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The Optimal Size of Government and the Armey Curve: A Review of Empirical Evidence

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Abstract

The objective of this study is to examine the "inverted U" relationship between public spending and economic growth known as the Armey curve, and to review the empirical evidence on the optimal level of public spending required, by country, to maximize gross domestic product (GDP), based on regression methods and the Armey curve. The Armey curve denotes a positive relationship between public spending and GDP up to a maximum point thereafter the relationship becomes negative: that is, public spending is productive only to a certain extent, after which it becomes unproductive. The empirical findings show the inverted U-shape between public spending and growth, and therefore whether government spending is of an optimal size. World Bank data on public spending (as a percentage of GDP) and GDP per capita in US$ purchasing power parity (PPP) for 2017 identifies countries with low public spending and high GDP per capita, such as the Special Administrative Region of Macao, China. Moreover, the studies reviewed show that current public spending and/or average public spending across different countries is above or below the threshold public spending level. Among the policy implications, it is suggested that countries below the threshold inject public spending into investments that generate a greater

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impact on the economy. The management of public spending to achieve the optimal government size should ensure long-term sustainable economic growth for the countries of the world.

Keywords: government size, Armey curve, optimal public spending, economic growth
JEL Classification: H50, O47, O57

1. Introduction

At present, many empirical analyses focus on determining the optimal level of public spending and government size of a country. One popular method of estimation is the Armey curve, which has characteristics of a production function whose slope represents the marginal product of the inverted-U production factor. When the product is maximum, the marginal product of the factor (MPL) becomes zero; in turn, with additions of the factor, production decreases while the MPL becomes negative, so that, assuming public spending as a factor of production, the law of diminishing marginal returns is fulfilled.

Mixed economies constantly redefine the boundaries between public and private activities (Stiglitz, 2003). Defining GDP as the sum of the value of goods and services produced within a country during a given period, Stiglitz (2019) points to the financial crisis of 2008, and the so-called "recovery" during the subsequent decade, as evidence that GDP as a measure does not provide an accurate assessment of the economy, let alone the state of the world or the people living in it. Given a variety of advances in methodology and technology, it is possible to construct far better metrics for the health of an economy and governments that go well beyond GDP.

The objective of this study is to examine the relationship between optimal public spending and economic growth across several countries. Based on an examination of recent calculations of optimal government size using the Armey curve, the study contributes with a discussion of the policy implications when current public spending is above or below the optimal threshold. The rest of the article is structured as follows: the second section reviews the literature on optimal public spending with an emphasis on the Armey curve method; the third compares the empirical evidence for several countries, as well as considering the policy implications; and finally, the fourth section presents a conclusion.

2. Armey curve and Optimal Size of Government

2.1 Armey Curve

Following the Barro model (1990), public spending is productive. Therefore, the production function with two factors is Q = f (K, G), where Q = Aggregate product, K = Private capital, and G = Production factor provided by the public sector, and the law of diminishing returns applies to each factor. Based on the production function, Barro explains the contribution of public spending to endogenous growth. Armey (1995) explains the relationship between the size of the public sector and economic growth. The Armey curve shows that as government spending grows, economic growth increases initially, reaches a maximum, and then falls. This technique is used as a measure of optimal government size in the economy.

Vaziri, Nademi, Paghe, and Nademi (2011) apply the two-sector production function developed by Ram in 1986, including the threshold variable "general government final expenditure divided by GDP" to estimate the threshold regression model for Iran and Pakistan, with regard to the effect of government size on economic growth. For the period 1960–2007, they find that the Armey curve exists in the economies of these two countries. Vaziri et al. (2011) and Nouira and Kouni (2018) find evidence of a non-linear relationship between government size and economic growth. For their part, Nouira and Kouni (2018) use a dynamic panel threshold approach, identifying a non-monotonic relationship in which there is a tipping level for government spending, beyond which economic growth falls significantly. For the period 1988–2016, they perform a dynamic panel threshold analysis with the aim of investigating this nonlinear effect. They find threshold effects of public spending on economic growth of between 10 and 30 percent for all 36 countries studied, between 20 and 30 percent for fifteen Middle-Eastern and North African (MENA) countries, and between 10 and 20 percent for twenty-one developing countries. The threshold effect proves significantly higher for the MENA countries.

