

AGEING POPULATION AND EXTERNAL DEBT: AN EMPIRICAL INVESTIGATION

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Received 30 September 2019; accepted 22 May 2020

Abstract. A rise in the ageing population is the current demographic challenge which is capable of pressuring the government to borrow more external funds in order to support domestic needs. This study aims to investigate the effects of the external debt of 36 upper-middle-income economies from 2000 to 2017 due to the increase in the ageing population. This study employed the system Generalised Method of Moments (GMM), where it revealed that the ageing population could increase the level of external debt if the population aged 65 and above was used as a proxy to represent the ageing population. However, the results were insignificant when the proxy was changed to the old-age dependency ratio. It illustrated that the increase in external debt occurs due to the increase in the population aged 65 and above because the government has to allocate more funds for healthcare, age-friendly infrastructure, social security and pensions. However, the dependency of the older people on government is minimal because of their long-term savings. Hence, the old-age dependency ratio has an insignificant relationship with the external debt level. For future research, it is suggested that the impact of the ageing population can be investigated on the domestic debt level.

Keywords: ageing population, external debt, GMM, upper-middle-income economies, old-age dependency, population ages 65 and above, healthcare, pensions, social security.

JEL Classification: E62, H63, J14.

Introduction

The two main demographic challenges globally at the current moment are the rise in the ageing population and a decline in the fertility rate (Fu et al., 2020; Mao et al., 2020). As for the former, the dependency on labors is expected to decline as technology is taking over the industry and is being accepted by many firms to replace manpower in their production lines. The change is driven by the need for artificial intelligence, robotics, machine learning and internet of other things. These elements, which are within the fourth industrial revolution, necessitates countries to inject more capital into some the critical areas. The areas include

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research and development, innovation, human capital investment and infrastructure development. These development expenditures are highly essential for future sustainable growth. However, an increase in the ageing population might additionally lead to a rise in the government's operating expenses.

Therefore, in order to accommodate higher demand for funds, the governments can generate funds from three primary sources, namely taxation, money creation and public debt (Ghosh & Ghosh, 2008). However, money creation is not preferred as it creates inflation. Similarly, tax is also less favorable as it imposes an excess burden to the public by limiting their purchasing power and by distorting the levels of consumptions and investments in an economy (Barro, 1979). Hence, the public debt falls in place, especially when the government is facing fiscal imbalances. Between the types of debts, domestic and external, the latter is more vulnerable. Countries with a high level of external debt should be able to confront the global economic turbulences because of their ability to repay the debt is highly dependent on the global economic situation.

Theoretically, the factors determining the level of external debt for a country are the average anticipated rate of inflation, the real values of the temporary movement of the government expenditures and the national income (Barro, 1979). Empirically, vast literature has discussed the determinants of external debt by including other variables such as government revenues (Mensah et al., 2017; Waheed, 2017), investments (Sadik-Zada & Gatto, 2019; Waheed, 2017; Mohd Daud & Podivinsky, 2012), current account (Waheed, 2017), reserve (Waheed, 2017), resource prices (Waheed, 2017) and primary balance (Hasanov & Cherif, 2012; Pirtea & Nicolescu, 2012; Poghosyan, 2018). However, the existing empirical literature does not conclusively highlight the roles of the ageing population in influencing the level of public debt. This paper attempts to fill in the gaps by providing some empirical evidence on how the ageing population affects the public debt in the upper-middle-income economies (UMIE). It is essential to address this issue as the government's burden is expected to increase when the economy is facing an increased number of the ageing population. The findings from this study might be helpful for governments and policymakers to redesign their existing policies by taking into account the impacts of the ageing population on the fiscal imbalances.

The organization of this paper is as follows. The next section discusses in brief the literature review of relevant studies. Follow suit is the third section that introduces the methodology, research framework, data and econometric models. The fourth section presents the findings and discussion, while the fifth section concludes the study and presents relevant policy implications.

