Nonlinear threshold approach for asymmetric effects of government size on economic growth in an emerging Asian economy: the Malaysian experience

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ABSTRACT

This paper discovers the asymmetric relation between government size and economic growth in Malaysia, an emerging Asian economy, by utilising a dynamic threshold nonlinear approach. The study finds empiric evidence that the threshold effect linking government size to economic growth in Malaysia exists when two different proxies of government size are set as the threshold variable. On closer inspection, it is found that an inverted U-shaped Arrey curve is present when allowing for endogenous government size threshold proxied by government operating/real GDP. However, a U-shaped curve of nonlinear relationship exists instead when the government investment/real GDP serves as the threshold variable. In general, this paper gives policymakers a real insight into the optimal government size in Malaysia especially when designing an effectual fiscal policy to advance sustainable economic growth to materialise its Shared Prosperity Vision by the year 2030.

1. Introduction

The view of the importance of government size to economic growth is undeniable. Many nations, especially developing countries, tend to expand their government size to stimulate economic growth. Malaysia, an emerging economy, is no exception where it has been struggling on for a high-income country status for many years. Even after the introduction of New Economic Plan and Vision (2020), Malaysia is still being stuck in the upper-middle income country status ever since 1996. As shown in Figure 1, after the year 2000, Malaysia had seen an increase in government expenditure. However, between 2004 and 2008 as well as from 2016 to 2019, the increasing pattern of government expenditure does not agree with the pattern of economic growth represented by GDP per capita growth.

According to Bank Negara Malaysia (BNM) (2019) data, Malaysian government has been spending over 95 per cent of its revenue on operating expenses for the past decade. In contrast, the development expenditure only takes 35 per cent share from the total revenue. In other words, the Malaysian government is very likely to only takes 35 per cent share from the total revenue. In other words, the Malaysian government is very likely to finance development expenses through debts (Yeap and Lee, 2018). A question that arises subsequent to this alarming situation is whether the fiscal budget has been in its efficient form. In addition, a study by Hla et al. (2016) found that Malaysian government expenditure is generally perceived as inefficient due to wastage and mismanagement of its resources. The authors added that the wastage and mismanagement of government resources are still a wall that impedes government efforts to develop sustainable fiscal policies and thus economic growth. According to Lahirushan and Gunasekara (2015), larger government size is likely to retard efficiency and economic growth due to high taxes, inefficient government operations and excessive burdens of regulatory process. As such, locating the optimal government size is worthy of Malaysian government's high regard to the most effective allocation of its expenditure in order to achieve its Shared Prosperity Vision 2030 to emerge as a developed economy with high income through inclusive and sustainable economic growth by the year 2030.

Generally, government expenditure in Malaysia can be categorised into two parts, that is, government operating expenditure and government development expenditure. The former is an unproductive expenditure that primarily aims to operate and maintain government operations such as emolument, pensions, debt service charges, subsidies, grants, transfers and other expenditure used to operate and manage the function of the government. Meanwhile, the latter, also otherwise known as government investment, aims to develop infrastructures and promote human capital development for instance expenditures on healthcare, education, social and community services, transports, public utilities, housing and other public infrastructure. Gupta et al. (2005) pointed out that the composition of government expenditures plays an important role in promoting economic growth, that is, when there is a large share of government expenditures accounted for emoluments, the economic growth would fall drastically. Conversely, it would in all likelihood

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contribute positively to the economic growth when government spends more on capital and non-wage goods and services. According to Sohrab and Albert (2012), a larger portion of the fiscal budget in Malaysia is normally allotted to the less productive operating expenditure compared to the development expenditure which is known to have larger multiplier effect even during bad economic times. To the best of our knowledge, the nonlinear and asymmetric impact of government size in Malaysia is not well studied for the fiscal policymakers to design an efficient fiscal budget utilisation that would improve the economic growth and thus economic well-being for all Malaysians.

Many researchers and economists have explored the association between government size and economic growth and obtained mixed results. For instance, some researchers found government size to have a positive effect on economic growth (Ghali, 1998; Ram, 1986; de Mendoza and Cecicedo, 2015; Jain et al., 2021), while others found that a bigger government harms economic growth (Dar and AmirKhalkhal, 2002; Stefan and Henrekson, 2001; Iyidogan and Turan, 2017; Aydin and Esen, 2019; Nirola and Sahu, 2019). Although the government plays a vital role in developing an economy by providing public goods and services and protecting property rights, it tends to overexpand its operating expenditure leading to increased taxation and crowding out effect in the economy. As a result, Barro (1990) suggested that the relationship between government size and economic growth is nonlinear rather than linear. Armey (1995) illustrates such nonlinear relationship between government size and economic growth as an “inverted-U” shaped curve, also known as the Armey curve. Most of the existing research studies that test the existence of Armey curve use panel data analysis (Kustepeli, 2005; Vaziri et al., 2011; Facchini and Melki, 2013; Hok et al., 2014; Asimakopoulos and Karavias, 2016; Ali and Khan, 2017; Kim et al., 2018; Murshed et al., 2018; Nouira and Kouni, 2021). Little evidence was found in the studies using time series dynamic threshold approach by Hansen (2000). In contrast to time series approach, the only weakness of panel data analysis is that researchers are unable to provide specific policy recommendations, but a general one for a group of sample countries.

This study, which employed disaggregated data level, therefore investigates the nonlinear and asymmetric relationship between government size and economic growth in an emerging economy, Malaysia. Moreover, it also aims to investigate the optimal threshold level of government size (proxied by government operating and development expenditures) on economic growth, which serves as a guide for policymakers to design a growth maximising government expenditure in Malaysia. Prior to this, there were some previous studies utilising aggregate data conducted on government size and economic growth in Malaysia using Data Envelopment Method (DEA) and ARDL method respectively by Rahmayanti and Theara (2010) and Ahmad and Othman (2014). In both studies, the researchers used a quadratic government size variable that had failed to capture the full effect of government size on economic growth as claimed by some other researchers.

