Malaysian Journal of Computing, 10 (1): 1979-1991, 2025

eISSN: 2600-8238

IMPACT OF AGEING POPULATION TOWARDS PENSION EXPENDITURE IN MALAYSIA: AN ARDL APPROACH

Nurul Dahiyah Shahirah Alias[1] and Rose Irnawaty Ibrahim[2*]

[1,2]Faculty of Science and Technology,
Universiti Sains Islam Malaysia, 71800 Nilai, Negeri
Sembilan, Malaysia
[1]dahiyah.syahirah@gmail.com, [2*]rose.irnawaty@usim.edu.my

ABSTRACT

When the aging population increases, the demand for pension is also higher causing pension expenditure to also increase. Persistent increase in pensions expenditure can cause strain on government budgets and pose sustainability challenges for pension systems in the future. Therefore, this empirical study delves into the relationship between population aging and pension expenditure and identifies both short-term and long-term relationships between pension expenditure and its determinant for the sample spanning from 1970 to 2020. This study uses Autoregressive Distributed Lag (ARDL) model to achieve the objectives. The independent variables are life expectancy, the population aged 65 and above, total fertility rate and growth domestic products (GDP) per capita. The findings indicate that the population ages 65 and above has the most significant impact on pension expenditure in the short run and long run. In addition, the findings also propose that there are both short run and long run relationships between life expectancy, total fertility rate, the population aged 65 and above, and GDP per capita with pension expenditure in Malaysia. Above all, this research intends to contribute valuable findings for policymakers and the government in making crucial decisions.

Keywords: *Expenditure Population Ageing, GDP per Capita, Life Expectancy, Pension, Population Ages 65 and Above, Total Fertility Rate.*

Received for review: 27-01-2025; Accepted: 03-03-2025; Published: 01-04-2025
DOI: 10.24191/mjoc.v10i1.4590

1. Introduction

Malaysia is a country that is actively moving towards ageing population as ageing population has grown substantially over time. According to World Bank (2022), percentage of population ages 65 and above in 2000 was 4.1% and rose to 7.01% in 2020 for Malaysia. This statement shows that Malaysia is experiencing rising ageing population. Malaysia is not the only country facing this ageing population problem. In fact, this phenomenon is encountered by a majority of nations globally. This statement supported by Thakur (2018) which stated that richer countries, such as Japan, Singapore, and Korea already have 14% or more of ageing population. The factors that contribute to ageing population are decline in fertility rates and longer life expectancy. Decline in fertility rates depicts that less child is given birth and less young population while higher life expectancy indicates people's average life span is getting longer. Since life expectancy is significantly increasing altogether with declining birth rate, it results in rapid growth of ageing population in Malaysia.

Salam *et al.* (2021) proposed that Malaysia will be an ageing nation by 2030, and the country must provide proper planning to support the elderly in the future. This is due to there will be risk of children abandoning their elderly parents leading to the issues of loneliness among the older population. Thus, having pension is very crucial as pensions act as a safety net to the retirees. Pension reduces the risk of poverty among the elderly and protecting them from falling into destitution. Besides, pensions help retirees to afford healthcare services and medications in their later year. It also relieves the pressure on families and allows them to allocate their resources to other needs. Pension expenditure refers to the total amount of money spent by government or organization to retired individuals. In context of public pension, pension expenditure refers to the amount of money spent by the government or other entities to provide retirement benefits to civil retirees. Pensions fall under social security component in GDP and usually social security is the largest components in GDP.

Moreover, Ismail *et al.* (2015) stated once Malaysia reaches ageing population status, the. This involves about 887,000 public pensioners and implies 28.3% of government spending ageing population will start to grow at a faster rate. As this continues, it may bring some benefits to the country, but it also can negatively impact pension sector. This is due to increase in the demand for pensions benefit when there are more retirees. On top of that, if pension expenditure constantly increases, it can put strain on government budgets and soon lead to sustainability issues for pension systems in the future. This statement is in line with Ministry of Finance, Malaysia (2023) that reported Malaysia government has spent RM28 billion for the pension expenditure in 2021goes to older population. Furthermore, Salam *et al.* (2021) proposed that population ages 65 and above in Malaysia are predicted to keep rising until 15.3% by 2030. As this goes, Malaysia will experience dramatic increase in pension expenditure in the future. In consequence, more government expenditure will be spent on pensions and deficit of government allocation could happen. Other than that, there is another worrying matter proposed by Ismail *et al.* (2015) which once Malaysia attained ageing population country, the ageing population will accelerate at faster rate. Malaysia is predicted to take 23 years for the elderly population to double up from 7% in 2020 to 14% in 2043 as compared to France that only took 115 years to double up its elderly population (Ismail *et al.*, 2015). This statement proved that the speed of ageing population in developing countries can defeat the speed of developed country. As a developing country, this situation puts Malaysia in jeopardy especially in financial terms. Above all, future government expenditure will be at stake if extremely large allocation goes to pension expenditure. Moreover, the rise in the elderly population will result in diminishing workforce in the future and raise concerns about the stability of old-age benefits.

