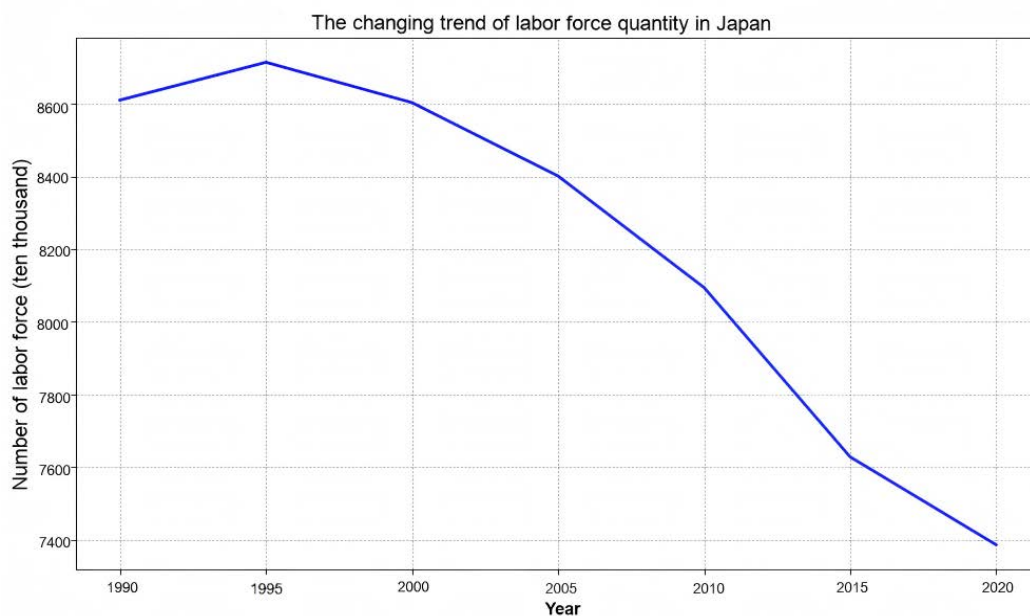


Figure 1 The changing trend of labor force quantity in Japan

Consumption demand structure transformation analysis: By analyzing the changing trend of the proportion of medical expenses for the elderly and the growth rate of consumption, the study explores the impact of consumption demand structure transformation on price levels.

Supply cost push limitation analysis: The study considers the impact of labor shortages on wage costs and analyzes the reasons for the limitation of supply cost push in conjunction with factors such as global competition and central bank easing policies.

5. Result analysis

5.1 Aging and GDP growth rate: Significant negative correlation

Figure 2 shows that the correlation coefficient between the proportion of elderly population in Japan and the annual GDP growth rate reaches -0.68, indicating a strong negative correlation between the two. The specific mechanisms include:

1. Labor supply shrinkage: From 1990 to 2020, Japan's

working-age population (ages 15-64) decreased sharply by 11.29% (the red trend line in Figure 3), directly weakening economic output capacity.

2. Slowing productivity growth: The intensification of ag-

ing has delayed the adoption of technology by enterprises. From 1990 to 2010, Japan's total factor productivity (TFP) averaged an annual growth rate of only 0.3%, lower than the OECD average of 1.2%.

