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Aging and inflation in Japan

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Abstract

The correlations between population aging and a low inflation level have recently been observed in industrialized countries. Japan has been experiencing a periods of falling prices for the past 25 years while the nation's population is aging rapidly. This unique phenomenon warrants investigation into how different population structure dimensions are associated with inflation. This study addresses the following questions in relation to Japan: (i) How is population composition by age group associated with inflation? (ii) How is dependency associated with inflation? and (iii) How is population aging associated with inflation? Applying regression analysis on panel data spanning 1975–2023 reveals that an increased proportion of the population among individuals in 0–14, 25–44, 45–59, and 60–64 age groups in the previous year is correlated with increased inflation. Specifically, as population age increased, the correlation tended to rise until the 45–59 age group. Conversely, decrease in youth dependency and increased in old-age dependency in the previous year are associated with decreased inflation. The findings indicate that Japan's population aging is associated with decreased inflation. In addition, an increase in individual real salary, the labor force participation rate, exchange rate, and basic discount rate in the previous year is associated with increased inflation while an unemployment rate increase in the previous year is associated with decreased inflation; the inflation rate during the energy shock period (2022–2023) was higher than that of the non-energy shock period.

Keywords: Aging; Dependent population; Inflation; Deflation; Japan

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1. Introduction

In the past several decades, many countries have been facing the economic influences of an aging population. The correlations between population aging and a low inflation level have recently been observed in industrialized countries (Broniatowska, 2019; Gajewski, 2015; Y. Liu & Westeliuas, 2016), while the correlations between population aging and a high inflation level have also been observed (Isa, 2021; Juselius & Takáts, 2015). The United Nations (UN) (2024) reported that global inflation decreased in 2022 and is projected to continue declining in the near future, while the UN (2023a) also reported that the global share of older adults is rising, and this proportion is projected to increase over the next decade.

Japan has been experiencing periods of falling prices of goods and services called deflation over the past 25 years, while its' population is aging rapidly making it the oldest society in the world (UN, 2023a). Falling prices may sound beneficial, but continuous deflation over time can have a negative effect on the economy (Mankiw, 1994). Chronic deflation was once considered a phenomenon unique to Japan (Kuroda, 2019). However,

the issues of population aging and accompanying deflation have been widely discussed in the media and by policymakers (Kuroda, 2019; Shirakawa, 2012; Ueda, 2025) and researchers concerned about the future cost of living. Nevertheless, how population aging is associated with inflation levels remains unclear. In response to this knowledge gap, this study examines whether a relationship exists between population structure and inflation in Japan and what the nature of this relationship is.

Many empirical studies linked population composition with inflation (Albuquerque *et al.*, 2020; Broniatowska, 2019; Isa, 2021; Juselius & Takáts, 2015; Lee *et al.*, 2024; Y. Liu & Westeliuas, 2016; Yoon *et al.*, 2018). The majority of them supported the significant influence of population structure on inflation though this association differs across studies. However, such empirical analysis on Japan is limited, and there is ample scope for examining this research. Therefore, this study contributes to the limited research on how population structure associates with inflation using population composition by age group as well as youth and old-age dependency. These variables were chosen as the majority of existing studies for Japan only examine the connection between old-age dependency and inflation.

Regression analysis on panel data spanning 1975–2023 revealed that an increased proportion of the population among individuals in 0–14, 25–44, 45–59, and 60–64 age groups in the previous year was correlated with increased inflation. Specifically, as population age increases, the correlation tends to rise until the 45–59 age group. In contrast, a decrease in youth dependency and an increase in old-age dependency in the previous year were associated with decreased inflation in Japan. The findings of this study provide valuable insights for policymakers' decisions and future research.

1.1. Brief background of Japan's population aging

Due to increased longevity and declining fertility, Japan's population has been aging. The proportion of the population aged 65 and above to the total population rose from 5.7% in 1960 to 29.4% in May 2025, with more than 1 in 10 people aged 80 and above (Statistics Bureau of Japan, 2025).

Japan's demographic transition occurred in three stages: before 1870 (first stage), 1871–1960 (second stage); and 1961–present (third stage) (Japan International Cooperation Agency, 2003). In the first stage, mortality and total fertility rates were high. The total fertility rate refers to the average number of children born to woman over her lifetime. In the second stage, a decline in the mortality rate began while the total fertility rate remained high. The decade following World War II was a breakthrough period, as life expectancy at birth for females increased from 54 years in 1947 to 67.8 years in 1955 (Sugiura *et al.*, 2010). In stage three, the total fertility rate decreased from 1.96 in 1961 to 1.20 in 2023 (Ministry of Health, Labor and Welfare (MHLW), Japan, 2024). The increasing marriage age and declining marriage rate seem to be two primary reasons for the lower fertility rate (Statistics Bureau of Japan, 2023).

It is also in the third stage that population aging began. The sales of adult diapers by Japan's largest diaper maker exceeded those for babies for the first time in 2011 (British Broadcasting Cooperation, 2024). Population aging has had consequences across multiple areas. For example, population aging affects labor markets. A decreasing working-age population (aged 15–64) causes a labor shortage, particularly for care workers. As a result, the number of older adult workers in the medical and welfare sector increased by 2.4 times over the past 10 years, according to the Internal Affairs and Communications, Japan (Chiba, 2024). Artificial intelligence-driven robots are currently being developed for future aged care (Asahi Shimbun, 2025). Demographic changes are creating new challenges for policymakers in terms of their potential detrimental to economy, workforce and society; nonetheless, demographic changes also offer technological opportunities.

1.2. References and model

1.2.1. Theory and political influence

Inflation is associated with a number of factors. The main causes can be grouped into demand-pull, cost-push, and inflation expectations (Mankiw, 1994; UN, 2023b). Demand-pull inflation is caused by the demand side of the economy, while the cost-push inflation is caused by the supply side of the economy. Inflation expectations denote people's perceptions regarding future inflation. An approach termed rational expectations assumes that people use all the available information to forecast future inflation (Kuroda, 2019; Mankiw, 1994).

The demand and supply model offers some of the most fundamental insights into economics, illustrating how the interaction between demand and supply determines the equilibrium price and quantity of a good, as well as how changes in external variables affect these outcomes (Mankiw, 1994). According to Keynesian demand-pull inflation theory, inflation arises when aggregate demand for goods and services exceeds available supply, creating an imbalance between demand and supply (Abel *et al.*, 2009; Sakakura, 2021). The theory posits that total spending in the economy, referred to as aggregate demand, strongly

influences economic output and, consequently, increases inflation (Abel *et al*., 2009).

Inflation is generally influenced by economic factors (Abel *et al*., 2009; Mankiw, 1994), which can be affected by non-economic factors. Shirakawa (2011; 2013), the former governor of the Bank of Japan, explained that demographic changes affect economic growth. In addition, even though they do not have a direct monetary value, non-economic factors, such as political or demographic factors, can be associated with inflation through several different pathways.

Associations between population composition and inflation have recently been observed. Demographic changes can influence the demand side of the economy, eventually affecting inflation in either direction, as lifestyle and spending habits differ across age groups. Shirakawa (2012; 2013) explained that aging substantially changes the economy's demand structure and suggested that aging leads to reduced pressure on inflation. Different age groups tend to have different approaches to spending and saving (Ando & Modigliani, 1963; Li & Cang, 2025; UN, 2023a; United Nations Population Fund [UNFPA], 2024). The life-cycle hypothesis by Ando & Modigliani (1963) emphasizes that income varies systematically over people's lives and that saving allows consumers to transfer income from periods of high income to periods of low income. This framework helps explain how expenditure and savings patterns change throughout the different stages of life.

