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The Implication of Ageing on the Fiscal Position in Malaysia

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ABSTRACT

The aged population in Malaysia has increased fast from 2000 to 2020. However, the implications of ageing on Malaysia's fiscal position still need to be clarified as the existing literature focuses on other fiscal aspects. This article examines the effect of ageing on government spending and government revenue in Malaysia in the short and long run using the annual data from 1990 to 2020. This paper applies the augmented autoregressive distributed lag bound (AARDL) test to determine whether the government spending and revenue equation is cointegrated. The AARDL method is believed to provide a more comprehensive examination of the cointegration properties. After the cointegration relationship is confirmed, the long-run and short-run implications of ageing are examined using the unrestricted error correction and error correction models, respectively. Estimating the government expenditure and revenue equations shows that cointegration exists. In the long run, an increase in the ageing population growth rate causes government expenditure and revenue to decrease. However, no robust evidence supports the statistically significant impact of ageing on both fiscal variables in the short run. The results suggest that the implication of ageing is long-run. Regarding policy implications, the Malaysian government needs to diversify income resources and implement stronger fiscal discipline to minimise the implications of ageing on its fiscal position.

Keywords: Ageing, Augmented ARDL, Government Expenditure, Government Revenue, Malaysia

1. INTRODUCTION

The ageing situation in Malaysia has deteriorated gradually over the years. According to the World Bank, those aged 65 and above only contributed to 2.6 per cent of the total Malaysian population in 1960, and the number increased by 4.1 per cent and 7 per cent in 2000 and 2020, respectively. This shows that the increasing trend of the aged population has been exacerbated. According to Schmillen et al. (2020), Malaysia is expected to become an ageing country in 2020 when 7 per cent of the total population is aged 65 and above, a standard international definition of an ageing country. The same source also forecasts that the country will become an aged society when 14 per cent of the population is 65 years old and above by 2044. With these facts, it is difficult for policymakers in Malaysia to ignore the possible impacts of ageing on the economy, especially the fiscal impact of ageing. The fiscal position in Malaysia deserves attention since Malaysia has experienced a persistent fiscal deficit since 1998, causing concerns about the possible economic vulnerability that is caused by these deficits. In detail, one of the impacts that has been discussed in the literature and by policymakers is how ageing could affect government revenue and government spending. The issue has become pressing for a country with constrained fiscal space. In Malaysia, government revenue has generally been downward since 1990.

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According to the WEO database, the total government revenue to GDP was 30.67 per cent in 1990. The figure dropped to 19.58 per cent in 2000. The figure rose slightly to 22.29 per cent in 2010 before declining to 20.18 per cent. Compared to the drop-in government revenue, the Malaysian government spending, proxied by the general government's final consumption expenditure as a percentage of GDP, has been relatively stable. According to the World Bank data in 1990, the government's final consumption expenditure as a percentage of GDP was 13.79 per cent and then fell to 10.17 per cent in 2000. From 2001 to 2020, the value fluctuated between 11 per cent and 14 per cent. It was 13 per cent in 2020.

This paper examines how ageing could affect Malaysia's fiscal position, i.e., government expenditure and government revenue, in the long run. Accordingly, the annual data from 1990 to 2020 is analysed for this objective. In terms of methodology, the augmented autoregressive distributed lag bound test (AARDL) is applied to detect any cointegration relationships in the equations. This paper's estimations show that ageing is cointegrated with government expenditure and revenue. Furthermore, the estimations of long-run coefficients show that ageing will reduce government expenditure and revenue in the long run. However, based on the estimation of the ECM model in this paper, there is no robust evidence to suggest that ageing is statistically significant in affecting both fiscal indicators in the short run.

This paper has the following contributions. First, the implications of ageing on fiscal policy are mainly explored in developed countries and are largely unexplored among developing countries. The findings will provide insights into the impact of ageing on Malaysia to the authorities and regional developing countries that could also face the ageing issue later. Second, this paper examines government spending and government revenue, exploring more detailed impacts on Malaysia's fiscal position. Only Fall et al. (2015) have reported the impact of ageing on these indicators in the same paper when examining a panel dataset. Finally, the proposed AARDL bound test by Sam et al. (2019) is deployed to provide more extensive evidence of cointegration and eliminate degenerate cases (i.e., non-cointegration) arising from the statistical insignificance of lagged dependent variables. This degenerate case has yet to be considered by many papers that applied the ARDL bound test because these papers examined the unit root properties of dependent variables to ensure that the dependent variable is I(1) or assume that the dependent variable is an I(1) variable. Having an I(1) dependent variable enables the ARDL bound test to detect any cointegrated relationship by only using the t-test for the lagged dependent variable and the F-test for all lagged variables (Sam et al., 2019). Nonetheless, the inconsistency of the results of different unit root tests has suggested that utilising the unit root test is insufficient, therefore, undermining the reliability of the ARDL bound test. Indeed, the statistical insignificance of all lagged dependent variables should be examined as well; the AARDL bound test in this paper will complete this task. Finally, the findings of the existing studies, such as Fall et al. (2015) and Temsumrit (2023), are still far from providing a consensus on the impact of ageing on fiscal indicators. As such, this paper will fill this knowledge gap by providing empirical evidence using Malaysian data.

This paper consists of six sections. Section 1 presents the research background and summary. Next, section 2 shows the relevant past literature. The model specification and methodology are presented in Section 3. The theoretical impacts of ageing on the fiscal variables are mentioned in that section, too. Furthermore, Section 4 contains information on the data of this paper. Subsequently, the results are discussed in Section 5, while Section 6 concludes.

2. LITERATURE REVIEW

The fiscal reaction function and model simulation can explore ageing's impact on fiscal indicators. Among the papers that use the fiscal reaction function as the basic model is by Nerlich and Reuter (2013). They confirm that the dependency ratio negatively affects the primary balance equation in 27 EU countries. Focusing on the EU as well, Bokemeier et al. (2020) discover that a longer life expectancy leads to a lower cyclical adjusted primary balance. Furthermore, Ramos-Herrera and Sosvilla-Rivero (2020) use the fiscal reaction function to study the impact of population ageing on fiscal sustainability in 11 European Union countries; the ageing weakens the cyclically-adjusted primary balance in the examined countries. Fall et al. (2015) report that the old dependency ratio negatively impacts the primary balance among developed countries, albeit economically insignificant; this happens because of the positive and negative association with government spending and government receipts. Notably, Korwatanasakul et al. (2021) cannot find a statistically significant impact of the ageing population on government balance in a panel dataset of 178 countries. However, ageing could affect healthcare spending positively. Otherwise Temsumrit (2023) examines the disaggregated panel data of government spending in n87 countries. A positive association between total government spending and ageing could be found only in developed countries. Besides, ageing could lower the spending on education but increase the spending on social protection and the environment. Nguyen et al. (2023) produce projections showing that ageing reduces government revenue by lowering personal income tax.

