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The Impact of Population Aging on Economic Growth in Asian Countries

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Abstract:

Purpose: *The purpose of this study is to examine the impact of population aging on economic growth. This paper forecasts the impact of population aging (demographic changes) on economic growth (measured by labor supply, household savings, and labor productivity) in three countries China, Japan, and Malaysia.*
Design/methodology/approach: *Data from 1990 to 2018 is used in this study. Interestingly, findings suggest that the older the population, the greater the negative impact on the economy.*
Findings: *The results show that population aging has a negative effect on labor supply and labor productivity in the three countries. Surprisingly, the impact of population aging on house saving is negative in Japan and Malaysia but positive in China.*
Practical implementation: *The results of this study may benefit the economists and governments regulators in these three Asian countries- China, Japan, and Malaysia- to overcome the population aging problem in the early stages by investigating the causing of these demographic changes that will negatively affect the economic position in each of these countries.*
Originality value: *The research refers to the aging problem in China, Japan and Malaysia and how this problem may affect the economic growth in these countries.*

Keywords: *Population aging, labor supply, household savings, labor productivity.*

JEL codes: *O10, O15.*

Paper type: *Research article.*

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1. Introduction

In the past three decades, many Asian countries, including Malaysia, Japan, and China, have experienced significant economic growth. The factors of Asia countries' extraordinary economic growth have been broadly studied. Changes in the demographic structure of Asia and transformation in past birth and mortality have led to dramatic repositioning in the age structure between 1960 and 2005 (Bloom, Canning, and Malaney, 1999). As the combination of life expectancy increases and fertility declines, population aging increases.

Maestas *et al.* (2016) stated that in the United States, for example, the fraction of the population age 60 or older will rise by 21% between 2010 and 2020 and by 39% between 2010 and 2050 In Asian countries, based on the latest estimate, by 2060, there will be 1.4 million people aged 60 and above in Asia's population, which is 26.9 percent of Asia's population[3]. Asia's population is objected to being 4.5 times as large in 2060 as in 1960. It can be notable that the growth of the oldest population (determined as 80 years old and above) shall be the most striking among the older population in the future years. A portion of individuals aged 80 and above between today and 2060 is projected to rise from 58706 thousand to 313291 thousand.

These remarkable figures of demographic change have caught the attention of many countries for three reasons. First, the productivity of the elderly population is generally inferior to that of the working-age population, so the economic growth rate of the economy with a higher proportion of the elderly population may slow down (Lee, 2016).

Secondly, it seems that part of the elderly population is much larger than in the past, so it must be endorsed by a relatively small group of economically active adults. In addition, due to older people needing more medical services than young people (Lee and Andrew, 2011), the elderly population will have a heavy burden on the entire economy as they present a large population.

Thirdly, changes in past birth rates and mortality rates may also lead to an increase in the proportion of the elderly. Lee and Shin (2019) concluded that during recent years, population aging had hindered economic growth, especially in more aged countries, which are mostly developed countries. Bloom, Canning, and Fink (2008) claimed that population aging has a downward trend in labor force participation rates and savings rates, thus raising concerns about a decline in future economic growth.

However, the results of empirical research are inconsistent; some studies found that population aging can promote economic growth (Pablo and Rafael, 2006), while a later study by Park and Shin (2011) pointed out that the aging population will have a huge pessimistic effect on the economy and lead to a slowdown in technological

[3]*According to UN (2019).*

progress while hoping to make progress through technology eliminates the impact of population aging.

Furthermore, Lee and Shin (2019) explained why some earlier studies failed to uncover a negative relationship between the aging population and economic growth. According to their results, the old-age population share increases the working-age population share only when the share of the old-age population is sufficiently high. In this case, the increase in the share of the old-age population has coincided with the decline in the share of the working-age population, thereby having a negative relationship with economic growth.

Due to the inconsistency of previous results, further studies are required to examine the impact of population age on economic growth in other countries so that we can get the knowledge to estimate the lane of economic growth by considering the economic adjustments that result from the changes in demography. Similarly, it is also important to determine the extent of policy intervention that fits to minimize the effects of population aging.

Therefore, this study intends to examine the impact of population aging (demographic changes) on economic growth (measured by labor supply, household savings, and labor productivity) in Asian countries (China, Japan, and Malaysia) In other words this study aims to answer the following questions:

- What is the relationship between population aging and labor supply?
- What is the relationship between population aging and household savings?
- What is the relationship between population aging and productivity?