In short, the demographic shift towards an ageing population will significantly influence public expenditure will be rising due to higher costs in healthcare, pensions, and long-term care. This shows Malaysia should start carry out necessary measures or else it will become a troublesome to the future government to deal with the consequences. Therefore, this study would like to investigate the impact of ageing population towards pension expenditure to provide insightful perspectives on this matter to future researcher and achieve the following objectives:

1. To identify the presence of short run relationship and long run relationship between total fertility rate, life expectancy, GDP per capita and population ages 65 and above and pension expenditure in Malaysia.
2. To analyze the effect of total fertility rate, life expectancy, GDP per capita and population ages 65 and above towards pension expenditure.

Moreover, this research intends to contribute valuable findings for policymakers and the government in making crucial decisions and help Malaysia accomplishing the vision of Malaysia Madani which is to shape future of Malaysia by considering the various transformative changes that occurring globally. However, the limitation of this study is the unavailability of recent yeheaar data on some variables causing the research to be conducted up until period of 1970 to

2020 only. As a result, few variables must be discarded due to incomplete data such as unemployment rate and gross saving since the data of 2021 and 2022 are not available.

2. Literature Review

Pension system in Malaysia is based on the World Bank's multi-pillar pension framework which encompasses most of essential components for a pension system, despite that notable gap still exists and can be improved. The fundamental goal of all pension systems is to assist individuals who may be unable to generate income in later years. The initial establishment of the Malaysia public pension system was during Malaya era under the Pensions Ordinance of 1951. Now, the Pensions Act (1980) remains to be the primary legislation governing the pension system since 1980. According to Hussein (2019), Malaysia pension system has several distinct institutions that are categorized into five separate areas which are pension scheme for public servants (KWAP), scheme for armed forces personnel (LTAT), retirement scheme for private sector employees (PRS), social insurance scheme, and private run defined contribution. On top of that, public pension scheme distributes a maximum of 60% of the retiree's final salary to retired civil service employees (Hussein, 2019). Currently, public pension benefits operate under Pay-As-You-Go (PAYGO) framework where individuals make payments to the government based on their income as they earn it, rather than paying a lump sum at the end of the tax year. The drawback of this setup is as ageing population increases, pension payments are rising faster than the growth of revenue. Meanwhile, Jaafar *et al.* (2019) proposed that one of the biggest supports for elderly individuals in Malaysia is the defined-benefit Civil Service Pension program offered by the government under Retirement Fund (Incorporated). Civil employees will start receiving their pension when they are reaching the age of 55, 56, 58 or 60.

According to Nerlich and Schroth (2018), population ageing will put further strain on age-related public spending. This statement is supported by Jaafar *et al.* (2019) that proposed the ageing population is a significant concern for the next twenty years in Malaysia, and robust pension system is fundamental to ensure adequate funding for retirees. Moreover, Hussein (2019) stated that pension payments now make up a larger share of government spending in Malaysia. Pensions and gratuities accounted for 2.7% of government expenses in 1977 and grown to 8.7% by 2015. The increase was nearly a hundred times larger, compared to an economy growth that had only expanded about 36 times. There are also many past researches that uses pension expenditure as dependent variable such as Garcia and Silva (2019) who used pension expenditure in Portugal as dependent variable of the study. Using Vector Error Correction Model, the study used ratio between pension spending and gross domestic product at current prices to represent pension expenditures.

To assess level of pension expenditure, there are few factors that are considered to influence pension expenditure in Malaysia such as life expectancy, GDP per capita, population ages 65 & above and total fertility rate. Apart from that, Zulqarnain and Yusuf (2022) concluded that the fertility decline in Malaysia has a significant impact on economic growth and preparedness for any changes in fertility especially the ageing population needs to be done. In addition, Cristian (2012) showed life expectancy have positive relationship with public pension expenditures in the EU-15 countries. However, in this study, the pension expenditure did not increase extremely although there was dramatic rise in life expectancy for the past decades. This may due to positive economy growth and the transition towards private pension at that time. The study suggested the aged population to stay in the labour sector longer so that retirement ages can be increased. This is supported by Verbic (2014) that deduced increasing life expectancy can cause strain on public pension expenditures. The findings proved increase in a year of life expectancy at birth increased pension spending from 28% to 31%. This proved that life expectancy has a positive relationship with pension expenditure in the long term. Similarly, the result is consistent with Wahab *et al.* (2017) that used ARDL Cointegration Technique to test long run and short run relationship between life expectancy and pension expenditure in Pakistan. The study proved that life expectancy has both short run and long run relationship with public pension expenditure and the relationship between them is positively correlated. Likewise, Ibrahim *et al.*

(2019) obtained long run coefficient value of life expectancy from ARDL bound test was positive and the highest among other variables in the study. This showed that in the long run, pension expenditure and life expectancy in Malaysia has positive relationship. As a result, Malaysia government must bear increasing expenses of pensioner as the life span of the population become longer.