The effect of ageing on the fiscal position can also be estimated using the simulation method. For example, Harding and van der Ploeg (2009) utilise the structural model simulation on the Norweigian data and summarise that a higher old dependency ratio could result in a lower non-hydrocarbon primary balance. Medina's (2015) simulation that decomposes the pension spending into old dependency, benefit ratio and eligibility ratio shows that an increase in the old dependency ratio causes pension spending in Bangladesh to increase. The budget projection of Pena (2020) using El Salvador's data also indicates that ageing increases expenditure for health, poverty, and social protection. Cai et al. (2018) forecasted that 20 per cent of the Chinese GDP would have to be used to fund expenditures on pension, education and healthcare based on simulation using the benefit generosity ratio. Crowe et al. (2022) projected that ageing will increase government spending on healthcare and pensions and prompt a rise in tax revenue using OECD data.

The implication of ageing on the fiscal position in Malaysia has focused on fiscal sustainability. Nonetheless, the role of ageing on government expenditure and government revenue needs to be given more attention. A related paper was produced by Wan Farisan et al. (2015), who examined fiscal sustainability in Malaysia by computing fiscal sustainability indicators. They report that ageing could affect government spending by raising pension payments and healthcare expenditures. Furthermore, Lau and Alvina (2018) apply the Bohn fiscal reaction function to investigate that issue and find that the fiscal position in Malaysia is sustainable. However, the ageing indicator is not considered in their paper. Noormahayu et al. (2021) discover a statistically insignificant positive effect in their ARDL model on the reactions of healthcare spending to the ageing population. In sum, the previous related studies mostly focus on developed countries and normally use the fiscal reaction function to examine the fiscal reactions to ageing. The attention that is given to investigating the implication of ageing on fiscal policy in Malaysia is also limited.

3. MODEL SPECIFICATION AND METHODOLOGY

3.1 Model Specification

All the data were collected from an extensive literature search. For the collection of data, the following processes have been followed:

Equations (1) and (2) present the model specifications for the government expenditure and revenue, respectively.

$$\mathrm{gfce}_t = \beta_0 + \beta_1 \mathrm{debt}_t + \beta_2 \mathrm{pop65}_t + \beta_3 \mathrm{op}_t + \beta_4 \mathrm{rgdpc}_t + \varepsilon_t \quad (1)$$

$$\mathrm{govrev}_t = \delta_0 + \delta_1 \mathrm{pop65}_t + \delta_2 \mathrm{op}_t + \delta_3 \mathrm{rgdpc}_t + \delta_4 \mathrm{to}_t + \varepsilon_t \quad (2)$$

where gfce is government expenditure, govrev is government revenue, debt is the gross debt, and pop65 is the ageing indicator. β and δ denote coefficients. Lastly, ε is the error term. The typical view of the implication of ageing on government spending is that the former has a positive association with the latter following the effect of ageing on pension and healthcare (Edes &

Morgan, 2014). However, this paper hypothesises that the relationship between the government's final consumption expenditure and the ageing indicator could be negative because increasing ageing could weaken government resources for other consumption. The Malaysian government's expenditure on emoluments and retirement stood at 48.3% of total operating expenditure in 2020 (Kang and Esther Lee, 2021). This figure shows how significant retirement expenditure could be for the Malaysian government.

On the other hand, an increase in the ageing population could lead to lower economic growth (Oliver, 2015). Therefore, the negative relationship could be due to lower consumption due to ageing. Subsequently, government revenue will be negatively affected. Another implication of the fiscal position is that ageing leads to less labour force supply, subsequently shrinking the collectable tax revenue. Otherwise, the increasing savings caused by ageing, as Wong and Tang (2013) argued, could provide the capital needed to promote economic growth. As a result, the government revenue could increase. In sum, this paper proposes that ageing has an ambiguous effect on government spending and government revenue. Hence, empirically exploring the nexus of ageing-fiscal indicators is necessary.

These equations included a few control variables that were frequently applied in the existing literature. For the government expenditure, the control variables are oil price (op) and real GDP per capita (rgdpc). The control variables in the gfce equation was selected following the importance of oil export and economic growth in deciding Malaysian government spending. Finally, op, rgdpc, and trade openness (to) are the control variables in the govrev equation. Hypothetically, these variables will affect the tax collection positively. The income will affect income tax collection in Malaysia. Besides, international trade and oil exports will also affect national revenue since Malaysia is an export-oriented economy and an oil exporter. Figures 1 and 2 illustrate the conceptual frameworks that are applied in this paper. Generally, the left-hand side of both figures shows the independent variables in the government spending and revenue model. Otherwise, the right-hand side of the figures illustrates the dependent variables. The direction of the arrow indicates the direction of the effect from independent variables to the dependent variable in each model.