Overall, the contributions and novelties of this paper to the government size literature especially from the perspective of Malaysia, one of the emerging Asian economies, are threefold. Firstly, this study differs from the previous studies in the sense that we use the dynamic threshold model of Hansen (1999, 2000) to investigate the nonlinear relationship between government expenditures and economic growth in Malaysian context. Secondly, for robustness check, this study endeavours to determine the optimal level of government expenditures threshold on economic growth by using different types of government expenditures (productive versus unproductive public spending) to estimate the threshold government size as well as its externalities toward economic growth in Malaysia. Lastly, the study intends to examine if the Armey curve by types of government expenditures occurs in Malaysia. Most of the existing research studies that investigate the validity of the Armey curve hypothesis are carried out in developed economies using panel data analysis and this study is therefore a contribution to this neglected area especially in an emerging Asian country context. The remainder of this paper is structured as follows. Section 2 reviews the relevant literature while Section 3 explains the data and methodology involved. Section 4 illustrates and discusses the empirical results and policy implication, followed by the conclusion in Section 5.

2. Literature review

2.1. The Armey curve

Many researchers have discussed theory concerning the association of linearity between government size and economic growth and found conflicting results. Using endogenous growth theory, Barro (1990) explained the role of government expenditure toward economic growth. In his analysis, public and private services are entirely different sectors incorporated into the growth model. Therefore, there is a direct effect of fiscal policy on economic growth (Tsoukis and Miller, 2003; Lupu and Asandului, 2017; Liao et al., 2019). Barro (1990), Fournier (2016) and Aydin and Esen (2019) also pointed out that there is variation in the government expenditure toward growth rate. Productive government expenditure directly impacts the private sector through property rights protection and infrastructures services such as transportation, schools, hospitals, and so on while the unproductive government expenditure has a limited effect on the private sector. To sustain the unproductive government expenditure, in the long run, it requires a higher tax rate which will reduce the incentives especially from the private sector to invest and subsequently lowering the economic growth.

The additional analyses from Armey (1995), Scully (2000), Aydin and Esen (2019), Nouira and Kouni (2021), and Jain et al. (2021) suggested

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1. This is due to the exclusion of the government variables in the exogenous growth model (Bergh and Henrekson, 2011).

Figure 1. GDP per capita Growth and Total Government Expenditure Growth, 1995–2019. Source: International Monetary Fund and Bank Negara Malaysia Monthly Statistical Bulletin.
that after a certain point, expansion of government size could lead to lower economic growth and the relationship between government size and economic growth is nonlinear rather than linear. With nonlinearity in mind, the notion of optimal government size is realisable. Armey (1995) and Altuc and Aydin (2013) illustrate the relationship between government size and economic growth as an “inverted-U” shaped curve. The curve, also known as the Armey curve, measures the growth (represented by real GDP growth rate) on the vertical axis and government size on the horizontal axis, as shown in Figure 2.

In an economy where there is no government or collective action, there is no public security, contract enforcement, and private agents are responsible for the operations of public goods and services. Inefficiency in providing public goods and services by private agents limits growth due to low incentive for savings and investment (Vedder and Gallaway, 1998). With the existence of government, it is possible for an economy to achieve higher economic growth. In a relatively small government size (i.e., below the optimal point of government size at G*), the government expenditure inclines to focus on the essential needs and replace the inefficiency, and thus interfering with the wealth creation in the economy (Chobanov and Mladenova, 2009; Lupu and Asandului, 2017; Jain et al., 2021). In addition, according to Mitchell (2005) and Nouira and Kouni (2021), government expenditure, whether to be financed by taxes or borrowing, creates a displacement cost in the productive sector. As a result, government expenditure would undermine economic growth by displacing the private sector when the government size is rather big (i.e., above the optimal threshold level of government size of G*).

In short, Facchini and Melki (2011) and Aydin and Esen (2019) argued that “inverted-U” relation between government size and growth rate derives from the two effects of government size as follows: the first is the positive effect of government expenditure that arises from rectifying market deficiency, whereas the negative effect emanates from the cost of intrinsic to market deficiency. These two effects imply that while the benefit of correcting the market deficiency decreases, most of the cost of state failure increases as the government size expands beyond the optimal point of G*.

2.2. Empirical literature on government size, labour force, capital and economic growth

The conventional Keynesian model evinces that the expanding government size is able to thwart a recession. The body of empirical studies about the association between government size and economic growth is considerable yet debatable. Ram (1986) studied 115 countries which consisted of developed and developing countries using panel estimation from 1960 to 1980 and found a consistent positive relationship between government size and economic growth.

Devarajan et al. (1996) studied 43 developing countries using the composition of government expenditure share to GDP. The study concluded that the current share of government expenditure positively affects growth rate while there is a negative relationship between government investment and economic growth. Furthermore, the research showed that developing countries tend to misallocate resources, rendering productive expenditure unproductive.

Ghose and Das (2013), using the methods of panel cointegrations and Dynamic Ordinary Least Square (DOLS), studied the government size and economic growth in 19 emerging markets and suggested that government size affects economic growth positively. On the other hand, Landau (1983) studied 104 countries from 1961 to 1970 and concluded that government operating size impacts economic growth adversely. The negative impact was found in the full sample. By grouping the nations via the income level, the researcher uncovered that the top 25 per cent and middle 50 per cent of national income are affected by the adverse effect of government operating size toward growth rate while the bottom half do not have such effect.

