

Population Aging and Economic Growth in Malaysia: New Evidence using Panel Threshold Analysis

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Abstract

Research Originality: This research contribution focuses on the panel threshold model to examine the non-linear relationship between population aging and economic development in Malaysia.

Research Objectives: This study aims to investigate the impact of aging on state economic growth in Malaysia (comprising 13 states and two federal territories) from 2005 to 2021.

Research Methods: This study employed a threshold regression to identify the minimum turning point of aging that significantly impacts the Malaysian state's economic growth, while controlling for other factors.

Empirical Results: The results revealed a single threshold effect between aging and economic growth, indicating a nonlinear positive relationship. The labor force aged 15-64 years has a positive impact on states' economic development.

Implications: Therefore, these findings underscore the importance of policymakers focusing on the turning point to achieve balanced economic growth. These new findings are crucial for policymakers as additional input for implementing government policies, especially the National Senior Citizens Policy (DWEN) and the Malaysian Population Policy, to stimulate sustainable economic growth in the Malaysian state.

Keywords:

population growth; aging; economic growth; panel threshold model

How to Cite:

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INTRODUCTION

The world's population aging poses challenges to consumption, savings, employment, and economic growth (Bloom & Luca, 2016). Since the 21st century, population aging has become one of the greatest challenges for humanity, profoundly impacting various fields, especially the economy (Liu, 2023). The issue of aging becomes critical when viewed in a broader context, including its relationship to population dynamics, demographic imbalances, and the future workforce. According to a United Nations projection (2015), Malaysia is expected to be an aging country in 2030, with the population aged 60 and above accounting for 15 percent of the total population. The rising aging population in both developed and developing countries has raised concerns among practitioners due to the reduction in the active workforce. For instance, Japan is considered a "super-aged nation," with approximately 30% of its population aged 65 or older in 2021. Although this statistic was anticipated, the issues related to aging and the challenges the Japanese government faces are becoming increasingly severe. Due to its low fertility rate, Japan likewise faces a declining population. Hence, Japan has to deal with the issue of covering the rising cost of social security and the shortage of labor, which affects the country's productivity.

Population aging trends are relevant to the SDGs 2030, including eradicating poverty, ensuring inclusive and equitable quality education, promoting lifelong learning opportunities, promoting sustained and sustainable economic growth, and achieving full and productive employment. According to the United Nations, an aging population is defined as changes in a population's age composition, such as an increase in the proportion of elderly aged 65 and above. There are approximately 727 million people worldwide aged 65 and above, most of whom live in low- and middle-income countries (United Nations, 2020). Over the next three decades, the elderly population is projected to grow by more than half, reaching more than 1.5 billion by 2050 (United Nations, 2020). Several factors may contribute to a significant increase in the aging population, including declining fertility rates, changes in marriage patterns, increased levels of education among younger generations, and other factors related to an aging population. However, the rapid increase in the global aging population will have a significant impact on almost all aspects of society (Cai, 2020; Roy, 2022).

Previous studies, such as Bloom & Luca (2016) and Lukyanets et al. (2021), have widely discussed the potential economic consequences of an aging population. An emerging concept that has gained popularity in recent literature is treating the issue as a demographic transition rather than a population increase. There is mixed evidence on the impact of population aging on economic growth, with both positive and negative relationships (Zhou & Li, 2019). The study found that the elderly population with a solid educational background will have a positive effect due to their large quantitative advantage and a productive characteristic that continues to contribute to China's economic growth. In addition, He et al. (2022) found that population aging has a significant positive impact on economic growth and on the economic growth of more developed areas in China.

On the other hand, Abd Rahman et al. (2020) found a negative effect on economic growth through two main channels: private consumption and government spending, across 32 upper-middle-income countries from 1990 to 2018. These countries will continue to fall into the middle-income trap, particularly as their populations age. In addition, according to Brendan and Sek (2016), Japan has various active-aging policies, such as employing the elderly in the workforce, to address these issues. This initiative will have the dual effect of mitigating the adverse effects of population aging while simultaneously generating greater economic benefits for the country. However, the elderly population aged 75 and above has a positive relationship with economic growth, as observed by Oliver (2015). In a recent study, Maestas et al. (2023) found that each 10 percent increase in the fraction of the population age 60+ decreased per capita GDP by 5.5 percent in the US. In addition, Sahoo et al. (2023) argued that the combined problems of the double burden of disease and population aging pose a severe sustainability challenge for healthcare financing and the entire health system.