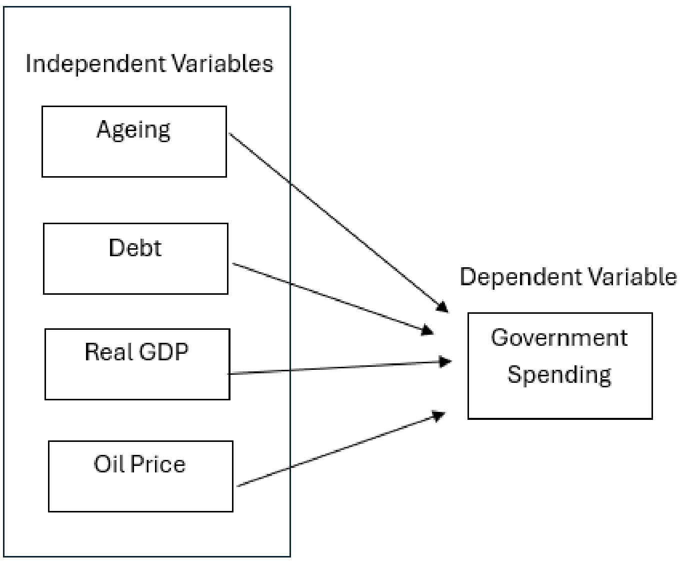

Figure 1. The Conceptual Framework of Government Spending Model

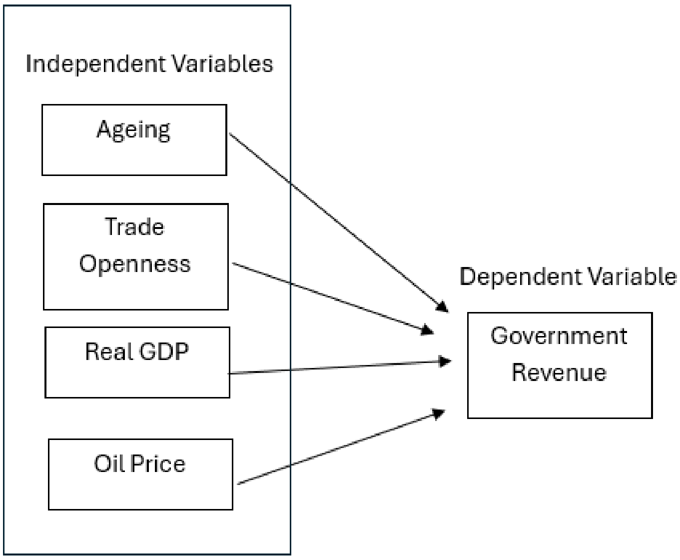

Figure 2. The Conceptual Framework of Government Revenue Model

3.2 Methodology

The first estimation involves the augmented Dickey-Fuller (ADF) test and Phillip Perron (PP) to examine the unit root properties of the variable. Two model specifications are assumed- models with a constant term and models with a constant term and a trend component. The number of lag and bandwidth for the ADF and PP tests are decided by deploying the Schwarz information criteria and Andrew bandwidth selection, respectively. This step is important to ensure that the model does not contain any variable integrated at order two or I(2). If there is an I(2) variable, that variable will be first differenced so that the variable will be estimated in the form of an I(1) variable. This data transformation ensures that the variable can be cointegrated with other I(0) and I(1) variables in the model. The same procedure is adopted by Goh et al. (2020).

Next, the long-run estimator in the fiscal equation is estimated by using the ARDL to cater for the different unit root properties that are detected in the data. As illustrated below, the ARDL model can be expressed in the unrestricted error correction term (UECM) model.

$$\begin{aligned}\Delta gfce_t = \beta_0 &+ \sum_{i=1}^{p} \alpha_1 \Delta gfce_{t-i} + \sum_{i=0}^{q} \alpha_2 \Delta debt_{t-i} + \sum_{i=0}^{r} \alpha_3 \Delta pop65_{t-i} + \sum_{i=0}^{s} \alpha_4 \Delta op_{t-i} \\ &+ \sum_{i=0}^{t} \alpha_5 \Delta rgdpc_{t-i} + \rho_1 gfce_{t-1} + \rho_2 debt_{t-1} + \rho_3 pop65_{t-1} + \rho_4 op_{t-1} \\ &+ \rho_5 rgdpc_{t-1} + \varepsilon_t \end{aligned} \quad (3)$$

$$\begin{aligned}\Delta govrev_t = \beta_0 &+ \sum_{i=1}^{p} \alpha_1 \Delta govrev_{t-i} + \sum_{i=0}^{q} \alpha_2 \Delta pop65_{t-i} + \sum_{i=0}^{r} \alpha_3 \Delta op_{t-i} \\ &+ \sum_{i=0}^{s} \alpha_4 \Delta rgdpc_{t-i} + \sum_{i=0}^{t} \alpha_5 \Delta to_{t-i} + \rho_1 govrev_{t-1} + \rho_2 pop65_{t-1} + \rho_3 op_{t-1} \\ &+ \rho_4 rgdpc_{t-1} + \rho_5 to_{t-1} + \varepsilon_t \end{aligned} \quad (4)$$

where p, q, r, s and t indicate the number of lags; t denotes time periods; β, α and ρ denote coefficients; Δ is the first difference of respective variables. The lag that is included in the UECM model is decided by using the stepwise-backwards estimation. Li et al. (2019) also adopt the stepwise measure to determine the lag in their estimation. Under this estimation, the lagged variables with the highest p-value will be excluded. Then, the variable with the highest p-value in the new estimated model will also be excluded. After that, both of the removed variables are compared with the forward p-value criteria, which is 0.1 in this paper. The excluded variables with p-values that are lower than 0.1 will be included. The process continues until the largest p-value is less than the backwards stopping criteria, which are assumed to be 0.1. Due to the relatively small sample size (31 observations), a maximum of three lags are assigned for each variable so that there is sufficient data for estimations. The equations are estimated using the ordinary least square (OLS).

Pesaran et al. (2001) propose a bound test to examine the cointegration among the variables in an equation. The bound test involves two indicators: the t-test of the lagged dependent variables and the overall F-test of all lagged variables. A cointegration test is confirmed if the t-statistics and F-statistics are above the critical values of the respective tests that have been generated by Pesaran et al. (2001). Here, the cointegration relationship is explored using the AARDL bound test discussed by McNown et al. (2018) and Sam et al. (2019). There are two advantages of the AARDL bound test. First, it avoids the false results of unit root tests, which could suffer from low power (Sam et al., 2019). Second, examining all hypotheses proposed by the AARDL bound test will provide a more comprehensive indication of the cointegration (Goh et al., 2020).

On top of the t-test and F-test applied in the Pesaran et al. (2001) cointegration test, the AARDL bound test examines the F-statistics of the lagged independent variables to detect the degenerate lagged independent case. If there is a degenerate lagged independent case, one can conclude that there is no cointegration. The null and alternative hypotheses of all three tests under the AARDL bound test for equation (3) are presented below.