This study differs from previous studies in many aspects; first, previous studies focused on the impact of population aging on economic growth in developed countries (Maestas *et al.,* 2016[4]; Feyrer, 2008; Burtless, 2013; Aiyar *et al.,* 2016), and very few, if none, studies, focused on developing countries. This study, however, focuses more on developing countries (China & Malaysia) which presents us with the situation in developing countries (Sarpong *et al.,* 2022).

Second, this study also includes the data from Japan (one of the developed countries), which will enhance our understanding of whether or not the impact of population aging on economic growth is similar in countries with different ranks of development. Third, the current study used more recent data from 1990 to 2018, which accurately measured the changes in economic growth due to changes in demographic structure in recent years.

[4]*Maestas et al. (2016) used the data of 51 states of America in their study in order to control the impact of the national policy environment, while Bloom et al. (2010) used the OECD countries data to examine the impact of population ageing on both labor-force participation and savings rates.*

Last but not least, this study measured economic growth by using three measurements which are labor supply, household savings, and productivity[5], which help the policymaker to consider the amount of appropriate intervention to minimize the impact of aging in each of these three measurements.

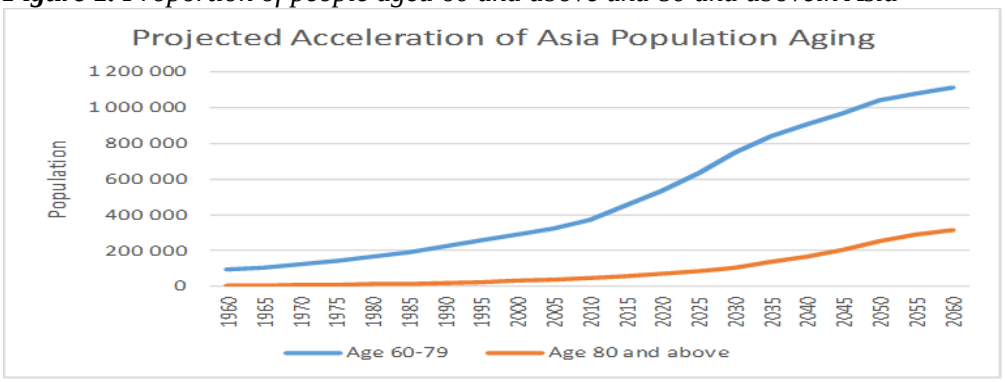
The remaining of this study is organized into the following sections: Section 2 Literature review, which briefly displays previous studies. Section 3 explains the hypotheses development and the research methodology. Section 4 discusses the results of the analysis, and Finally, Section 5 highlights the conclusion of the study.

2. Literature review

2.1 Previous Empirical Studies

Population aging is occurring in most countries in the world as well as in Asia. In the next few decades, the proportion of people aged 60 and above in Asia may likely rise to the highest level in history (Figure 1). 2060 estimation expects 1.4 million people have the reach age 60 and above of Asia population, presenting 26.9 percent of Asia population6 with 4.5 times as large in 2060 compared to 1960.

Figure 1. *Proportion of people aged 60 and above and 80 and abovein Asia*



Source: *UN (2019).*

China, India, Indonesia, Japan, and the United States has focused on the importance of using science to inform policy. Many studies around the world attempt to examine the impact of population age on different factors such as asset return (Yoo, 1994a; Macunovich, 1997), the real yield of treasury bonds (Yoo, 1994b), health care costs (Schwartz,1987), consumption growth (Sheiner, 2014), comparative advantage (Cai, and Stoyanov, 2016), and the future economic performance (Börsch-Supan, 2013;

[5]*Previous studies measured economic growth only by labor-force participation and savings rates (Bloom et al., 2010) or labor force growth and productivity growth (Maestas et al, 2016).*

[6]*According to UN (2019).*

Nawafly and Alarussi, 2018). Lee (2010) has implemented coordinated surveys aimed to understand the financial, social, and health status of older adults, with the aim of assisting in policy formulation and providing inputs for cross-country studies[7]. The alteration in age structure is due to a decrease in fertility, lessening the number of young people.

Therefore, since the number of older people has not changed, the proportion of aged people has increased. In short, the increase in the survival rate of people aged 65 years and above may also lead to an increase in the share of the elderly as the survival rate of other age groups increases. Short and Zhai (1998) and Winckler (2002) stated that China launched a more in-depth family planning program in 1979, the "one-child" project. This policy provided economic incentives for single-child families, economic restraints for large families, and huge regional and local differences; this policy leads to reduce fertility rate, which increased the population's age rate.