Other than that, GDP per capita also pose impact on pension expenditure due to its ts correlation with the overall economic well-being of the population. GDP per capita is calculated by dividing the total GDP of a nation by its population. It provides insight into economic well-being of individuals within a country and can be indicator to the average wealth generated per person. When GDP per capita increases, pension expenditure also tend to rise as a result of elevated living standards and longer life expectancy. A study by Ciobanu (2014) used this variable to seek relationship with pension expenditure whereas the regression result showed that GDP per capita is negatively weak related with the pension expenditure. Thus, decrease in GDP per capita can slightly increase the pension expenditure. The finding is in contrast with Radogna (2015) that stated as population ages, GDP per capita increases and more public funds are allocated to pensions. The reason for this is when a larger portion of government spending is directed towards pensions, households find it more beneficial to delay their consumption and leads to a reduction in GDP per capita. Apart from that, Nerlich and Schroth (2018) stated that the impact of the ageing population causes a 4.7% decline in GDP per capita in Euro Area which 19 countries that use Euro currency. The reason being that is may due to declining physical and cognitive abilities or evolving job requirements. Meanwhile a study by Ibrahim *et al.* (2019) study also used GDP per capita in the research. The findings of the study showed GDP per capita has strong negative relationship with pension expenditure whereas decrease 1% in the variable resulted in an increase about 0.339% in pension expenditure in Malaysia**.** This is in line with Ubochi-Nwankwo (2022) that deduced GDP per capita and pension expenditure has negative relationship in the short run in Nigeria. The reason is when GDP per capita decreases, it may limit the government's ability to generate revenue through taxes. Thus, it can constraint its capacity to fund pension programs adequately.

Besides that, as this study would like to analyze the impact of population ageing towards pension expenditure, thus number of populations ages 65 and above is one of important measure in this study. Pampel and Williamson (2016) uses the number of population ages 65 and older as one of variables and represents it with percent aged. The results showed there were two dominant effects and one of them was population ages 65 and above. This has proved it has significant and positive impacts on the pension expenditure. The study discovered that when high wealth and political democracy are present in a country, aged population rises as well as pension expenses. Another study by Ciobanu (2014) indicated population over 65 years has highest correlation values with public pension spending and it was the most significant variable based on the results. This shows there will be an increase in government spending on pensioners when the number of population ages over 65 increases. By the end of study, it was estimated that population over 65 years would incline up to 12.8% over the next 50 years which would cause public spending to rise about 2.4% to 3.9% of GDP. Another study by Wahab *et al.* (2017) have concluded in the study that population ageing has short run and long run relationship with pension expenditure in Pakistan based on Error Correction Model results and *F*-statistics under ARDL. Coefficient of Error Correction Term obtained was negative and it implies short term relationship exists between the variables. However, the study did not state the relationship between ageing population and pension expenditure is negative or positive. In addition, Mohd *et al.* (2021) stated that approximately 7% of the population in Malaysia, equivalent to 2.3 million people, is projected to be 65 years old and above during 2020. Meanwhile, Salam et al. (2021) stated Malaysia is anticipated to become an ageing nation by 2030, thus it urges ample preparation to support the elderly from aspect of healthcare, finance, and social services. Therefore, Malaysia government must focus on ensuring a high quality of life for the elderly, considering the potential issue of children abandoning their ageing parents.

On top of that, total fertility also an significant factor in this study as it determines the balance between the working-age population contributing to pension systems and the number of retirees drawing benefits. Cristian (2012) who advocated that total fertility rates will impose impact on public pension expenditures in 15 different countries in the study. The results form this study showed coefficient of fertility rate were all negative and proved that hypothesis of fertility rate influenced public pension expenditures negatively is true. The *p*-value obtained was insignificant indicating the impact of fertility rate on the pension expenditures of respective countries may be little or no impact. The finding is supported by Verbic (2014) who proposed when total fertility rate increases, pension expenditure will decrease in 33 countries such as Sweden, Germany and United States. The results supported the hypothesis and proved that higher fertility rate can lead to decrease in public pension expenditures. The study also proposed that a rise in fertility rate could lower public pension expenditures about 2.9%. It means fertility rate only pose little impact on pension expenditure in the respective countries.

In addition, Pampel and Williamson (2016) also used total fertility rate as one of the variables to examine the effect on public pension expenditures in 48 different countries. The findings indicated there is a negative long run relationship between pension expenditures and total fertility rate in the respective countries. This is because decline in fertility indicates that there will be less children could support the elderly in future. As a result, pension expenditure will increase exponentially. This is in line with Ibrahim *et al.* (2019) that concluded increase in fertility rate could decrease pension expenditures. The *F*-test statistic proved long-run relationship was existed between pension expenditures and total fertility rate. From long-run coefficient value of ARDL bound test, the study proved when fertility rate decreased by 1%, the pension expenditures in Malaysia will increase by 1% in a year. This shows that in the long run, decreasing fertility rates will result in higher pension costs even though the impact is small. The *p*-value of fertility rate was not significant in this study.

3. Methodology

This study will use regression to obtain results that can satisfy objectives of this study. A time series model is established where the dependent variable is pension expenditure (PE). The independent variables of this study are GDP per capita (GDP), life expectancy (LE), total fertility rate (TFR) and population ages 65 and above (P65). There are total 40 annual observations. Since dataset of GDP and P65 is large, therefore both variables need to take natural logarithm function and converted to LNGDP and LNP65. The measurement, data source and data period of all variables are as in Table 1.