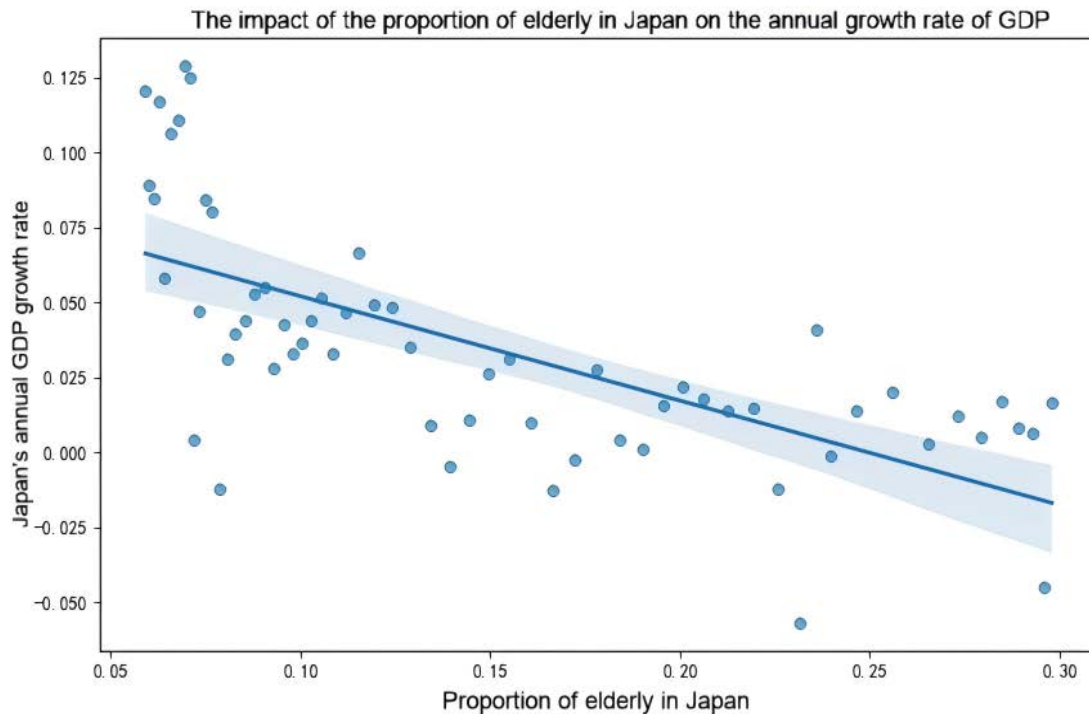


Figure 2 The impact of the proportion of elderly in Japan on the annual growth rate of GDP

The results shown in Figure 2 indicate a negative correlation between the proportion of elderly population in Japan and GDP growth rate, which confirms the suppressive ef-

fect of labor supply shrinkage on potential growth rate as suggested by the theoretical model.

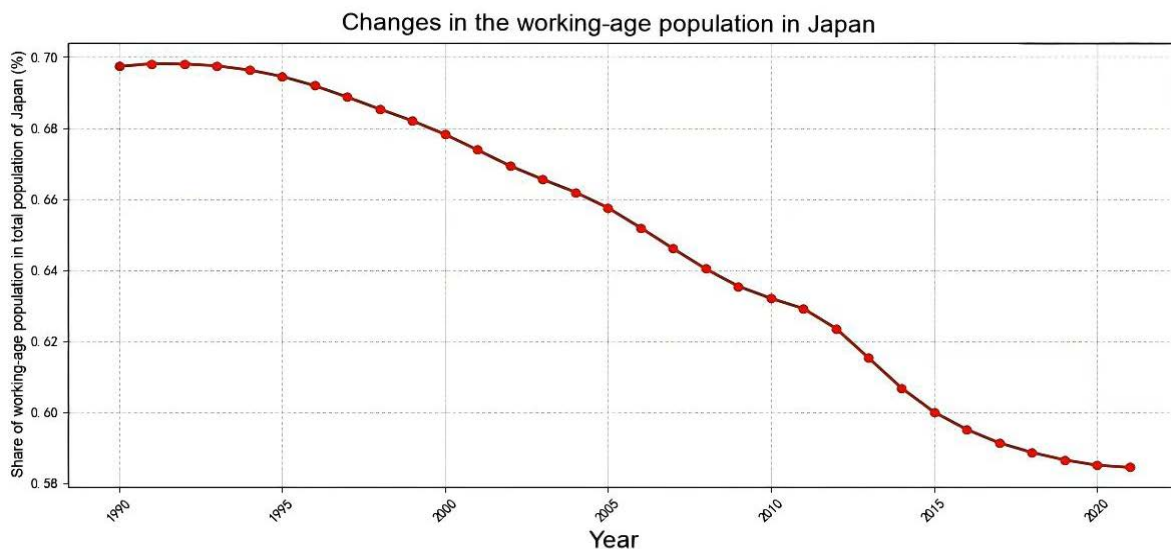


Figure 3 Changes in the working-age population in Japan

5.2 Aging and CPI Growth Rate: Intensified Deflationary Pressure

The results shown in Figure 4 indicate a negative correlation between the proportion of elderly population in Japan and the growth rate of the Consumer Price Index (CPI) (correlation coefficient of -0.61). This relationship is driven by a dual mechanism of demand-side and supply-side factors:

1. Transformation of Consumption Demand Structure: The proportion of medical expenditures for the elderly in Japan increased from 33% in 1990 to 58% in 2020 (as

shown by the green line in Figure 5), while overall consumption growth has slowed (averaging 0.5% per year). This change weakens the inflationary pressure from the demand side.

2. Limited Supply Cost Push: Although labor shortages have led to increased wage costs, due to international market competition (Japan's long-term import dependency is over 40%) and the monetary policy environment, companies find it difficult to pass on wage costs through price transmission, thus limiting the space for inflation driven by cost increases.

