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Aging and Economic Growth: Empirical Analysis using Autoregressive Distributed Lag Approach

(Penuaan dan Pertumbuhan Ekonomi: Analisis Empirik menggunakan Pendekatan Autoregresi Susulan Teragih)

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ABSTRACT

The purpose of this study was to examine the impact of aging on economic growth. The study used dynamic growth model and employed Autoregressive Distributed Lag (ARDL) approach for the period of 1980 to 2011. Three proxies for aging are used namely fertility rate, life expectancy and old dependency ratio. However, only fertility rate is detected to have a long run cointegration. The major finding of this study showed that a reduction of fertility rate lead to higher economic growth. This implied that even though Malaysia will face aging society by 2020, the economic growth is still stable and can increase by investing more on human capital.

Keywords: ARDL*; fertility rate; Malaysia; population aging*

ABSTRAK

Tujuan penyelidikan ini ialah untuk mengkaji impak penuaan kepada pertumbuhan ekonomi. Kajian ini menggunakan model pertumbuhan yang dinamik dan pendekatan autoregresi susulan teragih (ARDL) untuk jangka masa dari 1980 hingga 2011. Tiga proksi untuk penuaan telah digunakan iaitu kadar kesuburan, jangka hidup dan nisbah tanggungan orang tua. Namun hanya kadar kesuburan didapati mempunyai kointegrasi jangka panjang. Hasil utama kajian ini mendapati penurunan kadar kesuburan menyumbang kepada pertumbuhan ekonomi yang lebih tinggi. Ini menunjukkan bahawa walaupun Malaysia akan berdepan dengan masyarakat yang semakin tua pada tahun 2020, pertumbuhan ekonomi masih stabil dan boleh meningkat dengan lebih banyak membuat pelaburan dalam modal insan.

Kata kunci: ARDL*; kadar kesuburan; Malaysia; penuaan penduduk*

INTRODUCTION

Many Asian countries including Singapore, South Korea, Hong Kong, Taiwan, Thailand and Malaysia have experienced more distinct economic growth in the last three decades. According to the World Bank (2014), Malaysia's per capita GDP growth was approximately 3.80% on average per annum during 1978-2008. It was significantly higher than 1.9% for the United States, 1.84% for Europe and 2.07% for Japan. The reasons for Malaysia's remarkable economic growth have been extensively studied. Various factors are argued to be contributing to the growth in Malaysia, including trade openness, foreign direct investment (FDI) and institutional reforms. However the issue on demographic age structure on Malaysia's economic growth has been given less attention as Malaysia has not yet become an ageing society.

According to Coulmas (2007) there are three types of society based on the proportion of elderly: Ageing society if 7% - 13% of the population are 65 years or older; Aged society if 14% - 20% of the population are 65 years or older; and Hyper-aged society if 21% or more of the population are 65 years or older. According to Hamid (2015a, 2015b), Malaysia will become an ageing society by the year 2020 where Malaysia's population aged 65 years or older will reach 7%. However, once it reaches 7%, the speed of ageing will be faster i.e. it will take 23 years for Malaysia to double its elderly population to be 14% by 2043, which is much faster than the developed countries such as France who took 115 years to double their elderly population from 7% to 14% as stated by Kinsella and He (2009).

Population ageing rises with the increasing life expectancy and declining fertility rate. This phenomenon is depicted in Malaysia's demographic change over time. According to World Bank (2014), in 1970, Malaysia's elderly population was just 3.3%, however, in 2013 it's already reached at 5.4%. At the same time, the percentage of young population that age less than 14 decreases from 44.8% in 1970 to 26.1% in 2013, meanwhile working population rose from 51.9% in 1970 to 68.5% in 2013. If Malaysia does not make ample preparation for its coming to be ageing society, it will burden the government as a whole. Therefore this study aims to look at the impact of population ageing on economic growth in Malaysia, to alert policy makers and help formulate government policy such as on long-term care.

From theoretical standpoint, population ageing can retard the economic growth. The life-cycle hypothesis (Modigliani & Brumberg 1954) supports the view that population aging can slow down economic growth. The life-cycle hypothesis suggests that population aging will initially lead to an increase in national savings as the proportion of the population in the maximum savings years increases. As the population continues to age and the relative proportion of the population of those reaching retirement age grows relative to the middle-aged population, however, the life-cycle hypothesis predicts a reduction in aggregate savings. Bloom et al. (2008) argues that population ageing will tend to lower both labor-force participation and saving rates, therefore rising concerns about a future slowing of economic growth. However the empirical studies showed ambiguous results, some find population ageing can boost the economic growth and some find otherwise. For example, Park and Shin (2011) identified that there will be a sizable adverse economic impact where population ageing is more advanced. In contrast, Gomez and De Cos (2008) find that the process of population ageing is positively and significantly related to cross-country economic performance.