Drawing on Bulgarian data for the period 2000–2018, Vasilev (2020) provides a theoretical basis for the Armey curve using a standard Keynesian model, extended by way of a quadratic relationship between investment and public spending. The link is the dependence of both on the interest rate. The author finds that the growth of the economy is maximized at G = 1572.43 (in BGN million), therefore the economy is operating beyond the peak of the Armey curve, and the government needs to reduce its level of spending. The non-linear Armey curve relationship between the level of government purchases and GDP growth is a stylized fact. Other studies that

validate the existence of the Armey curve for different economies include Kleynhans and Coetzee (2019), Aydin and Esen (2019), and El Husseiny (2019).

Both Mahnaz and Tasnim (2017) and Murshed, Mredula, and Tabassum (2018) study the Armey curve for Asian countries. For the period 1990–2016, the former finds a non-linear relationship between government size and economic growth and validate the Armey curve using panel data for developing countries in South Asia (Pakistan, India, Bangladesh, and Bhutan) in the long term. The square shape of government spending has a negative impact on economic growth. In turn, the latter use annual data from 1980 to 2016 for a panel of nine selected countries in South and South-East Asia, obtaining statistical evidence in favor of the validity of the Armey curve in the context of the full panel and the South-East Asian sub-panel data. The optimal government sizes in the context of the full panel and the South-East Asian subpanel are estimated at US$ 148,627.5 and US$ 57,765.7 million, respectively.

2.2 Optimal Size of Government

There is empirical evidence of the Armey curve in Brazil (Ferreira de Mendonça & Cacicedo, 2015), Jamaica (Malcolm, 2017), USA, and Canada (Bozma, Başar, & Eren, 2019); and in certain other countries located in Latin America. Ferreira de Mendonça and Cacicedo (2015) analyze the effect of government size on Brazil's economic growth from January 2000 to March 2013, validating the Armey curve and finding that the optimal size for the Brazilian government would be approximately 22 percent of GDP. Malcolm (2017) finds that the optimal level of government spending required to maximize Jamaica's economic growth is 33.2 percent of total production, using quarterly data from 1993 to 2016. This amounts to a GDP that is 4.6 percent higher than the average level of public spending in that country. Bozma et al. (2019) investigate whether or not the Armey curve hypothesis is valid for G7 countries and estimate the level of optimal public spending using the autoregressive distributed lag (ARDL) cointegration procedure. For the period 1981–2014, their empirical results show that Armey's hypothesis is valid for USA, Canada, and France but not for the other G7 countries. They also calculate the optimal government spending for USA, Canada, and France at 12.4, 18.93, and 23.5 percent, respectively.

With annual data from 2000 to 2016, Linh, Nga, and Phan (2019) test the impact of public spending on economic growth in ten South-East Asian (ASEAN) countries such as Vietnam, Thailand, the Philippines, Indonesia, Malaysia, Myanmar, Laos, Cambodia, Brunei, and Singapore.

Using the generalized moments method (GMM), they find that public spending (GOVit) affects economic growth in the same direction, while, quadratic public spending impacts economic growth in the opposite direction. The optimal level of public spending in ASEAN countries is 21.05 percent of GDP. However, unlike Mahnaz and Tasnim (2017) and Murshed et al. (2018), these authors do not focus on validating the Armey curve. They find Thailand's government spending of 21 percent to be close to the optimal level (Linh et al., 2019).

There is also empirical evidence of the existence of the Armey curve for South Korea. Using annual data from 1953 to 2016, Kim, Han, Tierney, and Vargas (2020) find there is an inverted U-shaped relationship between government expenditures and the real GDP growth rate, and between private expenditures and the real GDP growth rate, for the country. The optimal level of the government expenditure ratio is 28.67 percent and 29.81 percent for the current year and one-year lags of the government expenditure ratio, respectively, which is within the thirty percent bounds for a developed nation.