A survey in Japan showed that monthly expenditure for older adults is lower than that for younger adults (Statistics Bureau of Japan, 2024). This lower expenditure may be linked to lower income, declines in health and energy levels, or preserving savings. Other survey results in Japan revealed that annual salary and monthly income tend to decrease by age group after aged 50–59 (National Tax Agency of Japan, 2024; Statistics Bureau of Japan, 2024). The Cabinet Office (2015) reported that, compared to younger adults, older adults may face mobility challenges when seeking to access affordable options due to physical limitations. As a result, activities that require mobility, such as shopping and traveling decline.

Moreover, older adults in Japan tend to preserve their savings and avoid depleting them, as they are concerned about longevity risk, unpredictable expenses, and the desire to leave bequests to their children (Cabinet Office, 2024). Ogawa & Retherford (1997) noted that older adults in Japan appear to distribute their savings to their children in return for receiving support for the rest of their lives. At present, individuals aged 70 and above hold nearly 40% of Japan's total financial assets, compared with about 30% in the United States (U.S.) (Cabinet Office, 2024). In such a context, an increasing proportion of older adults may lead to a decrease in aggregate demand, reflecting their lower levels of expenditure.

On the other hand, an increasing proportion of older adults may also lead to an increase in aggregate demand. On average, older adults in Japan spend more on medical care than younger adults. According to data from the MHLW, Japan (2024), the national medical care expenditure per capita in 2022 for population aged 75 and above was Japanese Yen (JPY) 940,900, 6.5 times higher than that for those aged 15–44 (JPY 144, 000). Similarly, in the U.S., personal health care expenditure per capita in 2020 for individuals aged 65 and above (USD 22,356) was over 5 times higher than that for children (USD 4,217) (Center for Medicare and Medicaid Services, 2025). In both Japan and the U.S., healthcare consumption increases with age.

Furthermore, while family members were historically the primary caregivers for older adults, institutional reforms such as Japan's public long-term care insurance (LTCI) program implemented in 2000, have reshaped intergenerational transfers and older adults' expenditure patterns (Ogawa *et al*., 2010). Ogawa *et al.* (2010) showed that in 2004, Japan's per capita expenditure increased with age among those aged 65 and above, attributing this rise to the implementation of the LTCI system. Similarly, the Cabinet Office (2010) found that Japan's healthcare spending increased by more than 10% in 2001, followed by fluctuations until 2009, suggesting that the expansion of nursing care services following the implementation of LTCI contributed to higher related expenditure in 2000, which led to an increase in related expenditures. By transforming unpaid family caregiver into paid workforce, the LTCI system has likely stimulated aggregate demand since 2000. Ikegami and Rice (2022) further observed that LTCI spending in Japan has increased more rapidly than healthcare spending, as population aging has a stronger effect on long-term care demand. Mason *et al.* (2022) argued that older adults' expenditures are already high in industrialized countries, highlighting the global economic implications of population aging. Consequently, rising demand for health services and LTCI expenditures by an increasing proportion of older adults may lead to higher aggregate demand. Thus, population aging can influence aggregate demand in either direction.

Demographic changes can also influence the supply side of the economy, eventually affecting inflation. A strong economy depends on a productive labor force, and both the quality and quantity of labor directly impact economic output. Productivity can differ based on the age structure

of a population. Feyrer (2005) showed that the 15–39 age group are associated with lower productivity while the 40–49 age group are associated with higher productivity in 19 Organization for Economic Co-operation and Development (OECD) countries. Thus, the age structure is an important factor influencing productivity and inflation. Aging may decrease labor supply, as older adults are less likely to participate in the workforce. A shrinking labor force can raise average wages due to labor shortage (Serow, 1982), and higher wages may increase inflation as producers pass on increased labor costs to consumers (Dervishi, 2023; Spengler, 1972). Therefore, population aging and inflation may be indirectly connected to the demand and supply sides of the economy through several pathways.

In addition to the demand and supply model, inflation may also be associated by political dynamics. Bullard *et al*. (2012) observed that inflation is relatively low when older-adults have more control over policy decisions. Similarly, Katagiri *et al*. (2014) found that population aging is deflationary when driven by increased life expectancy but inflationary when resulting from declining birth rates. Population aging also alters the composition of the electorate, increasing the proportion of older voters while decreasing that of younger voters. As a result, governments tend to expand the public sectors that reflect older voters' preferences. Since the majority of retiree are adverse to inflation, fearing the erosion of their savings during retirement, policymakers may prioritize price stability. The Bank of Japan, which sets interest rates to maintain price stability (Bank of Japan, 2024), may also face political pressure to keep nominal interest rates low, aligning with the preference of older voters. Therefore, changes in demographic structure can indirectly influence inflation.

1.2.2. Empirical literature review

Numerous empirical studies examined the association between demographic changes and inflation, with research supporting the effects in both directions. Lindh and Malmberg (1998) found that population aging affects the economy and inflation, showing how demographic composition, particularly age structure influences inflation. Lindh and Malmberg (2000) also showed how age structure can be referenced to forecast future inflation trends using data from the OECD for the period 1960–94. The authors explained that monetary policy can benefit from incorporating demographic projections in predicting inflation.

Various studies reported a connection between population aging and decreased inflation. Bruér (2002) found that in Sweden, older adults exerted the strongest deflationary influence during the period 1961–2000. Similarly, Faik (2012) identified a slightly negative relationship between old-age dependency and inflation in Germany during the period 1983–2009. Gajewski (2015) observed that population aging is deflationary in OECD countries and reported that a 1% point increase in the proportion of the population aged 80 and above corresponds to a 1% point decrease in inflation. Likewise, Yoon *et al*. (2018) reported that an increase in the share of population aged 65 and above led to decreased inflation in 30 OECD countries, including Japan over the period 1960–2013.

In contrast, Juselius and Takáts (2015) disagreed with the association noted above, showing that increased youth (under aged 19) and older adults (aged 65 and above) dependency ratios were correlated with increased inflation, while a larger share of the working-age population (aged 20–64) was correlated with decreased inflation in 22 industrialized countries, including Japan over the period 1955–2010. The authors explained that dependents tend to consume more than they produce, potentially leading to higher inflation through excess demand, while the working-age population produces more than it consumes, resulting in decreased inflation through excess supply. Their main finding shows a robust correlation between demographic structure and inflation, suggesting that population aging may eventually increase inflationary pressure.

Furthermore, Farvaque *et al*. (2010) reported that an increase in the population of the 15–29 age group was associated with decreased inflation in 20 OECD countries over the period 1973–79. The authors explained that although young adults are likely to spend more than they save, in these periods, their life trajectory is probably credit-constrained, which can reduce expenditure.

Broniatowska (2019) found that increased old-age dependency was associated with decreased inflation in 32 OECD countries, including Japan over the period 1971–2015. An increased old-age dependency of 1% point corresponded to a 0.19–0.39 decrease in the inflation rate. The results suggest that demographic changes may have a deflationary impact, particularly in aging countries. The author also noted that demographic change is one of the most important long-term challenges for the economy and the macroeconomic policy framework may need to be revised.

Albuquerque *et al*. (2020) showed that age structure affected inflation in 24 OECD countries including Japan, over the period 1961–2014. Specifically, they found that increases in proportions of 20–34, 65–74, and 75 and above age groups lead to higher inflation, while an

increase in proportion of the 35–64 age group lowers the inflation rate. The authors explained that the 20–34 age group consumes more than it produces, as this age group forms a family, buys a house, and spend on other durables, potentially leading to higher inflation, In contrast, the middle-aged population occupies only a small share of consumers' incomes, potentially leading to lower inflation. Older adults are likely to dissave. The propensity to spend among older adults is higher due to large expenditures on health and social care, leading to an inflationary effect. The authors concluded that a clear correlation exists between population age structure and inflation.