1. Literature review

1.1. Theoretical review

The public debt theory by Barro (1979), and extended by Mensah et al. (2017) can be used as a starting point to understand how ageing population affects the public debt level. The theory claims that the government have to incur public debt due to three reasons namely (1) the uses of funds, (2) the sources of funds, and (3) the policy objectives. The use of funds is primarily

to finance government expenditures. Meanwhile, the sources of funds can be derived from taxation (Mensah et al., 2017), investment (Sadik-Zada & Gatto, 2019; Waheed, 2017) and domestic borrowing (Mensah et al., 2017). However, if the government has enough funds to cover its expenditures, the level of external debt is expected to reduce. Finally, the government accumulates higher external debt to achieve the two main policy objectives, namely low inflation and high economic growth. The government is required to inject more funds to support the economy at the time of inflation or to achieve higher economic growth. Hence, the fiscal stimulus by using public debt might be necessary.

In relation to the ageing population, the government is expected to bear a higher financial burden when the number of the ageing population increases. Thus, the uses of funds are expected to increase, thus stimulating higher accumulation of public debt. The government can impose taxes to cover additional costs due to the rise in expenditures related to pensions, transfer payments, etc. However, it is not advisable to do so as it creates a distortionary effect on economic growth. Thus, theoretically, the ageing population will generally increase the government's debt.

1.2. Empirical review

Empirically, most of the papers have been focusing on the above-listed variables as theoretically outlined by Barro (1979) and Mensah et al. (2017). There is limited research available on how the ageing population as a demographic variable affects the external debt of countries. The investigation on this matter is crucial as the increase in the ageing population might force the government to spend more on age-friendly infrastructures (Goedl & Zwick, 2018), pensions (Alonso-Garcia & Rosado-Cebrian, 2019), medicines and so on. Thus, there is a tendency for the government to borrow more funds from the external market due to the rise in government spending. Excessive spending on the ageing population is not a good move as it might distort the economic growth. It is consistent with the theory of secular stagnation (Jackson, 2019), in which the increase in the ageing population will increase the budgetary pressure of the government. It will lead to economic stagnation because most of the expenditures for the ageing population are under the category of the operating expenditure. Instead, the government should focus on spending in development expenditures (Ono & Uchida, 2018; Shkolnyk & Koilo, 2018) since it gives higher benefits and value-added for long-term economic sustainability. The government can concentrate on developing the economy if everyone take charge in taking care of their parents' needs and wants. As discussed in the theory of intergenerational social contract, it is a social obligation of each individual to take care of their parents when they are older (Hillman, 2003). The burden should not be shifted to the government.

Moreover, previous empirical literature was focused on the oil and gas export-import countries (Waheed, 2017), advanced economies (Caruso & Domizio, 2017; Hasanov & Cherif, 2012), emerging economies (Poghosyan, 2018), lower-middle-income economies (Mensah et al., 2017) and mixed economies (Benfratello et al., 2018; Sadik-Zada & Gatto, 2019). UMIE has not received attention in the existing literature. The countries listed within UMIE are worth investigating since they are striving to achieve high-income economies. In order

to achieve higher income, substantial amounts of capital are needed to boost the economy, especially during the global transformation into the fourth industrial revolution. Hence, the need for external debt is highly relevant to these countries as opposed to domestic debt. High domestic debts tend to crowd-out private investments (Reinhart et al., 2012), thus slowing down the economic growth of the country. Since the UMIE aim to become high-income economies, the economic slowdown is not an option. Thus, external debt is necessary as an engine of growth for UMIE. Therefore, this research investigated the effects of the ageing population on the external debt of the UMIE from 2000 to 2017.

