UJoST
Universal Journal of Science and Technology
e-ISSN: 2962-9179
Vol. 1 No. 2 (2022) September 2022

Impact of Public Debt on Economic Growth: A Panel ARDL Approach in ASEAN-5

Jane Rose C. Bacay[1], Justine A. Diokno[1], Kimberly Anne D. Iguiz[1], Ronaldo R. Cabauatan[1,2,3]

[1]College of Commerce and Business Administration, University of Santo Tomas, Manila, Philippines
[2]Research Center for Social Sciences and Education, University of Santo Tomas, Manila, Philippines
[3]The Graduate School, University of Santo Tomas, Manila, Philippines

Abstract

This study examined the relationship between public debt and economic growth by employing the autoregressive distributed lag (ARDL) approach developed by Pesaran and Shin (1999) in the ASEAN-5 from 1986 to 2020. This paper considered a time period wherein there exists an episode of economic uncertainties. The other variables used in this study are exchange rate, foreign exchange reserves, and world uncertainty index. The data were extracted from the World Development Indicators (WDI) of the World Bank and the International Monetary Fund (IMF). It is essential to determine whether or not debt financing is a sound fiscal policy, particularly during an economic crisis, to protect a country's fiscal condition. The empirical analysis indicated a significant negative relationship between public debt and economic growth in the long run but an insignificant relationship in the short run. Specifically, an increase in public debt by 1% is associated with a 3.74% decrease in economic growth in the long run. This finding supports several previous studies, and it implies that governments need effective public debt management to mitigate the long-term impact of public debt. The results also suggest that public debt should be allocated to productive sectors and long-term investment projects to ensure debt sustainability.

Keywords: Public Debt, Economic Growth, ASEAN, ARDL

1. Introduction

Public debt is an important component of fiscal sustainability to finance government expenditures as a result of inadequate public revenue. To respond to the economic recessions over the past few decades, most developed and developing countries have utilized public debt to fund budget deficits. According to Omotosho et al. (2016) and Kueh et al. (2017), a reasonable level of public debt boosts economic growth as it increases capital accumulation to mitigate the negative impact of external economic shocks such as the Global Financial Crisis. During the COVID-19 pandemic, higher levels of public debt are justifiable as it mainly serves to address the pandemic's adverse economic impact (Tsinaridze & Beridze, 2021). However, excessive borrowing

Universal Journal of Science and Technology
e-ISSN: 2962-9179
Vol. 1 No. 2 (2022) September 2022

may lead to debt problems and negatively affect the economy through higher long-term interest rates, higher taxation, and greater uncertainty (Baharumshah et al., 2016). Therefore, effective public debt management is vital for the sustainable development of a country.

The Asian countries analyzed were exposed to three major crises during the selected period of study, the 1997 Asian financial crisis, the 2008 global financial crisis, and the COVID-19 pandemic, which boosted their public debt to GDP ratios. The response by governments worldwide to the Global Financial Crisis (GFC) was the last big episode of fiscal activism before the COVID-19 pandemic. As a result, the reaction to the COVID-19 pandemic reflects past responses to previous depressions. These economic crises have driven these countries to borrow money to maintain income and spending levels. Borrowings during a crisis are a response to the reduced tax receipts due to the recession and the need for the government to finance productive investments (Omotosho et al., 2016).

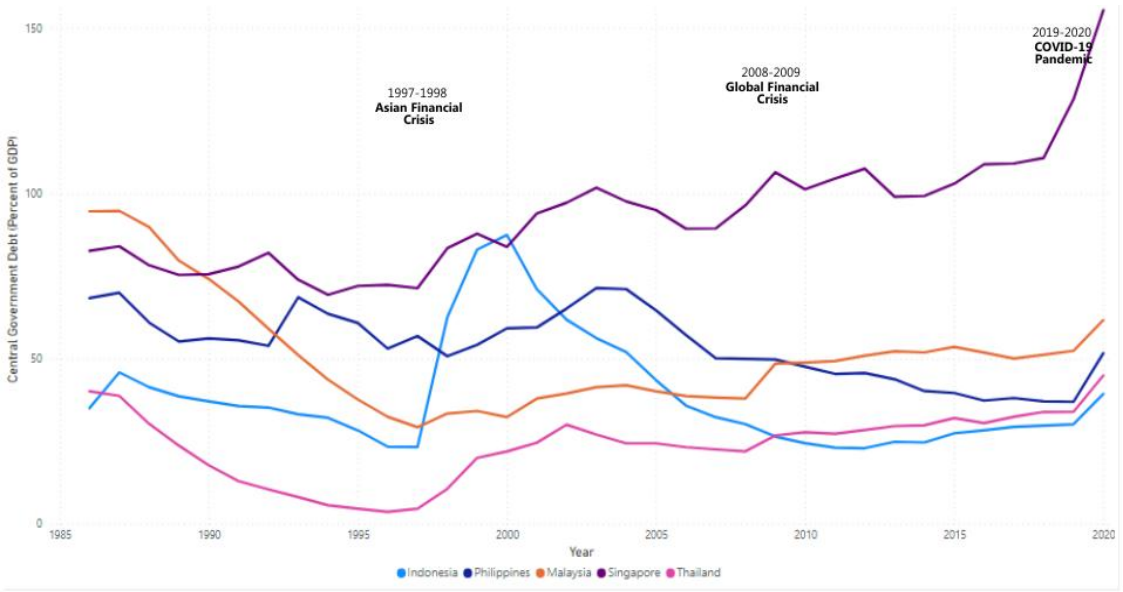

Figure 1 Central Government Debt as a percentage of GDP in the ASEAN-5, 1986-2020.
Source: International Monetary Fund