Empirical analyses of demographic composition and inflation in Japan are relatively new and limited. Y. Liu and Westelius (2016) used prefectural data from Japan over the period 1990–2007 and found that increased old-age dependency leads to lower inflation, and a 1% increase reduces inflation by 0.1% point. The authors provide strong support for the assertion that an aging population contributes to deflationary pressure. In contrast, using Japan's prefectural data over the period 1996–2017, Isa (2021) determined that an increase in old-age dependency raises inflation, indicating that population aging can contribute to inflationary pressure. The results show that when old-age dependency increases by 1%, inflation rises by 0.14%. In recent study, Lee *et al.* (2024) used prefectural data from Japan over the period 1970–2019 and found that increased old-age dependency negatively affects inflation, with a 1% point increase in dependency reducing the inflation rate by 0.03% points. The authors explained that an aging population reduces aggregate demand as a result of lower expenditure, and prices subsequently decline.

Extensive research supports the correlation between economic activity and inflation. Various factors interact with each other and affect inflation. In the United Kingdom, Phillips (1958) observed an inverse relationship between inflation and unemployment, called the Phillips curve. Mankiw (1994) and Moroney (2002) reported that increased money circulation (money supply) raises inflation.

Meanwhile, rising wage is another factor that contributes to increase inflation. Dervishi (2023) found that increased wages are positively associated with inflation. Similarly, Citci and Kaya (2023) observed that the foreign exchange rates affect inflation. Hirose (2022) described that in Japan, higher nominal wage, depreciation of JPY, and increased money supply are correlated with increased inflation.

Moreover, the National Transfer Accounts (NTA) provide a framework for understanding how changes in population age structure influence various economic aspects, such as the Second Demographic Dividend (SDD). The SDD is primarily referred to as higher individual wealth accumulation such as saving and investment and human-capital investment associated with long-term trends in aging population (Matsukura, 2024; UNFPA, 2024). In other words, increased economic growth can occur when individual wealth among an aging population increases. Ogawa *et al.* (2011) introduce the concept of *the elderly as latent assets*, showing how older adults in Japan can be seen not only as dependents but also as potential contributors to the economy. Japan's share of older adults is rising, and their desire to preserve savings as noted in Section 1.2.1, is an element of the SDD framework.

In summary, while the connections between old-age dependency and inflation in Japan have been examined, how the population age structure and youth dependency are associated with inflation remains unclear. Isa (2021) suggested that subsequent research could be refined by examining additional data, such as multiple population age groups. To the best of the current author's knowledge, no other study has analyzed the connections between multiple population age groups and inflation in Japan.

1.2.3. Model

Based on theoretical and empirical evidence from existing studies, beyond economic factors, connections between the population age structure and inflation are expected in Japan. These connections can be expressed as inflation is a function of population and economic characteristics. These relationships can be modified to include the population and economic variables referencing the research cited above. While the majority of existing studies on Japan have focused on old-age dependency, this study incorporated multiple population age groups, recognizing that various characteristics, such as productivity, spending patterns, and income sources, differ across age groups as noted in Section 1.2.1. Including multiple population age groups provides knowledge of how each age group is associated with inflation.

In addition, the study incorporated the basic discount rate because the Bank of Japan influences the formation of interest rates to maintain price stability (Bank of Japan, 2024). The basic discount rate is a monetary policy tool used by the Bank of Japan to indicate the rate of return the bank charges financial institutions for loans. The study also included the labor force participation rate which indicates the proportion of the population that is actively involved in the labor market. The trade balance (value of exports–value of imports) is also considered, as Japan has been experiencing a trade deficit starting in 2009, alongside a period of low inflation. To examine the SDD as noted in

the previous section, this study included Nikkei 225 index as an investment growth. The Nikkei 225 index is a stock market index for the Tokyo Stock Exchange.

Three period dummy variables were constructed to represent Japan's bubble economy period (1986–91), the COVID-19 pandemic (2020–22), and the energy shock (2022–23). During the bubble period, Japan's asset prices, particularly the Nikkei index and real estate values, increased rapidly. During the energy shock period, most prices, especially energy prices increased sharply.

Furthermore, a lagged variable (*t–1*) denoting 1 year before present was included in a model to examine how past events influence current outcomes, as the interactive outcomes of the relationship between variables may not be immediate but take time to emerge. Incorporating lagged independent variables into a regression model can investigate potential causal relationships, thereby reducing endogeneity problems.

The model is expressed as Equation (I):

$$Inflation_t = \beta_0 + \beta_1 \Delta X_{t-1} + \beta_2 \Delta C_{t-1} + \beta_3 D_t + \varepsilon_t \quad \text{(I)}$$

where *Inflation* is the annual percentage change in the consumer price index (CPI); Δ denotes the annual growth rate of a variable; *X* is the population characteristics, including total population, the share of a population age group to the total population, the youth dependency ratio, or the old-age dependency ratio; *C* is the control variables represented by real monthly salary; the unemployment rate, labor force participation rate, foreign currency exchange rate, trade balance, money supply, the basic discount rate, and Nikkei 225 index; and *D* is the three period dummy variables to represent the bubble economy, pandemic, and energy shock.

The two main alternative hypotheses (*H*) are as follows:

(i) H_1: An increase in the population by age group in the previous year is associated with an increase or a decrease in the inflation rate in the present year.

(ii) H_2: An increase in the dependency ratio in the previous year is associated with an increase or a decrease in the inflation rate in the present year.

2. Data and methods

This study uses annual panel data from Japan for the 1975–2023 periods to examine the correlation between population age structure and inflation. A long-term analysis is suitable for this inflation study because Japan's inflation rate has varied substantially (Isa, 2021). The data are obtained from a variety of sources and are all publicly available. Inflation rates are calculated using the Consumer Price Index (CPI), and the data are obtained from the OECD. The population data by age group and total population are sourced from the Statistics Bureau of Japan. Japan's population data provide detailed and precise representation (Li & Managi, 2023). Unlike many other countries, these data rely on a residential record system. The total population is divided into eight age groups, covering infant, toddler, and school-age (0–14); school-age and earlier working years (15–24); earlier working years (25–44); later working years (45–59); later working years and period of retirement (60–64); and the retirement period (65–74) and 75 and above, and 65 and above. The share of the population of an age group of the total population was derived by dividing the population of that age group by the total population.

A decreased youth dependency ratio and increased old-age dependency ratio are indicators of population aging; therefore, including these dependency ratios as predictor variables is essential while modeling population is aging. Youth dependency and old-age dependency ratios are derived from the population by age group. The dependency ratio is defined as "the ratio of the number of persons in a given dependent age group of interest to the number in a different age group considered to contain those persons providing support to those dependent" (Siegel & Swanson, 2004, p. 758). The youth dependency ratio was expressed in percentage of the population aged 0–14 relative to the population aged 15–64, while the old-age dependency ratio was expressed as the percentage of the population aged 65 and above relative to the population aged 15–64.

The data on nominal monthly salaries were sourced from the MHLW of Japan and adjusted to real monthly salaries using CPI as the inflation rate and monthly salary were highly correlated (correlation coefficient [*r*] = 0.89). The unemployment rate, the labor force participation rate, and Nikkei 225 index data were acquired from Japan's Statistics Bureau. The data on the exchange rate of JPY per USD were sourced from the US Federal Reserve System, and trade balance data were from Japan's Ministry of Finance. The money supply measured by M1, which covers currency, demand deposits, and other liquid deposits, were obtained from the International Monetary Fund (IMF). Basic discount rate data were from the Bank of Japan.

Time series data often exhibit serial correlation and tend to be non-stationary, resulting in unreliable model outputs and inaccurate predictions (Stock & Watson, 2003). To eliminate non-stationary and serial correlation influences, new variables were constructed using the percentage changes from period to period, excluding the inflation variable.