This paper contributes to the existing literature by addressing the following issues. Firstly, the effects of the ageing population on the external debt of the UMIE were investigated. This aspect has not been extensively explored (Goedl & Zwick, 2018), especially by using external debt and the UMIE as the scopes of settings. Secondly, this paper extends the model of external debt accumulation by Mensah et al. (2017) by integrating total government revenues as one of the independent variables. The previous model by Mensah et al. (2017) only included taxation as the source of government income. The inclusion of other sources of revenues was vital to capture the entirety of the fiscal imbalance apart from tax in the current study. Thirdly, to ensure the goodness of findings, the issues regarding endogeneity were handled accordingly in the estimation model. The robustness tests were also conducted to ensure consistency of the results by testing the debt model with two proxies that represent the ageing population.

The organization of this paper is as follows. Section 2 discusses the framework and methodology used to answer the objective. Section 3 and 4 presents the findings and discussion, respectively, while the last section concludes the study.

2. Research framework

The underlying framework of public debt accumulation was derived from Barro's model of public debt (Barro, 1979). In his framework, he stressed the importance of three variables in determining the public debt level, namely (1) average anticipated inflation rate, (2) temporary movement of the government expenditure and (3) national income. Due to the difficulties in measuring the anticipated rate of inflation, Barro has also proven that the long-term interest rate can be a good proxy for the anticipated inflation.

Decades later, the original framework by Barro (1979) was extended by Mensah et al. (2017) by the addition of four other variables (taxation, investment, domestic savings and domestic borrowings) in explaining the determination of external debt. Thus, a total of seven variables were grouped into three components of public debt namely, (1) the uses of funds (government expenditure), (2) the sources of funds (taxation, investment, domestic savings and domestic borrowings), and (3) the policy objectives (inflation and economic growth). In this paper, these variables were regarded as the control variables. Hence, the framework underlying this paper was mainly derived from Barro (1979) and Mensah et al. (2017). The framework was further enhanced by adding the ageing population and interest payments on external debt as additional elements in the model.

3. Data, methodology and econometric estimation

Based on the available data, this study included 36 out of 51 countries within the UMIE. The panel of data comprised of annual data from 2000 to 2017. The choice of these years as a period of study is due to data availability as well as the seriousness of the debt issue among UMIE from the early of 2000. Statistically, 55 percent of the countries under investigation were recorded to accumulate an average external debt of more than 40 percent of the GDP (The World Bank Group, 2018). Besides, given the average percentage of the ageing population to total population is increases across the years, high accumulation of external debt is a serious issue that might hinder the economic growth if it is not properly managed.

Prior to the estimation, three-year non-overlapping averages were calculated for all data to cater to the short-run business cycle fluctuations (Arčabić et al., 2018; Law, 2018; Kim et al., 2017). Since the data has a short time series with a large number of cross-sections, the Generalized Method of Moments (GMM) was employed as an estimation method. The method helps to solve the endogeneity problem that exists in the debt-growth model. On the other hand, the traditional panel data estimators such as Pooled Ordinary Least Square (POLS), fixed effect (FE) and random effect (RE) models are inappropriate due to their inability to solve the problem of endogeneity in short time series (Law, 2018). Thus, the baseline regression based on a dynamic model specification in the GMM is written as follows:

$$edebt_{it} = \rho edebt_{i,t-1} + \beta age_{it} + \delta X_{it} + U_{it}; \quad (1)$$

$$X = f(age, ge, rev, inv, sav, debt, inf, rgdp, inf); \quad (2)$$

$$U_{it} = \mu_i + v_{it}, \quad (3)$$

where *edebt* is the ratio of external debt stock to Gross National Income (GNI), *X* is the vector of control variable based on Barro (1979) and Mensah et al. (2017), *i* and *t* represent the countries and years respectively, while *U_{it}* is the error term which consists of unobserved time-invariant effect (μ_i) and random disturbance term (v_{it}). Besides, the proxy for the ageing population is the ratio of population aged 65 and above against the total population (noted by age1). The old-age dependency ratio was also used as a percentage of the working-age population as another proxy for the ageing population (indicated by age2). These two proxies were used for the robustness test to determine the consistency of the results. All data are in natural logarithm form. The detailed explanation of the variables used in this paper is provided in Table 1.