Asimakopoulos and Karavias (2016) and Rajput and Tariq (2019) use the GMM to test for the existence of the BARS curve and the Armey curve, respectively. The latter use the GMM on panel data for 89 non-OECD and OECD countries from 1990 to 2018, finding substantial evidence of the Armey curve only across non-OECD countries. One possible explanation is that the governments of non-OECD countries may be less efficient than those of the OECD countries (Rajput & Tariq, 2019), with the result that government expansion inhibits economic growth. Asimakopoulos and Karavias (2016) find that optimal public spending is higher in developing countries than in developed ones, although for their group of 129 countries, the optimal threshold level of government size is 18.04 percent of GDP.

Varol and Turan (2017) and Yüksel (2019) prove the existence of the Armey curve for the Turkish economy in the periods 1998–2015 and 1981–2018, respectively. Yüksel (2019) indicates that the parabolic shape of the Armey curve is essential for calculating the optimal size of the government. The optimal level of public spending that maximizes Turkey's economic growth is 16 percent of GDP (Yüksel, 2019), similar to the 16.5 percent obtained by Varol and Turan (2017). Vaziri et al. (2011) and Phan and Phung (2018) estimate government size represented as “general government consumption expenditure.” The latter, in the case of China and Japan during the period 1971–2013, relate it to real per capita GDP growth under the smooth transition autoregressive

(STAR) model. They obtain no evidence of convergence for Japan, while the threshold value of government size for China is 14.23 percent.

According to Di Mateo and Summerfield (2018, p. 2), the empirical relationship between government size and economic growth involves the Armey curve, also known as the BARS curve / Scully curve (following Barro, Armey, Rahn, & Scully). Using annual data from 1953 to 2016. Myeong, Yongseung, Heather, and Vargas (2020) find that there is an inverted U-shaped relationship called the BARS curve between public spending and the growth rate of real GDP for South Korea. Although there are studies that call the inverted U-shaped relationship the BARS curve, the Armey curve is frequently used in the literature (Yüksel, 2019). For the period 1980–2011, Thanh and Mai (2015), using a smooth transition regression model for panel data (PSTR), validate the existence of a non-linear relationship between government size and economic growth for ASEAN countries, the threshold level of public consumption spending is 25.69 percent of GDP, as government size exceeds this level, economic growth slows by 0.2 per cent. For the period 1980–2015, Hina, Ghumro, Abidi, & Lashari (2019) apply the OLS regression model and find that the optimal threshold level of public sector spending for Pakistan is 18.2 percent, and they also validate the Armey curve.

3. Methods and Discussion of Empirical Evidence

This section reviews studies that calculate the Armey curve and optimal public expenditure, as well as detecting trends in public spending in relation to economic growth in several countries, including Peru. These studies employ a range of regression methods to estimate the optimal size of government by country.

3.1. An Application of the Armey Curve

The Armey curve can be expressed as a quadratic function (Altunc & Adyin, 2013):

$$GDP_t = \beta_0 + \beta_1 G_t + \beta_2 G^2{}_t + \mu_t \qquad \beta_2 < 0 \qquad (1)$$

$$\text{Optimal spending } (G^*) = -\frac{\beta_1}{2(\beta_2)} \qquad (2)$$

G = Public spending

t = 1984, 1985, …, 2017

There is a non-linear relationship between public spending and economic growth and the coefficient ß2 (equation 1), which is negative and statistically significant in the regression model,

demonstrating the existence of the Armey curve (Altunc & Adyin, 2013). To calculate the optimal public spending required to maximize economic growth, equation (2) is used.

To estimate government size and growth in Peru, time-series data from 1984 to 2017 are used for a large sample n=34. Public expenditure (non-financial, by general government) and GDP at 2007 prices are employed, taken from the annual reports of the Banco Central de Reserva del Perú (BCRP). For this country, the optimal public expenditure is found to be 20.76 percent of GDP (Coayla, 2018).