In the context of the nonlinear studies, Lee and Shin (2019), Yang et al. (2021), and Le and Park (2020) examined the nonlinear effect of aging and economic growth. They found that the impact of an aging population on economic growth reaches a high level because, when the rate of population aging is low, the share rises, which does not correspond to a decrease in the share of the working-age population. However, when the old-age dependency ratio reaches a high level, the share of the working population will decline, thereby impeding economic growth (Lee & Shin, 2021; Ahmad & Khan, 2019). Mohd et al. (2021) observed that the study relates to Malaysia, which is projected to experience the negative effects of an aging population, including a decline in saving rates, unemployment, and a fall in the fertility rate. Demographic changes may affect not only economic growth but also savings and capital accumulation through labor-market mechanisms. Maestas et al. (2023) and Yusuf et al. (2020) argued that a declining fertility rate and rising indicators of aging, such as the old-age dependency ratio and the percentage of the population aged 65 and above, would have a negligible effect on economic growth. According to the studies (Roy, 2022; Hu et al., 2020; Cai, 2020), generating the second demographic dividend is essential in tackling the aging population.

In Malaysia, a recent study by Tassim (2020) examined the impact of an aging population on the country's economic growth between 1990 and 2017 and found that the aging population and increased spending on education have a significant effect on long-term economic growth. He proposed that improvements be made to the education sector to help the country become a high-income country while addressing the aging population. These improvements will lead to greater human capital. Bawazir et al. (2019) noted that labor force and demographic characteristics, such as population growth rate, were positively correlated with the old-age dependency ratio. In addition, Mamun et al. (2020) employed a time series analysis from 1972 to 2015 and found a positive long-run relationship between the aging population and GDP per capita. Similarly, the findings of Ismail et al. (2015) revealed that a decline in fertility rates affected economic growth, suggesting that even if a country's fertility rates decline, it may still result in

higher economic growth rates (Prettner, 2013). However, studies such as Nagarajan et al. (2021) and Maity & Sinha (2021) indicated that population aging is caused by various factors, including increases in life expectancy and declines in fertility rates, both of which have a substantial effect on the economy.

The issue of an aging population has been a serious concern for the Malaysian government, as the increase in the proportion of people aged 65 and above over the past decade has been consistent. For example, in 2022, the estimated percentage of the population 65 and above was 7.3%, or approximately 2.4 million people, an increase of 0.3% from the previous year. Based on population estimates for 2021, the rise in the population's average age is a significant contributor to the increase in life expectancy, indicating that people are expected to live longer. Currently, the average life expectancy at the age of 60 for females in Malaysia is 81.8 years, while for males it is 78.9 years (DOSM, 2022). Hence, this population aging issue has received special attention from the federal and state governments in Malaysia, as it can affect human capital, government spending, and future economic development.

Figure 1. The Scatter Plot of Population Aging and Economic Growth, 2005-2021

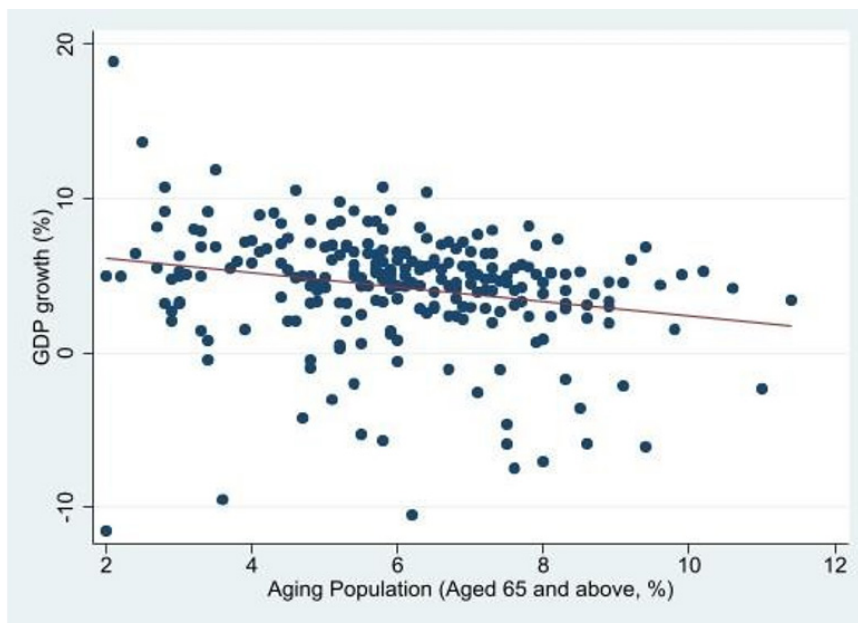
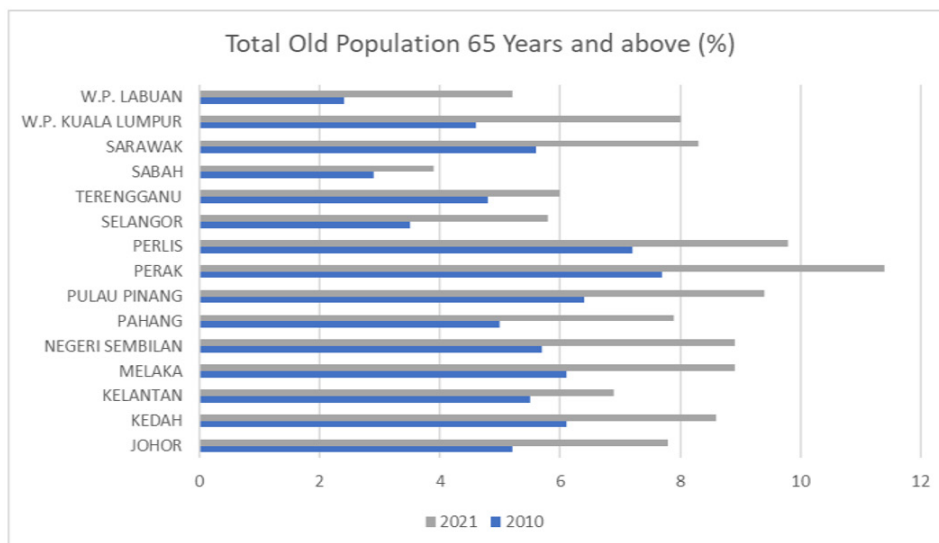


