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Does Government Size Affect Economic Growth in Developing Countries? Evidence from Non-stationary Panel Data

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Abstract

The Armey curve suggests that there is an inverted U relationship between government size and economic growth. In order to investigate this relationship for 12 developing countries from 1990 to 2012, this study uses panel data methodology including panel unit root, cointegration and causality tests. The results show that i) the series are integrated at order of *I(1)*, ii) there exists a long run equilibrium relationship between the variables, iii) economic growth is positively correlated with the government consumption expenditure, iv) economic growth is negatively correlated with the squares of government consumption expenditure, v) there exists a causality running from the explanotary variables to economic growth in the long run and short run. The study provides an evidence that there exists an inverted U relationship between government consumption expenditure and economic growth implying the validity of Armey curve in these countries. The study may also provide some policy implications.

Keywords: government size, economic growth, Armey curve, panel data analysis.

1. Introduction

Economic growth and its determinants has been one of the main topics investigated by theorists and politicians. According to growth literature, there are two fundamental kinds of growth theory. The first is the neoclassical growth theory. It is well known as the exogenous growth model presented by Solow (1956), Swan (1956), and Koopmans (1965). The second is the new growth theory developed by Romer (1986; 1990), Lucas (1988), Barro (1990), Rebelo (1991), Grossman and Helpman (1991), Aghion and Howitt (1992), and Jones (1996). This theory is also known as the endogenous growth model.

The neoclassical theory of growth generally focuse on capital accumulation and its relation to savings and population growth. It suggests that in the long run economy will reach a steady state where per capita output is constant. It also suggests that there is a linear relationship between a number of variables and economic growth in the long-run. According to this theory, government policy cannot influence the steady-state growth rates. As a result, the impact of government policy on the long run growth has not been investigated in this model.

The new growth theory suggests that both transition and steady state growth rates are endogenous and there are several determinants of long run growth. Here, long run growth rates can differ across countries and convergence in income per capita cannot occur. However, according

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to this theory government policy can affect economic growth either directly or indirectly. In this model there are three basic fiscal instrument affecting the long run growth rates: expenditure, taxation and the aggregate budgetary balance. Firstly, these instruments affect the efficiency of resource use and the rate of factor accumulation. These developments influences a country's long-run growth performance (Barro, 1989; 1990; Brons et al. 1999).

A part of the new growth theory focuses on the relationship between government size and economic growth. The literature on public expenditure and economic growth stresses on the presence of a historical relationship between government size and GDP growth. This is called as the Armey curve (Armey, 1995), Rahn curve (Rahn and Fox, 1996) or BARS curve (Barro, 1989; Armey, 1995; Rahn and Fox, 1996; Scully, 1994). This literature uses the form of an inverted U-shaped curve. The Armey curve is based on the law of diminishing factor returns and implies the idea that there is a positive correlation between public expenditure and GDP up to a certain point. After that the correlation becomes negative. In other words, after this point an increase in public expenditure leads to a decrease in GDP. So, Armey curve exhibits a relationship similar to that of Kuznets' curve. According to Armey curve, the government size and economic growth may be modelled by using a quadratic function (Vedder and Gallaway, 1998).

Barro (1990) investigates the impact of different sizes of government on economic growth. According to Barro, an increase in taxes decreases economic growth, while an increase in government expenditure raises marginal productivity of capital. So, economic growth increases. If the government is small, the second force dominates. If the government is large, the first force dominates. The study's main finding reveals that the relation between government expenditure and economic growth is non-monotonic.

The Armey curve can be formulized in different shapes in order to test whether an "inverted U" relationship exists between public expenditure and economic growth. The empirical research on this topic aims to test the presence of this relationship in different countries by using several econometric techniques. Examples are given by Miller and Russek (1997), Vedder and Gallaway (1998), Kneller et al. (1999), Folster and Henrekson (2001), Pevcin (2004), Chen and Lee (2005), Angelopoulos et al. (2008), Herath (2010), Magazzino and Forte (2010), Afonso and Furceri (2010), Wu et al. (2010), Ijeoma and O'Neal (2012), Roy (2012), and Altunc and Aydın (2013). But, the empirical literature provides inconclusive findings regarding the relationship between government expenditure and economic growth.

Miller and Russek (1997) investigate the link between government expenditure and economic growth in both developed and developing countries. The results indicate that debt-financed increases in government expenditure slow economic growth and tax-financed increases enhance economic growth for developing countries. The results also indicate that there is no relation between debt-financed increases in government expenditure and economic growth and there is negative link between tax-financed increases and economic growth for developed countries.