The empirical analysis of the relationship between population age structure and inflation included graphical

analysis, the augmented Dickey-Fuller (ADF) test to determine whether the time series exhibits a persistent trend, the Johansen test to examine a cointegrating relationship, the Pearson's correlation coefficient test to measure the linear correlation between two variables, an ordinary least squares (OLS) regression to estimate coefficients while controlling for others, the Breusch-Godfrey (BG) test to detect autocorrelation, and the Breusch-Pagan (BP) test to detect heteroskedasticity. Finally, the Chow test is applied to examine the presence of a structural break at a period.

3. Results

3.1. Descriptive statistics

Table A1 presents the descriptive statistics, indicating that Japan's population has aged over the period under study. For example, youth dependency decreased from 36% to 19% over the period 1975–2023 and old-dependency increased from 11% to 51% over the same period. Moreover, the share of the aged 75 and above population relative to the total population rose from 2.5% in 1975 to 15.8% in 2023.

The first step applies graphical analysis, and Figure 1A and B illustrate the trends in the key demographic variables and the inflation rate. Figure 1A reveals that the inflation rate varies substantially. After the 1973 oil shock, Japan suffered substantially high inflation over the period 1973–74. The inflation rate rose to nearly 30% in 1974, representing the highest rate in postwar Japanese history. It began to decline in 1975, trending downward, although the oil price increased twice as high as before in 1979 (Suzuki, 1981).

The inflation fell to below zero for the first time in 1995. In 2022, inflation started to increase sharply due to the COVID-19 pandemic (UN, 2023b). The vast majority of the inflation surge was due to rising commodity prices. At the same time, those prices in the U.S. and Europe also increased sharply due to the situation in Ukraine (T.Y. Liu & Lee, 2024). The inflation rate averaged 3.58% across the period 1975–95, while that for the 1996–2023 periods was 0.21%.

The Bank of Japan initiated the monetary easing program in 2001 to stimulate a stagnant economy and increase inflation. In Figure 1A, the inflation rate appears to have started increasing in 2001. Nevertheless, the cause of the inflation increase is unknown. Kuroda (2019), the former governor of the Bank of Japan, explained that the Bank of Japan tried various policies to raise inflation, including setting the price stability target at 2%. Table A2 reports the results of the Chow structural break analysis to test the presence of a structural break over a period as a result of the government policy changes.

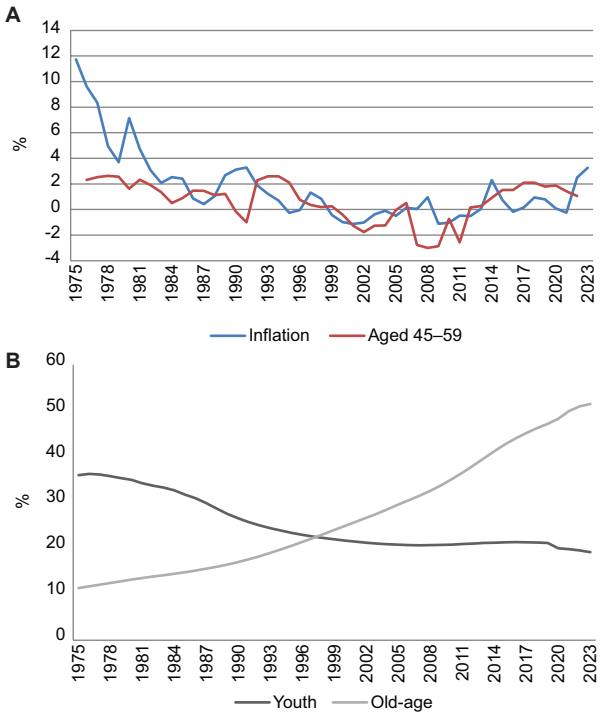

Figure 1. Trends in the inflation rate and demographic variables in Japan, 1975 –2023. (A) Inflation rate and the annual growth rate of the share of the 45–59 age group. (B) Youth and old-age dependency ratios. Sources: (A): Organization for Economic Co-operation and Development (2024); (A and B): Statistics Bureau of Japan (2000–2024).

Figure 1A also illustrates that the 45–59 age group and the inflation rate appeared to co-move closely together. In Figure 1B, the youth dependency ratio trends gently downward while the old-age dependency ratio trends gently upward. Figure 2 presents a scatter diagram that illustrates an inverse relationship between the inflation and unemployment, called the Phillips curve as, noted in Section 1.2.2.

In the second step, this study applied the ADF unit root test, including a constant, to determine whether the time series are stationary. Automatic optimal lag length selection was based on the Schwarz information criterion (SIC), while the maximum lag length was set at 9. The null hypothesis was that a time series contains a unit root. The results are presented in Table 1, revealing that, except for the annual growth rate of the youth dependency ratio$_{t-1}$ variable, the series are stationary at the 0.1 significance level. The test for the annual growth rate of the youth dependency ratio$_{t-1}$ fails to reject the null at the 0.1 significance level. Therefore, instead of the annual growth rate of the youth dependency ratio$_{t-1}$, the youth dependency ratio$_{t-1}$ variable was used for the following analyses. Although the youth dependency ratio was found to be non-stationary, it was maintained in level form to

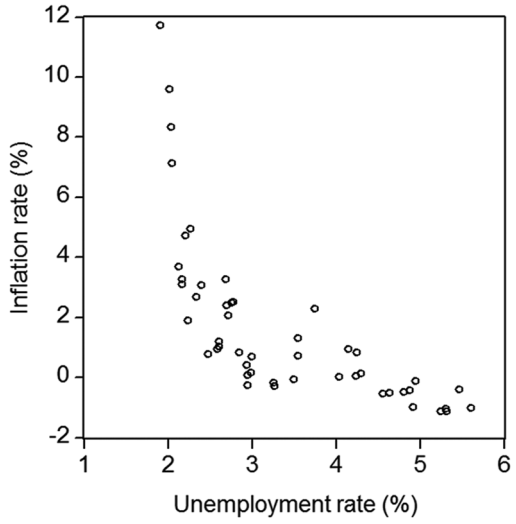

Figure 2. Scatterplot illustrating the inflation rate versus unemployment rate in Japan, 1975–2023
Sources: Organization for Economic Co-operation and Development (2024); Statistics Bureau of Japan (2000–2024).

maintain comparability and interpretability with other stationary demographic ratios.

In the third step, the Johansen test, including a constant, was applied to examine a cointegrating relationship between each time series and inflation. Automatic optimal lag selection was based on the SIC with a lag interval of 1–2. The null hypothesis was that there is no cointegration among the series. The results reported in Table 2 indicate that all series have a cointegrating relationship with inflation, which indicate a long-run equilibrium relationship exists between each series and inflation at the 0.05 significance level.

In the fourth step, Pearson's correlation analysis was performed. The null hypothesis was that there is no linear correlation between a pair of variables. The results of the coefficients are reported in Table 3, indicating that at the 0.05 significance level, inflation demonstrated a positive relationship with total population, the 45–59$_{t-1}$ age group, and the youth dependency ratio$_{t-1}$, while a negative relationship exists between inflation and the old-age dependency ratio$_{t-1}$. In addition, a positive relationship exists between inflation, real salary$_{t-1}$, and the labor force participation rate$_{t-1}$.

3.2. Regression results

The regression in this section further investigates the preliminary correlation results while controlling for others. Tables 4 and 5 present the OLS regression results with different model specifications. Independent variables, including the total population, the share of the population by age group, the youth dependency ratio, and the elderly dependency ratio were included in different models to reduce multicollinearity. For example, the r was 0.917 for total population$_{t-1}$ and youth dependency$_{t-1}$, –0.426 for youth$_{t-1}$ and old-age dependency$_{t-1}$, 0.503 for youth dependency$_{t-1}$ and the 45–59$_{t-1}$ age group, and 0.617 for old-age dependency$_{t-1}$ and the 65–74$_{t-1}$ age group.