Figure 1 presents data on aging and economic growth for 13 states and two federal territories from 2005 to 2021. The figure exhibits the relationship between aging and economic growth. The scatter plot shows a negative relationship between states' GDP growth and their aging populations. In addition, Figure 2 shows that Malaysia is undergoing population aging. Perak is the only state considered to have an elderly population, followed by Perlis and Pulau Pinang. The trend of an aging population in Perak has increased from 7.7 percent in 2010 to 11.4 percent in 2021. There is evidence of an increase in the life expectancy of senior citizens in Perak, as shown by the rising

proportion of the population aged 65 and above. This is due to advancements in science and technology, rising educational and living standards, increased awareness of healthcare, and falling fertility rates (Taasim, 2020; Hu et al., 2020). The aging population plays a significant role in the age structure of both the workforce and the overall population. With the increase in the proportion of older people in the population, the share of working-age individuals has decreased significantly, and the decline in human capital has continued to accelerate. Undoubtedly, one of the primary reasons for the recent slowdowns in economic expansions is the gradual weakening of demographic factors.

The relationship between an aging population and economic growth has been widely examined across countries, yet research focusing on Malaysia remains scarce. While demographic shifts are becoming more prominent in the region, limited empirical evidence has been provided in the Malaysian context to inform policymakers. This study, therefore, seeks to fill this gap by investigating how the aging population influences economic growth in Malaysia. The findings will provide policymakers with essential insights to shape future strategies within key frameworks, including the National Senior Citizens Policy (DWEN), the Malaysian Population Policy, and the National Policy for Older Persons (NPOPs).

Figure 2. The Total Aging Population (65 years and above), 2005-2021



Despite existing studies, such as those by Mohd et al. (2021) and Tassim (2020), which highlight the effects of aging on Malaysia's economy, there remain notable limitations. For instance, past research has primarily focused on the national level and has not examined regional disparities across Malaysian states. Such a gap is significant because the speed and intensity of aging vary across regions, potentially leading to heterogeneous impacts on economic growth. Furthermore, many prior studies have not adequately explored potential threshold effects—points at which aging shifts from being a neutral or positive factor to exerting a negative influence on growth.

To address these gaps, this study introduces several novelties. First, it uses state-level data to capture spatial variation in the aging–growth relationship, offering a more granular understanding highly relevant to state governments. Second, it applies threshold regression techniques to identify the minimal turning point of aging that significantly alters economic growth. By doing so, the study not only extends the empirical literature but also provides actionable insights for designing region-specific and growth-enhancing policy interventions to mitigate the challenges of demographic aging.

The structure of this paper is organized as follows. The following section discusses the data and methodology used in this study. The next section explains the empirical results and discussion based on the findings from the data analysis. The last section concludes the summary and policy implications.