The μ_i and v_{it} are independent of each other and among themselves. However, since the μ_i is not varied with time, Arellano and Bond (1991) suggested that the time-invariant effect should be eliminated by first-differencing the above equation. As a result, the fist-difference equation was derived as follows:

$$edebt_{it} - edebt_{it-1} = \rho(edebt_{i,t-1} - edebt_{i,t-2}) + \beta(age_{it} - age_{it-1}) + \delta(X_{it} - X_{it-1}) + (v_{it} - v_{it-1}). \quad (4)$$

GMM solves the endogeneity problem by including the lagged values of the explanatory variables as the instruments (Arellano & Bond, 1991). The two types of GMM that exist include difference GMM and system GMM. Although both methods include lagged values as

the instruments, the difference GMM only consists of the difference equation while system GMM consists of both difference and level equations. Nevertheless, system GMM is expected to generate a better estimation relative to the difference GMM as the independent variables become persistent (Blundell & Bond, 1998). It is because v_{it} in the difference GMM is correlated with the dependent lagged variable ($edebt_{i,t-1} - edebt_{i,t-2}$) that is included as a regressor. Therefore, this paper employed system GMM as it uses moment conditions of lagged levels as instruments for the differenced equation.

Nevertheless, the use of system GMM is subject to two main conditions. Firstly, the additional instruments added in the model must be valid. Hence, the Hansen test of over-identifying restrictions was used to validate the additional instruments (Hansen, 1982). Secondly, the v_{it} should be free from the second-order autocorrelation. This condition was tested using the Arrelano-Bond test for AR(2) with a null hypothesis that there is no second-order serial correlation for the disturbance in the equation.

Table 1. Variables used in this study

No.	Notation	Description of the variable	Measurement unit	Sources
1	<i>edebt</i>	External debt stocks to GNI	Percentage	World Development Indicator (WDI), World Bank
2	<i>ledebt</i>	Lag of external debt stocks to GNI (based on the initial value of the external debt for each overlapping three-year period)	Percentage	World Development Indicator (WDI), World Bank
3	<i>age1</i>	Ratio of the population ages 65 and above against total population	Percentage	World Development Indicator (WDI), World Bank
4	<i>age2</i>	Ratio of old age dependency ratio against working-age population	Percentage	World Development Indicator (WDI), World Bank
5	<i>ge</i>	General government total expenditure as a percentage of GDP	Percentage	World Economic Outlook, International Monetary Fund (IMF)
6	<i>rev</i>	General government revenue as a percentage of GDP	Percentage	World Economic Outlook, International Monetary Fund (IMF)
7	<i>inv</i>	Gross capital formation as a percentage of GDP	Percentage	World Development Indicator (WDI), World Bank
8	<i>sav</i>	Gross domestic savings as a percentage of GDP	Percentage	World Development Indicator (WDI), World Bank
9	<i>debt</i>	General government gross debt as a percentage of GDP	Percentage	International Monetary Fund (IMF)
10	<i>inf</i>	Annual percentage of inflation based on consumer prices	Percentage	World Development Indicator (WDI), World Bank
11	<i>rgdp</i>	Annual growth of real GDP	Percentage	World Economic Outlook, International Monetary Fund (IMF)
12	<i>int</i>	Interest payments on external debt as a percentage of GNI	Percentage	World Development Indicator (WDI), World Bank

4. Findings and discussion

Table 2 illustrates the summary statistics for all the variables used in this study. The interest on external debt has the lowest mean of 0.1468 while the ratio of the gross capital formation to GDP as a proxy of the investment recorded the highest mean, with the value of 50.14147. Meanwhile, the ratio of the general government expenditure to GDP scored the lowest standard deviation of 0.2992028, while the inflation rate measured the highest standard deviation value of 38.20234.