Table 1. Conceptual Framework

<table>
<tr><th colspan="2">Variables</th><th>Data Measured</th><th>Data Source</th><th>Data Period</th></tr>
<tr><td>Dependent</td><td>Pension Expenditure (PE)</td><td>Pension and gratuities per GDP</td><td>Economic Malaysia Report & CEIC</td><td rowspan="5">1970 to 2020</td></tr>
<tr><td rowspan="4">Independent</td><td>GDP Per Capita (GDP)</td><td>GDP per capita (current US$)</td><td>The World Bank Data</td></tr>
<tr><td>Life Expectancy (LE)</td><td>Total life expectancy at birth (years)</td><td>The World Bank Data</td></tr>
<tr><td>Total Fertility Rate (TFR)</td><td>Total fertility rate (births per woman)</td><td>The World Bank Data</td></tr>
<tr><td>Population Ages 65 & Above (P65)</td><td>Population ages 65 and above (% of total population)</td><td>The World Bank Data</td></tr>
</table>

3.1 Multicollinearity: Variance Inflation Factor (VIF) Test

Multicollinearity refers to a situation in a regression model where two or more independent variables are highly correlated with each other which can cause issues interpretation of the regression results. Variance Inflation Factor (VIF) is common test used to check multicollinearity. VIF measures the degree of multicollinearity by quantifying how much the variance of the estimated regression coefficient is inflated due to multicollinearity. VIF values greater than one indicates potential multicollinearity, however values more than 10 considered severe multicollinearity.

H_a: There is no multicollinearity among the independent variables.
H_0: There is multicollinearity among the independent variables.

3.2 Autoregressive Distributive Lag (ARDL) Bound Testing Approach

The empirical focus of this study is to assess whether there is short run or long run impact of ageing on the pension expenditure. To achieve the objective, the study uses Autoregressive distributed lag (ARDL) Bound Testing Approach developed by Pesaran *et al.* (2001) as it can provide short-term and long-term relationship of a model. Before performing ARDL, the study conducted unit root test to identify whether a unit root is present or not in the series to avoid the problem of spurious regression. Nkoro and Uko (2016) stated that when a time series exhibits a unit root (where the coefficient of the lagged first difference is zero), any shock to the data series will persists over time. To assess this, Augmented Dickey Fuller (ADF) tests were employed. The null hypothesis in the ADF test assumes that data is not stationary and indicates the presence of a unit root in the series. Therefore, if p-value obtained is more than 0.05, it implies the data needs to be differenced to achieve stationarity. There are 3 models of Augmented Dickey Fuller for each variable:

1) No constant and no trend:

$$\Delta y_t = \gamma y_{t-1} + \sum_{i=1}^{p} \beta_i \Delta Y_{t-i} + \mu_t$$

2) Constant and no trend:

$$\Delta y_t = \alpha + \gamma y_{t-1} + \sum_{i=1}^{p} \beta_i \Delta Y_{t-i} + \mu_t \qquad (1)$$

3) Constant and trend:

$$\Delta y_t = \alpha + \gamma y_{t-1} + \delta_t + \sum_{i=1}^{p} \beta_i \Delta Y_{t-i} + \mu_t$$

where y_t is value of dependent variable.

The hypothesis for unit root test is as follows:

H_o: Series has unit root.

H_a: Series does not have unit root.

If the result of ADF test showing the dat has no unit root, thus the study can proceed to perforn ARDL. For the analyses, the following model is used:

$$PE_t = \beta_0 + \beta_1 LE_t + \beta_2 TFR_t + \beta_3 LNP65_t + \beta_4 LNGDP_t + \varepsilon_t \qquad (2)$$

where;

PE_t	= pension expenditure
LE_t	= life expectancy
TFR_t	= total fertility rate
$LNP65_t$	= log of population ages 65 and above
$LNGDP_t$	= log of GDP per capita
ε_t	= error term

Next, Error Correction Model (ECM) is performed to analyse short run dynamics and convergence towards the long run equilibrium. This is to answer both objectives of this study. ECM can just be expanded from the ARDL model through a simple linear transformation. Nkoro and Uko (2016) stated when ARDL model reparameterized into ECM, it provides a single model that captures both short-run dynamics and the long-run relationship of the variables. This step also implements the bounds testing procedure to see the existence of long run relationship between the variables. As outlined by Pesaran *et al.* (2001), to perform ECM, equation (2) will be rephrase into equation (3) as follows:

$$\Delta PE_t = \alpha_0 + \sum_{i=1}^{p} \alpha_1 \Delta PE_{t-i} + \sum_{i=0}^{q_1} \alpha_2 \Delta LNGDP_{t-i} + \sum_{i=0}^{q_2} \alpha_3 \Delta LE_{t-i} + \sum_{i=0}^{q_3} \alpha_4 \Delta TFR_{t-i} + \sum_{i=0}^{q_4} \alpha_5 \Delta LNP65_{t-i} + \beta_1 PE_{t-i} + \beta_2 GDP_{t-i} + \beta_3 LE_{t-i} + \beta_4 TFR_{t-i} + \beta_5 P65_{t-i} + \varepsilon_t \quad (3)$$

where;

p, q_1, q_2, q_3, q_4	= numbers of lags of explanatory and dependent variables
ε_t	= error term
Δ	= the first difference
α_i	= coefficients of the short run where i is 1,23,4,5