In a study by Fölster and Henriksson (2001), the authors showed that taxation and government expenditure size negatively impact economic growth significantly across 23 OECD countries. Bergh and Henriksson (2016) examining on the relationship between economic growth and government size in the OECD countries suggested the following findings: firstly, rich countries typically have significant public spending; thus, the relationship is less positive or even negative. Secondly, a small government does not expand beyond its role in poorer countries and thus a positive relation that links government size to economic growth. In a more recent study, Ayad et al. (2020) examined the causality between government expenditure and economic growth in Algeria from 1980 to 2017 using various econometric procedures. Their findings of co-integration revealed the existence of long run relationship between the variables and there was a unidirectional causal association running from economic growth to government expenditure based on the causality test.

According to Rodrik (1996), Nguyen and Trinh (2018), and Nyasha and Odhiambo (2019), the relationship of investment size and labour force growth on economic growth is based on the principle of crowding-out effect. As the government expenditure is financed by tax revenue, any additional government expenditure can be financed through higher taxation or borrowing. An increase in taxation will distort private operating and lead to lower wealth creation due to the reduction in demand. Alternatively, government financing through borrowing will lead to an increase in the interest rates and thus the cost of borrowing. As a result, the private investment will be crowded out. Furthermore, according to Stepanyan and Leigh (2015), public sector employment can reduce the labour availability and employment in the private sector by offering higher wages and attractive benefits in the public sector. Besides, the incentive bias created by the public sector can also cause a skill mismatch in the labour market for private sector. Due to the crowding-out effect, wages and participation in the private sector are affected negatively. As such, this will certainly discourage the creation of businesses and jobs in the private sector and hence a negative effect on the growth rate.

2.3. Empirical studies on optimal government size

Vedder and Gallaways (1998) suggested that the growth of government size tends to contribute positively to emerging economies but negatively in many modern western economies. They pointed out that the inconsistent empirical results of the association between economic growth and government size come from the asymmetric effect of government expenditures on the growth rate. By using a multi-regression
method on five different classifications of government size and its square (i.e., total government expenditure/GDP, health expenditure/GDP, income security/GDP, net interest payment/GDP, and government investment/GDP), the authors revealed that the Armey curve exists only for government investment/GDP and total government expenditure/GDP with their respective optimal point of 7.33 per cent and 17.4 per cent from 1947 to 1997. Pevcin (2004) analysed the total government expenditure/GDP for 12 European countries separately from 1955 to 1996 using Autoregressive Integrated Moving Average (ARIMA) model and suggested the optimal point of government size proxied by the total government expenditure for these countries to be around 36.56 per cent to 42.12 per cent. Mutascu and Milos (2009) carried out a study on 15 old European Union (E.U) members and 12 new E.U members from 1999 to 2008 using Pooled EGLS and discovered a significant nonlinear correlation between growth and government size (proxied by total government expenditure/GDP) with an optimal size of 30.42 per cent for old E.U members and 27.46 per cent for new E.U members. A study by Altunc and Aydan (2013) on Bulgaria, Romania, and Turkey using the ARDL model from 1995 to 2011 proposed the optimal government size (which uses total government expenditure/GDP as a proxy) for these countries to be at 22.45 per cent, 20.44 per cent, and 25.21 per cent, respectively.

Chen and Lee (2005) performed a study to examine the optimal government size in Taiwan employing the Threshold Autoregressive (TAR) method. The authors found that the Armey curve is present in Taiwan with the use of government investment expenditure, total government expenditure and government consumption as proxies for the government size. Using the data between 1979 Q1 and 2003 Q3, they found the respective optimal point of government size proxied by government investment expenditure, total government expenditure and government consumption expenditure in Taiwan to be 14.96 per cent, 22.83 per cent and 7.20 per cent. In a more recent study, El Husseiny (2019) included quadratic government size variables in the model to examine the optimal government size in Egypt employing data from 1981/1982 to 2014/2015 fiscal year. The researcher noticed that Egypt's optimal government expenditure ranged from 30.50 per cent to 31.20 per cent of its total GDP. Besides, Nouira and Kouni (2021) conducted a study to investigate the optimal government size and its effect on economic growth in selected MENA and developing countries over the period of 1988–2016 using the threshold dynamic heterogeneous panel data model with cross-sectionally dependent errors. The results revealed that the threshold effects were significantly greater for MENA countries than for other groups where the threshold was between 10 per cent and 30 per cent for the whole sample, between 20 per cent and 30 per cent for the MENA countries and between 10 per cent and 20 per cent for developing countries.

In conclusion, previous literature review shows the existence of nonlinear association between economic growth and government size theoretically and empirically. Such nonlinear association between growth rate and government size hence suggests an optimal point where economic growth maximising government size exists as exhibited in the Armey curve.

3. Econometric methodology and the data

3.1. Empirical model

The study examines the nonlinear and asymmetric relationship between government size and economic growth in Malaysia. To perform this examination, the production functions of the Ram (1986) model is applied which is parallel to the theoretical and empirical framework developed in the work of Chen and Lee (2005). The production functions are classified into the non-government sector (C) and the government sector (G) in Eq. (3c). Each sector's output depends on the input of capital (K) and labour (L). Besides, Ram (1986) assumes that the government sector has effects of marginal “externality” on the other sector. Thus, the function of both sectors is designed as follows:

\[ C = C(K_C, K_G, G) \]  
\[ G = G(K_C, K_G) \]  

Given the functions of both sectors, the function of total inputs is as follows:

\[ L_C + L_G = L \]  
\[ K_C + K_G = K \]  
\[ Y = C + G \]  

Understanding the difference in the marginal productivity of each sector's factor of production is vital as it shows the effect of externalities of the government sector. By differentiating the factor of production of each sector, the externalities can be derived as shown in Eq. (4).

\[ \frac{G_L}{C_L} - \frac{G_K}{C_K} = (1 + \delta) \]  

In equation (4), \( G_{L,C} \) is derived from differentiating G with respect to L (\( dG/dL \)), which represents the marginal productivity of labour input in the government sector. \( C_L \) is derived from differentiating C with respect to K (\( dC/dK \)) of the private sector to get the capital input's marginal productivity in the private sector. \( C_K \) is derived from differentiating C and K (\( dC/dK \)), which indicates the marginal productivity of capital in the private sector. \( \delta \) shows whether the sector has a higher marginal factor of productivity. A positive value of \( \delta \) suggests that the government sector has higher input productivity, while a negative value of \( \delta \) illustrates that non-government sector input is more productive than government input.