UJoST
e-ISSN: 2962-9179
Universal Journal of Science and Technology
Vol. 1 No. 2 (2022) September 2022

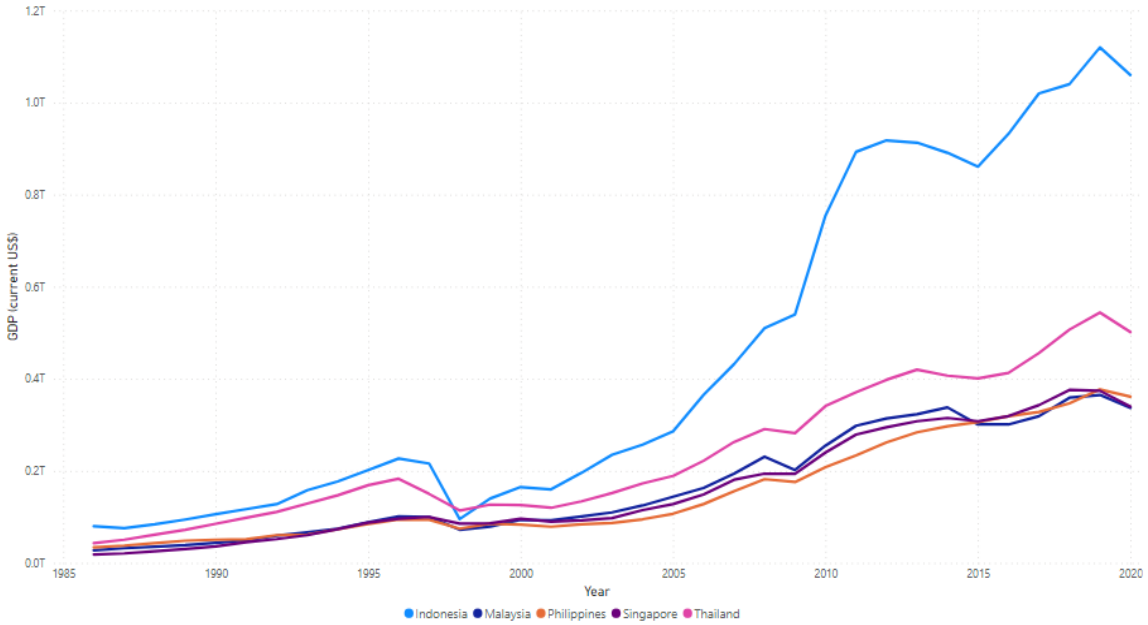

Figure 2 Gross Domestic Product in current US$ in the ASEAN-5, 1986-2020.
Source: World Development Indicators, World Bank

Figure 1 shows the central government debt as a percentage of GDP for each of the 5 ASEAN countries. It can be observed that their public debt-to-GDP ratios increased at the beginning of the Asian Financial Crisis. Particularly in Indonesia, from 23.34% in 1997, public debt-to-GDP ratio rose to 87.44% in 2000. For the rest of the countries, public debt-to-GDP ratio also increased significantly a few years after Asian Financial Crisis in order to cope with the economic shock. Although the Global Financial Crisis did not directly affect ASEAN economies, it can be seen in Figure 2 that the GDP of these countries still declined during this period. It can also be observed that for most of the countries, debt-to-GDP ratios are below 50% and Singapore reached a debt-to-GDP ratio of above 100%. It implies that the debt situation should also be evaluated based on the periods of development and macroeconomic condition of a particular country (Thao, 2018).

Although there are already numerous studies on the real effect of public debt on growth, this topic is still widely debated by economists and policymakers. There are several studies that pointed out a negative relationship between public debt and economic growth such as Chudik et al. (2017), Attard (2019), and Asteriou et al. (2020). On the other hand, there are also some studies that found a positive public debt-growth relationship, including Fincke and Greiner (2015), Wibowo (2017), Burhanudin et. al (2017), and Thao (2018). The large strand of literature on the debt-growth nexus started from the attempt of Reinhart and Rogoff (2010) to identify the possible non-linearities in the relationship between public debt and economic growth, as well as the point at which

debt already becomes detrimental to growth. Following this, the trend in the emerging empirical literature has been the examination of a nonlinear relationship between public debt and growth.

In order to contribute to the existing literature, this paper's main objective is to determine the short-run and long-run relationship between public debt and economic growth while taking into consideration the period of economic uncertainties. In particular, this paper examined the public-debt growth nexus of the ASEAN-5, which consists of Indonesia, Malaysia, Philippines, Singapore, and Thailand, from 1986 to 2020. Most of the past studies focused on the relationship between public debt and growth in developed countries, and only a few on the ASEAN-5. Furthermore, some of the studies were not able to include recent data. The link between public debt and economic growth has to be considered in making policy decisions, as it may significantly affect an entire economy in the long run. It is important to determine whether or not debt financing is a sound fiscal policy to protect a country's fiscal condition and be able to adjust public debt within its reasonable range. Apart from this, the paper also identified the other factors that affect economic growth, particularly exchange rates and foreign exchange reserves.