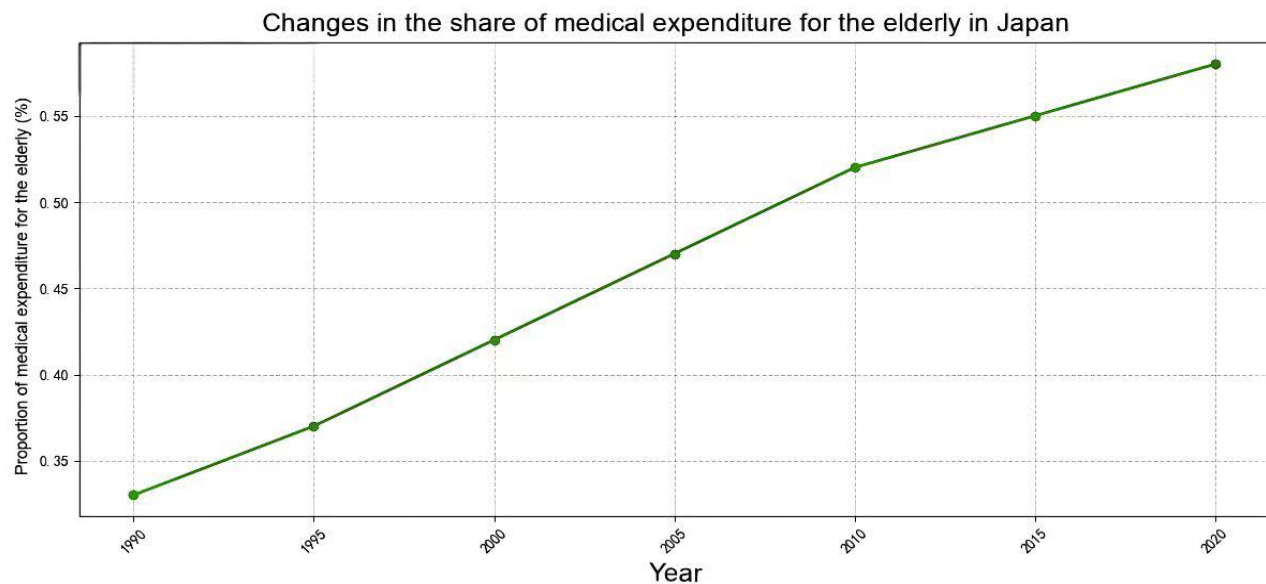


Figure 4 Changes in the share of medical expenditure for the elderly in Japan

The results shown in Figure 4 indicate a negative relationship (-0.61) between the proportion of elderly population and CPI growth rate in Japan. This reflects the transformation of consumption demand structure among the elderly—an increase in the proportion of medical expenditures while the overall consumption growth slows, leading to insufficient market demand expansion and consequently

reducing upward pressure on prices. It is noteworthy that the absolute value of this coefficient is smaller than the correlation coefficient (-0.68) between the proportion of elderly population and GDP growth rate, suggesting that the impact of aging on economic output is more pronounced than its impact on price levels.