3.2. Discussion on the Evidence of the Armey Curve and Optimal Government Size

Table 1. Illustrative estimates of optimal government size for certain countries

	Country & estimated Period	Authors/ Year	Optimal government size (% GDP)	Calculation method
Developed countries	27 OECD countries, 1975–2015	Lazarus et al. (2017)	27 OECD countries = 36.61%,	Panel regressions
	43 developed countries, 1980–2009	Asimakopoulos and Karavias (2016)	17.96% for developed countries	Generalized moments method
	26 transition economies, 1993–2016	Aydin and Esen (2019)	17.54% for developed economies	Dynamic panel data based on the threshold autoregressive (TAR) approach
	G7 countries: USA, Canada and France, 1981–2014	Bozma et al. (2019)	USA=12.46%, Canada=23.57%, France=18.93%	Autoregressive distributed lag (ARDL), cointegration procedure

Developing countries	17 countries in Latin America, 1989–2009	Pinilla et al. (2013)	12% to 24%	Panel data, nonlinear pooled OLS regressions and GLS with fixed and variable effects
	86 developing countries, 1980–2009	Asimakopoulos and Karavias (2016)	19.12% for developing countries	Generalized moments method
	26 transition economies, 1993–2016	Aydin and Esen (2019)	11.67% for developing economies.	Dynamic panel data based on the TAR approach
	50 countries in Africa, 1975–2015	Lazarus et al. (2017)	50 African countries = 15.61%	Panel regressions
	Romania, and Bulgaria,1995–2011	Altunc and Adyin (2013)	Romania=20.44%, Bulgaria=22.45%	ARDL cointegration method
	Ghana and Nigeria, 1970–2014	Anaduaka et al. (2016)	Ghana=12.1%, Nigeria=9.8%	Concave parabolic model
	Georgia, 2000–2015	Tabaghua (2017)	21%	Double logarithmic model, based on Barro's (1990) endogenous growth model
Emerging countries	China, 1971–2013	Phan and Phung (2018)	14.23%.	Smooth transition autoregressive (STAR)
	Turkey, 1995–2011	Altunc and Adyin (2013)	Turkey=25.21%,	ARDL cointegration method
	Turkey (quarterly), 1998:1–2015:1	Varol and Turan (2017)	16.5%	Threshold regressions
	Turkey, 1981–2018	Yüksel (2019)	16%	ARDL
	South Africa, 1992–2017	Kleynhans and Coetzee (2019)	18.5%	Fully modified ordinary least squares (FMOLS)
	Egypt, 1981/1982–2014/2015	El Husseiny (2019)	30.5% to 31.2%	Quadratic equation model

Asian countries	10 Southeast Asian countries, 2000–2016: (Vietnam, Thailand, the Philippines, Indonesia, Malaysia, Myanmar, Laos, Cambodia, Brunei, and Singapore)	Linh et al. (2019)	21.05%	Generalized moments method
	Pakistan, 1980–2015	Hina et al. (2019)	18.2%	OLS regression model
	ASEAN countries, 1980–2011: (Brunei, Cambodia, Indonesia, Laos, Malaysia, the Philippines, Singapore, Thailand, and Vietnam)	Thanh and Mai (2015)	25.69%	Smooth transition regression model for panel data (PSTR)

Varol and Turan (2017) provide an overview of studies about optimal government size estimates for several countries, using quadratic models and threshold or smooth transition models. Similarly, Malcolm (2017) and Kleynhans and Coetzee (2019) list studies that have proven the relationship between government size and economic growth.

Table 2. Descriptive statistics: Public spending and GDP per capita, 2017 (146 countries)

		Public spending (% GDP)	GDP per capita in PPP dollars
N		146	146
Average		27.0014	21143.9764
Median		26.4000	14666.1750
Dev. typ.		11.38670	19503.96447
Quartiles	25	18.7000	6186.9750
	50	26.4000	14666.1750
	75	34.2500	31729.3325

Source: World Bank data for 2017. Compiled by the author.