METHODS

The study employs panel data estimations and uses several factors from 13 states and two federal territories, excluding Wilayah Persekutuan Putrajaya from 2005 to 2021 due to data availability, as the states' data are documented over several years. The dependent variable in this study is gross domestic product (GDP) at the state level, deflated to a constant price. The independent variables consist of realized investment as a proxy of capital stock expressed in RM million (INV), total labor force aged 15-64 expressed in thousand persons (LAB), the total old population aged 65 and above (AGING), the total fertility rate (FR), and population growth (POP). All data sources are from the Department of Statistics Malaysia (DOSM), the Ministry of Finance (MoF), and the Malaysian Investment Development Authority (MIDA), respectively. Table 1 below presents descriptive statistics, including mean, standard deviation, minimum (Min), and maximum (Max).

Table 1. Descriptive statistics

Variable	Description	Mean	SD	Min	Max
Gross Domestic Product (GDP)	Log of GDP by the state at constant 2015 prices as a proxy economic growth, RM million	10.65	1.07	8.07	12.75
Realized Investment	Log of realized investment as a proxy of capital stock, RM million	6.56	2.14	0	11.20
Labor Force	Log of the total number of labor force by age group from 15-64 years, thousand persons	6.39	1.05	3.46	8.20
Aging	Total old population aged 65 and above, percentage	5.93	1.84	2	11.4
Fertility Rate	Total fertility rates per woman aged 15-49 years	2.24	0.56	1.25	3.9
Population growth	Total population growth rate, percentage	1.31	0.75	-1.28	5.07

Source: Author's Calculation Results (2023).

This study applies the Romer (1986) endogenous growth theory by assuming the output is determined by a three-factor Cobb-Douglas production function as proposed by Lee and Shin (2019), which can be represented as follow:

$$Y = AK^\alpha L^\phi H^{1-\alpha-\phi} \tag{1}$$

In equation (1), Y is gross domestic product (GDP) by the state at a constant price of 2015, K represents realized investment as a proxy of capital stock, L is the total number of the labor force, H is the human capital as a proxy of the total old population aged 65 and above and A is the productivity level. Based on a previous study, Tassim (2020) determined the proxy of the total old population aged 65 years and above and acknowledges that human capital is an essential determinant of economic growth. According to equation (1), this study was carried out by modifying the model developed by researchers such as (Romer 1986; Prettner 2013; Mohd et al. 2021; Abd Rahman et al. 2021). Equation (1) can be normalized by dividing both sides with the population (P), then taking the semi-logarithm, substituting α_0 for A, and Δ representing the time difference, thus, equation (1) is rewritten as follows:

$$\ln Y_{it} = \alpha_0 + \alpha \Delta \ln(K_{it}) + \phi \Delta \ln(L_{it}) + (1 - \alpha - \phi) \Delta \left(\frac{H}{P_{it}} \right) - \phi \Delta \ln P \tag{2}$$

Where equation (2) suggests that a state's growth rate of GDP per capita depends negatively on the age population of 65 years and above. Equation (2) also suggests that the relationship between an aging population (an increase in the total old population), $(\Delta(H/P_{it}))$ and economic growth is non-linear. Therefore, the specification model of the economic growth for this study is as follows:

$$\ln GDP_{it} = \beta_0 + \beta_1 \ln INV_{it} + \beta_2 \ln LAB_{it} + \beta_3 AGEING_{it} + \beta_4 FR_{it} + \beta_5 POP_{it} + \varepsilon_{it} \tag{3}$$

Where the β_1 , β_2 , β_3 , β_4 , and β_5 are the coefficients of the variable in equation (3), whereas i represents the state and t represents the year. The β_0 is the parameter constant, whereas the ε is the random error term. GDP, INV, and LAB are in log form, while the others are in percentage terms (%). Therefore, fertility rates and population growth are the control variables in this study.

Hansen (1999) proposed the static panel threshold regression model in Equation (4), which is used in examining the contrasting effect of aging on states' economic growth in the 'low-aging and 'upper-aging' regimes.

$$\ln GDP_{it} = \mu_i + \beta'_1 x_{it} I(AGEING_{it} \leq \gamma) + \beta'_2 x_{it} I(AGEING_{it} > \gamma) + e_{it} \tag{4}$$