Methods

In examining the dynamic linkage between Malaysia's economic growth and its major determinants, following the previous literature (Barro & Sala-i-Martin 2003; Bloom & Williamson 1998; Choudhry & Elhorst 2010; Mankiw et al. 1992), we formulate the economic growth model for Malaysia as follows:

$$lnGDP_t = \alpha_0 + \alpha_1 lnAging_t + \alpha_2 lnGE_t + \alpha_3 lnDS_t + \alpha_4 lnHC_t \varepsilon_t \quad (1)$$

where GDP_t is the GDP per capita (2005 constant USD); $Aging_t$ is either life expectancy (years), old dependency ratio (in percentage of working-age population) or fertility rate (births per woman); the control variables (CV) which are GE_t the government expenditure (in percentage of GDP); DS_t the domestic savings (in percentage of GDP); and HC_t is the primary education (number of students).

The data in (1) have been collected from World Development Indicators of World Bank except primary education which is from Malaysia's Department of Statistics. The time series data covers the period 1980-2011 (32 years).

The empirical focus is on assessing the long-run impact of aging on the economic growth. To achieve the objective, we use an autoregressive distributed lag (ARDL) bound testing approach of cointegration developed by Pesaran et al. (2001). Because an error-correction model (ECM) can be derived from the ARDL model via a simple linear transformation, the ARDL is a convenient tool to investigate the short-run and long-run parameters of the model simultaneously.

In order to implement the bounds testing procedure, following Pesaran et al. (2001), it is necessary to

$$\Delta lnGDP_t = \beta_0 + \eta_1 \sum_{i=0}^{p} \Delta lnGDP_{t-i} + \varphi_2 \sum_{i=0}^{p} \Delta lnAging_{t-i} + \xi_3 \sum_{i=0}^{p} \Delta lnCV_{t-i} + \lambda_1 lnGDP_{t-i} + \lambda_2 lnAging_{t-i} + \lambda_3 lnCV_{t-i} + \mu_t \quad (2)$$

where Δ is the first difference operator; p is lag length and μ_t is an error term assumed serially uncorrelated. In (2), the estimates of λ_1, λ_2 and λ_3 represent the long-run (cointegration) relationship. The coefficients of the summation signs ($\sum$), on the other hand, show the short-run relationship between Malaysia's economic growth and its major determinants.

Pesaran et al. (2001) show that in this type of specification, the selected variables are said to be cointegrated if all the lagged-level variables are jointly significant in the equation. This can be done by using an F-test with two sets of asymptotic critical values (upper and lower critical values) tabulated by Pesaran et al. (2001). An upper critical value assumes that all the variables are $I(1)$, or nonstationary, while a lower critical value assumes that they all are $I(0)$, or stationary. If the computed F-statistic falls above the upper bound of critical value, the selected variables are said to be cointegrated. It is worth mentioning that, since the ARDL is based on the assumption that all variables could be $I(1)$ or $I(0)$, unlike the standard cointegration techniques (Engle & Granger 1987; Johansen 1995), it can be applied irrespective of their order of integration and therefore avoids the pre-testing problems.

Results & Discussion

Since an increase in aging causes a decrease in the economic growth, it is expected that an estimate of α_1 is negative. An increase in aging can be indicated by an increase in life expectancy (Cervellati & Sunde 2009), an increase in old dependency ratio (Kelley & Schmidt 2005) or a decrease in fertility rate (Barro 2008, 1996; Choudhry & Elhorst 2010; De Gregario & Lee 2003).

In regards to the impact of life expectancy on economic growth according to Cervellati and Sunde (2009), in countries before the demographic transition, the main effect of reductions in mortality in other words, an increase in life expectancy is to accelerate population growth, which tends to reduce per capita income, while there is little effect on education. In countries that have completed the transition, however, reductions in mortality reduce population growth; accelerate human capital formation and increase income per capita. Therefore, life expectancy can have negative and positive impact on the economic growth. Lee and Mason (2006), Lee et al. (2001) and Mason and Lee (2004), argue that a longer life expectancy and a smaller family size may lead to a strong incentive for people to save for their extended period of retirement. Increased savings, no matter investing domestically or abroad, may contribute to economic growth given effective policies in support systems for the elderly. On the other hand, higher life expectancy can also lead to an increase in old dependency dependents which causes working-age population to fall therefore reduces economic growth.

Likewise, a reduction of old-age dependency may reduce tax and social security contributions paid by employed people in order to finance the retirement income and health care of the elderly and therefore also may increase labor supply. It also implies fewer mouths to feed and thus more savings accumulated for productive investment in the economy. Therefore an increase in old age dependency ratio indicates an increase in aging which causes a decrease in the economic growth. That is why the coefficient of old-age dependency ratio is expected to be negative.