Vedder and Gallaway (1998) test the validity of the Armey curve in the cases of United States, Sweden, Denmark, Canada, Britain and Italy over the period 1947-1997. The results show that there is empirical evidence supporting the validity of the Armey curve for all these countries. Employing panel data for 22 OECD countries, Kneller et al. (1999) show that productive government expenditure increases economic growth, while non-productive government expenditure does not.

Folster and Henrekson (2001) investigate the impacts of expenditure and fiscal measures on economic growth for rich countries over the period 1970-1995. The study finds a strong negative relationship between public expenditure and economic growth. Using panel data regression analysis based on five-year arithmetic averages, Pevcin (2004) examines the relationship between government expenditure and economic growth for European countries. The empirical findings support the presence of the Armey curve over the period.

Using a threshold regression approach, Chen and Lee (2005) analyse the non-linear relationship between government expenditure and economic growth in Taiwan. Applying the two-sector production function, the study provides evidence that government size has a threshold effect and that there is a non-linear relationship between the variables implying the presence of Armey curve in Taiwan.

Angelopoulos et al. (2008) analyze the relation between government spending and economic growth in developed and developing countries. Using a panel OLS and 2SLS, they find evidence that there is a nonlinear link between government expenditure and economic growth. The results show that an efficient public sector has a positive impact on economic growth.

Herath (2010) investigates the relationship between government expenditure and economic growth in the case of Sri Lanka by using second degree polynomial regressions. The findings show that there is a positive relation between the variables. The findings also support the Armey's idea of aquadratic curve for Sri Lanka.

Magazzino and Forte (2010) investigate the existence of Armey curve for the EU countries in the period 1970-2009 by using time-series and panel data techniques. The study provides empirical evidences generally supporting the presence of Armey curve.

Afonso and Furceri (2010) analyze the impacts of size and volatility of government revenue and spending on economic growth in OECD and EU countries by applying panel regression analyses. The findings suggest that both variables are harmful to economic growth. In particular, the results show that government consumption and investments have a negative effect on economic growth.

Wu et al. (2010) examine the causal relation between government spending and economic growth by using the panel Granger causality method presented by Hurlin (2004) and panel data set from 1950 to 2004. The study finds evidence of a positive relation between government spending and economic growth. The sudy also finds bi-directional causality between the variables for the different sub samples of countries.

Ijeoma and O'Neal (2012) examine the impact of government expenditure on economic growth for Nigerian economy from 1980 to 2011. Using ARDL bounds testing approach, the results indicate that government recurrent and capital expenditures are positively correlated with economic growth in the short-run. In the long run there is a positive relation between government recurrent expenditure and economic growth, while government capital expenditure is negatively linked to economic growth in Nigeria.

Using time-series data covering the period 1950-2007, Roy (2012) analyses the relationship between government size and economic growth in the United States. The study particularly investigates the impacts of government consumption and government investment expenditures on US economic growth. Based on the results of a simultaneous-equation model, government consumption expenditure decreases economic growth, while government investment expenditure increases economic growth in the United States. So, the study shows that the overall impact of total government spending on economic growth is uncertain.

Altunc and Aydın (2013) examine the presence of Armey curve for Turkey, Romania and Bulgaria by using ARDL bounds testing approach to cointegration from 1995 to 2011. This study finds an empirical evidence that the Armey curve is valid for Turkey, Romania and Bularia.

Following the empirical lietrature, this study's main aim is to investigate wether the Armey curve (the inverted U relationship between government size and economic growth) exists in developing countries over the period 1990-2012. In this purpose, we employ panel unit root tests developed by Maddala and Wu (1999), Hadri (2000), and Im et al. (2003). We also employ the cointegration methods developed by Kao (1999) and Maddala and Wu (1999) to examine the long-run relationship between the variables. Long-run estimation is conducted by panel OLS method. Finally, the long run and short run causality between the variables is investigated by panel vector error correction model (PVECM).

The remainder of this study is organized as follows. Section 2 describes the model and data of the empirical analysis. Section 3 presents the empirical methodology. Empirical results are reported in Section 4. Section 5 concludes the study with some policy implications.