Similar results existed in Japan which may be the world's most rapidly aging country, with the highest life expectancy in the world8 (Atoh, 1992). On the other side, the child mortality rate has a positive relationship with the population age (Cutler and Lleras-Muney, 2006). A later study by Yong (2020) argued that shifting from a one-child policy into a two-child policy is insufficient to promote economic growth in China, and a combination with other policies such as investment in human capital is necessary to minimize the economic recession due to population age.

Economic growth is one of the rock stones that studies hit; many studies examined the impact of several factors on economic growth, such factors as capital (Hendrickson *et al.,* 2018), the savings rate (Uddin *et al.,* 2016), the population growth rate (Bucci *et al.,* 2018), environmental interactions (Gürlük, 2019), political turmoil (Barro,1991), human development (Costantini and Monni, 2008), human capital investment (Chen and Fang, 2018; Haini, 2019), industrial pollutions (Gürlük, 2009), stock market liquidity (Rousseau and Wachtel, 2000), corruption (Mauro, 1995), trade and energy (Vivek and Chapman, 1998), country's culture (Baker, 2000) and a religion (Weber, 1930).

A few studies examined the impact of population aging on economic growth though they come up with inconsistent results; for example, Aiyar (2016) reported a negative association between workforce aging and economic growth in European countries. Similar results were reported by Bloom *et al.* (2010) and Maestas *et al.*

[7]*According to Coulmas (2007) there are three types of society based on the proportion of elderly: (1) Aging society if 7 percent to 14 percent of the population are 65 years or above, (2) Aged society if 14 percent to 20 percent of the population are 65 years or above and, (3) Hyper-aged society if 21 percent or more of the population are 65 years or above.*

[8]*Based on World Population Prospects, United Nations (2017), Japan reached to 20% of total population age in 2005, and Germany in 2008.*

(2016). Lee and Shin (2019), using the data for the period from 1960 to 2014, found that the old-age population share increases the working-age population share only when the share of the old-age population is sufficiently high.

In this case, the increase in the share of the old-age population has coincided with the decline in the share of the working-age population, thereby having a negative relationship with economic growth. By contrast, Koichi, and Tetsuya (2001) and Börsch-Supan and Weiss (2016) found no evidence that aging declines productivity, and Burtless (2013) reported a positive association between aging employees and productivity. Mamun *et al.* (2020) found a positive relationship between population aging and per capita real GDP in Bangladesh. With these inconsistent results, this study examines the association between population aging and economic growth in the three countries (Malaysia, China, and Japan) by using three measurements, namely labor supply, household savings, and labor productivity.

2.2 Selection of Variables, Hypotheses Development

2.2.1 Population Aging and Economic Growth

The two sources of population aging are longer life expectancy and lower population growth rate (Lee, 1994). Maestas *et al.* (2016) examined the impact of population aging on economic growth, using data from companies in the United States. They concluded that a 10% increase in the fraction of the population aged 60+ decreases the growth rate of GDP per capita by 5.5%. Huang *et al.* (2019) examined the impact of population aging on economic growth in Taiwan. Using quarterly data from 1981- to 2017, the results show a positive relationship between an aging workforce and economic growth.

However, the old-age dependency ratio has a significantly negative effect on economic growth. Studies have shown that during the "East Asian miracle," the first demographic dividend contributed 25% to 33% of the remarkable economic growth and significantly stimulated the recent economic growth of China and India (Bloom *et al.*, 2006). Wang and Mason (2008) estimated that between 1982 and 2000, about 15% of the unprecedented rapid growth of per capita output in China came from the first demographic dividend.

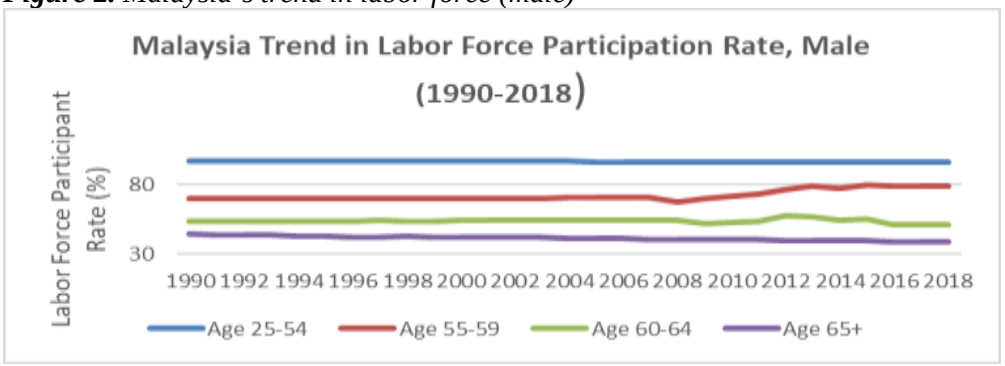
Wei and Hao (2010) used provincial data from 1989 to 2004 to confirm that changes in demographic structure, especially the decrease in youth dependency ratio caused by the decrease in fertility rate, significantly promoted economic growth. This effect was most obvious in more open provinces. This current study aims to examine the impact of population aging on economic growth (measured by labor supply, household savings, and labor productivity).