2. Literature Review

2.1 Public Debt and Economic Growth

In recent years, the link between public debt and economic growth continues to be widely disputed. Current empirical research on the debt-growth relationship splits into two strands of literature. The first strand concludes with a positive relationship between public debt and economic growth. In particular, Burhanudin et al. (2017) analyzed the debt-growth relationship in Malaysia with the employment of ARDL approach. The study revealed that government debt positively impacts Malaysia's sustainable economic growth both in the short run and in the long run. Wibowo (2017) obtained similar results: public debt contributes significantly to the growth of ASEAN economies, albeit it requires a few years (4 to 5 years). Similarly, Thao (2018) acquired empirical evidence of a significant positive association between public debt and economic growth in six ASEAN countries throughout the period between 1995 to 2015. The results suggested that ASEAN countries were never confronted with the problem of increased levels of indebtedness over the past two decades. Moreover, the study substantiated the nonexistence of a nonlinear debt-growth relationship among the six ASEAN countries. Through the use of panel data estimations and fixed effects estimation that allows for heterogeneity among the 8 selected emerging economies, Fincke and Greiner (2015) found that, although minimal, there is a significant and positive link between public debt and economic growth. This finding can be attributed to

the fact that emerging countries are going through a transition path where they exhibit significant growth rates and flourishing infrastructure investment that fosters growth. Meanwhile, Owusu-Nantwi and Erickson (2016) found evidence of public debt facilitating the economic growth of Ghana for a period spanning from 1970 to 2012. In the long run, the growth rate of real GDP and public debt has a positive and significant relationship, while in the short run, public debt and economic growth have a bidirectional relationship, an indication that economic growth is granger caused by public debt and vice versa.

On the other hand, many studies found strong evidence of a negative debt-growth relationship. For instance, Asteriou et al. (2020) found that in selected Asian countries between 1980 to 2012, economic growth was negatively impacted by public debt both in the short run and in the long run. Considering the common correlated factors, the negative link between debt and growth is revealed to be more significant. Simultaneously, the notion that the adverse impact of the public debt only takes effect once the 90% ratio of public debt is reached is inapplicable to Asian countries. Employing a collection of panel data models, Gunarsa et al. (2020) discovered that, in developing Asia, public debt's increasingly significant and negative influence on economic growth prevailed. From 1970 to 2015, a 10% increase in public debt is reported to be followed by an estimated 0.2% to 0.4% decline in economic growth. According to Chudik et al. (2017), the link between the rising levels of debt to GDP and economic growth is significant and negative in the long run, irrespective of debt thresholds. Additionally, The findings also showed that the direction of debt can carry major implications on economic growth as compared to the debt to GDP level. To assess the impact of debt on growth for a sample of 25 EU countries, Attard (2019) applied a panel ARDL model over the period of 1996 to 2017. The results revealed a negative debt-growth relationship both in the short run and in the long run. Additionally, their results implied that differing debt levels and significant economic events do not influence the negative association between debt and growth.

Alongside the two strands of literature, several studies have agreed that the relationship between public debt and growth is positive and negative. With consideration to individual features of EA economies, Gómez-Puig and Sosvilla-Rivero (2018) employed the ARDL bounds testing approach to probe into the debt-growth nexus of 11 economies in the Euro Area over the period of 1961 to 2013, finding that in the short run, public debt casts positive implications on economic growth. This short-run positive impact applies specifically to Finland, Germany, Portugal, and Spain. Whereas in the long run, public debt acts as an impediment to the growth of EA economies. The findings generally pointed out that the debt-to-GDP ratio that damages economic growth varies according to time and country. Mhlaba and Phiri (2019) reached the same conclusion with the use of ARDL cointegration approach. The study also highlighted that public debt exerted a stronger deleterious effect on economic growth during the periods

closely following the financial crisis. Another study by Mika and Zumer (2017), using cross-country panel regression models and mean group estimations that better reflect data properties, found that in 25 EU countries, public debt exerts a positive impact on economic growth in the short to medium run. In the long run, the impact of public debt on economic growth appears to be negative, which attests the inability of increasing debt to improve living standards indefinitely despite the stimulation on growth it can provide in the short run. Albu and Albu (2020) utilized a wavelet approach that makes it possible to examine the correlation between the economic variables at various time frames, which addresses the constraints faced by the other nonlinear approaches. The findings corroborate the classical theory of public debt, wherein public debt initially boosts economic growth. In the long run, however, public debt becomes increasingly deleterious on economic growth.

Although the standard static panel models, including pooled OLS, random effects, or fixed effects, are widely used in studies related to the debt-growth relationship, they cannot discern the long-run and short-run relationships between the variables (Arcabic et al., 2018). Furthermore, according to Campos and Kinoshita (2008, as cited in Ramos-Herrera & Prats 2020), when particular regressors are endogenous, the parameters can manifest biases. Conversely, the dynamic panel models, particularly the GMM difference estimator by Arellano & Bond (1991), and the GMM system estimator proposed by Arellano & Bover (1995) are beneficial only when the sample is represented by a significant amount of countries relative to the chosen sample period (Ramos-Herrera & Prats, 2020). Thus, the panel ARDL approach appears to be an efficient method in tackling these limitations. The ARDL method allows varied orders of integration of series, whether they are I(0), I(1), or a combination of the two (Pesaran & Shin, 1999). One key aspect of the ARDL method is that it can reduce the problem of endogeneity by including sufficient lags in all variables, particularly the Pooled Mean Group (PMG) and Mean Group (MG) estimators (Pesaran et al., 1999). In the standard cointegration test, the ARDL method avoids establishing a higher number of specifications. These choices include the quantity of endogenous and exogenous variables and how deterministic aspects should be treated. Additionally, unlike the standard cointegration test, the ARDL approach allows for different optimal lags for distinct variables (Kharusi & Ada, 2018).