Various forms of the model in Equation (I) were estimated to identify parameters that most likely explain the observed data. In Tables 4 and 5, all models showed

Table 1. Augmented Dickey-Fuller (ADF) unit root test statistics, Japan, 1975–2023

Series	ADF *t*-statistic	*p*-value
Inflation rate (%) (annual percentage change in the CPI)	–4.206	0.001
Youth dependency ratio$_{t-1}$[1]	–2.976	0.044
Annual growth rate		
Percentage distribution of age group		
0–14$_{t-1}$	–6.310	0.000
15–24$_{t-1}$	–3.468	0.014
25–44$_{t-1}$	–7.513	0.000
45–59$_{t-1}$	–2.794	0.068
60–64$_{t-1}$	–2.990	0.043
65–74$_{t-1}$	–2.664	0.088
≥75$_{t-1}$	–5.553	0.000
≥65$_{t-1}$	–2.681	0.085
Total population$_{t-1}$	–7.024	0.000
Youth dependency ratio$_{t-1}$	–1.112	0.237
Old-age dependency ratio$_{t-1}$	–2.698	0.082
Real monthly salary$_{t-1}$	–5.552	0.000
Unemployment rate$_{t-1}$	–4.277	0.001
Labor force participation rate$_{t-1}$	–2.920	0.050
Foreign currency exchange rate (JPY per USD$_{t-1}$)	–5.027	0.000
Trade balance$_{t-1}$	–6.067	0.000
Money supply, M1$_{t-1}$	–4.567	0.000
Basic discount rate$_{t-1}$	–4.137	0.002
Nikkei 225 index$_{t-1}$	–6.071	0.000

Notes: Automatic optimal lag length selection is based on the Schwarz information criterion, while the maximum lag length is set at nine.
[1]This youth dependency ratio variable is not in the annual growth rate.
Sources: Bank of Japan (2024); Ministry of Finance Japan (2025); International Monetary Fund (2024); Ministry of Health, Labor and Welfare, Japan (2024); Organization for Economic Co-operation and Development (2024); Statistics Bureau of Japan (2000–2024); the United States Board of Governors of the Federal Reserve System (2024).
Abbreviation: CPI: Consumer price index.

Table 2. Johansen, cointegration test statistics, Japan, 1975–2023

Series	Eigenvalue	Trace statistic
Youth dependency ratio$_{t-1}$[1]	0.294	24.575**
Annual growth rate		
Percentage distribution of age group		
0–14$_{t-1}$	0.428	30.951**
15–24$_{t-1}$	0.365	22.668**
25–44$_{t-1}$	0.344	29.918**
45–59$_{t-1}$	0.351	25.919**
60–64$_{t-1}$	0.263	23.091**
65–74$_{t-1}$	0.296	17.227*
≥75$_{t-1}$	0.304	26.401**
≥65$_{t-1}$	0.310	18.599*
Total population$_{t-1}$	0.274	15.573*
Old-age dependency ratio$_{t-1}$	0.324	19.177*
Real monthly salary$_{t-1}$	0.418	40.692**
Unemployment rate$_{t-1}$	0.281	28.457**
Labor force participation rate$_{t-1}$	0.285	23.611**
Foreign currency exchange rate (JPY per USD) $_{t-1}$	0.321	31.545**
Trade balance$_{t-1}$	0.466	42.086**
Money supply, M1$_{t-1}$	0.280	27.291**
Basic discount rate$_{t-1}$	0.394	37.074**
Nikkei 225 index$_{t-1}$	0.395	32.948**

Notes: *p<0.05, **p<0.01. Automatic optimal lag length selection is based on the Schwarz information criterion with a lag interval of 1–2. [1]This youth dependency ratio variable is not in the annual growth rate. Sources: Bank of Japan (2024); Ministry of Finance Japan (2025); International Monetary Fund (2024); Ministry of Health, Labor and Welfare, Japan (2024); Organization for Economic Co-operation and Development (2024); Statistics Bureau of Japan (2000–2024); the United States Board of Governors of the Federal Reserve System (2024).

Table 3. Pearson's correlation coefficient between the inflation rate *t* and the annual growth rates of explanatory variables$_{t-1}$, Japan, 1975–2023

Variables (r)	Coefficients
Total population$_{t-1}$	0.654***
Percentage distribution of age group	
0–14$_{t-1}$	0.032
15–24$_{t-1}$	0.168
25–44$_{t-1}$	0.064
45–59$_{t-1}$	0.497***
60–64$_{t-1}$	–0.069
65–74$_{t-1}$	0.017
≥75$_{t-1}$	0.006
≥65$_{t-1}$	–0.037
Youth dependency ratio$_{t-1}$[1]	0.775***
Old-age dependency ratio$_{t-1}$	–0.302*
Real monthly salary$_{t-1}$	0.358**
Unemployment rate$_{t-1}$	–0.163
Labor force participation rate$_{t-1}$	0.344*
Foreign currency exchange rate (JPY per USD$_{t-1}$)	0.148
Trade balance$_{t-1}$	0.039
Money supply, M1$_{t-1}$	0.101
Basic discount rate$_{t-1}$	0.127
Nikkei 225 index$_{t-1}$	0.035

Notes: *p<0.05, **p<0.01 ***p<0.001 (two-tailed). [1]This youth dependency ratio variable is not in the annual growth rate. Sources: Bank of Japan (2024); Ministry of Finance Japan (2025); International Monetary Fund (2024); Ministry of Health, Labor and Welfare, Japan (2024); Organization for Economic Co-operation and Development (2024); Statistics Bureau of Japan (2000–2024); the United States Board of Governors of the Federal Reserve System (2024).

overall significance of the regression. In Model 1, the total population$_{t-1}$ is an independent variable, and the results indicate that there is sufficient evidence to reject the null hypothesis and accept the hypothesis that an increase in the total population$_{t-1}$ is associated with increased inflation at the 0.1 significance level. In addition, the results also indicate a positive association between the energy shock period and inflation.

In Models 2-1–2-3, all variables for the share of the population by age group$_{t-1}$ were independent variables. Unemployment$_{t-1}$ and basic discount rate$_{t-1}$ were included in Models 2-1 and 2-2 due to the moderate correlation (r = –0.441) between the two variables. Model 2-3 introduced the period variables into the Models 2-1 and 2-2. In Models 2-1–2-3, a population increase in the 0–14$_{t-1}$, 25–44$_{t-1}$, 45–59$_{t-1}$, and 60–64$_{t-1}$ age groups was associated with increased inflation. The magnitude of the coefficient for the population by age group increases as the age increases until reaching the 45–59$_{t-1}$ age group, indicating that as age increases, the positive association between an age group and inflation rises until reaching the 45 –59$_{t-1}$ age group. In other words, a change in the 45–59$_{t-1}$ later working-age group has the most substantial positive effect on inflation among the age groups examined.