(i) $H_0: \rho_1 = 0;\; H_A: \rho_1 \neq 0$
(t-test for lagged dependent variable)

(ii) $H_0: \rho_1 = \rho_2 = \rho_3 = \rho_4 = \rho_5 = \rho_6 = 0;\; H_A: \text{any } \rho_1, \rho_2, \rho_3, \rho_4, \rho_5, \rho_6 \neq 0$
(F-test for all lagged variables)

(iii) $H_0: \rho_2 = \rho_3 = \rho_4 = \rho_5 = \rho_6 = 0;\; H_A: \text{any } \rho_2, \rho_3, \rho_4, \rho_5, p_6 \neq 0$
(F-test for lagged independent variables)

It is worth mentioning that failing to reject the null hypothesis suggests that the variables are not cointegrated. The critical values of the t-test and overall F-test are available in Pesaran et al. (2001) and Narayan (2005), respectively. Finally, the critical value for the F-test for the lagged independent variables is computed by Sam et al. (2019). The AARDL bound test in this paper assumes that there are unrestricted intercepts and that the trend component is absent.

The Jacque Bera normality test, Ramsey RESET F-test, Breusch-Godfrey serial correlation LM test, Breusch-Pagan-Godfrey Heteroskedasticity test, and CUSUM square test examine the model's performance in terms of normality, model specification, serial correlation, heteroskedasticity, and stability, respectively. In addition, if serial correlation or heteroskedasticity is detected, the model will be estimated using the heteroskedasticity and autocorrelation consistent (HAC) standard error to minimise the distortion that is caused by these issues.

Based on discussions in Section 3.1, it is expected that pop65 will have ambiguous signs in gfce and govrev. The debt will positively affect gfce since it increases the government resources available for consumption. As an oil-producing country, a higher op should increase the gfce and govrev. A higher rgdpc could also increase all dependent variables since it could increase the government expenditure ability and create more tax income. However, a negative association could be established if a government must devote more effort to collecting tax income (Gnangnon, 2022). Lastly, trade openness will have an ambiguous sign in the govrev equation. On the one hand, more international trading could increase economic activities, contributing to more government revenue. On the other hand, the economic volatility caused by more international trade could be detrimental to government revenue.

Lastly, this paper also estimates the error correction model (ECM) to measure the speed of adjustment. Moreover, the short-run relationships between ageing and fiscal indicators established in the ECM model are also presented. Equations (5) and (6) present the general form of the ECM models.

$$\Delta gfce_t = \delta_0 + \sum_{i=1}^{p} \delta_1 \Delta gfce_{t-i} + \sum_{i=0}^{q} \delta_2 \Delta debt_{t-i} + \sum_{i=0}^{r} \delta_3 \Delta pop65_{t-i} + \sum_{i=0}^{s} \delta_4 \Delta op_{t-i} + \sum_{i=0}^{t} \delta_5 \Delta rgdpc_{t-i} + \gamma_1 ect_{t-1} + \varepsilon_t \quad (5)$$

$$\Delta govrev_t = \delta_0 + \sum_{i=1}^{p} \delta_1 \Delta govrev_{t-i} + \sum_{i=0}^{q} \delta_2 \Delta pop65_{t-i} + \sum_{i=0}^{r} \delta_3 \Delta op_{t-i} + \sum_{i=0}^{s} \delta_4 \Delta rgdpc_{t-i} + \sum_{i=0}^{t} \delta_5 \Delta to_{t-i} + \gamma_1 ect_{t-1} + \varepsilon_t \quad (6)$$

where p, q, r, s, and t are the number of lags; t denotes time periods. δ and γ denote coefficients. Δ is the first difference of respective variables. Lastly, ect and ε represent the error correction term (ECT) and the error term, respectively. The stepwise-backwards estimation decides the lag length in this case. The ECT is derived from the error terms of the OLS estimation of gfce and govrev. The coefficient of the ECT value should be between 0 and -1 for a cointegrated relationship. It represents the percentage of the deviation from the long-run relationship corrected a year later in this paper. However, Barik and Sahu (2022) highlight that if the ECT falls between -1 and -2, the convergent to the long-run equation oscillates but is still stable.

Finally, the sensitivity of the results is investigated by deploying the old dependency ratio. It is measured as the percentage of the population older than 64 to those aged between 15 and 64 (olddep), as an alternative indicator of ageing. Besides, different combinations of control variables are examined to check the conclusion.

4. DATA

This paper utilises the time series data, i.e., the annual data from 1990 to 2020. The data availability decides the sample duration. The general government final consumption expenditure as a percentage of GDP is applied to represent government expenditure. It is worth mentioning that this data does not consider pension and healthcare expenditures. As for the government revenue, the total government revenue as a percentage of GDP is its indicator. Ageing is indicated by the ratio of the number of citizens aged 65 and above to the total population. The debt level is proxied by the general government gross debt. The oil price is represented by the world crude oil price measured in the current United States Dollar (USD). Finally, the proxy of real GDP per capita and trade openness is the GDP per capita measured in the constant value of the local currency unit and the ratio of the sum of exports and imports to GDP, respectively. All data are transformed into natural logarithm form. The sources of the data applied are presented in Table 1.

Table 1 Data Sources

Data	Measurement	Source
General government final consumption expenditure (gfce)	Percentage of GDP	World Bank Data
Total Government Revenue (govrev)	Percentage of GDP	World Economic Outlook
Population aged 65 and above (po65)	Percentage of population	World Bank Data

Data	Measurement	Source
Population older than 64 and above (olddep)	Percentage of the population aged 15-64	World Bank Data
General government gross debt (debt)	Percentage of GDP	World Bank TCdata 360
Real GDP	Constant USD in 2015	World Bank Data
Crude oil price (op)	Current USD	Our World in Data Database
Real GDP per capita (rgdpc)	Constant local currency unit	World Bank Data
Trade openness (to)	The sum of exports and imports to GDP	World Bank Data

Note: The parentheses contain the acronym of the variables deployed in the estimations in this paper.
Source: Author Calculation

5. ESTIMATION RESULTS

Table 2 shows the raw data's mean, standard deviation, and minimum and maximum values from 1990 to 2020. Generally, all variables have positive values. Besides, as shown by standard deviations, minimum and maximum values, most variables have relatively wide fluctuations. It shows that the domestic and global economic variables have been relatively volatile during the examined sample. The stability of ageing is expected as no significant incidents affect the demographic in Malaysia, and ageing is a gradual process.