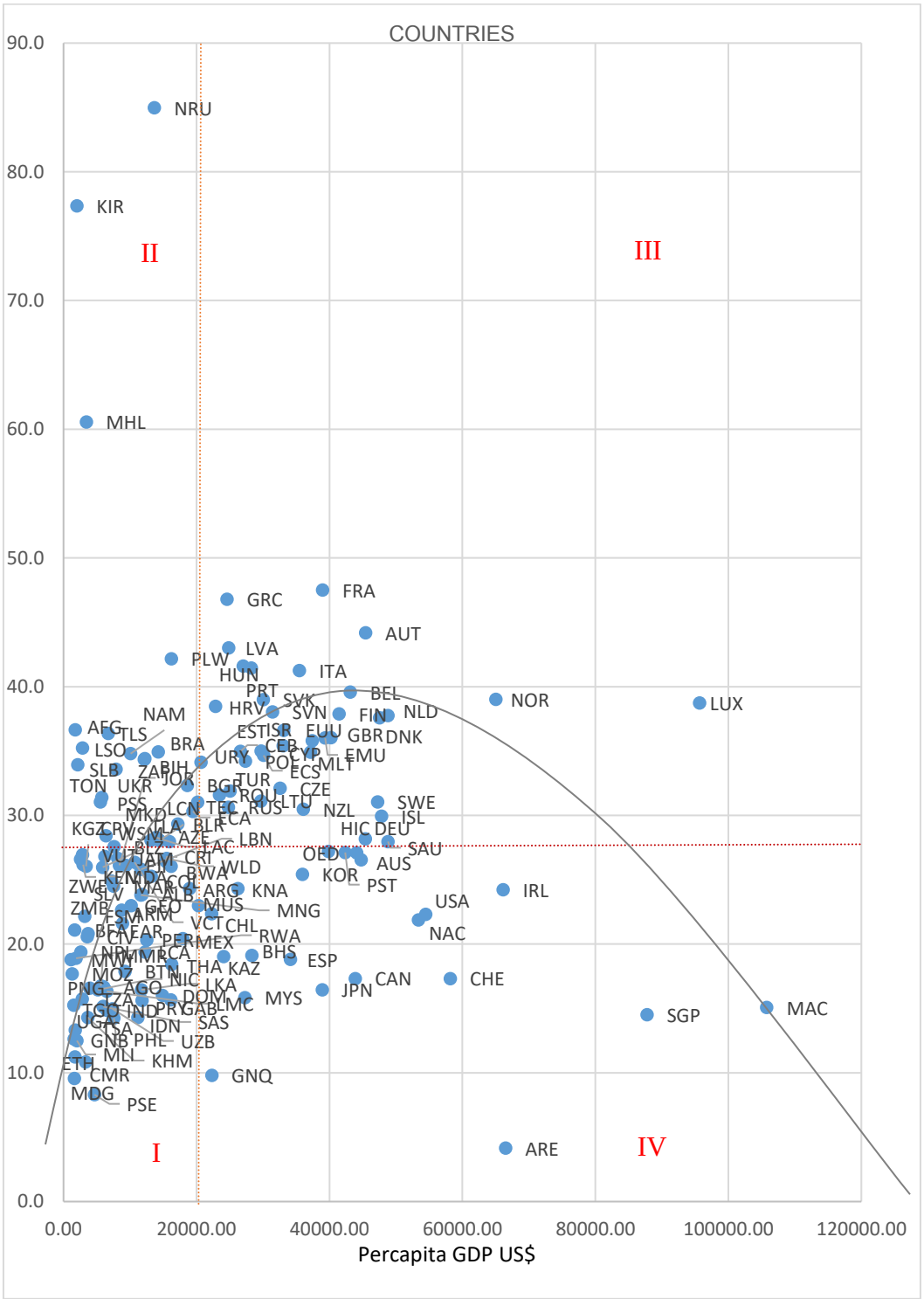

Figure 1. Public sector size and GDP per capita (US$ PPP)

Source: Matute (2019) and World Bank data for 2017. Compiled by the author.