In Model 2-1, the coefficient for the 45–59$_{t-1}$ (1.129) indicates that a 1% population increase in the 45–59 age group 1 year prior is associated with 0.011points increase in inflation while controlling for others. While the estimated positive sign for the 45–59$_{t-1}$ group matched the findings of the earlier graphical and correlation analyses, 15–24$_{t-1}$, 65–74$_{t-1}$, 75 and above$_{t-1}$, and 65 and above$_{t-1}$ age groups were insignificant. The 25–44 age group findings aligned with those of Albuquerque *et al.* (2020), who found that the 20–34

Table 4. Ordinary least squares estimates, Japan, 1975–2023

Explanatory variables (annual growth rate)	Model 1	Model 2-1	Model 2-2	Model 2-3
Intercept	−0.045	1.532	1.481	1.684
	(0.211)	(0.433)	(0.447)	(0.454)
	0.833	0.001	0.002	0.001
Total population$_{t-1}$	5.448			
	(0.520)			
	0.000			
Aged 0–14$_{t-1}$		0.430	0.427	0.449
		(0.154)	(0.149)	(0.157)
		0.008	0.006	0.007
Aged 25–44$_{t-1}$		0.652	0.587	0.829
		(0.268)	(0.287)	(0.287)
		0.019	0.048	0.006
Aged 45–59$_{t-1}$		1.129	0.821	0.986
		(0.199)	(0.222)	(0.195)
		0.000	0.001	0.000
Aged 60–64$_{t-1}$		0.315	0.281	0.215
		(0.100)	(0.099)	(0.097)
		0.003	0.007	0.033
Real monthly salary$_{t-1}$			0.369	
			(0.218)	
			0.099	
Unemployment$_{t-1}$	−0.069	−0.076		
	(0.019)	(0.028)		
	0.001	0.011		
Labor force participation rate$_{t-1}$	1.014		1.108	1.101
	(0.308)		(0.551)	(0.571)
	0.002		0.051	0.061
Foreign currency exchange rate$_{t-1}$		0.045	0.050	
		(0.026)	(0.025)	
		0.097	0.061	
Basic discount rate$_{t-1}$			0.011	0.010
			(0.005)	(0.005)
			0.065	0.099
Bubble economy period (1986–91)	−0.763			0.873
	(0.495)			(0.831)
	0.132			0.300
COVID-19 pandemic (2020–22)	0.668			1.779
	(0.728)			(1.054)
	0.364			0.100
Energy shock (2022–23)	4.567			2.028
	(0.870)			(1.270)
	0.000			0.119
F-statistic	23.533	5.873	5.314	4.526
p-value on joint	0.000	0.000	0.000	0.000
R^2	0.780	0.469	0.528	0.524
Adjusted R^2	0.747	0.389	0.429	0.409

Note: Coefficients are in the first row, standard errors are in parentheses in the second row, *p*-values are in the third row. Dependent variable: The inflation rate $_t$(%).
Sources: Bank of Japan (2024); Ministry of Finance Japan (2025); International Monetary Fund (2024); Ministry of Health, Labor and Welfare, Japan (2024); Organization for Economic Co-operation and Development (2024); Statistics Bureau of Japan (2000–2024); the United States Board of Governors of the Federal Reserve System (2024).

Table 5. Ordinary least squares, Japan, 1975–2023

Explanatory variables (annual growth rate)	Model 3-1	Model 3-2	Model 4-1	Model 4-2
Intercept	−6.229	−7.172	2.939	3.662
	(0.810)	(0.778)	(1.182)	(1.400)
	0.000	0.000	0.017	0.012
Youth dependency ratio$_{t-1}$[1]	0.302	0.339		
	(0.031)	(0.031)		
	0.000	0.000		
Old-age dependency ratio$_{t-1}$			−0.628	−0.840
			(0.353)	(0.402)
			0.082	0.043
Real monthly salary$_{t-1}$			0.561	0.496
			(0.151)	(0.157)
			0.000	0.003
Unemployment$_{t-1}$		−0.040		
		(0.019)		
		0.038		
Labor force participation rate$_{t-1}$	0.920	0.551	1.106	1.040
	(0.308)	(0.304)	(0.388)	(0.397)
	0.005	0.078	0.006	0.012
Foreign currency exchange rate$_{t-1}$	0.056	0.036		
	(0.017)	(0.016)		
	0.002	0.031		
Bubble economy period (1986–91)		−0.716		0.167
		(0.495)		(0.675)
		0.156		0.806
COVID-19 pandemic (2020–22)		0.110		−1.641
		(0.688)		(1.077)
		0.873		
				0.135
Energy shock (2022–23)		2.570		1.977
		(0.825)		(1.127)
		0.003		0.087
F-statistic	36.555	22.365	9.754	5.708
p-value on joint	0.000	0.000	0.000	0.000
R^2	0.719	0.801	0.411	0.497
Adjusted R^2	0.699	0.764	0.379	0.415

Notes: Coefficients are in the first row, standard errors are in parentheses in the second row, *p*-values are in the third row. Dependent variable: The inflation rate $_t$(%). [1]This youth dependency ratio variable is not in the annual growth rate.
Sources: Bank of Japan (2024); Ministry of Finance Japan (2025); International Monetary Fund (2024); Ministry of Health, Labor and Welfare, Japan (2024); Organization for Economic Co-operation and Development (2024); Statistics Bureau of Japan (2000–2024); the United States Board of Governors of the Federal Reserve System (2024).

age group has a positive impact on inflation in 24 OECD countries for the period 1961–2014. However, the findings from current analysis for the 45–59 and 60–64 age groups differ from those of Albuquerque *et al.* (2020), who observed that the 35–64 age group has negative effect on inflation.

The youth dependency ratio$_{t-1}$ was an independent variable in Models 3-1 and 3-2 and was associated with

an increased inflation rate. In other words, a decrease in this ratio is associated with a decreased inflation rate. The positive sign for the youth dependency ratio$_{t-1}$ is consistent with the results from the correlation analysis. In addition, the result indicates that a positive association exists between the energy shock period and inflation.

In Models 4-1 and 4-2, the old-age dependency ratio$_{t-1}$ was an independent variable. In these models, an increase in the ratio was associated with decreased inflation. In Model 4-2, the coefficient for the old-age dependency ratio$_{t-1}$ indicates that a 1% increase in the old-age dependency in one year prior is associated with approximately 0.01 point decrease in the inflation rate while controlling for others. The estimated negative sign for the old-age dependency ratio$_{t-1}$ is consistent with the results from the correlation analysis.

These finding is also consistent with those of Y. Liu & Westelius (2016) and Lee *et al*., (2024) who all found that population aging in Japan is deflationary, while the findings of this study contradict Isa (2021), who found that population aging in Japan is inflationary. It also matches those of Bruér (2002), conducted in Sweden for the period 1961–2000, and those of Faik (2012), conducted in Germany for the period 1983–2000, both of which reported that population aging is deflationary, although the analyses periods are different. The Sweden study was conducted 15 years before the current Japan's period.

Moreover, the findings from this analysis match those of Gajewski (2015), Yoon *et al*. (2018), and Broniatowska (2019) who all reported that population aging is deflationary in OECD countries. In addition, an increase in health services and LTCI expenditures, together with a growing demand for LTCI noted in Section 1.2.1, applies not only to Japan but also to many OECD and other countries. For example, in 2023, the U.S. state of Washington launched the WA Cares Fund, the nation's first public, mandatory LTCI program to provide more security in an aging society for working Washingtonians (Washington State Department of Social and Health Services, 2023). An increase in LTCI expenditures associated with a rising share of older adults could increase aggregate demand through several pathways.

The results of the BP and BG tests are presented in Table A3. The BG test was applied to detect autocorrelation in all models. The null hypothesis was that there is no autocorrelation in the residuals. The results indicate that no significant autocorrelation was detected in the residuals for all models at the 0.05 significance level. The BP test was also applied to detect the presence of heteroskedasticity. The null hypothesis was that the residual variances are constant in a regression model. The results revealed that homoscedasticity, where the residual variances are constant, was present for all models at the 0.05 significance level. Furthermore, to detect multicollineariy among the age groups in Models 2-1–2-3, the variance inflation factor (VIF) method was used. As Table A4 shows, there were no large VIF values, indicating that there were no serious multicollinearity problems. In Models 1, 3-1, 3-2, 4-1, and 4-2, the VIF values were less than 1.5 for all explanatory variables.