Table 2 Data Descriptive Analysis

Variables	Number of observations	Mean	Standard deviation	Minimum	Maximum
Gfce	31	12.29	1.07	9.77	13.842
Govrev	31	23.85	3.02	19.52	30.67
pop65	31	4.77	1.07	3.68	7.184
Olddep	31	7.31	1.26	6.21	10.36
Debt	31	47.82	11.42	29.62	74.129
To	31	169.36	31.34	116.43	220.407
Op	31	48.94	31.92	12.72	111.67
Rgdpc	31	29442.35	8083.48	16165.30	44579.637

Source: Author Calculation

Table 3 displays the unit root result. Most unit root tests indicate that pop65 could be integrated at order two. Similarly, olddep is considered an I(2) variable as indicated by the PP unit root test. Since the PP unit root test is generally superior to the ADF unit root test, this paper treats that variable as an I(2) variable. As discussed, this variable will be transformed into the first differenced variable in all following estimations, so the ageing indicator becomes an I(1) variable and could be cointegrated with other variables in the equation. This caused the observation number to be reduced by one for all variables, starting in 1991.

Since the variables are either I(0) or I(1), the cointegration relationship among the variables using the AARDL bound test is conducted. The summary of the cointegration test is available in Table 4. All government spending and government revenue equations in this paper contain cointegration. Hence, the next step is estimating the long-term government spending and government revenue reaction to ageing.

5.1 The Long-Run Effects of Ageing on Fiscal Indicators

Table 5 shows all the long-run estimates from the gfce and govrev equation. The discussions begin with models that have been estimated using pop65. According to panel A, the pop65 has been linked to lower government expenditure and government revenue. The negative effect of government expenditure follows the hypothesis that the aged society prompts the Malaysian government to reduce the consumption of final goods and services. The inversed relationship between ageing and government revenue indicates that the assumption that ageing affects tax collections and consumption negatively is supported. Additionally, the reduction effect of ageing on government revenue is larger than its impact on government spending, causing concern about fiscal sustainability.

Besides, a higher debt enables the Malaysian government to sustain its final goods and services consumption. Particularly, a one per cent increase in debt will cause the gfce to increase from 0.27 per cent to 0.54 per cent. On the other hand, the negative association between pop65 and gfce is established in Model 1 and Model 2. For example, a 1 per cent increase in pop65 causes government expenditure to drop by 3.71 per cent in model 1. Nonetheless, the coefficient sign turns negative in Model 3.

Besides, the rgdpc does not have the expected positive effect. A similar result is reported by Agnello et al. (2015), who found a negative sign of real GDP growth in the primary spending equation in the UK. Furthermore, gfce rises marginally at 0.01 to 0.04 per cent after a one per cent increase in the op, although the effect is statistically insignificant in most models.

Additionally, all coefficient signs are consistent in all robustness estimations that the olddep has estimated. The model performance is presented in panel B. The estimations in Models 3, 5, and 6 contain a lag two autocorrelation, causing both estimations to be estimated using HAC standard error. Notably, all models are free from heteroskedasticity, model misspecification, non-normality, and model instability.

Changing the ageing indicator to olddep does not change the conclusion, and the coefficient size is similar to those of the pop65 models. Additionally, the statistical significance of the independent variables' coefficient is mostly substantiated, except for rgdpc and trade openness (to). Regarding the model performance, the BG LM test suggests that results in Models 2, 3, and 6 suffer from lag two autocorrelation (see panel D). Hence, these models are estimated using HAC standard error. All govrev equations do not suffer from other examined statistical properties.

In sum, comparing the coefficient size reckons that ageing is a significant determinant for government expenditure and government revenue in Malaysia in the long run, and there is a risk that ageing could weaken fiscal sustainability. The next important determinant is debt for the gfce equation and rgdpc for govrev. Surprisingly, op is relatively economically insignificant in deciding government expenditure and revenue, as shown by its small coefficient size (near 0.1 in Table 5); potentially caused by the continuous economic diversification efforts by the Malaysian government.

Table 3 Unit Root Test Results

Variables	ADF (Constant)			ADF (Constant and Trend)		PP (Constant)			PP (Constant and Trend)		
	level	**1st diff**	**2nd diff**	**level**	**1st diff**	**level**	**1st diff**	**2nd diff**	**level**	**1st diff**	**2nd diff**
gfce	-2.996	-3.001		-3.406	-5.590	-2.322	-5.557		-2.497	-5.590	
	(7)**	(4)**		(3)*	(0)***	(0.11)	(0.59)***		(0.54)	(0.68)***	
govrev	-2.155	-6.612		-2.650	-6.516	-2.080	-6.612		-2.649	-6.516	
	(0)	(0)***		(0)	(0)***	(1.71)	(0.23)***		(0.88)	(0.18)***	
pop65	2.173	-1.209	-4.293	-1.763	-4.266	5.479	-1.286	-4.293	-0.708	-2.810	-4.210
	(2)	(0)	(0)***	(6)	(5)**	(6.53)	(2.01)	(0.74)***	(5.10)	(2.49)	(0.74)**
olddep	2.420	-1.034	-3.167	0.078	-4.670	5.776	-1.194	-4.410	0.428	-2.991	-4.338
	(2)	(0)	(5)**	(6)	(5)***	(5.78)	(1.86)	(0.70)***	(4.60)	(2.27)	(0.70)***
debt	-1.472	-2.986		-3.005	-3.756	-1.910	-2.859		-2.497	-5.590	
	(0)	(0)**		(0)	(0)**	(4.18)	(1.36)*		(0.54)	(0.68)***	
to	0.122	-3.993		-1.880	-4.644	-0.189	-4.053		-2.649	-6.516	
	(0)	(0)***		(0)	(0)***	(2.56)	(1.25)***		(0.88)	(0.18)***	
op	-1.184	-4.313		-1.295	-4.424	-1.184	-4.313		-1.875	-4.679	
	(0)	(0)***		(0)	(1)***	(0)	(0)***		(1.31)	(1.14)***	
rgdpc	-1.991	-4.319		-2.894	-4.512	-1.991	-4.319		-2.936	-3.756	
	(0)	(0)***		(0)	(0)***	(0)	(0)***		(1.34)	(0.38)**	

Notes: ***,**,* indicate the significance levels of 1%, 5%, and 10%. The values within the parentheses show the number of lags in the ADF test and the bandwidth in the PP test, respectively. 1st diff and 2nd diff indicate the first and second differences, respectively. All data are transformed into natural logarithms before the unit root test.