2. Model and Data

In this study, we investigate the relationship between government size and economic growth in selected developing countries. We use panel data covering the period 1990-2012 gathered from the World Development Indicators (WDI) online database (2014). The countries examined in this study are Brazil, Gabon, Colombia, Costa Rica, Peru, Bostwana, China, Malaysia, Mexico, South Africa, Thailand and Turkey. This sample is selected on the bases of upper-middle income country and data availability. In order to test the existence of the inverted-U shaped relation between government size and economic growth (Armey curve), the following quadratic function presented by Vedder and Gallaway (1998) can be used

$$LNGDP_{it} = \alpha_0 + \alpha_1 LNGOV_{it} + \alpha_2 LNGOV_{it}^{\ 2} + \varepsilon_{it} \quad (1)$$

where *GDP*, *GOV* and *GOV*² represent per capita real income, government consumption expenditure as a percentage of real GDP and square of government consumption expenditure as a percentage of annual real GDP, respectively. So, government consumption expenditure is used as an indicator of government size. The data are transformed to natural logarithm because log-linear form provides a better result. α_1 and α_2 are the slope coefficients and the sign of the coefficients is expected to be positive and negative, repectively (Vedder and Gallaway, 1998; Herath, 2010; Altunc and Aydın, 2013). ε_t is the error term assumed to be normally distributed with zero mean and constant variance. Table 1 presents the descriptive statistics of the variables employed in the analysis. Figure 1 shows the plots of the series.

Table 1. Descriptive statistics

Balanced panel: N=12, T=23, Observations=276						
Variable	Unit	Mean	Median	Std. Dev.	Min.	Max.
LNGDP	GDP per capita, 2005=100, $	8.308	8.410	0.535	6.137	9.053
LNGOV	Goverment consumption expenditure/GDP, 2005=100, $	2.616	2.579	0.297	2.080	3.177
$LNGOV^2$	Square of LNGOV	6.935	6.651	1.573	4.328	10.094

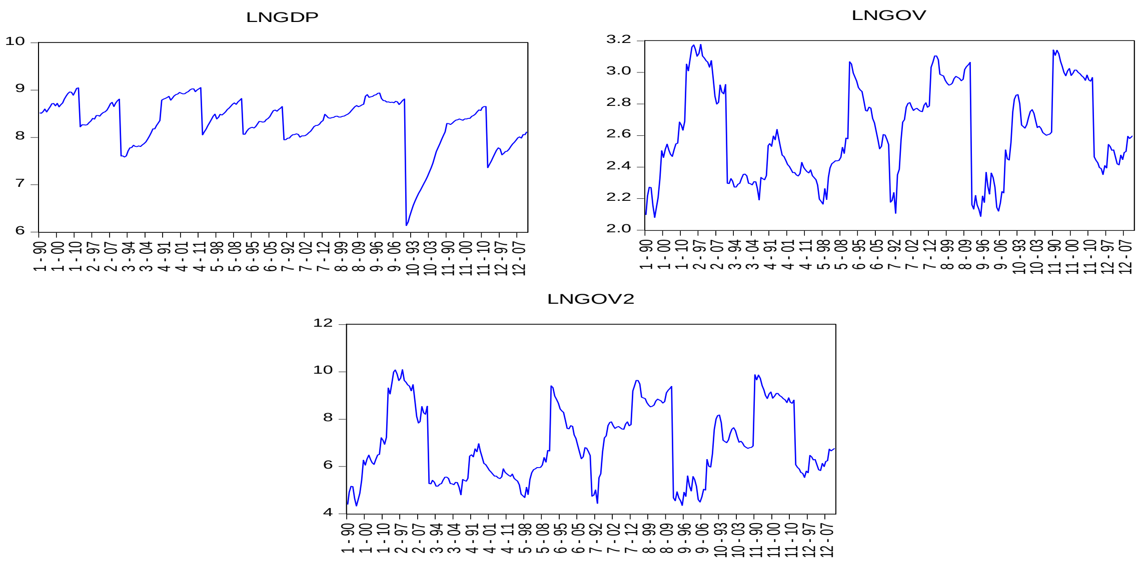

Fig. 1. The plots of LNGDP, LNGOV and $LNGOV^2$ series

3. Econometric Methodology

As the main aim of this study is to examine the cointegration and causality relationship between goverment size and economic growth over the period, our econometric strategy consists of three steps. In the first step, we investigate the order of integration in the variables by using panel unit root tests presented by Maddala and Wu (1999), Hadri (2000) and Im et al. (2003). Using cointegration methods developed by Kao (1999) and Maddala and Wu (1999), the second step tests the cointegration relationship between the variables. In the third step, the long-run parameters are estimated and final step investigates the Granger causality between the variables by applying PVECM.