Similar to Matute (2019), who uses data from the World Bank, this study considers a sample of 146 countries for 2017, divided into four groups by the average of both public spending (percentage of GDP) and GDP per capita (US$ PPP), at 27 percent and US$ 21,144 respectively (Table 2). In Figure 1, the X axis represents GDP per capita in US$ PPP and the Y axis measures public spending as a percentage of GDP. Group I contain countries with below-average GDP per capita and public sector sizes, including middle-income countries in the Latin American region such as Peru (PER), Colombia (COL), Costa Rica (CRI), Argentina (ARG), Chile (CHL), and Paraguay (PRY); and low-income countries in Africa such as Rwanda (RWA) and Uganda (UGA). In turn, Group II contains countries with a public sector of more than 27 percent of GDP but economic development measured by GDP per capita similar to the countries of Group I. For Latin America, this applies to countries such as Brazil (BRA) and Uruguay (URY). Group IV presents countries with high GDP per capita and public spending below 27 percent of GDP; of particular note are the Special Administrative Region of Macao, China (MAC) with GDP per capita of US$ 105,774 and public expenditure of 15.1 percent, in addition to Singapore (SGP), the United Arab Emirates (ARE), Switzerland (CHE), Ireland (IRL), the United States (USA), and Canada (CAN). Among the Group III countries, with a public sector greater than 27 percent of GDP and high GDP per capita, are Luxembourg (LUX), Norway (NOR), the United Kingdom (GBR), Denmark (DNK), Belgium (BEL), Sweden (SWE), and France (FRA).

Using the generalized moments method (GMM) with World Bank data from 129 countries for the period 1980–2009, Asimakopoulos and Karavias (2016) discover an inverted, robust, and statistically significant U-shaped relationship between public spending and economic growth for developed and developing countries. Their applied method allows endogenous independent and endogenous threshold variables, and is empirically relevant because greater growth over time may encourage greater public spending through the channel of higher tax returns. Asimakopoulos and Karavias (2016) use five-year-averaged data and time dummies to abstract from economic cycle influences. They also find that the optimal level of government size required to maximize economic growth is 18.04 percent for their set of 129 countries, 19.12 percent for developing countries, and 17.96 percent for developed countries. On the other hand, Pinilla, Jiménez, and Montero (2013) find that public spending (measured as final consumption by general government and primary expenditure by central government) is strongly correlated with

the level of per capita economic production between 1989 and 2009, for seventeen countries in Latin America.

In Matute (2019) study of 82 countries in 2015, the relationship between public sector size and GDP per capita in PPP dollars follows an inverted-U trajectory; GDP per capita increases along with the size of the public sector until it reaches a point of inflection corresponding to a level of income of between US$ 50,000 and US$ 60,000. Thus, the relationship between these variables is negative and pertains to the Armey curve. Matute (2019) and Di Matteo (2013) use per capita public spending (in US$ PPP). Per capita government spending (US$ purchasing power parity dollars, PPP) for the countries in the IMF database for 2011 ranged from US$ 101 to US$ 33,878, with an average of US$ 5,333. Among the fifty countries that spend the most, Di Matteo (2013) observes that per capita spending varied from a minimum of US$ 6,744 (for South Korea) to a maximum of US$ 33,878 (for Luxembourg). In the present study of 146 countries taken from the 2017 World Bank database, per capita public spending ranges from US$ 1,154 to US$ 105,774.

Anaduaka, Nnetu-Okolieuwa, Aguegboh, and Okorie (2016) adopt a concave parabolic model, utilizing the Armey curve model not only to empirically validate the Armey curve hypothesis, but also to identify the optimal government spending of Ghana and Nigeria, using time series data from 1970 to 2014. The results show that the Armey curve hypothesis applies in both Nigeria and Ghana, and that it is statistically more significant in the former case. The governments of Nigeria and Ghana should spend 12.1 percent and 9.8 percent of their GDP to achieve the optimal growth of 9.96 trillion Naira and 6,422 million Ghanaian Cedi, respectively. These two West African countries are developing countries, although Nigeria is close to being an emerging country.