By totally differentiating equation (1) and equation (2) and then substituting the result into Eqs. (3a) and (3b), which are also totally differentiated, we can derive that:

\[ dY = C_L dL + C_K dK + C_G dG + \frac{\delta}{1 + \delta} dG \]  

Next, by dividing Eq. (5) with Y, we can find the equation for growth rate approximation, and setting \( \alpha = C_L \) and \( \beta = C_L/L \) where \( \alpha \) is the marginal output of capital in the non-government sector while \( \beta \) is the elasticity of the non-government sector's production which is represented by C with respect to L (Ram, 1986).

\[ \frac{dY}{Y} = \alpha \left( \frac{L}{Y} \right) + \beta L + \left( \frac{\delta}{1 + \delta} + C_G \right) \frac{dG}{G} \frac{G}{Y} \]  

In Eq. (6), \( C_G \) is an indicator that shows the effect of marginal externalities of the non-government sector's output in respect of the government sector. The following empirical regression can be built based on Eq. (6),

\[ \hat{Y}_t = \alpha_0 + \alpha_1 \left( \frac{L}{Y} \right) + \alpha_2 L_t + \alpha_3 G_t \left( \frac{G}{Y} \right) + \epsilon_t \]  

Eq. (7) shows the effects of investment rate (L/Y), labour growth (L), and the multiplication of government expenditure growth (G) by government size (G/Y) towards economic growth (Y). \( \alpha_2 \) indicates the government sector’s reciprocal effect which has two common effects, direct and indirect (i.e., externality effect), on the private sector. Empirical analysis from previous literature shows a nonlinear characteristic of the relation between economic growth and government size (Ahmad and Othman, 2014; Vedder and Gallaway, 1998). Thus, some modification is needed to change the estimation into a threshold
regression that allows the asymmetric relationship to be observed. As such, the two-regimes Threshold Autoregressive (TAR) method proposed by Hansen (1999, 2000) is employed to the adapted two-sector production model of Ram (1986) in this study. The threshold autoregressive model (TAR) is popular in the nonlinear time series literature, which uses both asymptotic and bootstrap-based tests to allow for the joint consideration of non-linearity (thresholds) and non-stationary (unit roots) (Caner and Hansen, 2001). One of the advantages of the TAR method is that it improves the subjective setting of Vedder and Gallaway (1998) squared-term regression model by enabling the objectivity of the estimation of threshold value. The modification based on the two-regimes model of TAR can be shown as follows:

\[ y_t = \theta_1 y_{t-1} + \theta_2 x_t + \epsilon_t \quad \text{if} \quad q_t \leq \gamma \]

(8)

\[ y_t = \theta_1 y_{t-1} + \theta_2 x_t + \epsilon_t \quad \text{if} \quad q_t > \gamma \]

(9)

The equation is divided into two regimes by using the term \( q_t \) as the threshold variable. \( y_t \) is the dependent variable, \( x_t \) is the explanatory variable with \( \theta_1 \) as the coefficient, and error term is captured by \( \epsilon_t \). The equation reacts according to the value of the threshold. Eq. (9) appears if the threshold variable is less than or equal to the threshold value, while Eq. (10) comes into existence when the threshold variable exceeds the threshold value. To integrate the two-regimes equation into the growth equation, it is assumed the two regimes as a dummy variable. Thus, the dummy variable can be written as \( I(\gamma) = (q_t \leq \gamma) \) with \( \gamma \) an indicator of the function.

By letting \( x_t(\gamma) = x_tI(\gamma) \), equation (8) and equation (9) can be rewritten as the following:

\[ y_t = \theta_1 y_{t-1} + \theta_2 x_t(\gamma) + \epsilon_t \quad \text{and} \quad \epsilon_t \sim iid \left(0, \sigma^2_\epsilon\right) \]

(10)

In Eq. (11), \( \theta = \theta_1, \theta_2, \rho = \rho_1 - \rho_2 \) and the error term \( \epsilon_t = [\epsilon_t(\gamma_1), \epsilon_t(\gamma)] \), where \( \theta, \rho, \) and \( \gamma \) are the parameters to be estimated. The prediction of the estimator leads to the sum of squared residual as below:

\[ S_1(\gamma) = \hat{\epsilon}_t(\gamma) \hat{\epsilon}_t(\gamma) \]

By calculating the sum of squared residual, the optimal threshold value can be written as:

\[ \hat{\gamma} = \text{argmin}_{\gamma} S_1(\gamma) \]

(12)

The following Eq. (13) is the variance of residual:

\[ \hat{\sigma}^2 = \frac{1}{T} \hat{\epsilon}_t^2 = \frac{1}{T} S_1(\hat{\gamma}) \]

(13)

Once the optimal threshold value is obtained using Eq. (12), the vectors of the slope for the estimated coefficients are \( \hat{\theta} = \hat{\theta}(\hat{\gamma}) \) and \( \hat{\rho} = \hat{\rho}(\hat{\gamma}) \). By including the two-regimes TAR model in Eq. (7), the model can be rewritten as:

\[ Y_t = \left( a_{10} + a_{11} \left( \frac{L}{\gamma} \right) + a_{12} \hat{G}_1 \left( \frac{G}{\gamma} \right) \right) I(q_t \leq \gamma) + \left( a_{20} + a_{21} \left( \frac{L}{\gamma} \right) + a_{22} \hat{G}_1 \left( \frac{G}{\gamma} \right) \right) I(q_t > \gamma) + \hat{\epsilon}_t \]

(14)

The threshold value for \( \gamma \) can be found by estimating Eq. (14). One of the features of this model is that the exogenous variables out of the theoretical model can be set as the threshold variable. In this study, the threshold variable is set by the government size.