In addition, in Models 1–4-2, the results that included control variables indicate that an increase in individual real monthly salary, labor force participation rate, foreign currency exchange rate, and basic discount rate is associated with increased inflation. In contrast, an increase in the unemployment rate is associated with decreased inflation. Nevertheless, the coefficients for the foreign currency exchange rate, basic discount rate, and unemployment rate were small, indicating a weak relationship between the explanatory variable and inflation. To examine potential endogeneity, the Granger causality test was applied. The results are presented in Table A5, revealing the existence of Granger causality from the foreign currency exchange rate and the basic discount rate to inflation, but no evidence of vice versa. In contrast, there was a bidirectional causality between real salary and inflation, suggesting a mutually reinforcing relationship between the two.

These findings revealed that an increase in real salary in the previous year was associated with increased inflation, whereas Hirose (2022) determined that an increase in nominal salary contributes to higher inflation in Japan. Moreover, these results indicate that the inflation rate during the energy shock period (2022–23) was higher than that of the non-energy shock period. However, there was insufficient evidence to support that inflation is associated with trade balance, M1, the Nikkei stock, the bubble economy period, and the pandemic period.

Finally, the Chow test was applied in Model 2-1 to test the presence of a structural break that may have resulted from government policy changes as noted in Section 3.1. The null hypothesis was that there is no structural break in the regression model. The results are presented in Table A2, revealing structural breaks in the year 1986, 1989, 1997, 2000, 2001, and 2004 at the 0.05 significance level. This means that the regression coefficients differ significantly before and after the known break-point for those years.

4. Discussion

The aim of this study was to provide additional evidence regarding how population age structure is associated with inflation in Japan. Several notable findings from this study merit discussion.

The first discussion is that the empirical results indicate that an increased population among the 0–14, 25–44, 45–59, and 60–64 age groups in the previous year is associated with increased inflation. As the ages increase, the positive association between the age group and inflation becomes greater until reaching the 45 –59_{t-1} age group. This finding raises the important question of why a change in the 45–59 later working-age group population is most positively associated with inflation out of the age groups analyzed? There may be several reasons for this association. One is that an increase in the population of the 45–59 age group might be associated most with increased aggregate demand through several different pathways. Shirakawa (2013) reported that demographic changes substantially change an economy's demand structure. Meanwhile, Keynesian theory states that total spending in an economy, also called aggregate demand, strongly influences economic output and increases inflation (Abel *et al.*, 2009).

This age group's expenditures, salaries, and incomes seem to be the highest among the age groups. Surveys in Japan showed that monthly expenditure by household heads' age, annual salary, and monthly income tend to increase as age increases until aged 50–59 (National Tax Agency of Japan, 2024; Statistics Bureau of Japan, 2024). According to the Statistics Bureau of Japan (2024), in 2023, the households with two or more people headed by aged 50–59 had, on average, the highest level of total monthly expenditures (JPY 348,025), compared with 272,468 for aged under 40; 323,660 for aged 40–49; 306,476 for aged 60–69; and 249,177 for aged 70 and above. In Japan, consumer spending increases until reaching the aged 50–59 and decreases thereafter. In this context, it is possible that an increase in the population of the 45–59 age group is most associated with increased aggregate demand through several pathways.

Another possible reason is that inflation expectations among those in the 45–59 age group may be higher than those of other age groups. Inflation expectations refer to the beliefs that people and firms have about future inflation increases. For example, if firms expect increased inflation, they may increase product and service prices, resulting in increased inflation. If workers expect increased inflation, they may demand increased wages, which would also increase inflation.

Ueda (2025), the governor of the Bank of Japan, states that inflation expectations are one of main causes of recent inflation. Many recent analyses have shown that households' inflation expectations are affected by their experience (Kuroda, 2019; Shirakawa, 2013; UN, 2023b). The Becker Freidman Institute (2022) found that the inflation expectations among those aged 40–60 are higher than aged under 40 in the U.S. Younger age groups' inflation expectations are lower than older age groups (Blanchflower & MacCoille, 2009), especially those who had experienced relatively high inflation (Kuroda, 2019; 2022). The inflation expectations for those in the 45–59 later working-age groups may be higher than those of younger age group, as they have experienced difficult employment and living circumstances under high inflation during the 1973–90 periods.

These could be the reasons why the 45–59 age group is most positively associated with inflation. However, a more comprehensive understanding of the mechanisms behind this relationship will provide valuable insights into implementing more effective policy approaches to address population aging, establish overall economic stability, and control inflation. Thus, further research is required to better understand this positive relationship.

The second finding is that the results indicate an increase in old-age dependency is associated with decreased inflation. One possible explanation is that minimal spending of those aged 65 and above compared with that of the 15–64 age group could be related to lower aggregate demand. Shirakawa (2013) reported that aging changes the economy's demand structure. This is the opposite circumstances for the 45–59 age group as noted above. Shirakawa (2012) also suggested that aging leads to downward pressure on inflation rates. Similarly, surveys indicate that older adults spend less than younger adults, and their salaries and incomes are also lower (National Tax Agency of Japan, 2024; Statistics Bureau of Japan, 2024). The lower spending may also be linked to other issues, such as declines in health, energy levels, or preserving savings, as noted in Section 1.2.1. Japan's deflationary bias may be reinforced by structural features unique to its economy—such as the high saving preference of the older adults population—while the nation continues to age rapidly and remains the oldest society in the world (UN, 2023a).

Another possible reason for the observed association between higher old-age dependency and decreased inflation may relate to political influence as noted in Section 1.2.1. Bullard *et al.* (2012) and Katagiri *et al.* (2014) reported that inflation is lower when older adults have more influence over redistributive policy. In summary, these reasons may explain why this study finds higher old-age dependency to be associated with decreased inflation. However, it is difficult to establish a definite causal link due to several complex factors. Therefore, additional research into this negative relationship is warranted.

4.1. Policy implications

The empirical results indicate that decreased youth dependency and increased old-age dependency in the prior year are associated with decreased inflation. Japan's youth dependency is projected to decrease from 18.5% in 2025 to 17.6% in 2060, while the old-age dependency is projected to increase from 49.2% in 2025 to 71.8% in 2060 (Statistics Bureau of Japan, 2023, 2025). All else being equal, this structural change is likely to lower inflation. Therefore, policy controls by the government may be needed to stabilize economic output and control inflation. The policy direction depends on the current inflation rate which is above or below the target inflation rate (2%).

The findings from this study indicate that an increase in the share of the working-age population among individuals in 25–44, 45–59, and 60–64 age groups in the prior year is correlated with increased inflation. Specifically, as population age increases, its correlation with increased inflation tends to rise until age 45–59. This 45–59 age groups is characterized by career stability and seniority. Leveraging their high level of experience and expertise improves productivity, eventually affecting inflation. On the other hand, among this age group, a variety of complex health challenges increase, including stress from meeting work demands (Halloran, 2024). Companies should support employee health, including work stress. Thus, the government should implement policies to protect the health of the working-age population.

Another way to increase inflation is to encourage older adults to spend more. The share of the population aged 65 and above is projected to be 37.9% in 2060 (Statistics Bureau of Japan, 2023). The market for older adults is growing rapidly with spending power. However, older adults can face mobility challenges due to declines in health and energy levels as noted in Section 1.2.1. The government can implement policies that facilitate easier shopping for them. Alternatively, the government can support the private sector through funding to develop new products which will be favored by and support the older adults.