Table 1 Summary of the association between public debt and economic growth

AUTHOR/S	SAMPLE COUNTRIES	TIME PERIOD	METHOD	FINDINGS
Albu, A., & Albu, L. (2021)	Euro area countries	2000 - 2019	Wavelet approach	Short run: positive relationship Long run: negative

				relationship
Asteriou, Pilbeam, and Pratiw (2020)	14 Asian countries	1980 - 2012	Asymmetric panel ARDL	Negative relationship
Attard, J. (2019)	25 EU countries	1996 - 2017	Panel ARDL model	Negative relationship
Burhanudin, M.D., Muda, R., Nathan, S.B., & Arshad, R. (2017)	Malaysia	1970 - 2015	ARDL approach	Positive relationship
Chudik, A., Mohaddes, K., Pesaran, H., and Raissi, M. (2017)	40 countries	1965 - 2010	• Panel Threshold Output Growth Model • Panel Threshold ARDL model • Monte Carlo experiments • Threshold VAR model	Negative relationship
Daud, S.N.M. (2016)	Malaysia	1970 - 2012	• ARDL • Granger causality test • Threshold regression method by Hansen (2000)	Nonlinear relationship
Eberhardt, M., and Presbitero, A. (2015)	118 countries	1960 - 2012	Standard linear regression models	Relationship varies across countries
Fincke, B., & Greiner, A. (2015)	8 emerging economies	1980 - 2012	Panel data estimations	Positive relationship
Gómez-Puig, M. & Sosvilla-Rivero, S. (2018)	11 Euro area countries	1961 - 2013	Autoregressive Distributed Lag (ARDL) bounds testing approach	Short run: positive relationship Long run: negative relationship
Gunarsa, S., Makin, T., and Rhode, N. (2020)	25 Asian countries	1970 - 2015	Panel Data Models: random-effects model, fixed-effects model, and dynamic panel model estimated using difference GMM (Arellano and Bond 1991).	Negative relationship

Mhlaba, N., & Phiri, A. (2019)	South Africa	2002 - 2016 (Quarterly data)	ARDL model	Short run: positive relationship Long run: negative relationship
Mika, A., & Zumer, T. (2017)	EU countries	1995 - 2015	Traditional cross-country panel regressions and mean group estimations	Short run: positive relationship Long run: negative relationship
Omotosho, B.S., Bawa, S., and Doguwa, S.I. (2016)	Nigeria	2005 - 2015 (Quarterly data)	Khan and Senhadji (2001) approach	Nonlinear relationship
Owusu Nantwi, V., and Erickson, C.	Ghana	1970 -2012	Vector error correction model	Positive relationship
Thao, T.P.T. (2018)	6 ASEAN countries	1995 to 2015	Regression analyses based on General Method of Moments (GMM) estimation	Positive relationship
Ramos-Herrera, M.C., and Sosvilla-Rivero, S. (2017)	115 countries (developed and developing)	1970 - 2013	Empirical approach	Debt-growth relationship is complex
Wibowo, M.G. (2017)	8 ASEAN countries	2006 - 2015	Autoregression Vector models (VAR) Granger causality test	Positive relationship

2.2 Non-linearity in Debt-Growth Nexus

Most of the contemporary literature points out that the effect of public debt on economic growth is non-linear. The study of Reinhart and Rogoff (2010) exerted a substantial influence on the creation of macroeconomic policies globally, particularly in the austerity measures implemented in the aftermath of the 2008 Global Financial

Crisis. Using simple descriptive statistics in a panel of 44 economies, their main findings suggested that public debt levels above 90% of GDP are associated with lower growth outcomes across advanced countries and emerging markets. This was supported by the study of Cecchetti et al. (2011) in 18 OECD countries from 1980 to 2010, which suggested a public debt threshold of around 85% of GDP.

Subsequent studies investigated the threshold effects proposed by Reinhart and Rogoff (2010). Herndon et al. (2013) replicated the study and contended that public debt levels beyond 90% do not consistently lead to a decrease in a country's economic growth. Non-linearity occurs when public debt levels range between 0% and 30% of GDP, depending on the country and time period. They asserted that the errors of Reinhart and Rogoff (2010) resulted from data exclusions, spreadsheet errors, and inappropriate weighting methodology. In another paper by Egert (2015), the findings also revealed a large amount of cross-country heterogeneity using the same data set used by Reinhart and Rogoff (2010). It further showed that the government debt threshold could be as low as 20% of GDP. Another study revisited the study by Reinhart and Rogoff (2010) and found that there is no evidence that countries will experience significant reductions in GDP growth after reaching a certain debt-to-GDP ratio. Amman and Middleditch (2019) observed that after the financial crisis, the number of higher debt regimes exploded, which gives support to the reverse causality of debt caused by economic slumps.