The hypothesis for cointegration bound test is as follows:

$H_0 : \beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = 0$ (Cointegration and long run relationship does not exist)
$H_a : \beta_1 \neq \beta_2 \neq \beta_3 \neq \beta_4 \neq \beta_5 \neq 0$ (Cointegration and long run relationship does exist)

If F-test statistic that is obtained from bound test is larger than $I(0)$ and $I(1)$, we reject null hypothesis, thus it indicates there is cointegration and long run relationship when the result for bound test is null hypothesis rejected. The long run and short run model of the ARDL equation can be estimated. Other than that, the coefficients of ECT, γ that will be obtained from ECM indicates the short run speed of transition to return to its long run equilibrium. The value must be between zero and 1 and the p-value must be significant to ensure the validity value of ECT. ARDL are only applicable if independent variables or dependent variables series are stationary at level $I(0)$ or at the first difference $I(1)$ or both, but not for $I(2)$.

4. Results and Discussion

In order to identify the model for equation (2), the ADF test must be run first. Table 2 presents the results of equation (1) for the test. Before performing ADF Test, two series were taking logarithm to get rid of outliers in the process and bring all variables to the same level. Columns 2, 3, and 4 indicate the p-value for the series at level form, while columns 5, 6 and 7 display the p-value for series at first-difference. Given that p-values of PE, LNGDP, LE and LNP65 are 0.0000, 0.0001, 0.0035 and 0.0034 at first difference. Since all the p-values are lower than 5% level of significance, null hypothesis of series has unit root is rejected and shows the series of PE, LNGDP, LE and LNP65 are stationary at first difference. This means order of integration for these variables are $I(1)$. Meanwhile, the p-values for TFR at level form is 0.0239 indicating the variable is stationary at level form which is $I(0)$. Since there are mixture of $I(1)$ and $I(0)$ in the variables, thus it holds the conditions of Autoregressive Distributed Lag Model. The dataset is ready to proceed to ARDL.

Table 2. Unit Root Test: Augmented-Dickey Fuller

N	Level Form			1st Difference		
	Intercept	Trend & Intercept	None	Intercept	Trend & Intercept	None
PE	1.0000	1.0000	0.9912	0.0000	0.0000	0.0056
LNGDP	0.8217	0.4900	0.9953	0.0001	0.0007	0.0000
LE	0.3393	0.1565	0.9990	0.0035	0.0108	0.0072
TFR	0.7016	0.4476	0.0239	-	-	-
LNP65	1.0000	1.0000	0.8785	0.9668	0.0034	0.9403

Before conducting regression, VIF test is performed to check whether the dataset is multicollinear to each other or not. Table 3 shows centered VIF values for LE, LNGDP, LNP65 AND TFR are 1.766680, 1.166294, 4.050922, and 4.795145. Since all values are lower than 5, it indicates very low multicollinearity exist between the series. The dataset is said to be free from severe multicollinearity problem and ready to proceed to regression.

Table 3. VIF Test

Variable	C	DLE	DLNGDP	DLNP65	TFR
Centered VIF	NA	1.766680	1.166294	4.050922	4.795145

To obtain the most reliable result, the optimal lag model (2,1) is chosen using the Akaike Information Criterion (AIC), and fixed regressors. Restricted constant is chosen as for trend specification. The model selection is (2,1,1,1,1). ARDL is performed using the criteria mentioned following Equation 2. Next, Error Correction Model (ECM) is performed to obtain result of short run relationship since both objectives of the study is to examine the presence of short run relationship and long run relationship between PE and independent variables. ECM follows Equation 3 in previous part. Result of ECM is summarized in Table 4. Variables that have p-value that are less than 1%, 5% and 10% implies they are statistically significant in the short run. The findings show LNGDP, TFR and LNP65 are significant since all p-values are below than significance levels except for LE. This means LNGDP, TFR and LNP65 have significant impact onto pension expenditure in the short run while LE may have little or no impact to PE in the short run.