Table 2. Summary statistics of all variables

Variables	Observation	Mean	Standard Deviation	Minimum	Maximum
<i>edebt</i>	193	3.6267	0.7949	0.3054	4.9996
<i>age1</i>	205	1.9619	0.4622	1.1818	3.0271
<i>age2</i>	205	2.3769	0.4282	1.6657	3.4549
<i>ge</i>	205	3.3558	0.2992	2.4929	4.0048
<i>rev</i>	205	3.2687	0.3148	2.3887	3.8830
<i>inv</i>	190	50.1414	14.9228	0.2565	104.8875
<i>sav</i>	199	43.5547	31.0919	0.0382	120.7834
<i>debt</i>	205	3.5507	0.6820	1.3779	5.1776
<i>inf</i>	203	15.0414	38.2023	0.2964	509.8990
<i>rgdp</i>	205	8.1663	5.7986	0.0305	47.8089
<i>int</i>	193	0.1468	0.9654	-4.7405	1.9605

Table 3 illustrates the correlation matrix between all variables used in the current study. Among the independent variables, four series were identified to possess correlation values of more than 0.8 namely between *ge* and *rev* ($r = 0.929$) as well as *age1* and *age2* ($r = 0.9936$). However, to ensure robust estimation, this study did not include *age1* and *age2* together in the same model to avoid multicollinearity problem.

Table 3. Correlation matrix

	<i>edebt</i>	<i>debt</i>	<i>ge</i>	<i>int</i>	<i>rev</i>	<i>sav</i>	<i>inv</i>	<i>inf</i>	<i>age2</i>	<i>rgdp</i>	<i>age1</i>
<i>edebt</i>	1										
<i>debt</i>	0.4358	1									
<i>ge</i>	0.0721	0.1495	1								
<i>int</i>	0.8544	0.4107	0.034	1							
<i>rev</i>	0.0146	-0.027	0.929	-0.002	1						
<i>sav</i>	-0.525	-0.538	-0.144	-0.438	0.048	1					
<i>inv</i>	-0.526	-0.333	0.109	-0.562	0.145	0.5466	1				
<i>inf</i>	-0.147	-0.134	0.082	-0.055	0.042	0.124	0.2033	1			
<i>age2</i>	0.3662	0.0156	0.349	0.2993	0.335	-0.242	-0.021	-0.035	1		
<i>rgdp</i>	-0.121	-0.319	-0.148	-0.102	-0.057	0.2549	0.2767	-0.032	-0.039	1	
<i>age1</i>	0.3196	-0.006	0.359	0.2481	0.348	-0.199	0.0135	-0.023	0.9936	-0.027	1

Table 4. System-GMM results

Independent Variables	1	2	3	4
<i>l.edebt</i>	0.756*** (0.013)	0.754*** (0.015)	0.743*** (0.014)	0.737*** (0.018)
<i>debt</i>	0.070*** (0.013)	0.077*** (0.013)	0.084*** (0.013)	0.080*** (0.013)
<i>ge</i>	0.147** (0.054)		0.117** (0.056)	
<i>int</i>	0.118*** (0.010)	0.124*** (0.012)	0.119*** (0.010)	0.134*** (0.011)
<i>rev</i>		0.056 (0.056)		0.003 (0.070)
<i>sav</i>	-0.002*** (0.000)	-0.002*** (0.000)	-0.002*** (0.000)	-0.002*** (0.000)
<i>inv</i>	0.001* (0.001)	0.002*** (0.001)	0.001 (0.001)	0.002** (0.001)
<i>inf</i>	-0.001*** (0.000)	-0.001*** (0.000)	-0.001*** (0.000)	-0.001*** (0.000)
<i>rgdp</i>	-0.004*** (0.001)	-0.005*** (0.000)	-0.004*** (0.001)	-0.005*** (0.000)
<i>age1</i>			0.058** (0.027)	0.063** (0.031)
<i>age2</i>	0.026 (0.020)	0.033 (0.032)		
Constant	0.162 (0.165)	0.381* (0.192)	0.204 (0.177)	0.550** (0.218)
Observations	176	176	176	176
No. of instruments	49.000	41.000	49.000	41.000
AR1 <i>p</i> -value	0.013	0.018	0.015	0.022
AR2 <i>p</i> -value	0.154	0.165	0.147	0.148
Hansen <i>p</i> -value	0.906	0.634	0.879	0.692