Examining the robust evidence of a positive relationship between primary surplus and public debt is commonly used in previous studies (Shastri et al., 2018; Magazzino et al., 2019; Bui, 2020; Lau & Lee, 2021) to assess fiscal sustainability. The findings of recent studies on the debt-growth nexus tend to vary depending on the country, time period, econometric method, and other specifications. Most studies concluded that public debt positively impacts growth when the debt level is below the threshold, and debt above the estimated threshold could hurt economic growth. (Daud, 2016; Omotosho et al., 2016; Baharumshah et al., 2017; Tran, 2018; Yang & Su, 2018; Ramos-Herrera & Prats, 2020; Lee & Kueh, 2021; Bentour 2021; Rajakaruna & Suardi, 2022). Further analyses established whether the long-run relationship is the same in each country, or whether there are significant differences in the debt-growth nexus across countries.

In the study of Bi (2017) and Karadam (2018) on the non-linear effects of debt, the threshold is lower for developing countries implying that public debt can harm growth at lower debt levels than in developed ones. Moreover, Eberhardt and Presbitero (2015) argued that no matter the shape and form of the debt–growth nexus, it differs across countries, opposing the claim of a common debt threshold. Ramos-Herrera and Sosvilla-Rivero (2017), Tran (2018), Bentour (2021) and Rajakaruna & Suardi (2022) also found heterogeneity across countries. Butkus et al. (2022) examined uncertainty as

one of the factors that caused this heterogeneity, and it turns out that lower uncertainty is related to a more positive effect of debt on growth and a higher threshold in the debt-growth nexus. On the other hand, higher uncertainty results in a lower positive effect of debt on growth in both linear and quadratic specifications.

2.3 Exchange Rate and Economic Growth

According to Hameed and Quddus (2020), the exchange rate is a significant indicator of economic growth as the appreciation of the exchange rate signifies that the local currency has depreciated. When this happens, the price of imported goods and raw materials will rise, which will reduce imports. Due to the relatively lower cost of domestic goods, consumers would prefer them over foreign goods, which will increase the level of domestic production, encourage exports, and have a promising impact on economic growth. Furthermore, the increase in the exchange rate will make exports more expensive for the importing nations; in the long run, demand for exports will decrease, which will contract GDP growth by deteriorating the country's trade balance (Lee & Kueh, 2021). In the study of Lee and Kueh (2021), they used the exchange rate as one of the control variables and found that it adversely impacts economic growth. Similarly, Hameed and Quddus (2020) found that the exchange rate significantly and negatively affects economic growth in the short run but has an insignificant and positive relationship in the long run.

2.4 Foreign Exchange Reserves and Economic Growth

Foreign exchange reserve accumulation undervalues the exchange rate, causing domestic assets to look more affordable in foreign currencies. One of the possible reasons for the build-up of foreign exchange reserves is debt payment. Moreover, accumulating foreign exchange reserves is a powerful macroeconomic means of increasing long-term growth rates (Polterovich & Popov, 2003).

3. Research Method

3.1 Data

This study used panel data on ASEAN 5 countries—Indonesia, Malaysia, the Philippines, Singapore, and Thailand—with annual data from 1986 to 2020. The rationale for selecting the period is to incorporate economic uncertainties from the 1997

Asian Financial Crisis until the 2020 COVID-19 pandemic. The variables in the study are as follows: Gross Domestic Product (GDP), public debt (PUBLIC_DEBT), exchange rate (FOREX), foreign exchange reserves (RESERVES), and world uncertainty index (WUI). The annual data of the variables are all retrieved from the World Development Indicators (WDI) of the World Bank, except the data on public debt and the world uncertainty index, which are obtained from the International Monetary Fund (IMF). The relationship between the said variables can be represented by:

$$GDP_{it} = F(PUBLIC\_DEBT, FOREX, RESERVES, WUI) \quad [1]$$

The current model is transformed into an empirical growth model:

$$GDP_{it} = \beta_0 + \beta_1 PUBLIC\_DEBT_{it} + \beta_2 FOREX_{it} + \beta_3 RESERVES_{it} + \beta_4 WUI_{it} + \varepsilon_{it} \quad [2]$$

In equation [2], the subscripts i and t refer to country and time respectively; GDP refers to Gross Domestic Product (in current US$); PUBLIC_DEBT refers to Central Government Debt (Percent of GDP); FOREX refers to Official exchange rate (LCU per US$, period average); RESERVES refers to Total reserves minus gold (current US$); and WUI refers to World Uncertainty Index.

3.2 Method

3.2.1 Panel Unit Root Tests

Before developing the ARDL model, it is necessary to perform panel unit root tests to check the stationarity of a time series. Following Asteriou et al. (2020), the study employed IPS (Im et al., 2003) and LLC (Levin et al., 2002) unit root tests based on the assumption of cross-sectional independence. The study also utilized ADF and PP Fisher Chi-square. These tests have a null hypothesis of non-stationarity and comparing the results from the different methods is a good way to test the accuracy of the conclusions.

3.2.2 Panel Cointegration Tests

This study utilized the Pedroni cointegration test, which is expressed as equation [3]:

$$y_{i,t} = \alpha_i + \delta_i + \beta_1 x_{1i,t} + \beta_2 x_{2i,t} + \beta_3 x_{3i,t} + \varepsilon_{i,t} \quad [3]$$

Where y is Gross Domestic Product (GDP), the dependent variable and x are public debt (PUBLIC_DEBT), exchange rate (FOREX), foreign exchange reserves (RESERVES), and world uncertainty index (WUI), which are the independent variables.

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e-ISSN: 2962-9179
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Furthermore, a_i refers to the fixed effects, δ_i refers to the individual specific deterministic trend effects, and ε refers to the residuals.