In equation (4), $\ln GDP_{it}$ is the constant price of the gross domestic product, $AGEING_{it}$ is the total percentage of the old population aged 65 and above, which is a threshold variable that splits the sample into upper and lower regimes; γ is the unknown threshold parameter with the slope of the coefficient β_1 and β_2 . Moreover, $I(\cdot)$ is the indicator function. For the identification of β_1 and β_2 , It is required that the elements of x_{it} where x_{it} is a vector of control variables, including investment, labor force, population growth rate, and fertility rate. While the errors (e_{it}) are assumed to be independent and identically distributed (i.i.d.) with mean zero and finite variance σ^2 . The parameter of μ_i

represents the heterogeneity of the fixed effect of the state under the different parameters and e_{it} is the disturbance term. Hence, the i.i.d assumption excludes lagged dependent variables from x_{it} . There is an alternative way of writing equation (4) as follows:

$$\ln GDP_{it} = \begin{cases} \mu_i + \beta'_1 x_{it} + e_{it}, & AGEING_{it} \leq \gamma \\ \mu_i + \beta'_2 x_{it} + e_{it}, & AGEING_{it} > \gamma \end{cases} \quad (5)$$

Where the threshold variable can be smaller or larger than the threshold value γ The method emphasizes the examination of identifying the impact of an aging population on state economic growth in lower and upper regimes. Hence, the non-linear specification in equation (4) requires substantial consideration rather than simple linear models. The following describes the hypothesis of the nonlinearity effect in this study:

$$\begin{aligned} H_0: \beta_1 &= \beta_2 \\ H_1: \beta_1 &\neq \beta_2 \end{aligned}$$

Where β_s are parameter coefficients. Linear regression is the null hypothesis, and nonlinear regression is the alternative hypothesis. If the null hypothesis is rejected, accept the alternative nonlinear regression hypothesis. Hence, the threshold model will have two split regimes, upper and lower, to determine the threshold's minimum points in this study. According to Hansen (1996), the bootstrap procedure will generate an asymptotically valid set of p-values and critical values. However, a nuisance parameter problem will arise if (γ) is unknown, which will cause the (γ) estimator's distribution to be nonstandard. Hansen (1999) demonstrated that least-squares estimators consistently yield confidence intervals based on the likelihood ratio (LR) statistic. Therefore, the null hypothesis of no threshold effect is tested by a linear constraint in the testing procedure $H_0: \gamma = \gamma_0$.

This study performed quantile analysis to ensure reliable results for the threshold model. Quantile regression is an extension of standard linear regression that estimates the conditional median of the outcome variables and can be used when the assumptions of linear regression are not met.

RESULT AND DISCUSSION

Table 2 shows the correlation matrix of the relationships among investment (lninv), labor (lnlab), fertility rate (fr), population size (pop), and aging. Investment is positively correlated with labor (0.6196), suggesting that higher labor input is associated with greater investment, consistent with economic theory that labor drives productive activities. Interestingly, investment shows a weak negative relationship with the fertility rate (-0.3044), suggesting that higher fertility may not be associated with investment growth, possibly because resources are allocated to household consumption rather than capital accumulation. Investment also shows weak, insignificant correlations with population (-0.0199) and aging (0.1744), indicating no strong linear relationship with these demographic variables at the aggregate level.

On the other hand, aging shows distinct negative and positive associations with demographic factors. It is negatively correlated with population (-0.5669), reflecting the

demographic reality that as populations age, growth rates tend to slow down, reducing the relative share of younger cohorts. Aging has only weak correlations with labor (0.0566) and fertility (-0.0567), suggesting limited direct connections in this dataset, though theory often associates aging with declining labor supply and fertility. Fertility, meanwhile, is negatively associated with both investment and labor, but positively correlated with total population (0.2273), consistent with the notion that higher fertility increases population numbers, though not necessarily productive capacity. Overall, the table highlights that while investment and labor are strongly linked, demographic variables such as aging and fertility introduce more complex, often negative, relationships with economic growth factors.

Table 2 summarizes the correlation analysis for the impact of aging and economic growth in Malaysia. The results show no strong relationship among the variables, indicating that the labor force is only moderately correlated with realized investment. In contrast, the other variables are not strongly correlated.

Table 2. Correlations Coeficients

	lninv	lnlab	fr	pop	aging
lninv	1.0000				
lnlab	0.6196	1.0000			
fr	-0.3044	-0.2195	1.0000		
pop	-0.0199	0.0594	0.2273	1.0000	
aging	0.1744	0.0566	-0.0567	-0.5669	1.0000

Source: Author's Calculation Results (2023).

Before the threshold estimation, Table 3 summarizes the estimation results of aging on state economic growth in Malaysia using a pooled model (column 1), a random-effects model (column 2), a fixed-effects model (column 3), and a robust fixed-effects model (column 4). This study used the Breusch-Pagan LM test (1980) to determine to what extent the random-effect model could address heterogeneity compared to pooled OLS. The LM test results indicate heterogeneity (the null hypothesis is rejected at a 0.01 level). Hence, the random effect model is more reliable than the pooled OLS. In addition to the Breusch Pagan LM test, the Hausman test is used to examine the fixed and random effect models. As a result, this study reveals that the fixed-effect model is more appropriate than the random-effect model, as the p-value for the coefficient is less than 0.01.