2.2.2 Population Aging and Labor Supply

The labor force participation rate is the result of individual factors such as age, gender, education level, and personal disposable income. Maestas *et al.* (2016) used

a predicted variation in the rate of population aging across U.S. states over the period 1980-to 2010. They reported that a 10% increase in the fraction of the population aged 60+ decreases 1.6% in the labor force growth. In Malaysia, for example, the labor force participation rate for a male under 65 was relatively stable from 1990 to 2008 (Figure 2).

Figure 2. *Malaysia's trend in labor force (male)*

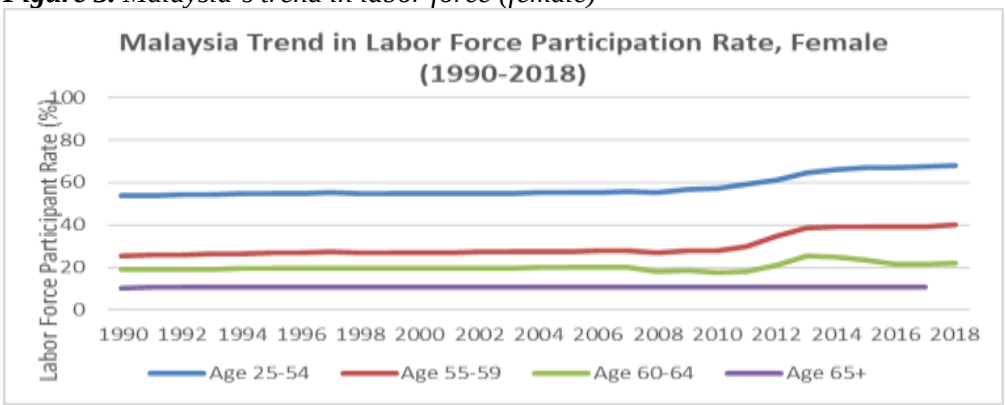


Source: *Thomson Reuters Datastream.*

The labor force participation rate of males aged 55 to 59 increased significantly, from 67% in 2008 to 79% in 2018. By contrast, the labor force participation rate of Malaysian females of all ages has increased significantly during this period. Specifically, before 2009, the labor force participation rate of females aged 25 to 54 increased rapidly and then stabilized at about 56%. After 2009, labor force participation rates for females in all other age groups began to rise (Figure 3).

The analysis shows that, with the continuous development of the aging population, there is limited room for improving the labor participation rate of men in each age group, while the labor participation rate of females in each age group can be correspondingly improved.

Figure 3. *Malaysia's trend in labor force (female)*



Source: *Thomson Reuters Datastream.*

One possible explanation for this is that an aging population is accompanied by a decline in the birth rate, which in turn leads to a decrease in women's time to have and raise children, creating conditions for women to enter the labor market. In turn, females enter the labor market and have an independent source of income, which further reduces the demand for children and further promotes the aging of the population. The theoretical argument for establishing the connection is based on the well-known theory of consumption and savings life cycle (Modigliani and Brownberg, 1954).

2.2.3 Population Aging and Household Savings

People often worry that population aging will cause reduce in savings rates, lower capital, and all subsequent economic problems. Horioka *et al.* (2007) report a negative relationship between the aging population and household savings rates in Japan. Similar results were found by Uddin *et al.* (2016) in Australia. Mason and Lee (2007) indicate that population aging will result in a substantial increase in assets, sufficient to support the rate of decline in per capita consumption, but only if there is a strong dependency on the retirement fund.

In other words, if one country relies mainly on public or non-public transfer payments to meet retirement wants, the population aging would result in a significant deterioration in per capita income and expenditure. The standard assumption in economic theory is to assume a humped life cycle savings curve. In its easiest way, the life cycle hypotheses assume that households save until retirement and then stop saving (Modigliani and Ando, 1957).

Furthermore, savings can depend to a large extent on context, and this approach is not fully understood by empirical models, the empirical evidence of savings and demographics is far from being resolved (Zhang and Zhang, 2005). Another obstacle is the complex response to the aging of the population, for example, Retirement age, how much the elderly rely upon family members for support, and the size of the public transfer system may be affected by the extension of life expectancy and retirement time (Preston, 1984). Bloom *et al.* (2003) has affirmed a negative correlation between savings and dependency ratios. They included age structure and life expectancy to test the effect of these variables on the savings rate in the model and theoretically demonstrated that the pure impact of life expectancy extension is to increase the savings rate.