4.2. Limitations

One of the limitations of this research was that the data were mainly demographic and economic factors, as changes in these factors have a profound impact on inflation. However, inflation is a function of more factors than those applied in this study. Although longer-term data with volatile fluctuations would be advantageous for examining Japan's inflation trajectory (Isa, 2021), some of the explanatory variable data for certain periods could not be found, as the study period covered almost a half-century. This study can be expanded by leveraging other variables. For example, the inclusion of inflation expectations would provide a better measurement of the association between aging and inflation. Further research should identify additional explanatory variables.

Another limitation was that a Newey-West estimator is not available in the software used. To address this limitation, alternative rigorous methods, including the BG, BP, Johansen, and Granger causality tests, were used.

5. Conclusion

This study provides new evidence regarding the relationship between population structure and inflation in Japan using regression analysis for the period 1975–2023. The findings revealed that an increase in the total population, as well as the share of the population in the 0–14, 25–44, 45–59, and 60–64 age groups in the prior year is associated with increased inflation.

Specifically, as age increases, the positive association tends to increase until age 45–59, and an increase in the population of the 45–59 age group is most positively associated with inflation among the age groups examined.

The findings indicate that decreased youth dependency and increased old-age dependency in the previous year are associated with decreased inflation, suggesting that Japan's population aging is associated with a decreased inflation rate. One possible explanation is that the spending of the 65 and above population, which is lower than that of the 15–64 age group, could be associated with lower aggregate demand through several pathways. The lower expenditure may be linked to lower income, declines in health and energy levels, or preserving savings.

In addition, the results indicate that an increase in real salary, the labor force participation rate, exchange rate, and basic discount rate is associated with increased inflation while an unemployment rate increase is associated with decreased inflation; the inflation rate during the energy shock period (2022–23) was higher than that of the non-energy shock period.

The relationship between demographics and inflation is complex. Hence, additional research is required to elucidate the underlying mechanisms, thereby providing more effective policy insights to address population aging, sustain overall economic stability, and control inflation.

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Appendix

Table A1. Descriptive statistics, Japan, 1975–2023

Variable	Mean	Standard deviation	Minimum	Maximum
Inflation rate (annual percentage change in the CPI: %)	1.658	2.785	–1.130	11.730
CPI	93.484	12.376	54.611	107.500
Total population (thousand)	124,033	4,429	111,940	128,084
Population by age group (thousand)				
0–14	20,468	4,577	14,173	27,747
15–24	15,319	2,533	11,730	19,290
25–44	34,234	2,609	27,671	37,377
45–59	24,784	2,657	17,824	28,197
60–64	7,188	1,706	4,285	10,590
65–74	12,136	3,971	6,027	17,683
≥75	9,904	5,458	2,842	20,078
≥65	22,040	9,359	8,869	36,236
Youth dependency ratio (aged 0–14/aged 15–64); (%)	25.209	5.687	19.165	36.230
Old-age dependency ratio (aged≥65/aged 15–64); (%)	26.901	12.631	11.344	51.436
Nominal monthly salary (JPY)	270,835	48,639	130,004	316,622
Unemployment rate (%)	3.366	1.117	1.900	5.608
Labor force participation rate (%)	62.047	1.541	64.000	59.100
Foreign currency exchange rate, JPY per USD	144.69	58.746	79.696	296.785
Trade balance, (million JPY)	4,255,437	7,681,838	–20,329,541	13,991,357
Money supply, M1 (billion JPY)	361,281	283,655	54,727	1,065,003
Basic discount rate (%)	2.124	2.431	0.1	8.146
Nikkei 225 index	15,744	7,629	4,538	38,915

Sources: Bank of Japan (2024); Ministry of Finance Japan (2025); International Monetary Fund (2024); Ministry of Health, Labor and Welfare, Japan (2024); Organization for Economic Co-operation and Development (2024); Statistics Bureau of Japan (2000–2024); the United States Board of Governors of the Federal Reserve System (2024).

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Table A2. Chow test statistics for structural break, Japan, 1975–2023

The government policy change	*F*-statistic	*p*-value
1986, Tax reform	12.458	0.000**
1989, Consumption tax 3%: First consumption tax	10.364	0.000**
1997, Consumption tax 5%	12.153	0.000**
2000, Long-term care insurance was launched.	7.391	0.000**
2001, Monetary quantitative easing	7.109	0.000**
2004, Monetary quantitative easing	4.201	0.002**
2010, Tax reform	2.091	0.072
2013, Monetary easing program: Set the "price stability target" at 2%	0.893	0.522
2014, Consumption tax 8%	0.524	0.810

Notes: *p<0.05, **p<0.01. Model 2-1 is applied.
Sources: Bank of Japan (2024); Ministry of Finance Japan (2025); International Monetary Fund (2024); Ministry of Health, Labor and Welfare, Japan (2024); Organization for Economic Co-operation and Development (2024); Statistics Bureau of Japan (2000–2024); the United States Board of Governors of the Federal Reserve System (2024).

Table A3. Statistics of the Breusch-Godfrey test for autocorrelation, and Breusch-Pagan test for heteroskedasticity, Japan, 1975–2023

Breusch-Godfrey test			Breusch-Pagan test		
Model	*F*-statistic	*p*-value	Model	*F*-statistic	*p*-value
1	0.643	0.669	1	1.824	0.097
2-1	1.315	0.277	2-1	1.112	0.382
2-2	1.345	0.266	2-2	1.807	0.112
2-3	1.549	0.227	2-3	0.971	0.505
3-1	2.050	0.107	3-1	1.831	0.089
3-2	1.556	0.199	3-2	1.592	0.136
4-1	2.029	0.129	4-1	1.560	0.185
4-2	1.718	0.151	4-2	1.812	0.100

Sources: Bank of Japan (2024); Ministry of Finance Japan (2025); International Monetary Fund (2024); Ministry of Health, Labor and Welfare, Japan (2024); Organization for Economic Co-operation and Development (2024); Statistics Bureau of Japan (2000–2024); the United States Board of Governors of the Federal Reserve System (2024).

Table A4. Variance inflation factor of Models 2-1 – 2-3, Japan, 1975–2023

Variable	Model 2-1	Model 2-2	Model 2-3
Aged 0–14$_{t-1}$	2.562	2.570	2.758
Aged 25–44$_{t-1}$	2.438	2.736	2.857
Aged 45–59$_{t-1}$	1.733	1.993	1.745
Aged 60–64$_{t-1}$	1.912	1.996	1.834
Real monthly salary$_{t-1}$		1.760	
Unemployment rate$_{t-1}$	1.375		
Labor force participation rate$_{t-1}$		1.776	1.779
Foreign currency exchange rate$_{t-1}$	1.288	1.336	
Basic discount rate$_{t-1}$		1.199	1.210
Bubble economy period (1986–91)			1.449
COVID-19 Pandemic (2020–22)			1.210
Energy shock (2022–23)			1.191

Sources: Bank of Japan (2024); Ministry of Finance Japan (2025); International Monetary Fund (2024); Ministry of Health, Labor and Welfare, Japan (2024); Organization for Economic Co-operation and Development (2024); Statistics Bureau of Japan (2000–2024); the United States Board of Governors of the Federal Reserve System (2024).

Table A5. Statistics of the Granger causality test, Japan, 1975–2023

Null Hypothesis	*F*-statistic	*p*-value
Foreign currency exchange rate does not Granger cause inflation	7.052	0.002**
Inflation does not Granger cause foreign currency exchange rate	0.901	0.414
Basic discount rate→Inflation	2.995	0.061*
Inflation→Basic discount rate	0.443	0.645
Real salary→Inflation	3.319	0.046**
Inflation→Real salary	6.834	0.003**

Notes: *p<0.1, **p<0.05. The arrow "→" denotes no Granger causality.
Sources: Bank of Japan (2024); Ministry of Health, Labor and Welfare, Japan (2024); Organization for Economic Co-operation and Development (2024); the United States Board of Governors of the Federal Reserve System (2024).