In contrast, the reduction in fertility rate in other words having fewer children frees up the time for women to work. So the increase in female labor participation increases the working-age population which boosts the economic growth. In the short term, a higher fertility rate means that increased resources must be devoted to childrearing rather than production of goods. In the long term, a portion of the economy's investment must be used to provide capital for new workers (after children have grown up) rather than to raise capital per worker. Also with a decline in fertility, in the short-run the youth-age population share declines and the working-age share increases. Working-age people contribute to the labor force more than youth-age and if these individuals are gainfully employed (Bloom et al. 2007) then while income per worker can remain the same, income per capita increases. In Malaysia, the decline in the total fertility rate has bought with it an increase in the working-age share. However, as the total fertility rate falls below the replacement rate in many Asian countries, the working-age share will decrease in the long-run (Bloom et al. 2008) and old-age shares will increase. Therefore, a decline in fertility indicates an increase in aging which causes a decrease in economic growth. That's why the coefficient of fertility rate is expected to be negative.

If the government expenditure leads to an increase in economic activity, thereby increasing the economic growth in Malaysia, it is expected that an estimate of α_2 is positive. Since an increase in domestic savings boosts the economic growth, it is expected that an estimate of α_3 is positive. Finally, if an increase in human capital investment leads to an increase in economic growth, it is expected that an estimate of α_4 is positive.

Before implementing the ARDL modeling, the important specification issue to be addressed is the determination of lag length for the model. Many empirical studies (Bahmani-Oskooee & Ardani 2006; Bahmani-Oskooee & Brooks 1999) show that the empirical results of the F-test are quite sensitive to change in lag structure on first differenced variables. Following Pesaran et al. (2001), we first determine the lag structure (p) in (2) in conjunction with the Schwarz Bayesian Criterion (SCB) (due to the small sample size of 32 years) and diagnostic tests for serial correlation based on the Langrange multiplier (LM) statistics (Table 1).

We focus on the equation which has long-run cointegration. Only the equation where fertility rate become aging proxy has long-run cointegration. The equations which are life expectancy and old dependency ratio as proxy for aging found to have no long-run cointegration. The SBC indicates that $p = 2$ is the most appropriate lag length for Malaysia's economic growth in which the fertility rate becomes the aging proxy. The LM statistic, however, shows that the null hypothesis of no serial correlation can be rejected at $p = 2$ at the 5% level. We then select $p = 1$, which provides the second lowest SBC statistic as well as the failure to reject the null of no serial correlation. Therefore, a lag length of one year ($p = 1$) is used for further analysis.

With the selected lag length ($p = 1$), we then test the existence of a level relationship (cointegration) among the selected variables in (2). For this purpose, the null hypothesis of non-existence of the long-run relationship ($\lambda_1 = \lambda_2 = \lambda_3 = 0$) in (2) was tested using an F-test. The results showed that the calculated F-statistic lies outside the upper level of the 5% critical bounds (4.77) (Table 1), indicating the existence of a stable long-run relationship among economic growth, ageing and the control variables. We then estimate (2) using the ARDL approach in order to obtain the long-run and the short-run coefficients. The maximum lag length is set to one ($p = 1$). Given this, the SBC-based ARDL suggests ARDL (1,2,2,0,0) as the optimal lag structure for the model.

The results of the long-run coefficient of Malaysia's economic growth where fertility is the aging proxy show that all variables are statistically significant at 5% level and have the expected signs (Table 2). More specifically,