Panel cointegration tests were employed after checking for the presence of unit root among the variables. This is to ensure whether a long-term relationship between the variables exists. In particular, the cointegration test of Pedroni (1999, 2004) was utilized. These tests were also used in the study of Attard (2019) and Lee and Kueh (2021). All two tests have the null hypothesis of no cointegration. Rejection of the null hypothesis in the test of Pedroni (1999, 2004) indicates that the variables are cointegrated in all panels. The Westerlund (2007) cointegration test was also employed by several studies, including, Ramos-Herrera and Prats (2020), Shastri et al. (2018), and Asteriou et al. (2020). However, Attard (2019) stated that according to Westerlund himself, the test is frequently subject to distortions when the number of periods is less than 100, which suggests that the test is not suitable for this study.

3.2.3 Panel ARDL Model

After conducting the panel unit root tests and the cointegration tests, the panel ARDL model is specified if no cointegration is found. According to Pesaran and Shin (1999), this method can be applied regardless of the order of integration of the variables, as long as it is I(0) or I(1) or a mixture of both. This approach is conducted to examine the short-run and long-run relationship between economic growth, public debt, exchange rate, foreign exchange reserves, and world uncertainty index in the selected 5 ASEAN economies. According to Pesaran et al. (1999), the panel ARDL approach can address the problem of endogeneity due to its capability to discern between dependent and explanatory variables. It also generates robust and consistent results compared to alternative methodologies. Moreover, this approach is more appropriate for a sample dataset that is small-scale and finite.

Following Blackburne and Frank (2007, as cited in Lee & Kueh, 2021), the ARDL model is shown as equation [4]:

$$y_{it} = \sum_{j=1}^{p} \lambda_{ij} y_{i,t-j} + \sum_{j=0}^{q} \delta'_{ij} X_{i,t-j} + \mu_i + \varepsilon_{it} \qquad [4]$$

Where:

$$\begin{bmatrix} lnGDP_{it} \\ lnPUBLIC\_DEBT_{it} \\ FOREX_{it} \\ RESERVES_{it} \\ WUI_{it} \end{bmatrix} = \begin{bmatrix} a_{11it} \\ a_{12it} \\ a_{13it} \\ a_{14it} \\ a_{15it} \end{bmatrix} + \begin{bmatrix} \beta_{1it} & \theta_{1it} & \lambda_{1it} & \delta_{1it} & \gamma_{1it} \\ \beta_{2it} & \theta_{2it} & \lambda_{2it} & \delta_{2it} & \gamma_{2it} \\ \beta_{3it} & \theta_{3it} & \lambda_{3it} & \delta_{3it} & \gamma_{3it} \\ \beta_{4it} & \theta_{4it} & \lambda_{4it} & \delta_{4it} & \gamma_{4it} \\ \beta_{5it} & \theta_{5it} & \lambda_{5it} & \delta_{5it} & \gamma_{5it} \end{bmatrix} \begin{bmatrix} \sum lnGDP_{it-k} \\ \sum lnPUBLIC\_DEBT_{it-k} \\ \sum FOREX_{it-k} \\ \sum RESERVES_{it-k} \\ \sum WUI_{it-k} \end{bmatrix} + \begin{bmatrix} e_{1it} \\ e_{2it} \\ e_{3it} \\ e_{4it} \\ e_{5it} \end{bmatrix}$$

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e-ISSN: 2962-9179
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It is also noteworthy to perform a Wald test for the ARDL as it establishes whether a long run relationship between the variables exists.

4. Results and Discussion

4.1 Preliminary Tests

Table 2 Panel Unit Root Test Results

	Levin, Lin & Chu t*		Im, Pesaran and Shin W-stat		ADF - Fisher Chi-square		PP - Fisher Chi-square	
	Statistic	Prob**	Statistic	Prob**	Statistic	Prob**	Statistic	Prob**
Tests in logarithmic levels								
FOREX	-0.8921	0.1862	0.1723	0.5684	7.5141	0.6762	7.8444	0.6440
LOG(GDP)	-2.9528	0.0016	-0.0764	0.4696	9.2075	0.5125	9.1097	0.5217
LOG(PUBLIC DEBT)	-0.2004	0.4206	-0.0713	0.4716	12.4476	0.2562	8.1317	0.6160
LOG(RESERVES)	-4.8835	0.0000	-1.8028	0.0357	20.0312	0.0290	17.1171	0.0718
WUI	-8.8737	0.0000	-8.2204	0.0000	77.4554	0.0000	82.4803	0.0000
Tests in first logarithmic differences								
FOREX	-6.69671	0.0000	-8.22649	0.0000	76.3572	0.0000	76.5701	0.0000
LOG(GDP)	-6.93057	0.0000	-7.10504	0.0000	65.2203	0.0000	65.3659	0.0000
LOG(PUBLIC DEBT)	-4.00694	0.0000	-5.29279	0.0000	46.1503	0.0000	44.062	0.0000
LOG(RESERVES)	-4.88345	0.0000	-1.80281	0.0357	20.0312	0.029	17.1171	0.0718
WUI	-0.5948	0.2760	-5.66293	0.0000	55.322	0.0000	111.564	0.0000
Tests in second logarithmic differences								
FOREX	-12.1197	0.000	-15.3431	0.000	148.575	0.000	160.346	0.000
LOG(GDP)	-6.67781	0.000	-12.6812	0.000	124.75	0.000	138.507	0.000
LOG(PUBLIC DEBT)	-11.796	0.000	-13.8672	0.000	134.015	0.000	153.275	0.000