3.1.1. Testing for threshold regimes

To investigate the nonlinear effect of government size toward economic growth in Malaysia, a linearity test is required. To test the linearity of the model, Hansen (1999) heteroskedasticity-consistent Lagrange Multiplier is used. Hansen (1999) uses the bootstrap sampling procedure to produce asymptotically correct p-values in order to test the null hypothesis of \( H_0: \delta_{i1} = \delta_{i2} i = 0,1,2,3, \ldots \) where the non-rejection of the null hypothesis suggests that there is no threshold effect or a linear model is present. Conversely, if the null hypothesis is rejected, it would mean that there is a threshold effect or the model is nonlinear. The existence of the threshold effect indicates that the two regimes of \( \delta_{i1} \) and \( \delta_{i2} \) show different effects. Let \( S_0 \) and \( S_1 \) be the residual of the sum of squares under the null and alternative hypotheses, the F-test is computed as follows:

\[ F_1 = \frac{S_0 - S_1(\hat{\gamma})}{\hat{\sigma}^2_1} \]

(15)

As indicated by Hansen (1999, 2000), whilst the threshold effect is present, the actual threshold for \( \gamma_0 \) is consistent with the estimator \( \hat{\gamma} \) in Eq. (15). Due to the presence of nuisance parameters in the model, an asymptotic distribution is appropriate for the non-normal distribution. Hence, to achieve the asymptotic distribution of the statistics, the maximum likelihood estimator is utilised to examine the threshold value of \( \gamma \). With the null hypothesis of \( H_0: \gamma = \gamma_0 \), the likelihood ratio statistics can be obtained as follows:

\[ LR_1(\gamma) = \frac{S_1(\gamma_0) - S_1(\hat{\gamma})}{\hat{\sigma}^2_1} \]

(16)

where \( S_1(\gamma_0) \) and \( S_1(\hat{\gamma}) \) in Eq. (16) can be obtained from Eq. (11). The estimated threshold values’ valid asymptotic confidence intervals can be formed using the asymptotic distribution of \( LR_1(\gamma_0) \). Due to the non-normal distribution of the statistics of \( LR_1(\gamma_0) \), Hansen (2000) computed the non-rejection region, \( c(\alpha) \). The condition of non-rejection of the null hypothesis of \( H_0: \gamma = \gamma_0 \) exists if \( LR_1(\gamma_0) \leq c(\alpha) \) where \( c(\alpha) \) is calculated as follows:

\[ c(\alpha) = -2 \ln \left(1 - \sqrt{1 - a}\right) \]

(17)

The rejection of the null hypothesis in Eq. (17) using the bootstrap test \( F_1 \) test shows that there is at least one threshold regime present in the model and therefore \( \hat{\gamma}_1 \) is assumed to have been estimated. In order to test whether the second threshold value of \( \gamma_2 \) exists in the model, there is a need to test the following condition:

\[ S_2(\gamma_2) = S(\hat{\gamma}_1, \gamma_2) \quad \text{if} \quad \hat{\gamma}_1 \leq \gamma_2 \]

(18)

\[ S(\hat{\gamma}_1, \hat{\gamma}_2) \quad \text{if} \quad \hat{\gamma}_2 < \hat{\gamma}_1 \]

The threshold estimator is calculated in Eq. (19) as below:

\[ \hat{\gamma}_2 = \text{argmin}_{\gamma} S_2(\gamma) \]

(19)

In Eq. (18) the null hypothesis of \( H_0 \) of only one threshold value is present versus \( H_1 \) of two threshold values are present is then tested using the following likelihood ratio statistics:

\[ F_2 = \frac{S_1(\hat{\gamma}_1) - S_1(\hat{\gamma}_2)}{\hat{\sigma}^2_2} \]

(20)

If the test statistic \( F_2 \) in Eq. (20) exceeds the critical value, it shows a rejection of the null hypothesis with the implication of the existence of two threshold regimes. Such procedure is repeated to examine whether three threshold regimes are present until no further rejection of the null hypothesis in order to ensure the number of existing threshold regimes.

3.2. The data

This study used the data in Malaysia from the first quarter of 2005 to the fourth quarter of 2019. The choice of the sample period is generally confined by the availability of the data used in this study, which is considered the main limitation of the study. In addition, due to the outbreak of coronavirus disease (COVID-19) that was first reported on 31 December 2019, the sampling period of the study ends in the fourth
quarter of 2019 in order to avoid any possible undesirable effects arising from such pandemic. While we collected the data of real GDP from the Department of Statistics Malaysia (DOSM), private gross fixed capital formation and labour force data were obtained from the International Monetary Fund (IMF) database. Besides, government operating and government investment were obtained from Bank Negara Malaysia (BNM) statistics. To examine if the Armey curve is present in Malaysia, we utilise the proportion of government expenditure to real GDP as the threshold variable, where two different categories of government expenditure (i.e., government operating expenditure and government investment expenditure) are analysed for robustness of the results. The summary of data description is presented in Table 1.