TABLE 1. Results of cointegration test among variables

Lag order	SBC	χ^2_{SC}	F-statistic
1	-4.76	2.75	5.93**
2	-5.20	6.07*	4.48*

Note: χ^2_{SC} is Lagrange multiplier (LM) statistic for testing the hypothesis of no serial correlation. F-statistic is the test statistics for cointegration. F-statistic for the 5% critical value bound is (3.35, 4.77, which is obtained from Table case III in Narayan (2005). * An asterisk indicates significance at less than 10% level. ** Double asterisks indicate significance at less than 5% level. *** Three asterisks indicate significance at less than 1% level the economic growth has a negative long-run relationship with fertility rate, indicating that a fall in fertility rate leads to a rise in aging which consequently leads to a decline in economic growth. A 1% decline in fertility rate causes the economic growth to increase by 1.22%. This supports the theory that as the fertility falls, in the long-run, the working-age population also falls. This is also consistent with findings from previous literature. Prettner et al. (2012) find evidence, using a cross-country panel dataset for 1980-2005, that greater investment in education and health can help to counter the declining labor supply that may come about because of declining fertility. This conclusion is consistent with the view that economic growth and development are not merely a function of the quantity of labor but also of its quality, which is increased by the contributions of education and health to human capital. Similarly, Cutler et al. (1990) cross-national comparative study using panel data came up with a conclusion that decreasing labor force growth results in increasing labor productivity. Moreover, the optimistic perspectives in why aging leads to higher economic growth focus on technological advancement and human capital investment i.e. it prioritizes on creating quality workers rather than large quantity of workers. Usually young individuals are faster at accepting new technology than elder individuals. Regardless, increasing investment into the human capital of the young generation and older workers who have growth mindset would produce more quality workers even though they are less in quantity. Their productivity will compensate for the low quantity of workers (Cutler et al. 1990; Gee & Gutman 2000; Scarth 2002). In addition, scholars point out the positive effects of population aging and low growth on economic growth such as development of labor-saving technology (Futagami & Nakajima 2001) and increased investment into human capital, which is assumed to compensate for the lost growth rate due to quantitative decrease in labor input. Scarth (2002), for example, asserts that population aging could lead to productivity growth by motivating increased investment into human capital as labor becomes a relatively scarce production factor. Therefore, the government should focus on improvising policies on long-term care in investments of education, health & technological advancements.

On the other hand, the economic growth has a positive long-run relationship with the control variables, implying that Malaysia's economic growth tend to increase as the control variables i.e. government expenditure, savings and human capital increase. The economic growth increases by 1.05%, given a 1% increase in government expenditure, while a 1% increase in domestic savings causes economic growth to increase by 0.69%. Also a 1% increase in human capital (primary education) causes economic growth to increase by 0.48%.

The results of the short-run coefficient estimates of Malaysia's economic growth show that the fertility rate is statistically significant at the 1% level. The control variables are also statistically significant. These findings indicate that, in the short-run, the fertility rate plays a more important role in affecting the economic growth.

It is worth emphasizing that the error correction term (ec_{t-1}) is negative and significant at the 1% level (Table 3). The negatively significant coefficient of ec_{t-1} implies that the long-run equilibrium can be achieved. The absolute value of ec_{t-1} shows the speed of adjustment to equilibrium. As such, the result suggests that the economic growth equation tends to go back to its long-run equilibrium

TABLE 2. Estimated long-run coefficients and t-ratios of Malaysia's economic growth

Variable	Coefficient	t-Ratio
Fertility rate (LFR)	-1.22***	-15.05
Government expenditure (LGE)	1.05***	9.01
Domestic savings (LDS)	0.69***	4.70
Human capital (LHC)	0.47***	2.38
Constant	-1.37	-1.51

Note: ***, **, * indicate significance at the 1%, 5% and 10% level, respectively

TABLE 3. Estimated short-run coefficients and t-ratios of Malaysia's economic growth

Variable	Coefficient	t-Ratio
ΔLFR	-7.32	-3.70***
ΔLFR_{t-1}	6.59	3.43***
ΔLGE	0.81	10.76***
ΔLGE_{t-1}	-0.13	-2.32**
ΔLDS	0.49	6.60***
ΔLHC	0.34	1.95*
ec_{t-1}	-0.72	-6.88***
Constant	-0.98	-1.41

Note: ***, **, * indicate significance at the 1%, 5% and 10% level, respectively
ec_{t-1} represents the error correction term

position. The adjustment toward equilibrium however is not instantaneous. The coefficient of ec_{t-1} is -0.72, implying that approximately 72% of the adjustment occurs in a year in the equation; in other words, it takes more than 1 year (1/0.72 = 1.39 years) to correct the disequilibria.

Finally, in order to ensure that estimated coefficients are stable over time, the cumulative sum (CUSUM) and cumulative sum of squares (CUSUMSQ) tests are applied to the residual of error correction model in (2). The result showed that the estimated coefficients are generally stable over the sample period; hence, the ARDL models presented are well defined and provide sound evidence.

Conclusion

This study carried out an investigation whether aging has significant impact on economic growth. The estimation was carried out using dynamic model for the period of 1980 to 2011. The result showed that only fertility rate which proxy for aging have a long run relationship meanwhile the other two proxy namely old dependency ratio and life expectancy did not have a long run cointegration. Our result showed that aging (proxy by fertility rate) negatively affect the economic growth. In other words, in the long run, even though Malaysia will face the aging society by year 2020, the economic growth can remained stable as reduction on fertility rate implies that women will be participating more in the labor market and thus contribute to higher labor productivity and economic growth too. The government should keep on investing on human capital, health and technological advancement so that even though we face the aging society, we already prepared stock of quality human capital.

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