Notes: Values in bracket represent standard errors in parentheses.

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Next, Table 4 reports the findings of the system-GMM estimations for the four models. The main difference between the four models is the use of variables as a proxy of the ageing population. Two models used the old-age dependency ratio to the working-age population (*age2*), while the third and the fourth models used the ratio of population aged 65 and above against the total population (*age1*). Moreover, since *rev* and *ge* possess high correlation values, each of the ageing population proxies analyzed these two variables independently.

On the other hand, the lagged dependent variable (*l.edebt*) was found to be positive and highly significant for all four models. Consistent with the previous research, the significance implied that the level of current external debt for the UMIE is highly related to the past value of the external debt (Benfratello et al., 2018). The coefficient values for all four models fell

within the range of 0.73 to 0.75, further illustrating that the past amount of external debt leads to an even higher level of current external debt in the UMIE. Therefore, the UMIE's are required to acquire additional funds to boost the economy and to repay previous debts.

In addition, the need for a higher level of funding among the UMIE is further supported by considering the significant value of the domestic debt (debt) as another independent variable. The coefficient of the debt variable indicates a meaningful positive relationship with the level of external debt. It signifies that the UMIE requires massive funds for their economic development agenda. If the domestic debt level increases, the external debt level is also expected to increase but at a minimal rate. Thence, UMIE heavily relies on domestic debt compared to the external debt as a possible source of funding.

Referring to the variables under investigation, the ageing population generated a significantly positive relationship with UMIE's external debt, but at a very minimal impact (in between 0.058 percent to 0.063 percent). This relationship emerged when the population age of 65 and above was used as a proxy to represent the older population (in model 3 and 4). Meanwhile, when the old-age dependency ratio was used as a proxy of the ageing population, this variable possessed no significant relationship with the level of the external debt (as shown in model 1 and 2). Indirectly, the use of both proxies instigated that the ageing population may or may not be able to influence the external debt of the UMIE. This finding illustrates that the public debt theory by Barro (1979) and Mensah (2017) is not necessarily true in the case of UMIE. An increase in the population of age 65 and above gives pressure for the government to incur higher external debts as the needs for funds increase. This is in-line with the theory that stresses the uses of funds as one of the determinants of public debt. Nevertheless, when the proxy of ageing population is changed into the old-age dependency ratio, the public debt theory is no longer applicable. Probably, it is due to the fact that the elder people are not depending too much on the government. Instead, their burden is transferred to their children or relatives. Thus, the needs of funds do not change even when the old-age dependency ratio increases.

Empirically, a larger population of 65 years of age and above increases the external debt level due to the needs of the governments to inject more funds into healthcare industry, age-friendly infrastructure, retirement benefits and social security (Carbonaro et al., 2018; Horioka et al., 2018; Miranda, 2018; Mao, et al., 2020). Hence, the government may have to sacrifice the development projects due to limited revenues. Consequently, there might be a slowdown in the economic growth as postulated in the theory of secular stagnation since the government have to borrow money to finance their operating expenditure due to an increase in the number of ageing population. If they insist on injecting funds for the development projects, which are essential for economic growth, the governments will have to borrow more funds from the local and external sources.