4. Results and policy implication

4.1. Results

Table 2 demonstrates the descriptive statistics of all the variables involved in this study. As shown in Table 2, the mean of economic growth (represented by real GDP growth rate) in Malaysia over the sample period from 2005 Q1 to 2019 Q4 is 1.245 per cent with the minimum value of -7.758 per cent, which occurred in the first quarter of 2009 and maximum value of 5.890 per cent in the third quarter of the same year. \(\frac{G}{Y}\) indicates that, on average, the size of investment in Malaysia is 12.887 per cent, with a median of 12.352 per cent. The largest investment size is observed at 22.984 per cent in the second quarter of 2018 while the minimum of 4.964 per cent is found in the fourth quarter of 2005. The mean of labour force growth rate in Malaysia is 0.685 per cent, with the maximum of 2.184 per cent and the minimum of 0.161 per cent. The government size, proxied by government operating expenditure divided by real GDP (GS1) has a mean of 12.264 per cent and a median of 11.588 per cent. The maximum and minimum values for GS1 are 18.352 per cent in the fourth quarter of 2011 and 8.607 per cent in the first quarter of 2007, respectively. GS2, another government size which is proxied by the government investment/real GDP, has a mean of 4.586 per cent and a median of 3.593 per cent. The maximum value of GS2 is 11.475 per cent in the second quarter of 2007, while the minimum value of GS2 is 1.306 per cent in the third quarter of 2006.

Table 3 exhibits the variations in the government size over time. It is shown that GS1 expands from 11.612 per cent between 2005 and 2009 to 13.317 per cent between 2010 and 2014, and then gradually decline to 11.925 per cent between 2015 and 2019. Meanwhile, GS2 shows a dissimilar trend where it is declining all the way down from 5.511 per cent between 2005 and 2009 to 4.416 per cent between 2010 and 2014, and further declines to 3.410 per cent between 2015 and 2019.

To examine the nonlinear effects of government size on economic growth in Malaysia, we used government operating expenditure/real GDP and government investment expenditure/real GDP as a proxy for government size. We applied bootstrapping method with times setting at 5000, consistent with Hans (1999, 2000), to find the p-value. The results of threshold test in Table 4 displayed that both proxies, GS1 and GS2, have one threshold value at 1 per cent significance level where both the bootstrap p-values of GS1 and GS2 are 0, implying the presence of the threshold effect. However, the \(F_2\) statistic of two thresholds test for both GS1 and GS2 has failed to reject the null hypothesis of one threshold indicating that there is only one threshold that is present for both GS1 and GS2. In other words, there are two threshold regimes that exist of big government size and small government size. The regime with a higher value than the threshold level represents big government size, while the regime that has a smaller value than the threshold level indicates that the government size is small. From Table 4, the estimated threshold regime value for GS1 is 12.309 per cent and 4.210 per cent for GS2. After confirming the existence of threshold effects and thus threshold regimes for both proxies of government size, we go a step further to examine how the linear and nonlinear impacts of different proxies of government size affect the economic growth in discrete threshold regimes.

Table 5 exhibits the threshold regression result for the first proxy of government size (GS1), i.e., government operating expenditure/real GDP. The linear model result indicated that government operating expenditure positively impacts economic growth significantly at 1 per cent level where as the government operating expenditure increases by one per cent, the economic growth on average tends to increase by 0.560 per cent. Nevertheless, when the government size is small (i.e., the regime which is below 12.309 per cent) in the two-regime model, the mean of the economic growth inclines to increase significantly by 1.354 per cent for an additional one per cent increase in the government operating expenditure. On the other hand, when the government size (GS1) is greater than the threshold level of 12.309 per cent, the contribution of government operating expenditure appears to be negative, though insignificantly, toward economic growth. For each increase of 1 per cent of government operating expenditure, economic growth on average falls by 0.094 per cent. Thus, the result for threshold regression

| Table 1. Variable definitions and source. |
|------------------------------------------|
| **Variable Name** | **Definition** | **Source** |
| \(Y\) | Real GDP growth | DOSM |
| \(\frac{I}{Y}\) | The proportion of real private gross fixed capital formation to real GDP | IMF |
| \(L\) | The labour force growth rate | IMF |
| \(G (\frac{G}{Y})\) | The growth rate of real government expenditure multiplied by the proportion of real government expenditure to real GDP | BNM |
| \(G/Y\) | The proportion of real government expenditure to real GDP | BNM |

| Table 2. Descriptive statistics. |
|----------------------------------|
| **Variables** | **Mean (%)** | **Median (%)** | **Maximum (%)** | **Minimum (%)** | **Std Dev. (%)** |
| \(Y\) | 1.245 | 2.5633 | 5.890 | -7.758 | 3.136 |
| \(\frac{I}{Y}\) | 12.887 | 12.352 | 22.984 | 4.964 | 4.949 |
| \(L\) | 0.685 | 0.5133 | 2.184 | 0.161 | 0.486 |
| GS1 | 12.264 | 11.588 | 18.352 | 8.607 | 2.273 |
| GS2 | 4.586 | 3.593 | 11.475 | 1.306 | 2.383 |

| Table 3. The changes in government size. |
|-----------------------------------------|
| **Time** | **GS1 (%)** | **GS2 (%)** |
| 2005Q1 – 2009Q4 | 11.612 | 5.511 |
| 2010Q1 – 2014Q4 | 13.317 | 4.416 |
| 2015Q1 – 2019Q4 | 11.925 | 3.410 |

Data in this table shows the average changes of 5 years.

| Table 4. Threshold test. |
|--------------------------|
| **Threshold variable** | **Government operating/real GDP (GS1)** | **Government investment/real GDP (GS2)** |
| F1 value of one threshold test | 29.424*** (0) | 17.822*** (0) |
| F2 value of two threshold tests | 6.777 (0.487) | 7.167 (0.342) |
| Threshold regime | 12.309 | 4.210 |
| 95% confidence interval | [12.126,13.773] | [4.210,4.210] |

Value in the parenthesis denotes the bootstrap p-value. Value in the square parenthesis means the confidence interval for the estimated range of threshold values. *, **, *** denote significance level of 10%, 5%, and 1% respectively.
which denotes a model of nonlinearity can conclude the probable presence of the nonlinearity of Armey curve in Malaysia when GS1 is the threshold variable. In addition, there is a significant and positive impact of the investment ratio on the economic growth in both regimes. Meanwhile, the labour force growth also shows positive impacts on the economic growth in both regimes, but not significant.