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e-ISSN: 2962-9179
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LOG(RESERVES)	5.84314	1.000	-10.5584	0.000	104.421	0.000	140.12	0.000
WUI	-4.54577	0.000	-14.7524	0.000	134.383	0.000	92.1034	0.000

*** Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality.*

An autoregressive distributed lag (ARDL) model requires the basic assumption of stationarity to be met. To start the analysis, three panel unit root tests were performed to determine the order of integration of the variables of interest: Levin, Lin, and Chu (LLC); and Im, Pesaran, and Shin (IPS); and Fisher Chi-square tests. These tests assume cross-sectional dependence across units. Schwarz's Information Criterion is employed to choose the suitable lag length. Table 2 reports the panel unit root test results. As demonstrated, the results conclusively reject the null hypothesis of non-stationarity, as all variables are revealed to be stationary at second difference. After having determined the panel unit root, panel cointegration tests were conducted to identify if a long run relationship among the variables exists.

Table 3: Pedroni Residual Cointegration Test Results

Variables	Test Statistics	Panel (Within-Dimension)	
		Statistic	Prob.
LOG(GDP), FOREX, LOG(RESERVES), LOG(PUBLIC_DEBT), WUI	*V*	2.586927	0.0048
	rho	-0.485192	0.3138
	t	-1.344811	0.0893
	adf	-1.492439	0.0678

Panel cointegration test has no deterministic trend
V: the variance ratio, *t*: Pedroni test, *adf*: augmented dickey fuller
The optimum lag lengths are determined by Schwarz Information Criterion (SIC).

Pedroni cointegration tests were conducted to determine if a long-run relationship exists among the variables. Table 3 shows that the majority of the test statistics are statistically significant at a 10% significance level. It indicates that the variables are cointegrated in the long-run and have a long-run relationship. Therefore, the null hypothesis of no cointegration is rejected. According to this result, the ARDL method can be employed. The result corresponds with the study of Lee and Queh (2021) and Shastri et al. (2018), who also utilized Pedroni cointegration tests and found a long-term relationship among their respective variables.

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4.2 Panel ARDL Results

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
Long-Run Equation				
D(FOREX)	0.007839	0.020033	0.391291	0.6967
LOG(RESERVES)	0.991770	0.033979	29.18733	0.0000
DLOG(PUBLIC DEBT)	-3.738471	0.605176	-6.177492	0.0000
WUI	-0.140273	0.132507	-1.058610	0.2931
Short-Run Equation				
COINTEQ01	-0.098881	0.041881	-2.360993	0.0208
D(FOREX,2)	-0.080534	0.040657	-1.980787	0.0512
D(FOREX(-1),2)	-0.040569	0.038240	-1.060917	0.2921
D(FOREX(-2),2)	-0.013978	0.046746	-0.299033	0.7657
D(FOREX(-3),2)	-0.007844	0.008438	-0.929554	0.3555
DLOG(RESERVES)	0.044247	0.024382	1.814743	0.0735
DLOG(RESERVES(-1))	0.152733	0.097491	1.566636	0.1214
DLOG(RESERVES(-2))	0.105990	0.031783	3.334842	0.0013
DLOG(RESERVES(-3))	0.021219	0.089206	0.237862	0.8126
DLOG(PUBLIC_DEBT,2)	-0.082249	0.114811	-0.716383	0.476
DLOG(PUBLIC_DEBT(-1),2)	-0.034272	0.129025	-0.265620	0.7913
DLOG(PUBLIC_DEBT(-2),2)	-0.008233	0.077943	-0.105634	0.9162
DLOG(PUBLIC_DEBT(-3),2)	-0.043586	0.039528	-1.102675	0.2736
D(WUI)	-0.001329	0.018434	-0.072076	0.9427
D(WUI(-1))	-0.013405	0.033822	-0.396340	0.6930
D(WUI(-2))	-0.017542	0.034676	-0.505885	0.6144
D(WUI(-3))	-0.020282	0.019209	-1.055851	0.2944
Constant	0.137611	0.042889	3.208541	0.0020

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Root MSE	0.022224	Mean dependent var	0.068807
S.D. dependent var	0.126104	S.E. of regression	0.033239
Akaike info criterion	-3.018863	Sum squared resid	0.083965
Schwarz criterion	-1.284951	Log likelihood	350.6034
Hannan-Quinn criter.	-2.315262		

The result of ARDL using the Akaike info criterion as the selection method is presented in Table 4. It showed that log reserves and log public debt are significant to log GDP at a 10% significance level in the long run. Although log public debt has a negative coefficient in the short run, it is not significant. On the other hand, the exchange rate is insignificant to log GDP in both the short and long run.

The result also demonstrated that the series of log reserves have a positive effect on log GDP, while log public debt has a negative effect on log GDP in the long run. The coefficient for log public debt is -3.738471, which implies that an increase in public debt of 1% is associated with a decrease in the economic growth of 3.74% in the long run. This negative public debt and economic growth nexus in the long run is consistent with many of the past literature, such as that of Chudik et al. (2017), Attard (2019), Asteriou et al. (2020), Gunarsa et al. (2020), Hameed and Quddus (2020), and Lee and Kueh (2021).