Nevertheless, the current trend exhibited that most of the elderly citizens have received proper education in their previous years (Croix & Licandro, 1999; Soong, 2020). Their level of literacy signified no significant influence of the old-age dependency ratio on the level of the external debt of the UMIE. The dependency is not a problem since older people have their savings to survive in their remaining life (Hillman, 2003). Even though the savings are expected to deteriorate over time, older people can still depend on their children. This is consistent

with the theory of intergenerational social contract (Hillman, 2003), in which the children are responsible in taking care of their parents when their parents are no longer working. Hence, the governments are not pressurized to borrow more funds externally in these circumstances.

Of the seven control variables, *rev* was the only variable that had an insignificant relationship with external debt. As for the other control variables, *ge*, *int* and *inv* were capable of significantly influencing the external debt in a positive direction. Consistent with Barro (1979) and Mensah et al. (2017), the government will be forced to secure more funds if their level of expenditure increases over time. In this circumstance, imposing a higher level of taxation is not a wise decision as it will only distort the economic growth of a country. Secondly, higher external debt is expected as the interest rate on external debt increases. This finding contradicts with previous literature which found the relationship to be negative (Benfratello et al., 2018; Pirtea & Nicolescu, 2012; Waheed, 2017). One of the possible reasons for the finding is due to the needs of the government to pay a higher amount of interest when the interest rate increases. Thirdly, the investment may or may not give a significant favourable influence on the level of the external debt. If it is significant, the level of significance is not too strong, especially for model 1 and 4. Despite the significant investment level, countries within the UMIE are not able to fully reap the benefits from the investment (Waheed, 2017). Instead, leads to a higher dependency on external debt. To the contrary, the result can also be insignificant as illustrated in model 3, consistent with the previous finding (Sadik-Zada & Gatto, 2019).

The remaining control variables (*sav*, *inf* and *rgdp*) exhibited a significant negative relationship with the level of the external debt. Parallel with the findings by Waheed (2017), an increase in the national savings will help to reduce the external debt but at a very minimum rate. The government can utilise the savings for national development projects without relying too much on external debt. Similarly, *inf* and *rgdp* as the macroeconomic variables indicated a significant negative impact on the external debt of the UMIE. Furthermore, during inflation the public will begin to save their money for future consumption, thus leading to a lower level of current consumption (Hasanov & Cherif, 2012; Tarek & Ahmed, 2017).

Consequently, during the time of lower current consumption, the government may not be able to generate higher income. Therefore, external debt increases as a result of inflation. However, when the economy is good, dependency on external debt is expected to decline. In this regard, the economy that has more income does not need additional funding to grow the economy (Barro, 1979; Benfratello et al., 2018; Mensah et al., 2017; Waheed, 2017).

The results discussed above are only deemed valid if they meet the two main conditions. Firstly, the residuals should be free from second-order autocorrelation. Hence, the Arellano-Bond (AB) test was employed with the null hypothesis stating no autocorrelation in the residuals can be rejected at the AR(1) test, but not at the AR(2) test. This indicates that there is no second-order autocorrelation exists in the residuals. Even though the first-order autocorrelation exists in the residuals, the GMM estimator allows it to happen since the system GMM consists of both level and first difference variables (Arellano & Bond, 1991). Secondly, the instruments should appear to be exogenous. By using the Hansen test, the instruments in the model were estimated to be valid and exogenous if the null hypothesis of over-identifying restrictions was not rejected. The outcomes show that the null hypothesis is failed to be rejected, thus the instruments used in the models are valid and exogenous.

Conclusions

This study empirically investigated the impacts of the ageing population on the external debt of the UMIE. The study argued that the ageing population increases the burden of the government, thus pressuring the governments to borrow more external funds. The results in this study were based on the panel data analysis which employed the system GMM estimation for 36 countries within the UMIE from 2000 to 2017.