Table 4. Error Correction Model (ECM)

Variable	D(LE)	D(LNGDP)	D(LNP65)	D(TFR)
Coefficient	0.063460 (0.3863)	-0.347551 (0.0007)***	2.623348 (0.0011)***	0.623022 (0.0008)***
CointEq(-1)	-0.970405 (0.000)***			

***indicates 1% significance, **indicates 5% significance, *indicates 10% significance

Findings in Table 4 portrays that in the short run, 1% increase in LE cause 0.063% increase in PE in the short run. This is because when a person lives longer, there will be longer period of retirement. Thus, there will be longer period of retirement causing rise in pension expenditure. However, since the p-value of LE is insignificant, it shows that life expectancy only poses subtle effect on the pension expenditure in the short run in Malaysia. Similarly, GDP is also experiencing same pattern where 1% increase in LNGDP will cause pension expenditure to decrease about 0.347551%. This is because when GDP increases, it usually indicates economic is experiencing downturn and during this period, many people are struggling financially especially pensioner as they have no income. Thus, government will have to increase allocation or made some adjustment on pension to overcome the issue. For example, during Covid-19 pandemic happen in 2020 in Malaysia, the government allow early withdrawal pension for employees causing pension expenditure at that time to increase from 1.84% in 2019 to 2.09% in 2020. Furthermore,

Conversely, 1% increase in LNP65 will increase pension expenditure about 2.623348%. This is because a higher percentage of people aged 65 and above indicates an increased number of individuals who are eligible to receive pension benefits. On top of that, it also signifies LNP65 pose the most significant impact onto pension expenditure in Malaysia as compared to other variables. Meanwhile, TFR implies positive impact onto pension expenditure where 1% increase in TFR will increase about 0.623022% of pension expenditure. This is can be due to increase in fertility rates indicating increase in dependents of head family and larger expenses need to be borne by head family causing government to increase payments of pension.

Other than short run relationship, ECM also provides error correction term (EC_t) which indicates with CointEq(-1) in Table 4. EC_t obtained for this study is negative and lagged one period residuals. Nkoro and Uko (2016) stated that positive coefficient signifies a divergence, whereas negative coefficient suggests convergence. Its *p*-value is 0.000 which show EC_t is significant at 1% significance level. EC_t is a proof that there is presence of long run causality in the model. Besides that, coefficient of EC_t indicates speed of adjustment of any equilibrium and in this case, short run equilibrium state towards long run equilibrium state. The coefficient of EC_t obtained in this study is 0.970405 then 97.04% of the adjustment takes place to move from short run equilibrium to long run equilibrium in the model each year. It shows the speed of adjustment for this model is very fast as the speed is close to 100%. Thus, the model is responsive to shocks and the system corrects deviations from equilibrium relatively quickly, approaching the long-term relationship between the variables.

The result of *F*-Bound test is used to look for the long run relationship (cointegration) between dependent variable and independent variable. *F*-bound test result for this study is tabulated in Table 5.

Table 5. *F*-Bound Test Result for Error Correction Model

Test Statistic		**Critical Values**		
		Significance Level	**Lower Bound *I*(0)**	**Upper Bound *I*(1)**
F-Statistics	4.311121	10%	2.20	3.09
		5%	2.56	3.49
		2.5%	2.88	3.87
		1%	3.29	4.37

Table 5 shows that there is long-run relationship between PE and LE, LNGDP, LNP65 and TFR. *F*-value obtained is 4.311121 and is greater than the upper bound *I*(1) and lower bound *I*(0) of significance level 10%, 5%, 2.5%. Hence, null hypothesis is not rejected. Therefore, there is cointegration relationship between PE and LNGDP, LE, TFR, and LNP65 respectively in the long run. Nkoro and Uko (2016) stated cointegration suggests that variables have a common stochastic trend, although each of them potentially exhibits non-stationary behaviour individually. These findings indicate that the pension expenditure fluctuates in the long run based on the life expectancy, GDP per capita, total fertility rate and population ages 65 and above.

Since it is confirmed there is cointegration relationship through *F*-bound test, the dataset can proceed to perform Long Run Bound Test to answer both objectives which to examine long run relationship between the variables. The findings are tabulated in Table 6.

Table 6. Long Run Form and Bounds Test

Variable	**LE(-1)**	**LNGDP(-1)**	**LNP65(-1)**	**TFR(-1)**
Coefficient	0.103182 (0.0393) **	-0.433647 (0.0005) ***	3.253297 (0.0001) ***	0.537538 (0.0008)***
R-squared	0.970405			

Notes: ***indicates 1% significance, **indicates 5% significance, *indicates 10% significance

All variables are lagged one period residuals. LNGDP, LNP65 and TFR are significant at 1% level while LE is significant at 5% level. Furthermore, *R*-squared obtained for ARDL model is 0.970405. Since the value is below than 1, thus it proves the model has no spurious regression in the dataset. Next, the coefficients of each variable and their long run relationship with pension expenditure will be examined further detail afterward. Firstly, the findings indicate that LNGDP has a substantial significant effect on pension expenditure in the long run where 1% increase in GDP per capita resulting in a 43.36% decrease in pension expenditure in Malaysia. This is because economic growth typically leads to higher wages and salaries. As a result, pension benefits tied to income levels such as defined benefit pensions may increase, causing pension expenditure to rise. This finding is supported by Ibrahim *et al.* (2019) and Ciobanu (2014) that deduced GDP per capita and pension expenditure has negative relationship in Malaysia and EU countries. However, Ubochi-Nwankwo (2022) and Radogna (2015) found that pension expenditure is positively correlated to GDP per capita. This difference is supported by Verbic (2014) that stated not every country will have same correlation between pension expenditure and GDP per capita. This can be due to differences in economic structure or demographic factors.