The following step is to perform a diagnostic test. The variance inflation factor results indicate a VIF of 1.56, which is less than 10. Hence, the findings show there is no multicollinearity problem. In addition, the null hypothesis of heteroscedasticity is rejected based on the test results. The result shows there is heteroscedasticity. The fixed-effects model with robust standard errors is applied to obtain accurate standard errors, since heteroscedasticity is a problem. The results of the robust fixed-effect model in Table 3 indicate that the coefficient for the labor force aged 15-64 years (*lnLAB*) is positively associated with economic growth. In the robust fixed-effect model, a unit increase in the labor force increased economic growth by 0.8326 percentage points. These

results are consistent with previous studies (Hu et al., 2020; Tassim, 2020), indicating that increased education spending will enhance human capability to replace the working elderly population in the future and that there is a positive correlation between the labor force and economic growth. In contrast, the interaction between the aging population and the labor force negatively affects Malaysian economic growth.

Table 3. Static Panel Analysis

Regressors	(1) Pooled Model (POLS)	(2) Random Effect Model (REM)	(3) Fixed Effect Model (FEM)	(4) Robust Fixed Effect Model
lninv	0.0066 (0.0136)	-0.0032 (0.0038)	-0.0035 (0.0038)	-0.0035 (0.0056)
lnlab	0.8703 (0.0266)***	0.8520 (0.0522)***	0.8326 (0.0596)***	0.8326 (0.0668)***
fr	-0.4773 (0.0429)***	-0.0254 (0.0282)	-0.0194 (0.0289)	-0.0194 (0.0298)
pop	-0.0862 (0.0369)**	-0.0000 (0.0083)	0.0006 (0.0082)	0.0006 (0.0069)
aging	-0.02693 (0.0149)*	0.1085 (0.0075)***	0.1124 (0.0077)***	0.1124 (0.0157)**
llabag	-	-0.0089 (0.0041)***	-0.0095 (0.0041)***	-
constant	6.3961 (0.1994)***	4.6455 (0.3710)***	4.7346 (0.4024)***	4.7346 (0.4153)***
Observations	255	255	255	255
Number of groups	-	15	15	15
R-squared	0.8969***	0.7972***	0.7915***	0.7915***
Breusch-Pagan LM test	0.0000***			
Hausman test	0.0000***			
Multicollinearity	1.56			
Heteros.	0.0002***			

Note: standard errors are in (.). *, ** and *** denotes significant at 10%, 5% and 1%, respectively. llabag – interaction between labor force and aging population.

Source: Author's Calculation Results (2023).

Similarly, the estimated result indicates that the aging population (aged 65 and above) also positively impacts the economic growth. This study reveals that the aging population is significantly positive at the 0.05 level. The results are consistent with those of Bawazir et al. (2019), Mamun et al. (2020), and He et al. (2022). Theoretical studies show that the aging population benefits economic growth in the long run. However, it also depends on whether the fertility rate and mortality rate increase or decrease in the long run. This study is also aligned with the extended endogenous growth model of Prettner (2013). In addition, an increase in longevity positively affects economic growth when the mortality rate declines faster than the fertility rate (Prettner, 2013). Moreover, Bawazir et al. (2019) noted that the aging population has a beneficial influence as the old population is not yet a completely dominant demographic force. Acemoglu and Restrepo (2017) show that aging societies tend to adopt more automation, which can

offset shrinking labor supply and boost productivity growth. Maestas et al. (2023) also demonstrate that older workers' experience can maintain productivity levels in certain sectors. In addition, population aging may yield a silver dividend that contributes to economic growth (ADB, 2019). Park and Shin (2023) provide evidence that lower total factor productivity growth is the main mechanism through which population aging harms economic growth. The labor shortage caused by population aging is largely offset by higher labor force participation rates among males, females, and older workers.

Table 4 presents the F-statistics for single-, double-, and triple-threshold effects, along with the bootstrap p-values proposed by Hansen (1999), to investigate the threshold effects of aging on economic growth. Applying 300 bootstrap replications and a 1% trimming percentage, the F-statistic of 33.98 indicates that the single threshold is significant at the 5% level, as it exceeds the critical value of 33.53. However, the double and triple thresholds are insignificant, with the bootstrap p-values of 0.6033 and 0.7900, respectively.

Table 4. Test for threshold effects between aging and economic growth.