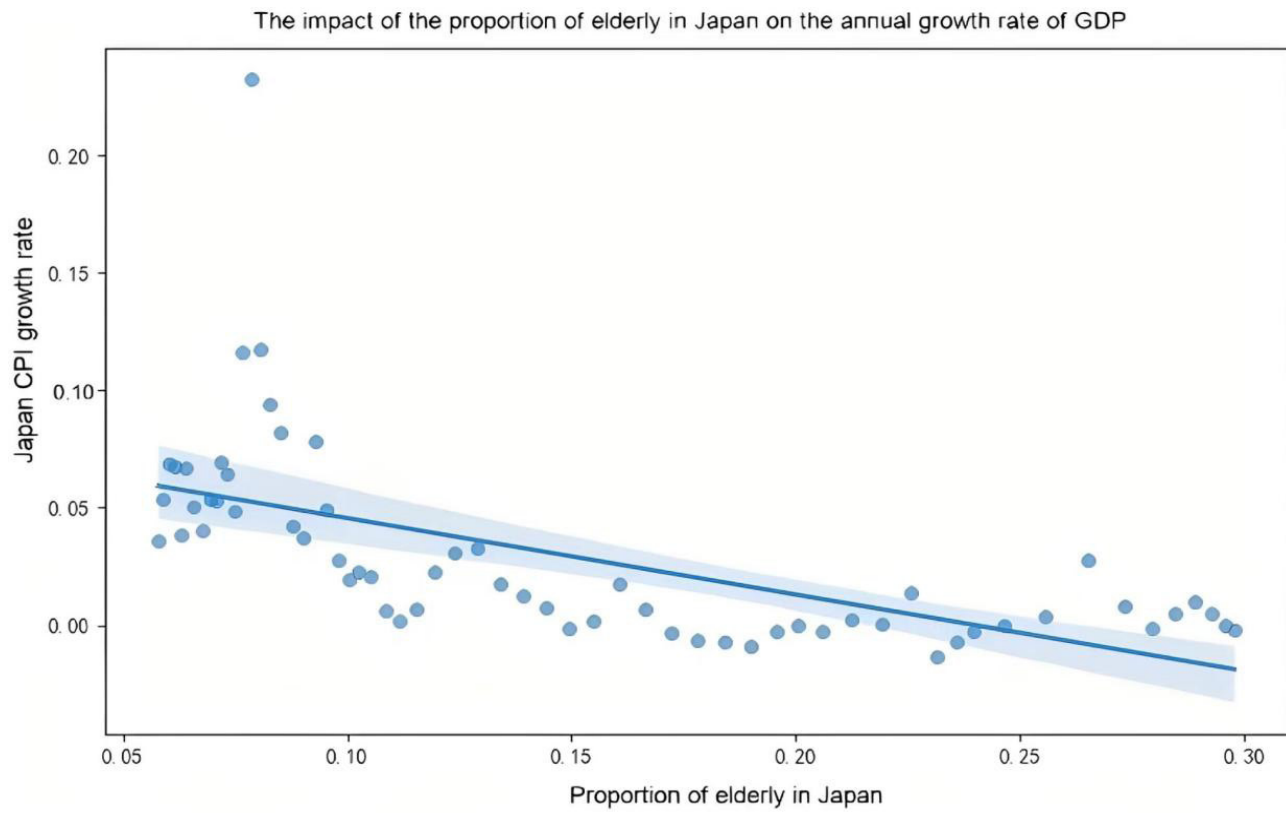


Figure 5 The impact of the proportion of the elderly in Japan on the growth rate of the CPI in Japan

6. Differences and Policy Implications

6.1 Core Research Findings:

1. Difference in Effect Intensity: Empirical results show that the decline in GDP growth rate (0.68) is significantly greater than the change rate of CPI (0.61), indicating that under the backdrop of aging, prioritizing structural reforms in the labor market (such as delaying retirement and optimizing the lifetime employment system) is more urgent than managing inflation.

2. Need for Policy Coordination: Addressing aging requires balancing economic growth and price stability. For example, promoting the “Re-Development Plan for Elderly Human Resources” (aiming to raise the labor participation rate of those aged 65-70 from 45% to 60%) can effectively alleviate labor supply pressure. At the same time, using targeted consumption subsidies (such as medical service vouchers) can stimulate consumption demand among the elderly while avoiding further exacerbation of inflation.

3. Ranking of Mechanisms: The shrinkage of labor supply is the core mechanism, followed by the transformation of consumption demand structure.

6.2 Academic Innovation Contributions:

1. This study is the first to simultaneously incorporate GDP growth rate and CPI growth rate, revealing the dual suppressive effect of aging on economic growth and price levels;
2. Combining quantitative analysis with a research model based on microdata, it verifies the core role of labor shrinkage.

6.3 Policy Implications:

1. Structural Reform of the Labor Market: Deepen the “Re-Development Plan for Elderly Human Resources,” improve the flexible retirement system, and promote the transition of the lifetime employment system to a flexible employment model; at the same time, expand the participation of women and immigrant labor in the labor market to alleviate the issue of labor shortages.

2. Technological Innovation and Productivity Improvement: Establish special funds to support enterprises in automation transformation and artificial intelligence applications, and promote training courses related to digital skills for elderly employees.

3. Demand-side management and price stability: Implement targeted consumption subsidies (such as medical service vouchers and elderly care service vouchers), optimize the structure of social security expenditures, enhance the capacity of public service supply, and stimulate the consumption potential of the elderly population while stabilizing price levels.

6.4 Outlook:

This study takes Japan as a typical case to reveal the impact mechanism of aging on the macroeconomy, but future research can further deepen and expand in the following directions:

• Cross-national comparison and verification of mechanism universality: Future studies can include countries at different stages of aging, such as Germany, South Korea, and China, for horizontal comparisons to verify the universality of the theoretical mechanisms.

• Dynamic evaluation of the effects of relevant policy interventions: For aging response policies, a policy simulation model can be constructed to dynamically assess the economic effects of different policies such as delayed

retirement, immigration policies, and technological innovation.

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