2.2.4 Population Aging and Labor Productivity

Feyrer (2002) stated that there is an inverted u-shaped relationship between workers' age and total factor productivity. Specifically, productivity growth increases with the proportion of workers aged 40 to 49 and decreases with the proportion of older workers. Maestas *et al.* (2016) found that a 10% increase in the fraction of the population aged 60+ decreases 3.9% in the labor productivity of workers across the age distribution. Burtless (2013) stated that although the proportion of the elderly population has increased, the income of the elderly workers has been increasing

relative to the young workers, so there is little evidence that the aging of the American labor force has damaged the economic productivity.

Though the productivity of manual laborers, such as factory workers or construction workers, may decline with age, a more mature labor force will have greater average levels of work experience, with a potentially positive influence on productivity (Disney, 1996; Venn, 2008). Moreover, if job requirements change over time, older workers may find it more difficult to adapt (OECD, 1998; Dixon, 2003). Based on the above discussion, the hypotheses can be drawn as follows:

H1: There is a relationship between population aging and labor force supply.
H2: There is a relationship between population aging and household savings.
H3: There is a relationship between population aging and labor productivity.

3. The Data, Sample, and Model Specifications

3.1 Data Collection Approach

This study follows a quantitative approach to examine the association between population aging and economic growth. The numerical data is derived from the United Nations (UN) and the data stream. The three Asian countries involved in this research are China, Japan, and Malaysia. Stratified sampling data had been used in this study to collect the data. The advantages of stratified sampling include getting more accurate information about the variables in the subpopulation (Barreiro and Albandoz, 2001; Alarussi *et al.*, 2009). The sample size is 87 in this study equals 29 years from 1990 to 2018 in each of the three countries.

3.2 Data Analysis Techniques

Statistical Product and Service Solutions (SPSS) are used to analyze the collected data. Miles and Huberman (1994) provided several consecutive stages for carrying out data analysis. The approach of analysis implemented in this study included descriptive analysis. Descriptive statistics engage a short set of descriptive coefficients that summarize and organize the given data set (Yusuf *et al.*, 2013; Alarussi and Goa, 2021).

Descriptive analysis of the data limits generalization of the specific population observed. Many simple action studies include descriptive analysis and deliver valuable information about the nature of specific groups (Best and Kahn, 2003). Pearson correlation can measure the relationship between an independent variable and dependent variables to see their correlations (Hauke and Kossowski, 2011).

Multiple linear regression is used as predictive analysis to examine the causality between population aging (independent variable) and economic growth (dependent variable) (Alarussi, 2021; Sarpong and Alarussi, 2022). Rawlings *et al.* (2001) state

that a T-test is used to check the significance of individual regression coefficients in multiple linear regression models, and adding an important variable to the regression model can make the model more efficient.

The study uses Linear Regression to analyze the collected data; the model is used in this study to examine economic growth as follows:

$LS = \alpha + \beta 1\ PA + \varepsilon$ (Model 1)
$HS = \alpha + \beta 1\ PA + \varepsilon$ (Model 2)
$LP = \alpha + \beta 1\ PA + \varepsilon$ (Model 3)

where, α and $\beta 1$ is coefficient. LS (Labor Supply), HS (Household Savings), LP (Labor Productivity) are dependent variables, and PA (Population Aging) is the explanatory variable, and ε is the error term.

4. Discussion of the Results

4.1 Descriptive Analysis

After normal population testing, no extreme outliers were found; all are within the acceptable range. Descriptive analysis in Table 1 shows that the skewness value of China's labor supply states -0.027, which is left-skewed (negative). Kurtosis value of labor supply is -0.096, which is less than 0; thus, it has a light tails distribution.

Table 1. *Descriptive Analysis of China*

	Minimum	Maximum	Mean	Std. Deviation	Skewness	Kurtosis
LS	-.0125	-.0005	-.005244	.0030336	-.247	-.096
HS	-.3110	.0628	-.095660	.0871633	-.744	1.148
LP	-.1354	-.0110	-.084737	.0322028	.334	.158

Note: *LS-Labour Supply; HS- Household Savings; LP-Labour Productivity.*
Source: *Own study.*

Household savings have a skewness value of -0.744, which is left-skewed (negative), while labor productivity state value of 0.334, which is right-skewed (positive).