Table 4 AARDL Bound Test Results

Panel A **Independent variable**	**dependent variable: gfce**					
	constant, debt, pop65, rgdpc	**constant, debt, pop65, op**	**constant, debt, pop65, rgdpc, op**	**constant, debt, olddep, rgdpc**	**constant, debt, olddep, op**	**constant, debt, olddep, rgdpc, op**
t-statistics (lag dependent)	-8.047***	-5.945***	-4.022***	-8.470***	-9.425***	-10.119***
F-statistics (overall)	17.116**	10.992***	6.799***	19.41***	22.584***	25.718**
F-statistics (lagged independent)	14.991**	11.984***	8.224***	16.719***	14.660***	26.149***
Summary	Cointegration	Cointegration	Cointegration	Cointegration	Cointegration	Cointegration
Panel B Independent variable	dependent variable: govrev					
	constant, pop65, rgdpc, to	constant, pop65, rgdpc, op	constant, pop65, rgdpc, to, op	constant, olddep, rgdpc, to	constant, olddep, rgdpc, op	constant, pop65, olddep, to, op
t-statistics (lag dependent)	-5.261***	-6.693***	-10.949***	-5.028***	-6.548***	-6.578***
F-statistics (overall)	7.843***	13.159***	27.340***	7.022***	12.025***	10.658***
F-statistics (lagged independent)	6.278***	12.516***	27.328***	6.408***	11.197***	11.893***
Summary	Cointegration	Cointegration	Cointegration	Cointegration	Cointegration	Cointegration

Note: ***,**, and* indicate the significant levels of 1%, 5%, and 10%, respectively.

Table 5 Long-Run Estimates

dependent variable: gfce						
A. Long-run estimates	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**
constant	2.428 (0.852)**	1.076 (0.203)***	3.571 (0.451)***	2.206 (0.862)**	1.269 (0.136)***	3.405 (0.465)***
debt	0.536 (0.056)***	0.382 (0.064)***	0.274 (0.041)***	0.554 (0.05)***	0.323 (0.040)***	0.316 (0.035)***
pop65	-3.706 (1.726)*	-3.096 (1.221)**	1.451 (0.615)*			
olddep				-3.825 (1.559)**	-2.243 (0.715)***	1.694 (0.487)***
rgdpc	-0.191 (0.094)*		-0.227 (0.047)***	-0.176 (0.09)*		-0.221 (0.055)***
op		0.011 (0.016)	0.043 (0.010)***		0.013 (0.012)	0.037 (0.005)***
B. Diagnostic tests						
BG LM (2 lags)	2.859 (0.240)	3.325 (0.190)	12.011 (0.003)	4.348 (0.114)	12.409 (0.002)	18.980 (0.000)
BPG Heteroskedasticity	5.947 (0.948)	13.444 (0.414)	20.979 (0.179)	7.869 (0.852)	11.398 (0.578)	17.531 (0.419)
Ramsey RESET	0.343 (0.570)	0.8546 (0.374)	0.918 (0.363)	1.0821 (0.321)	0.611 (0.450)	2.992 (0.127)
JB	2.412 (0.299)	0.1836 (0.912)	0.133 (0.936)	0.703 (0.703)	0.944 (0.624)	0.280 (0.629)
CUSUM squares	Pass	Pass	Pass	Pass	Pass	Pass
Type of standard error	Normal standard error	Normal standard error	HAC Standard error	Normal standard error	HAC standard error	HAC standard error
dependent variable: govrev						
C. Long-run estimates	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**
constant	5.090 (2.63)*	4.041 (0.456)***	8.357 (0.836)***	7.257 (1.93)***	4.043 (1.256)***	10.068 (0.783)***
pop65	-6.375 (2.78)**	-6.544 (0.470)***	-4.231 (0.803)***			
old_dep				-4.426 (2.34)*	-6.117 (1.779)***	-3.482 (0.578)***
rgdpc	-0.107 (0.206)	-0.111 (0.048)*	-0.405 (0.07)***	-0.258 (0.153)	-0.111 (0.130)	-0.518 (0.062)***
to	-0.159 (0.130)		-0.261 (0.03)***	-0.286 (0.117)**		-0.374 (0.033)***
op		0.084 (0.009)***	0.092 (0.008)***		0.074 (0.023)***	0.090 (0.004)***
D. Diagnostic tests						
BG LM (2 lags)	1.273 (0.529)	13.403 (0.001)	9.215 (0.010)	0.6099 (0.737)	3.1759 (0.240)	13.255 (0.001)
BPG Heteroskedasticity	11.161 (0.597)	2.479 (0.140)	20.511 (0.198)	11.829 (0.377)	16.059 (0.449)	23.479 (0.266)

Ramsey RESET	0.269 (0.6129)	0.124 (0.734)	020.223 (0.648)	0.0086 (0.927)	0.942 (0.357)	1.466 (0.293)
JB	4.946 (0.084)	0.747 (0.689)	0.123 (0.941)	0.115 (0.944)	0.553 (0.759)	0.823 (0.663)
CUSUM squares	Pass	Pass	Pass	Pass	Pass	Pass
Type of standard error	Normal standard error	HAC standard error	HAC standard error	Normal standard error	Normal standard error	HAC standard error

Notes: BG LM denotes the Breusch-Godfrey serial correlation LM test, BPG heteroskedasticity denotes the Breusch-Pagan-Godfrey Heteroskedasticity test, JB denotes the Jarque Bera Normality test, and HAC denote heteroskedasticity- and autocorrelation- consistent. The values with the parentheses in panel A and panel B show the standard errors and p-value, respectively. The CUSUM square is more presented here to conserve space and is available upon request.