Next, LNP65 moved accordingly with pension expenditure over time, meaning that a 1% increase in number of population of ages 65 and above will cause to 262.33% increase in pension expenditure over the short run and long run. If this holds true, it means aging population can put pension expenditure at risk in the future. This is because as the population ages, there will be a larger number of individuals reaching retirement age and becoming eligible for pension benefits. This increase in the number of retirees naturally leads to higher pension expenditure as more people are receiving pension payments. The positive relationship is supported by Ibrahim *et al.* (2019), Wahab *et al.* (2017), Pampel and Williamson (2016) and Ciobanu (2014) that concluded that there will be an increase in pension expenditure when population ages 65 and above growing substantially as this population will require pension payment to support their retirement period. On top of that, it also indicates LNP65 pose the most significant impact onto the pension expenditure in the long run.

Similarly, the findings report that increase 1% in LE will causes the PE to rise by 10.32% which implies longer expectancy will increase pension expenditure in the long run. This is because longer life expectancy indicates individuals have to spend more years in retirement. Thus, increase in pensions payments will happen to support retirees for extended duration. This is consistent with Wahab *et al.* (2017) and Ibrahim *et al.* (2019) found that life expectancy has both short run and long run relationship with pension expenditure and related positively. However, study from Verbic (2014) and Cristian (2012) that deduced rise in life expectancy will contribute to higher pension expenditure only in the short run, not in the long run. This opposite can be due the studies were conducted in different countries. Different countries have different demographic characteristics, economic conditions and population structure. This condition can affect the findings of each study and explains why results for each study is different.

Conversely, it is obtained that TFR has positive relationship with pension expenditure in the long run. The coefficient of TFR explained 1% increase in total fertility rate will cause pension expenditure will also increase by 53.75%. When the total fertility rate rises, the average number of children born per woman rises as well. As these children grow older and enter the labour force, this demographic trend may result in a larger working-age population in the long run. It will initially increase economic productivity however, as this trend continues, a larger working-age-population will enter retirement. As a result, there may be increasing demand for pension and social security benefits that potentially can pose pressure on pension systems as more people become eligible for and use pension funds.

5. Conclusion

This study utilized the ARDL model to examine factors that affecting pension expenditure in Malaysia and which variable has significant impact. The findings suggest that total fertility rate, life expectancy, GDP per capita and population ages 65 and above has short run and long run relationship with pension expenditure. Out of four independent variables, only life expectancy does not have significant impact onto pension expenditure in the short run. It suggests life expectancy slightly related to pension expenditure in Malaysia since it only poses little or no impact towards pension expenditure. This is because, Malaysia use pay-as-you-go (PAYG) system which is a system that relies on contributions from current workers to fund current retirees, short-term fluctuations in life expectancy may not have immediate impact on pension expenditure and will take years to take effect. Furthermore, majority of the population is still in the working-age bracket, the impact of increased life expectancy on pension expenditure may not be pronounced yet. Other than that, lower socio-economic groups often facing shorter lifespans and limited opportunities to benefit from wealth accumulation. Apart from that, total fertility rate, life expectancy and population ages 65 and above are positively impact on pension expenditure in both short run and long run. At the same time, GDP per capita negatively impact on pension expenditure in both short run and long run. Above all, population ages 65 and above pose the largest effect on pension expenditure as its coefficient value is the largest. This means, increase in population ages 65 and above could pose a serious threat towards pension expenditure.

Since GDP per capita, total fertility rate and population ages 65 and above can cause pension expenditure to increase, government can start to prepare necessary measures to counteract issue of ageing population along with lavish pension expenditure. For example, government or policymaker can encourage higher birth rates by spreading out awareness or organize parenting support programs. Other than that, extension of retirement age also effective in reducing the burden of pension expenditure. In this case, policymaker can adjust retirement policies to encourage individuals to work longer. Moreover, upgrading technology and innovation also an effective approach to encourage aging workforce to work in their later year if it can produce technology that can adapt with skill and ability of aging workforce. In general, this study has help future research in comprehending the behaviour of pension expenditure in an effective manner. Moreover, policymakers stand to gain insights from this research by utilizing the findings as a guide to enhance policies and ensuring the resilience of the pension system and readiness for potential consequences particularly amid the growing aging population and escalating government expenditure in Malaysia.

Acknowledgement

The authors would like to thank Universiti Sains Islam Malaysia for providing the support and facilities to carry out the research work.

Funding

The authors received no specific funding for this study.

Author Contribution

Author1 prepared the literature review, collected the data and wrote the research methodology. Author2 conducted the statistical analysis, interpreted the results and made a revision of the entire paper.

Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

References

Yusof, N. N., Mohamed, A., & Abdul-Rahman, S. (2015, September). Reviewing classification approaches in sentiment analysis. In *International conference on Soft Computing in Data Science* (pp. 43-53). Springer, Singapore.