Also, the kurtosis value of household savings and labor supply are 1.148 and 0.158, respectively. The maximum value of household savings is 6.28%, while the minimum is -31%, which indicates that when the population becomes more aging, 6.28% of people have the habit of savings, but there are still 31% of people spending. The kurtosis value of all three variables is within the normal distribution range (-3 to 3). On the other hand, the skewness value also lies between -2 and 2, which are in the normal distribution.

Table 2. *Descriptive Analysis of Japan*

	Minimum	Maximum	Mean	Std. Deviation	Skewness	Kurtosis
LS	-.0254	.1239	.018107	.0327217	1.526	2.679
HS	1.3181	3.3743	1.765846	.4133100	2.377	6.487
LP	.1540	.1830	.165592	.0724834	-.518	-1.091

Note: *LS-Labour Supply; HS- Household Savings; LP-Labour Productivity*
Source: *Own study.*

Japan has a skewness value of 1.526 in labor supply, which is right-skewed (positive). The kurtosis value is 2.697, which is greater than 0, so the distribution is the heavy tail (leptokurtic distribution). Although Japan is the most aging country, the maximum value is 12.39% which means the Japanese will still contribute to the labor supply.

Since Japan is the world's third-largest economy, it may face the risk of losing its status if some of its biggest industries, such as cars and electronics, do not maintain their production levels. So, most old-age people need to work in the labor market, resulting in an increase in the country's savings and productivity. The skewness of household savings in Japan states 2.377, which is the right skew (positive). Its kurtosis value is 6.487, which shows a heavier tail (leptokurtic distribution). Labor productivity has a skewness value of -0.518, which is less than 0; the distribution is light tails.

Table 3. *Descriptive Analysis of Malaysia*

	Minimum	Maximum	Mean	Std. Deviation	Skewness	Kurtosis
LS	-.0253	.0086	-.000749	.0069347	-2.100	5.477
HS	-.4667	.3771	.220430	.3881103	-.762	-.433
LP	-.0260	.0750	.035666	.0253141	-.674	.022

Note: *LS-Labour Supply; HS- Household Savings; LP-Labour Productivity*
Source: *Own study.*

Malaysia's labor supply has a skewness value of -2.1, which indicates a left-skewed Household savings of Malaysia has a kurtosis value that is less than 0 (-0.433) means the distributions have light tails. The skewness value of household savings is -0.762, which is left-skewed (negative). Its kurtosis value is greater than 0 (5.477), the distribution is light tails (platykurtic distribution).

Labor productivity states the skewness value of negative, which is -0.674 while its kurtosis value is 0.022. According to Table 3, the three variables of Malaysia have the lowest mean because Malaysia is not yet a population aging country, so it has less impact on the variables.

Table 4 demonstrates the Pearson correlation coefficients between the independent variable (population aging) and dependent variables (labor supply, household savings, and labor productivity). According to Table 4, there is a negative and

significant correlation between the population aging and labor supply and (r=-0.569) in China. This indicates that the older the age structure of the labor force, the lesser the total labor participation rate and the smaller the labor supply. Table 4 shows a positive and significant correlation between population aging and household savings (r =0.582). Generally, over the past three decades, the household saving rate in China has risen sharply.

Younger and older generations save more than they did in the early 1990s. Due to this reason, even the population is becoming more aging, household savings in China are still positively related to population aging. Ge, Suqin, Yang and Zhang (2012) stated that the savings rate of younger and older households increased by more than 10% higher than that of middle-aged households.

Table 4. *Pearson Correlation of China*

Correlations					
		PA	LS	HS	LP
PA	Pearson Correlation	1			
LS	Pearson Correlation	-.569**	1		
	Sig. (2-tailed)	.001			
HS	Pearson Correlation	.582**	-.559**	1	
	Sig. (2-tailed)	.001	.002		
LP	Pearson Correlation	-.723**	.530**	-.335	1
	Sig. (2-tailed)	.000	.003	.076	
**. Correlation is significant at the 0.01 level (2-tailed).					

Source: *Own study.*

Table 4 also shows a significant but negative correlation between population aging and labor productivity, which is -0.723. This significant correlation can be explained that the old labor force is slower to accept new knowledge and science and technology than the young ones, thus less able to adapt to new industries. The development of new products and technological innovation of enterprises are also affected to some extent.

With the rapid development of science and technology, the acceleration of knowledge progress, and the increasingly fierce competition, the aging of the labor force population has a more adverse impact on the improvement of labor productivity and economic growth. Werding (2008) proved that there was an inverted u-shaped structure between the labor force of all ages and its contribution to total factor productivity. Based on this, if the working-age population aging increase, then labor productivity will have a significant downward trend.