Table 6 exhibits the threshold regression results when the government investment expenditure/real GDP (i.e., GS2) serves as the threshold variable. The linear model result showed a positive association between economic growth and government investment expenditure, but insignificantly. For every 1 per cent increase in government investment expenditure, the economic growth on average increases by 0.027 per cent. The result for government investment is opposite of the finding of Hasnul (2015) which suggested a negative relationship between government investment and economic growth. As for the nonlinear two-regime model, the threshold regression results demonstrated that the relationship between the government investment expenditure and economic growth is a U-Shaped curve instead of an inverted U-shaped curve. This implied that the nonlinear situation of the Armey curve did not exist between economic growth and government investment expenditure in Malaysia. Instead of maximum level, GS2 displayed an optimal minimum level of threshold value at 4.210 per cent. When the government size is small (i.e., the regime below 4.210 per cent), there is a significant negative relationship between government investment expenditure and economic growth at 1 per cent level. On the contrary, in the regime of big government size (i.e., the regime above 4.210 per cent), the government investment expenditure is significantly and positively related to the economic growth at 1 per cent level where for additional one per cent increase in the government investment expenditure, the economic growth on average increases by 0.158 per cent, ceteris paribus.

Moreover, the investment ratio showed a significant negative impact on the economic growth when the government size is small while a significant positive effect on the economic growth when the government size is big. The labour force growth displayed just the same trend as the investment ratio in both of the two regimes, but are insignificant. The reason for a significant negative relation between investment ratio and economic growth when the government size is small could possibly be due to the negative externality of the inefficient government investment expenditure that results in the restraining effect to private investment and hence the economic growth. On the other hand, a significant positive association between investment ratio and economic growth when the government size is big signifies that the positive externality of government investment expenditure expedites the encouraging effect to private investment and thus the economic growth (Lin, 1994).

Based on the empiric results above, it is concluded the presence of threshold effects between economic growth and government size in Malaysia when government operating expenditure/real GDP (GS1) and government investment expenditure/real GDP (GS2) serve as the threshold variables in the nonlinear model. However, only when the government size of GS1 is used as the threshold variable, the empirical evidence suggests the existence of a nonlinear association of the Armey curve in Malaysia.

4.2. Policy implication

According to the empiric results, it can be concluded that Malaysian government has still been observing Keynesian hypothesis which states that expanding government expenditure will accelerate economic growth. As shown in Figure 1, when Malaysia was facing with economic crisis in 1997/8 and the global financial crisis in 2007–2009, the government expenditure was used extensively as a proactive fiscal policy which is at large regarded as a counter-cyclical policy vehicle to alleviate short-term variations in both employment and output (Zagler and Durnecker, 2003; Shafuda, 2015).

Nonetheless, the empirical evidence of this paper’s analysis showed the existence of nonlinear relationship of the Armey curve in Malaysia when the threshold variable is set by the government operating expenditure/real GDP (i.e., GS1), where over-expansion of the government expenditure beyond the optimum government size of 12.309 per cent will likely lead to negative effects on the economic growth. The Malaysian government operating size in 2019 averaging around 11.46 per cent of total GDP, which is 0.84 per cent below the optimal size. The deviation is suggestive of the government operating size approaching very closely to the optimal level on a quarterly basis. Thus, it is advisable for the government not to further excessively use the government operating expenditure beyond the optimum level to harm the economic growth. Instead, the government should trim unnecessary expenditure on its civil servants’ emolument including pensions and strengthen the efficacy of government operating expenditure at its optimum with the aim of promoting sustainable economic growth in the future. For instance, with the country’s economy currently being plagued by the continuance of Covid-19 pandemic, it is suggested that the government of the day cut down its operating expenditure by scaling down the size of its cabinet consisting of so many ministerial posts in every ministry, which is criticised as among the largest in the world. In doing so, the resultant savings can be of great help to improve the overall economic welfare for the poor and needy in this difficult time and even to other more productive economic activities for future growth, such as human capital development.

Besides, the empirical results of the threshold regression also demonstrated that the relation between economic growth and the government investment size (i.e., GS2) in Malaysia is a U-Shaped curve instead of an inverted U-shaped Armey curve. The threshold nonlinear two-regime model showed that government investment expenditure significantly affects economic growth negatively when it is lower than

Table 5. Regression result for government size proxied by government operating expenditure/real GDP (GS1).

| Dependent variable: Real GDP growth rate | Linear model | Government size is small | Government size is big |
|----------------------------------------|--------------|-------------------------|-----------------------|
| Threshold Value                        | <4.2100      | >4.2100                 |                       |
| Constant                               | 1.081        | 6.740 (1.706)***        | -3.02 (1.874)         |
| (I/Y)                                  | 0.064        | -0.396 (0.120)***       | 0.205 (0.0822)***     |
| (I/Y)                                  | 0.126        | -0.184 (0.807)          | 0.188 (0.918)         |
| (I/Y)                                  | 0.027        | -1.089 (0.226)***       | 0.158 (0.055)***      |
| Joint R²                               | 0.3382       | 0.3907                  | 0.23826               |
| Heteroskedasticity test                | 0.973332     |                         |                       |
| Observation                            | 60           | 34                      | 26                    |

The bracket ( ) represents the standard error. *, **, *** denote significance level of 10%, 5%, and 1% respectively.