Test for single threshold	
7.2	
F_1	33.98
p-value	0.0467**
(10%, 5%, 1% critical values)	(26.51, 33.53, 43.31)
Test for double threshold	
4.0	
F_2	9.05
p-value	0.6033
(10%, 5%, 1% critical values)	(25.97, 35.26, 47.88)
Test for triple threshold	
3.8	
F_3	5.49
p-value	0.7900
(10%, 5%, 1% critical values)	(22.15, 27.48, 40.94)

Note: *, ** and *** denotes significant at 10%, 5% and 1%, respectively.

Source: Author's Calculation Results (2023).

The threshold model specifications in Table 5 indicate that the coefficient estimate for aging is significant and positive at both levels, either above (gamma sub 2 greater than 7.2) the threshold. The estimated coefficient below the regime is 0.1376 and is significant at the 0.01 level. This study indicates that economic growth increases by 0.1376 percent for states with an aging population of 7.2 percent or less, with each 1 percent increase in aging. The second regime result is also significant, implying a positive relationship between aging and economic growth when aging is more significant than 7.2. Hence, in the context of Malaysia, the results suggest that changes in the aging population at the state level are less worrisome than at the aggregate level. The finding is supported by Le & Park (2020), who report a significantly positive threshold estimate

for the aging population. These findings highlight that the relationship between aging and states' economic growth is nonlinear. Therefore, the imposition of a priori static restriction on the relationship could also be ambiguous. In addition, Lee and Shin (2019) found that population aging, proxied by the old-age population share (or old-age dependency ratio), negatively affects economic growth only when it reaches a high level, and its negative effects grow stronger as population aging deepens. The historical nonlinear relationship between the proportions of the working-age and elderly populations is linked to the nonlinear relationship between population aging and economic growth. In the early stages of a demographic shift in most countries, as the old-age population share rises, the working-age population share tends to increase as well.

Table 5. Coefficient for threshold effects

Regressors	Coefficient	Std Error	t-stat
lninv	-0.0036	0.0036	-0.99
lnlab	0.7662	0.0593	12.92***
fr	-0.0336	0.0279	-1.20
pop	-0.0003	0.0079	-0.03
Threshold			
$\gamma_1 \leq 7.2$	0.1376	0.0093	14.72***
$\gamma_2 > 7.2$	0.1282	0.0082	15.56***
Constant	5.0629	0.3941	12.85***

Note: *** denote significant at 1%, respectively

Source: Author's Calculation Results (2023)

Table 6. Robustness check using quantile approach at different quantiles.

lngdp	(1)	(2)	(3)
	Q(0.25)	Q(0.50)	Q(0.75)
lninv	0.0727 (0.0261)***	0.0467 (0.0147)***	-0.0553 (0.0205)***
lnlab	0.8116 (0.0509)***	0.8548 (0.0286)***	0.9605 (0.0401)***
fr	-0.3800 (0.0821)***	-0.5160 (0.0461)***	-0.4471 (0.0648)***
pop	-0.1272 (0.0706)	-0.0629 (0.0397)	-0.1040 (0.0557)*
aging	-0.0156 (0.0287)	-0.0608 (0.0161)***	-0.0447 (0.0226)**
Observations	255	255	255
No. of group	15	15	15

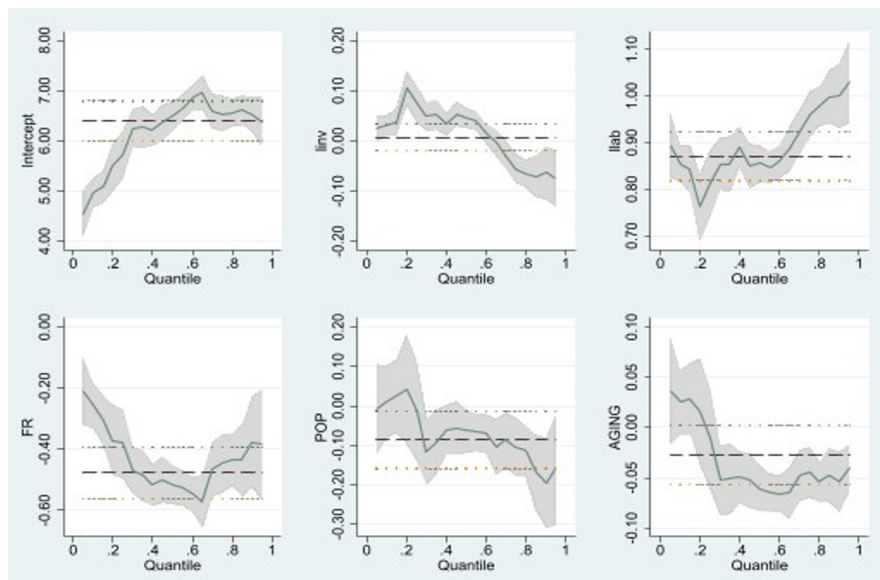
Note: standard errors are in (.). ***, ** and * denotes significant at 1%, 5% and 10%, respectively.