5.2 The Error Correction Model

Table 6 displays the output from the error correction model. For the sake of brevity, only the ECT and the short-run impact from ageing to fiscal indicators are presented. All ECT terms have a statistically significant negative coefficient, showing evidence of cointegration. The value ranged from -0.58 to -1.49. In detail, the short-run deviation in Model (3), Model (5) and Model (6) of gfce, and Model (2), Model (3) and Model (6) of govrev equation will be convergent to the long-run equation in an oscillation pattern. Moreover, the short-run coefficient of pop65 and olddep shows insufficient evidence to support the statistically significant influence of both variables on gfce and govrev because the impact of ageing is mostly statistically insignificant in all models, as shown in Table 6. This conclusion is not surprising considering that ageing is a slow process, hence, it is unlikely to have any short-term effect on government spending and revenue.

Table 6 ECM Model Output

Fiscal indicator	Model	ECT	Impact of Ageing on Fiscal Indicators			
			t	t-1	t-2	t-3
gfce	Model 1	-0.585 (0.211)**	3.171 (1.882)	0.839 (1.651)	0.779 (1.582)	0.840 (1.767)
	Model 2	-0.971 (0.186)***	0.443 (1.469)	4.353 (1.442)***		
	Model 3^	-0.854 (0.349)**	3.924 (1.034)***			
	Model 4	-0.578 (0.213)**	2.229 (1.814)	0.920 (1.491)	0.810 (1.447)	0.675 (1.701)
	Model 5^	-1.204 (0.155)***	3.651 (0.688)***			
	Model 6^	-1.775 (0.211)***	-2.424 (0.321)***			
govrev	Model 1	-0.759 (0.200)***		3.811 (0.106)	-1.709 (2.300)	
	Model 2^	-0.460 (0.215)		0.643 (1.529)	-0.815 (1.577)	-2.399 (1.278)*
	Model 3^	-1.491 (0.323)***	-0.398 (1.554)	1.592 (1.361)	0.613 (0.867)	
	Model 4	-0.786 (0.188)***	3.200 (1.834)*	-1.246 (1.942)		
	Model 5	-0.816 (0.210)***	2.200 (2.178)	1.280 (2.243)	-1.149 (2.268)	
	Model 6^	-1.205 (0.299)***	-0.955 (1.034)	0.707 (0.925)	0.765 (1.131)	-1.426 (1.382)

Note: The values in the parentheses are normal standard errors unless the variable is marked by ^, which indicates that an HAC standard error is reported. ***, **,* indicate the statistical significance at 1%, 5%, and 10%, respectively. t, t-1, t-2, and t-3 indicate fiscal indicators at current, lag one, lag two, and lag three.

6. CONCLUSION

The paper determines cointegration relationships in two fiscal equations: i.e., government expenditure and government revenue in Malaysia. Moreover, the ARDL estimation and ECM Model explore the long-run and short-run impacts. These exercises involve the annual data from 1990 to 2020. Equally important, this paper applies the AARDL bound test in which the joint significance of the lagged independent variables is examined together with the t-statistic of the lagged dependent and the F-statistic of all variables to provide more comprehensive evidence of the cointegration.

The estimations reveal three key findings. First, cointegrated relationships are found in the government expenditure and revenue equation. Second, according to the most estimated models, ageing reduces government expenditure and spending in the long run. Third, statistical evidence indicates that ageing might not affect the fiscal variables in the short run. Notably, when the ageing issue worsens, government revenue will decline more than spending, thus, threatening fiscal sustainability in Malaysia.

Regarding policy implications, there is no immediate concern about the implication of ageing on the economy. However, there is an urgency for the Malaysian government to search for new income sources in the long run. Government expenditure will be crowded out by increasing the allocation of healthcare and pensions to the ageing population. The new income sources could come from direct or indirect taxes on the right targeted groups. For example, Japan has preferred to adjust consumption tax continuously (Hong & Schneider, 2020). These policies could help tackle the declining government revenue that was caused by ageing and finance the cost of ageing. Alternatively, the Malaysian government should practice steps to reduce unnecessary health expenditures. Rouzet et al. (2019) suggest a few steps for this purpose in the OECD, such as focusing on outpatient basics, using generic drugs, and providing financial incentives; the Malaysian government could also use these suggestions. One possible area of research in Malaysia is the impact of ageing on specific government spending, such as education. This will enable a more detailed understanding of how ageing affects government spending. Besides, simulation studies could be conducted to examine the impact of ageing over time. One possible method is the dynamic ARDL simulation.

REFERENCES

Agnello, L, Dufrenot, G., & Sousa, R. M. (2015). Nonlinear Effect of Asset Prices on Fiscal Policy: Evidence from the UK, Italy and Spain. *Economic Modelling*, *44*, 358–362. https://doi.org/10.1016/j.econmod.2014.07.024

Barik, A., & Sahu, J. P. (2022). The Long-Run Effect of Public Debt on Economic Growth: Evidence from India. *Journal of Public Affairs*, *22*(1), e2281. https://doi.org/10.1002/pa.2281

Bokemeier, B., Stoian, A., Dumitrescu, B. A., & Cepoi, C. (2020). *Heterogeneity in the Fiscal Reaction Function: An Empirical Analysis for EU Member States*. (Universitat Bielefeld Faculty of Business Administrative and Economics Working Paper No. 08-2020). Retrieved from https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3737499

Cai, Y., Wang F., & Ke, S. (2018). Fiscal Implications of Population Aging and Social Sector Expenditure in China. *Population and Development Review*, *44*(4), 811-831. https://doi.org/10.1111/padr.12206

Crowe, D., Haas, J., Millot, V., Rawdanowicz, L., & Turban, S. (2022). *Population Ageing and Government Revenue: Expected Trends and Policy Considerations to Boost Revenue* (OECD