Ciobanu, R. (2014). Influence of demographic factors on public pension spending. Budgetary Research Review (BRR), 6(1), 3-13. https://www.econstor.eu/handle/10419/157654

Cristian, M. M. (2012). Demographic dynamics and sustainability of public pension expenditures within European Union-15 member states, *4*, 171-174. https://www.utgjiu.ro/revista/ec/pdf/2012-04.I/28_MILOS%20Marius%20Cristian.pdf

Garcia, M. T., & Silva, A. F. R. R. D. (2019). Assessing Pension expenditure determinants: the case of Portugal. https://www.repository.utl.pt/handle/104005/17358

Hussein, N. (2019). The Malaysian Pension System. *Nomura Journal of Asian Capital Markets*, *3*(2), 15-20.

Ibrahim, R. I., Yusuf, M. M., & Abrisam, W. N. A. W. M. (2019). Impact Of An Ageing Population on Pension Expenditure Using Autoregressive Distributed Lag Model. *ASM Science Journal*, 6, 151-156.

Ismail, N. W., Rahman, H. S. W. A., & Hamid, T. A. T. A. (2015). Does population aging affect economic growth in Malaysia. *Prosiding Perkem*, *10*, 205-210. https://www.ukm.my/fep/perkem/pdf/perkem2015/PERKEM_2015_2C1.pdf

Jaafar, R., Daly, K. J., & Mishra, A. V. (2019). Challenges facing Malaysia pension scheme in an era of ageing population. *Finance Research Letters*, *30*, 334-340. https://www.sciencedirect.com/science/article/pii/S1544612318304057

Ministry of Finance, Malaysia. (2023). Economic Performance and Outlook 2019. https://belanjawan.mof.gov.my/pdf/belanjawan2023/economy-fiscal/section1.pdf

Mohd, S. N. A., Ishak, A. A., & Selvaratnam, D. P. (2021). Ageing Population's Impact on Economic Growth in Malaysia From 1981 to 2019: Evidence From an Autoregressive Distributed Lag Approach. *Frontiers in Public Health*, *9*, 731554. https://www.frontiersin.org/articles/10.3389/fpubh.2021.731554/full

Nerlich, C., & Schroth, J. (2018). The economic impact of population ageing and pension reforms. *EconomicBulletinArticles*, *2*.https://ideas.repec.org/a/ecb/ecbart/201800022.html

Nkoro, E., & Uko, A. K. (2016). Autoregressive Distributed Lag (ARDL) cointegration technique: application and interpretation. wealth https://www.researchgate.net/profile/Elvis-Ganyaupfu-2/post/How_to_carry_out_regression_of_multiple_nonstationary_time_series_data2/attachment/60ddc7f56160740001e715a8/AS%3A1040757704097792%401625147381213/download/ARDL_Journal+of+Statistical+and+Econometric+Methods.pdf

Pampel, F. C., & Williamson, J. B. (2016). Age structure, politics, and cross-national patterns of public pension expenditures. *American Sociological Review*, 782-799. https://www.jstor.org/stable/2095504

Pesaran, M. H., Shin, Y., & Smith, R. J. (2001). Bounds testing approaches to the analysis of level relationships. *Journal of applied econometrics*, *16*(3), 289-326. https://onlinelibrary.wiley.com/doi/abs/10.1002/jae.616

Radogna, P. (2015). The Aging of Population: Expenditure on Education and Social Security. http://diposit.ub.edu/dspace/handle/2445/67306

Salam, N. Z. M. A., Hamid, N. A. A., Rahman, S. H. A., Nor, M. F. M., & Hassim, M. H. (2021, April). a Segment Study of the Elderly Ageing Population: Malaysia, Bangladesh, Qatar, Singapore and Japan. In *International Conference On Syariah & Law* (pp. 89-99). http://conference.kuis.edu.my/iconsyal/images/eprosiding/2015.pdf

Thakur, G. (2018). Ageing in East Asia challenges and policies: A comparative study of welfare services for the elderly in Korea and Japan. *Lensa Budaya: Jurnal Ilmiah Ilmu-Ilmu Budaya*, *13*(2). http://journal.unhas.ac.id/index.php/jlb/article/view/5295

The World Bank, World Development Indicators (2022). Population ages 65 and above (% of total population), Atlas method [excel]. Retrieved from https://data.worldbank.org/indicator/SP.POP.65UP.TO.ZS

Ubochi-Nwankwo, C. T. (2022). Aging Population and Its Effect On The Nigerian Economy. *Madonna Journal of Economics and Finance*, *1*(1), 59-69. View of Aging Population and Its Effect On The Nigerian Economy (madonnauniversity.edu.ng)

Verbic, M. (2014). Aging population and public pensions: Theory and macroeconometric evidence. 61(3), 289-316.http://www.panoeconomicus.org/index.php/jorunal/article/view/473

Wahab, M., Mufti, O., & Khan, M. A. (2017). The effects of population ageing on the public pension system in Pakistan. *Abasyn J Soc Sci*, *10*(2), 252-269.

Zulqarnain, A.M, & Md Yusuf, M,. (2022). The Relationship Between Socioeconomic Factors With Fertility Rate In Malaysia. *Malaysian Journal of Computing*, 7(2): 1222-1235.