Source: Author's Calculation Results (2023).

Table 6 presents the results of the robustness check using a quantile approach on the impact of aging on economic growth in Malaysia, represented by the lower, median,

and upper quantiles, which validate the responsiveness of the estimated threshold value. Most variables are insignificant at the lower quantile of gross domestic product by state, except *lnINV*, *lnLAB*, and *FR*. The results in the 0.25 quantile show the baseline effects on economic growth (*lnGdp*). Investment (*lninv*) has a positive and significant impact (0.0727), indicating that higher investment contributes to GDP growth. Labor (*lnlab*) also shows a strong positive and significant coefficient (0.8116), highlighting the critical role of labor input in driving Malaysia's economic performance. Fertility rate (*fr*), however, has a large negative effect (-0.3800), suggesting that higher fertility may reduce growth, possibly due to increased dependency burdens. Population (*pop*) shows a negative but insignificant effect (-0.1272), while aging has a small, insignificant negative coefficient (-0.0156), suggesting no direct linear effect in this specification.

Figure 3: Graphical quantile regression analysis for each determinant of Economic Growth across the states in Malaysia



Source: Author's Calculation Results (2023).

When considering the 0.50 quantile, the results provide more nuanced insights. Investment remains positive and significant (0.0467), though its effect is smaller compared to the baseline, reflecting a reduced contribution of investment to growth in lower-growth states. Labor continues to show a strong positive impact (0.8548), underscoring its consistent role across different levels of growth. Fertility maintains a negative and significant effect (-0.5160), indicating that high fertility is particularly detrimental in lower-growth contexts. Population remains negative but statistically insignificant (-0.0629). Importantly, aging becomes negative and significant (-0.0608), suggesting that in states with lower growth performance, aging poses a stronger challenge to economic expansion.

At the higher growth quantile (Q0.75) in column (3), the dynamics change further. Investment turns negative and significant (-0.0553), which may indicate diminishing returns to investment in high-growth states where capital accumulation is already substantial. Labor remains positive and highly significant (0.9605), strengthening the evidence that

labor is the dominant driver of growth across all levels. Fertility still exerts a negative and significant effect (-0.4471), reinforcing its drag on growth across all growth levels. Population (-0.1040) becomes weakly significant, pointing to potential crowding effects in higher-growth states. Aging remains negative and significant (-0.0447), suggesting that as states grow, the economic costs of an aging population become more apparent. However, Pham and Vo (2021) show that, in the long run, a positive relationship exists between the share of the population aged 65 and older and economic performance. The quantile regression results confirm the importance of an aging population on economic growth at most percentiles. Though from lower to higher percentiles, the estimated magnitudes differ.

CONCLUSION

This study examines the relationship between population aging and economic growth in Malaysia. It provides new evidence on the nonlinear impact of population aging on economic growth in Malaysia, using the threshold level of aging across 13 states and two federal territories (excluding Wilayah Persekutuan Putrajaya) from 2005 to 2021. This study employs a static model based on Hansen's (1999) threshold effect. The threshold point compares the states differently between low-level and high-level aging to examine its impact on economic growth. The results revealed a threshold effect of aging, with a nonlinear positive relationship with economic growth. This study provides new evidence of a positive nonlinear relationship between population aging and Malaysian economic growth. Thus, the aging population also has a positive impact on economic growth.

There are several policy implications for policymakers regarding the aging population and economic growth in Malaysia. First, Malaysian policymakers and authorities should consider the future direction of aging policies, especially the National Senior Citizens Policy (DWEN) and Malaysian Population Policy. The Silver Human Resource Center is widely implemented in Japan. It can be used as an example in the Malaysian state of employing the elderly in the workforce, where this group gains experience and contributes ideas and guidance for future generations. Second, the total labor force for Malaysia has a significant positive effect on growth. Therefore, policymakers should prioritize strategies to increase job opportunities in each state to avoid young people migrating to other states with more attractive job opportunities. Hence, better education and training for the younger generation will foster a favorable business environment and help resolve the labor-market mismatch in the state's economy. Finally, an investment policy should be devised to accelerate the current investment rate in the long run. Fiscal measures encompassing social welfare policies should be appropriately expanded to cover most of the aging population to maintain a poverty-free, healthy standard of living.

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