Table 6. Regression result for government size proxied by government investment expenditure/real GDP (GS2).

| Dependent variable: Real GDP growth rate | Linear model | Government size is small | Government size is big |
|----------------------------------------|--------------|-------------------------|-----------------------|
| Threshold Value                        | <4.2100      | >4.2100                 |                       |
| Constant                               | 1.081        | 6.740 (1.706)***        | -3.02 (1.874)         |
| (I/Y)                                  | 0.064        | -0.396 (0.120)***       | 0.205 (0.0822)***     |
| (I/Y)                                  | 0.126        | -0.184 (0.807)          | 0.188 (0.918)         |
| (I/Y)                                  | 0.027        | -1.089 (0.226)***       | 0.158 (0.055)***      |
| Joint R²                               | 0.3382       | 0.3907                  | 0.23826               |
| Heteroskedasticity test                | 0.973332     |                         |                       |
| Observation                            | 60           | 34                      | 26                    |

The bracket ( ) represents the standard error. *, **, *** denote significance level of 10%, 5%, and 1% respectively.
the optimal size at 4.210 per cent of GDP. As exhibited in Table 6, among 60 observations of government investment expenditure, there are more than 50 per cent of the observations below the threshold value of 4.210 per cent over the sample period between 2005 quarter 1 and 2019 quarter 4. This implies that more than 50 per cent of the government investment size has been under-expanding for the past 15 years.

In addition, as shown in Table 3, GS2 displays a further decline to 3.410 per cent between 2015 and 2019. In 2019, the mean of government investment size on a quarterly basis was 3.90 per cent of total GDP, which is lower than the optimal size of 4.210 per cent. This suggests that the Malaysian government does not achieve the full potential for its government investment expenditure and the government investment size in Malaysia in general operates below the optimal level. Barro (1990), Fournier (2016) and Adeoun et al. (2020) pointed out that productive government expenditure especially on investment directly impacts the private sector and thus a positive effect on economic growth, and vice versa. Moreover, Butkiewicz and Yanikkaya (2011) opined that developing countries should invest in infrastructure and confine their governments’ operating expenditure to accelerate the future growth and improve economic growth. Hence, it is recommendable the Malaysian government resume negotiation with its Singapore counterpart on the Kuala Lumpur–Singapore High Speed Rail project (HSR) in the near future in order to enhance connectivity between the two countries. Through the HSR, it opens up the possibilities of rejuvenating smaller cities in Peninsular Malaysia by connecting them to the two major metropolises and subsequently stimulating a promising future growth and high economic growth. Besides, it is time Malaysian government should think about how to intensify government investment expenditure through allocating the funds into development projects or productive sectors under the Five-Year Malaysia Plan. With the dawn of digital and disruptive technologies altering the nature of work as well as the mechanism of the world economy, it is desirable for the government to always make it the main priority for all future federal budgets to increase the investment allocation in its human capital development via education especially TVET (Technical and Vocational Education and Training) on cognitive skills which are believed to be a key factor to Malaysia's future development progress and sustained economic growth. This is vital to boost the economy and promote economic growth to ensure Malaysia’s success in transition to become a developed nation with high income under Shared Prosperity Vision 2030.

5. Conclusion

This paper attempts to investigate the asymmetric association between government size and economic growth in Malaysia in a different way by employing a dynamic threshold nonlinear regression model compared to previous papers that mostly use either linear models or quadratic variables in panel data analysis which fail to capture the full effects of the government size. The application of the threshold regression model enables us to ascertain the threshold value of government size objectively. The paper adopts nonlinear theories (Barro, 1990; Armey, 1995; Aydin and Eisen, 2019) to examine if the Armey curve is present in Malaysia. The TAR approach which is proposed by Hansen (1999, 2000) is applied to the modified two-sector production model of Ram (1986) to investigate the threshold effect of government size in Malaysia. The empiric evidence shows the presence of threshold effect between economic growth and government size in Malaysia when two different proxies of government size (i.e., GS1 and GS2) are set as the threshold variable.

On closer inspection of government expenditure, it is found that only when the threshold variable is set by the government operating expenditure divided by real GDP (GS1), an inverted U-shaped curve of nonlinear relation of Armey curve exists in Malaysia where the threshold regime is 12.309 per cent. When the government size is small, the expansion of government operating expenditure does accelerate economic growth. Conversely, over-expanding government operating expenditure may harm economic growth and well-being when the government size is big. However, a U-shaped curve of nonlinear relationship exists with the threshold regime of 4.210 per cent when the threshold variable is set by the government investment expenditure divided by real GDP (GS2).

The above conclusion provides us a real insight into the optimal size of government expenditure in Malaysia. Specifically, it gives an overview of whether the policy maker has appropriately been managing the level of government expenditure, be it historically or currently, to promote the economic growth. The government operating expenditure that is over-expanding will not accelerate economic growth due to the crowding-out effects and higher tax rates, while the expansion of the government investment size may significantly improve economic growth by strengthening the private sector through the provision and maintenance of infrastructure for smoother future growth in the private sector. Thus, the government should increase the efficiency of government expenditure by investigating whether the government size composition is correct when designing an effective fiscal policy to promote sustainable economic growth in Malaysia.

Declarations

Author contribution statement

Muhammad Syawal Bin Mohd Aznan, Han-Hwa Goh, Seow-Shin Koong, Siow-Hooi Tan: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

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Data availability statement

Data will be made available on request.

Declaration of interest’s statement

The authors declare no conflict of interest.

Additional information

No additional information is available for this paper.

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