Kleynhans and Coetzee (2019) calculate the optimal public sector size in South Africa at an average of 0.185, or 18.5 percent of final consumption expenditure and public sector capital investment (from 1992 to 2017) compared to the actual size of approximately 30 percent in 2017. That is, the size of the South African public sector is significantly larger than optimal. In common with South Africa, Turkey and Egypt are emerging countries. Turkey's public spending between 1993 and 2018 remained above its optimal level of 16 percent (Yüksel, 2019). Using time series data for the Egyptian economy over the fiscal-year period from 1981/82 to 2014/2015, El Husseiny (2019) finds that the relationship between government size and economic growth in that country

follows the inverted U-shaped Armey curve. The optimal size of government ranges from 30.5 to 31.2 percent of GDP. Thus, the current size of the Egyptian government is neither too big nor too small in relation to the optimum.

Aydin and Esen (2019) find strong evidence that government expenditures have a non-linear effect on the economic growth of 26 economies in transition during the 1993–2016 period. Applying a dynamic panel data analysis based on a threshold model, they show that government expenditures have a positive and statistically significant effect on growth when the government size is below the threshold level, and that the effect becomes negative but not statistically significant when it exceeds the critical level of 11.67 percent for developing economies and 17.54 percent for developed economies.

3.3 Policy Implications

Focusing on emerging countries, since 2005 Brazil has spent above the optimal public spending of 22 percent (Ferreira de Mendonça & Cacicedo, 2015). The actual level of public spending in Turkey and South Africa exceeds the optimum of 16 percent and 18.5 percent of GDP, respectively (Kleynhans & Coetzee, 2019; Yüksel, 2019). In contrast, the current size of the Egyptian government is close to the optimal at 31 percent (El Husseiny, 2019). When it comes to Asian countries, Pakistan's actual public spending of 20.4 percent exceeds the optimal threshold of 18.2 percent (Hina et al., 2019). Thanh and Mai (2015) calculate the average optimal government size of 25.69 percent for nine Southeast Asian countries, while Linh et al. (2019) identify a threshold level of average public spending of 21.5 percent for ten Southeast Asian countries. By comparing the average public spending of the Southeast Asian countries studied by Thanh and Mai (2015) and Linh et al. (2019), Brunei's average public spending is found to exceed the optimal threshold level. In that country, the increasing government spending beyond the optimal level is detrimental to long-term sustainable economic growth. By contrast, the other countries of Southeast Asia must increase public spending in the near future in order to reach the optimal threshold of economic growth (Linh et al., 2019). In sum, the impact of government spending on economic growth is quantitatively greater when it is below the optimal threshold than when it exceeds that threshold (Asimakopoulos & Karavias, 2016).

Spending on public investment in Latin American countries is lower than that of their ASEAN counterparts. In developing countries, public investment in infrastructure has positive

impacts on economic growth and equity (Armendáriz & Carrasco, 2019). The extent to which the population's standard of living can be improved depends on the quality of the processes and institutions that oversee public spending. Thus, the ethical competence of public-spending policymakers is crucial. Optimal public spending should ensure sustainable long-term economic growth, and efficient management of public spending during these times of pandemic is very important. In this context, it is vital that public investments have the greatest possible impact on the economy in order to mitigate economic recession or depression. The way in which public spending is managed in different countries will have an impact not only on economic growth but also on people's quality of life.

4. Conclusions

This study examined an inverted U-shaped relationship between government size and economic growth, and reviewed calculations of the optimal level of public spending in several countries. Sufficient empirical evidence was found to demonstrate the existence of the Armey curve.

Drawing on 2017 World Bank data on public spending (percentage of GDP) and GDP per capita (US$ PPP) for 146 countries, the study found countries with high GDP per capita and public spending below 27 percent of GDP. Notable among this group are the Special Administrative Region of Macao, China with a GDP per capita of US$ 105,774 and public expenditure of 15.1 percent, as well as Singapore, the United Arab Emirates, Switzerland, Ireland, the United States, and Canada.

Asian and developing countries should use public spending to make high-impact investments that promote long-term sustainable economic growth. In general, an optimal level of quality public spending will have the greatest impact on a population's living standards and on the development of the world's economies.

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