Economics Department Working Paper, No. 1737). https://doi.org/10.1787/9ce9e8e3-en.
Edes, N. W., & Morgan, P. J. (2014). Managing Fiscal Sustainability and Aging in Emerging Asia. *Public Policy Review*, *10*(2), 319–347. Retrieved from https://dl.ndl.go.jp/view/prepareDownload?itemId=info%3Andljp%2Fpid%2F10314518&contentNo=1
Fall, F., Bloch, D., Fournier, H. M., & Hoeller, P. (2015). *Prudent Debt Targets and Fiscal Frameworks*. (OECD Working Paper No. 15). https://doi.org/10.1787/2226583X
Gnangnon, S. K. (2022). Tax Revenue Instability and Tax Revenue in Developed and Developing Countries. *Applied Economic Analysis*, *30*(88), 18–37. https://doi.org/10.1108/AEA-09-2020-0133
Goh, S. K., McNown, R., & Wong, K. N. (2020). Macroeconomic Implications of Population Aging: Evidence from Japan. *Journal of Asian Economics*, *68*, 101198. https://doi.org/10.1016/j.asieco.2020.101198
Harding, T., & van Der Ploeg, F. (2009). *Is Norway's Bird-In-Hand Stabilization Fund Prudent Enough? Fiscal Reactions to Hydrocarbon Windfalls and Greying Population*. (CESifo Working Paper No. 2830). Retrieved from https://www.cesifo.org/en/publications/2009/working-paper/norways-bird-hand-stabilization-fund-prudent-enough-fiscal
Hong, G. H., & Schneider, T. (2022, March). Shrinkonomics: Lessons from Japan. *Finance & Development*, 20-23. Retrieved from https://www.imf.org/en/Publications/fandd/issues/2020/03/shrinkanomics-policy-lessons-from-japan-on-population-aging-schneider
Kang, S. L. 0, & Esther, L. (2021). *Addressing a Rising Pension Bill. Edge Weekly*. The Edge Malaysia. Retrieved from https://www.theedgemarkets.com/article/cover-story-addressing-rising-pension-bill
Korwatanasakul, U., Sirivunnabood, P., & Majoe, A. (2021). *Demographic Transition and Its Impacts on Fiscal Sustainability in East and Southeast* Asia. (ADBI Working Paper No 1220). Retrieved from https://www.adb.org/publications/demographic-transition-impacts-fiscal-sustainability-east-southeast-asia
Lau, E., & Alvin, L. S. Y. (2018). Estimating Fiscal Reaction Functions in Malaysia, Thailand and The Philippines. *Jurnal Ekonomi Malaysia*, *52*(1), 67–76. http://dx.doi.org/10.17576/JEM-2018-5201-6
McNown, R., Sam, C. Y., & Goh, S. K. (2018). Bootstrapping the Autoregressive Distributed Lag Test for Cointegration. *Applied Economics*, *50*(13), 1509–1521. https://doi.org/10.1080/00036846.2017.1366643
Medina, L. (2015). *Assessing fiscal risks in Bangladesh*. (IMF Working Paper, No. WP/15/110). Retrieved form https://www.imf.org/external/pubs/ft/wp/2015/wp15110.pdf
Narayan, P. K. (2005). The Saving and Investment Nexus for China: Evidence from Cointegration Tests. *Applied Economics*, *37*(17), 1979-1990. https://doi.org/10.1080/00036840500278103
Nerlich, C., & Reuter, W. H. (2013). *The Design of National Fiscal Frameworks and Their Budgetary Impact*. (ECB Working Paper, No. 1588). Retrieved from https://www.ecb.europa.eu/pub/pdf/scpwps/ecbwp1588.pdf
Nguyen, H. A., Nguyen, V. H., Vu, T. B. H., & Giang, T. L. (2023). The Impact of Population Aging on Personal Income Tax Revenue in Vietnam. *Journal of Asian and African Studies*. Advance Online Publication. https://doi.org/10.1177/00219096231200594
Noormahayu, M. N., Zarul, A. N., Norasyikin A. F., Muhammad A. Z. A K., & Khalijah, R. (2021). Malaysia's Healthcare Expenditure: ARDL Bound Test. *Advances in Business Research International Journal*, *7*(2), 267-275. https://doi.org/10.24191/abrij.v7i2.13340
Rouzet, D., Sanchez, A. C., Renault, T., & Roehn, O. (2019). *Fiscal Challenges and Inclusive Growth in Ageing Societies*. (OECD Economic Policy Paper No. 27). Retrieved from https://www.oecd-ilibrary.org/deliver/c553d8d2-en.pdf?itemId=%2Fcontent%2Fpaper%2Fc553d8d2-en&mimeType=pdf

Oliver, M. (2015). Population Ageing and Economic Growth in Japan. *International Journal of Sociology and Social Policy*, *35*(11/12), 841–863. https://doi.org/10.1108/IJSSP-02-2015-0018

Pena, W. (2020). Population Aging and Public Finances: Evidence From El Salvador. *The Journal of the Economics of Ageing*, *17*, 100260. https://doi.org/10.1016/j.jeoa.2020.100260

Pesaran, M. H., Shin, Y., & Smith, R. J. (2001). Bound Testing Approaches to the Analysis of Level Relationships. *Journal of Applied Econometrics*, *16*(3), 289–326. https://doi.org/10.1002/jae.616

Ramos-Herrera, M. D. C., & Sosvilla-Rivero, S. (2020). Fiscal Sustainability in Aging Societies: Evidence from Euro Area countries. *Sustainability*, *12*(24), 10276. https://doi.org/10.3390/su122410276

Sam, C. Y., McNown, R., & Goh, S.K. (2019). An Augmented Autoregressive Distributed Lag Bound Test for Cointegration. *Economic Modelling*, 80, 130–141. https://doi.org/10.1016/j.econmod.2018.11.001

Schmillen, A. D., Wang, D., Yap, W. A., Bandaogo, M. A. S. S., Simler, K., Zainab, A. A., & Amanina, A. R. (2020). *A silver lining – Productive and inclusive aging for Malaysia*. Retrieved from https://www.worldbank.org/en/country/malaysia/publication/a-silver-lining-productive-and-inclusive-aging-for-malaysia.

Temsumrit, N. (2023). Can Ageing Population Affect Economic Growth Through the Channel of Government Spending? *Heliyon*, *9*, e19521. Retrieved from https://www.cell.com/heliyon/pdf/S2405-8440(23)06729-4.pdf

Wan Farisan, W. S., Zulkefly, A. K., & Norlin, K. (2015). Assessing Fiscal Sustainability for Malaysia: Fiscal Sustainability Indicator. *Prosiding PERKEM 10*, Melaka, Malaysia, 2015, pp. 44–56. Retrieved from https://www.ukm.my/fep/perkem/pdf/perkem2015/PERKEM_2015_1A4.pdf

Wong, B., & Tang, K. T. (2013), Do Aging Economies Save Less? Evidence from OECD Data. *International Journal of Social Science*, *40*(6), 591–605. https://doi.org/10.1108/03068291311321875