Table 5. *Pearson Correlation of Japan*

Correlations					
		PA	LS	HS	LP
PA	Pearson Correlation	1			

	Sig. (2-tailed)				
LS	Pearson Correlation	-.670**	1		
	Sig. (2-tailed)	.000			
HS	Pearson Correlation	-.648**	.929**	1	
	Sig. (2-tailed)	.000	.000		
LP	Pearson Correlation	-.614**	.678**	.606**	1
	Sig. (2-tailed)	.000	.000	.000	
**. Correlation is significant at the 0.01 level (2-tailed).					

Source: *Own study.*

Table 5 shows the correlation between population aging and economic growth measurements in Japan. It can be noticed that the association between population aging and labor supply is -0.67, demonstrating a strong negative degree of connection. This indicates that when the population of aging increases, the labor supply will decrease. Similarly, the table shows a large negative association between household savings and population aging, which is -0.648 and a significance of 0.000.

This negative and significant correlation is indicating that older people intend to save less money for the rest of their lives. Furthermore, there is a negative and significant difference between Japan's labor productivity and population aging, meaning when the labor supply is negatively affected by the increase of population aging. It is worth mentioning here that the table shows a strong positive connection between household savings and labor supply which is 0.929, which demonstrates that as the labor supply increase, the wages of workers will increase and lead the household savings larger.

Table 6. *Pearson Correlation of Malaysia*

Correlations					
		PA	LS	HS	LP
PA	Pearson Correlation	1			
LS	Pearson Correlation	-.424*	1		
	Sig. (2-tailed)	.022			
HS	Pearson Correlation	-.523**	.49**	1	
	Sig. (2-tailed)	.000	.005		
LP	Pearson Correlation	-.570**	.480**	.352	1
	Sig. (2-tailed)	.001	.008	.061	
*. Correlation is significant at the 0.05 level (2-tailed).					
**. Correlation is significant at the 0.01 level (2-tailed).					

Source: *Own study.*

Table 6 shows a medium degree of association between the population aging and labor supply with a negative direction (r=-0.424) in Malaysia, which is less significant compared with the other two variables. It is due to Malaysia is not yet a population aging country, so the effect on the variables is not so strong. The association between population aging and household savings is -0.523, meaning that

aging will reduce economic growth momentum, reduce savings rates, and create a "crowding out effect" on capital. From the perspective of consumption, aging under the "silver industry" future growth potential is huge.

As the population ages, the fiscal burden is expected to increase, the economy will face deflationary pressures, and the balance of payments structure will be affected (Menon and Ng, 2013). As the table is shown, the connection between population aging and labor productivity is negative but significant with r=-0.57, indicating that when the elderly become more and more, the labor supply will decrease and affect labor productivity.

It is worth mentioning, that among the three countries, Japan has the most aging population in the world, and the dependent variables (LS and HS) have the largest negative correlation with the independent variable (aging population). However, the relationship between labor productivity and an aging population is not the greatest because Japan is a developed country with mainly technology-intensive industries.

The improvement of labor productivity mainly depends on science and technology, and the psychological demand for workers is higher than the demand for energy. It has been argued that the aging of the labor population has a less adverse impact on the improvement of labor productivity, and the rich experience of skilled old workers will have a positive effect on the improvement of labor productivity (Skirbekk, 2008).

4.2 Multiple Linear Regression

The multiple regression equation models is obtained through adaption of standardized coefficient beta. Table 7 shows the impact of population aging on the three measurements of economic growth, which are labor supply, household savings, and labor productivity in Japan, China, and Malaysia. The results discussion of the regression analysis can be stated as follows:

Labor Supply:
Table 7 displays a negative and significant relationship between population aging and labor supply for Japan, China, and Malaysia, the coefficient t-value and (P) = 4.684 ($p < 0.001$), 3.596 ($p < 0.001$), and 4.140 ($p < 0.005$) respectively. Hence, the first hypothesis is supported. The more the population ages, the less labor supply in these countries.

The outcomes are similar to the study done by Vodopivec and Arunatilake (2008), who found that the composition of population aging, translates into slower labor force growth and then into a shrinking workforce, the economy of the country will also be affected. The value of R-square presents to what extent the population aging (independent variable) explains the labor supply (dependent variable), which are 42.8%, 29%, and 14.9% for the three countries, respectively.

Household Savings:
Table 7 shows a negative and significant relationship between population aging and household savings in Japan and Malaysia, with the coefficient t-value and (P) = 4.416 ($p < 0.001$), and 4.140 ($p < 0.001$) respectively. Interestingly, Table 7 shows a positive and significant relationship between population aging and household savings in China, with the coefficient t-value and (P) = 6.980 ($p < 0.001$).