Based on the results, mixed results were yielded in which the ageing population may or may not affect the external debt of the UMIE. The effects of the ageing population on the external debt depended on the proxy used to measure the ageing population. From one perspective, a higher number of population aged 65 and above increased the burden of the government, thus leading to a higher level of external debt. The increase of the government's burden may come from the needs to spend more on healthcare, age-friendly infrastructure, pensions and social security. However, based on the other perspective, the old-age dependency ratio (another proxy of the ageing population) indicated no significant influence on the external debt of the UMIE. It is because the older generation in the UMIE consisted of educated pensioners who have enough savings for their future expenses. Hence, the dependency on the government is minimal where it does not impact the level of the external debt.

Several implications were derived from the results of this study. Firstly, the private sector should work together with the public sector in building age-friendly infrastructure to cater to the ageing population. It will help to reduce the government's burden as the country is approaching the era of the ageing population. Secondly, the government should encourage all labors to contribute a portion of their income for their health insurance and retirement days which also includes entrepreneurs who are running their own businesses. If everyone has subscribed to health insurance and savings for their retirement days, the government can slowly focus on productive expenditures. In turn, it will also reduce the level of external debt which might harm the economic growth of a country.

This study is only focusing on how the ageing population affects the external debt of the UMIE. It does not consider the role of the ageing population on the domestic debt level. Hence, more rooms remain for future research as the increase in the ageing population might also give extra burden for the domestic debt.

For future research, we suggest forthcoming studies to examine the impact of the ageing population on the domestic debt level. It is because the ageing population is expected to increase the burden of the government, hence might increase the domestic debt level. An increase in the debt level may harm the economic growth of a country if the government fails to manage their funds well.

Funding

This study was funded by 2020 Teja's Internal Grant Scheme by Universiti Teknologi MARA, Melaka, Malaysia.

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APPENDIX

List of upper-middle-income economies:

Included	1. Albania 2. Algeria 3. Armenia 4. Azerbaijan 5. Belarus 6. Belize 7. Bosnia and Herzegovina 8. Botswana 9. Brazil 10. Bulgaria 11. China 12. Colombia	13. Costa Rica 14. Dominican Republic 15. Ecuador 16. Fiji 17. Gabon 18. Guatemala 19. Guyana 20. Islamic Republic of Iran 21. Jamaica 22. Jordan 23. Kazakhstan 24. Malaysia	25. Mauritius 26. Mexico 27. Montenegro 28. Paraguay 29. Peru 30. Romania 31. Russian Federation 32. Serbia 33. South Africa 34. Thailand 35. Turkey 36. Venezuela
Excluded due to data unavailability	1. American Samoa 2. Cuba 3. Dominica 4. Equatorial Guinea 5. Grenada 6. Macedonia	7. Lebanon 8. Libya 9. Iraq 10. Marshall Islands 11. Namibia 12. Nauru 13. Maldives	14. Samoa 15. St. Lucia 16. St Vincent and the Grenadines 17. Suriname 18. Tonga 19. Turkmenistan 20. Tuvalu

Notations*Abbreviations*

- AGE1 – Ratio of population ages 65 and above against total population;
 AGE2 – Ratio of old age dependency ratio against working-age population;
 DEBT – General government gross debt as a percentage of GDP;
 EDEBT – External debt stocks to GNI;
 FE – Fixed effect;
 GDP – Gross Domestic Product;
 GE – General government total expenditure as a percentage of GDP;
 GMM – Generalised Method of Moments;
 INF – Annual percentage of inflation based on consumer prices;
 INT – Interest payments on external debt as a percentage of GNI;
 INV – Gross capital formation as a percentage of GDP;
 LEDEBT – Lag of external debt stocks to GNI;
 POLS – Pooled Ordinary Least Square;
 RE – Random effect;
 REV – General government revenue as a percentage of GDP;
 RGDP – Annual growth of real GDP;
 SAV – Gross domestic savings as a percentage of GDP;
 UMIE – upper-middle-income economies.