Asteriou et al. (2020) found a negative long-run relationship between public debt and economic growth; however, it is only significant in one technique of ARDL, the PMG method. In the model of Gunarsa et al. (2020), they also obtained a negative and highly significant effect of public debt on economic growth. They studied 25 developing Asian countries and predicted that a 10% increase in debt could possibly decrease economic growth by around 0.4%. In the study of Lee & Kueh (2021), upon reaching the public debt threshold level of selected ASEAN countries, 1% increase in public debt will decrease economic growth by 0.689%.

Meanwhile, Attard (2019) established a negative relationship between public debt and economic growth in both short run and long run in European countries, which is evident across all debt levels. This suggests that public debt and economic growth nexus is not influenced by the initial level of debt-to-GDP ratio. His study also showed that significant economic events, such as the European sovereign debt crisis, did not affect the relationship between public debt and economic growth. Similar to this paper, the period of study includes three major economic crises and they did not alter the negative relationship between public debt and economic growth in the long run.

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Furthermore, economic uncertainties are exhibited to have no significant effect on economic growth even in the short run.

The negative long-run relationship between public debt and economic growth reduces efficiency of public spending (Mika & Zumer, 2017). For instance, according to Lee and Kueh (2021), the interest payment of public debt will divert the funds from other sectors, such as education which is important for long-term economic growth. This analysis is the same as Hameed and Quddus (2020), which highlighted that high public debt reduces the circular flow of income due to higher payment of debt obligations.

Apart from that, the results also showed that an increase in foreign exchange reserves by 1% will increase economic growth by 0.99% in the long run. Foreign exchange reserves are essential in free market economies such as the ASEAN 5, as it increases investments by increasing investors' confidence. It also plays a vital role in exchange rate stability. According to Polterovich and Popov (2003), foreign exchange reserve accumulation attracts foreign direct investment, leading to lower exchange rates. In this case, domestic assets become more affordable for foreign investors.

Table 5 Wald Test

Test Statistic	Value	df	Probability
t-statistic	0.391291	76	0.6967
F-statistic	0.153108	(1, 76)	0.6967
Chi-square	0.153108	1	0.6956
Null Hypothesis: C(1)=0			
Null Hypothesis Summary:			
Normalized Restriction (= 0)	Value	Std. Err.	
C(1)	0.007839	0.020033	
Restrictions are linear in coefficients.			

After running the ARDL model, Wald Test was used to test if the coefficients are simultaneously equal to zero. Table 5 shows that the probability of the test statistics of the Wald test is greater than 10% significance level, which means that the null hypothesis of C(1)=0 cannot be rejected. Hence, the variables are independent of each other.

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5. Conclusion

5.1 Summary

The study probed into the short run and long run effects of public debt on economic growth in the selected 5 ASEAN economies (Indonesia, Malaysia, Philippines, Singapore, and Thailand), taking into account economic uncertainties which are present during the period of study. For the analysis, this paper utilized a panel dataset that spanned between 1986 to 2020 and consisted of gross domestic product (GDP), central government debt as a percentage of GDP (PUBLIC_DEBT), total reserves minus gold (RESERVES), official exchange rate (FOREX), and world uncertainty index (WUI).

The empirical investigation started by performing a unit root test to ascertain the stationarity of our variables and thus, preventing a spurious regression. The results of LLC, IPS, and Fisher tests established that all the variables are stationary at the second difference. Subsequently, the Pedroni cointegration test revealed a long-run relationship among the variables. Meanwhile, the results of the Panel Autoregressive Distributed Lag (ARDL) approach by Pesaran and Shin (1999) indicated a significant negative relationship between public debt and economic growth in the long run while an insignificant relationship in the short run. Specifically, a 1% increase in public debt is followed by a 3.74% decrease in economic growth in the long run.

Foreign exchange reserves have a long-run positive and significant relationship with GDP. Particularly, a 1% increase in foreign exchange reserves is accompanied by a 0.99% increase in economic growth. On the other hand, exchange rates have an insignificant relationship with GDP both in the short and long run. Moreover, our empirical findings pointed out that, in the short run and in the long run, economic uncertainties do not have any significant effect on economic growth. Concurrently, the wald test reported that the variables are independent of each other. For future studies, it is suggested to compare the effect of public debt on growth among the ASEAN-5 depending on their macroeconomic condition and to identify whether a particular debt threshold exists in these economies.

5.2 Policy Implications

The findings of this study have several policy implications on public debt management in ASEAN countries. Although debt financing plays a vital role in the development of emerging economies, the government needs to put effort into maintaining its borrowings to a certain level at which debt servicing won't risk greater fiscal uncertainty. Debt dependence for funding government expenditures should be discouraged for the benefit of the economy; however, more than debt reduction is

needed to address the problem. In order to mitigate the drastic long-run impact of public debt, it is important to adapt debt management and fiscal policy frameworks that will help ensure debt sustainability.

Government spending, particularly of the ASEAN-5, can be shifted toward the sectors that are foundations for long-term economic growth, such as health and education. Cutting down government expenditures that should be least prioritized can reduce budget deficits and lowers the chance of incurring unnecessary debts. Therefore, it is necessary for the government to determine its investment priorities and make clear of the objectives of public debt acquirement.

Public debt should be allocated to productive sectors and long-term investment projects such as increasing the quality of health and education, building highways and bridges from agricultural regions, and improving telecommunications services. These investments justify public debt as they contribute to economic productivity and help generate income, preventing insolvency or further debt burden. Ensuring sufficient funds to pay debt obligations is crucial to prevent the abrupt implementation of distortionary taxes, which may further lead to inflation.

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