Hence, the second hypothesis is supported. It has the same view as Ma, Guonan, and Wang Yi (2010). Based on historical experience, international standards, and models, China's savings rate is high and rising. In addition, as shown by Horioka (1997), the age structure of the Japanese population can also explain the trend of household savings over time.

In Japan, the dependency ratio of young people decreased over time, and the dependency ratio of old people increased over time, but the relative speed of these trends changed over time. Based on the Adjusted R square, population aging can explain household savings by 39.8%, 58%, and 36.6% in Japan, China, and Malaysia, respectively.

Labor Productivity:
Table 7 displays a negative and significant relationship between population aging and labor productivity for Japan, China, and Malaysia, the coefficient t-value and (P) = 4.044 ($p < 0.001$), 5.442 ($p < 0.001$), and 3.893 ($p < 0.001$) respectively. Hence, the third hypothesis is supported. The more the population ages, the less labor productivity in these countries.

The results support the findings of Skirbekk (2008), who stated that aging affects labor productivity because physical changes affect strength and endurance, cognitive ability, vision, hearing, and health. Behavioral factors may also be relevant; for example, age is related to knowledge and skills acquired through experience. In addition, age is associated with changes in family obligations and incentives, which can affect labor effort and productivity.

Gobel and Zwick (2009) found that in the different age groups of 50-55 years old, the productivity of business institutions increased with the increase of the proportion of employees, while in the older age groups, the productivity decreased only slightly.

However, the company still can hire more elderly or extend the working life to increase economic growth. The first advantage of hiring older people is to reduce pension payments to the elderly and improve health. Studies have shown that older people can be more alert or active by using their brains and bodies in their work. In addition, through the employment of skilled workers, the training of novices could also be facilitated, and the reduction in the labor force resulting from lower fertility could be supplemented (Paulson and Willig, 2008).

Therefore, if the elderly are hired, the increasing labor supply leads the labor productivity to increase, and the household saving will also increase with getting monthly wages.

Table 7. *Regression resul*

Regression																		
Model	Japan						China						Malaysia					
	LS		HS		LP		LS		HS		LP		LS		HS		LP	
	B	t	B	t	B	t	B	t	B	t	B	t	B	t	B	t	B	t
	-8.512	-4.684***	-93.9	-4.416***	-17.2	-4.044***	-.153	-3.596***	2.399	6.980***	-2.060	-5.442***	-.213	-4.140**	-17.500	-4.140***	-1.098	-3.893***
Constant	.365		6.007		.991		-.001		.010		-.031		.004		.788		.059	
Durbin-Watson	.800		.830		.450		.660		.874		1.163		.858		.951		.660	
ANOVA	.000[b]		.000[b]		.000[b]		.001[b]		.000[b]		.000[b]		.022[b]		.000[b]		.001[b]	
Std. Error	.02475		.32071		.05825		.00254		.03861		.02265		.00640		.30912		.02063	
F-Value	21.939		19.504		16.355		12.934		48.722		29.619		5.920		17.137		15.152	
R-square	.448		.419		.377		.324		.603		.523		.180		.388		.359	
Adjusted R-square	.428		.398		.354		.299		.580		.505		.149		.366		.346	

Note: *LS-Labour Supply, HS- Household Savings, LP-Labour Productivity*
Source: *Own study.*

5. Conclusion, Limitations, and Applications

This paper aims to empirically examine the impact of population aging (demographic changes) on economic growth (measured by labor supply, household savings, and labor productivity) in three countries Japan, China, and Malaysia. Utilizing the data of the three countries for 29 years each between 1990 to 2018, the findings showed that the older the population, the greater the negative impact on the economy.

In specific, the results indicate a negative effect of population aging on each labor supply and labor productivity in the countries China, Japan, and Malaysia; however, for house saving, the study showed mixed results that population aging has a negative impact on house saving in Malaysia and Japan but a positive impact in China. Generally speaking, as the population ages, the world is likely to become a giant nursing home for more elderly.

This means that employment patterns, the structure of pension plans, the cost of health care, and the economic impact of an aging population will alter. These results help the policymakers to establish government policy in each of these countries to alleviate the negative impact of population aging. Early action could make countries better prepared to cope with the social, economic, and political implications of impending demographic changes.

As with any other study, this study has its own limitations; first, the sample size is still small, is only 29 years, a future study can increase the sample size to increase the intensity of the study, decrease the margin of error and make the study more accurate. Future studies can include more dependent variables such as consumption and investment.

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