3.1 Panel Unit Root Tests

Im et al. (2003) provides a very simple panel unit root test which is well known as IPS test. They employ a separate ADF regression as follows:

$$\Delta y_{it} = \alpha_i + \rho_i y_{i,t-1} + \sum_{j=1}^{p_i} \beta_{ij} \Delta y_{i,t-j} + \varepsilon_{it} \qquad (2)$$

where $i = 1, \ldots, N$ and $t = 1, \ldots, T$

The test allows for a heterogeneous coefficient of y_{it-1} and bases on averaging individual unit root test statistics. In this test, the null and alternative hypotheses are as follows:

$$H_0 : \rho_i = 0 \text{ for all } i \qquad (3)$$

$$H_1 : \rho_i \langle 0 \text{ for } i = 1, 2, \ldots .. N_1$$

(4) $H_1 : \rho_i = 0$ for $i = N_1+1, \ldots .. N$ (5)

The IPS t-bar statistic indicates an average of the individual ADF statistics and is estimated as follows:

$$\bar{t}_{NT} = \frac{1}{N}\sum_{i=1}^{N} t_{\rho i} \qquad (6)$$

where $t_{\rho i}$ is the individual t-statistic for testing H_0 hypothesis. In case the lag order is always zero, IPS provides simulated critical values related with t-bar for different number of cross-sections N and series lenght T. IPS reveals that standardized t-bar statistic exhibits an asymptotic $N(0,1)$ distribution.

The unit root test developed by Maddala and Wu (1999) uses the Fisher (p) test. Under cross-sectional independence of the error terms ε_{it}, the joint test statistic can be expressed as follows:

$$p = -2\sum_{i=1}^{N} \ln(\pi_i) \qquad (7)$$

In this procedure, the null and alternative hypotheses are similar to IPS's hypotheses. Using the ADF estimation equation in each cross-section, this test computes the ADF t-statistic for each individual series. So, the Fisher-test statistics are calculated and are compared with the appropriate χ^2 critical value.

Hadri (2000) presents a panel version of the Kwiatkowski et al. (1992) test. In this procedure, the null hypothesis implies that there exists stationarity in all units. The null hypothesis is tested against the alternative of a unit root in all units. The test is based on Langrange multiplier test and the residuals are obtained from the following regression:

$$y_{it} = \delta_{mi} d_{mt} + \varepsilon_{it}, \text{ m = 2, 3 for i = 1, ... N.} \qquad (8)$$

The test statistic is then given by

$$H_{LM} = \frac{1}{NT^2}\sum_{i=1}^{N} \sum_{t=1}^{T} \frac{S_{it}^2}{\hat{\sigma}_{ei}^2} \qquad (9)$$

with $\hat{\sigma}_{ei}^2 = \frac{1}{T}\sum_{t=1}^{T}\hat{e}_{it}^2$.

3.2 Panel Cointegration Tests

Kao (1999) suggests several residual-based panel tests and they have parametric properties. In these tests, the null hypothesis implies that there exsists no cointegration. In this procedure, the DF and ADF unit root tests are added to panel cointegration analyses. The main feature of these tests is that they base on the spurious least squares dummy variable panel regression equation as follows:

$$y_{it} = \alpha_i + \delta_{it}\beta + e_{it},\ i = 1,......N;\ t = 1,.......T \quad (10)$$

in which $y_{it} = \sum_{s=1}^{t} u_{is}$ and $x_{it} = \sum_{s=1}^{t} \varepsilon_{is}$ are restricted to be atmost $I(1)$ with $u_{it} \sim (0, \sigma_u^2)$ *i.i.d.* and εit~ $(0, \sigma_\varepsilon^2)$ *i.i.d.*. The ADF type panel statistic developed by Kao bases on the following AR (p) regression

$$\hat{e}_{it} = p\hat{e}_{i,t-1} + \lambda_1 \Delta\hat{e}_{i,t-1} + ... + \lambda_p \Delta\hat{e}_{i,t-p} + v_{itp} \quad (11)$$

Kao (1999) formulates the ADF panel test statistic as follows:

$$ADF = \frac{\frac{\sum_{i=1}^{N}(e_i^{'}Q_i v_i)}{s_v\sqrt{\left[\sum_{i=1}^{N}(e_i^{'}Q_i e_i)\right]}} + \frac{\sqrt{6N\hat{\sigma}_v}}{2\hat{\sigma}_{0v}}}{\sqrt{\frac{\hat{\sigma}_{0v}^2}{2\hat{\sigma}_v^2} + \frac{3\hat{\sigma}_v^2}{10\hat{\sigma}_{0v}^2}}} \quad (12)$$

where $Q_i = I - X_{ip}(X_{ip}^{'}X_{ip})^{-1}X_{ip}^{'}$, and X_{ip} indicates a matrix of observations on the regressors $(\Delta\hat{e}_{i,t-1}, \Delta\hat{e}_{i,t-2}, ..., \Delta\hat{e}_{i,t-p})$.

$$s_v^2 = \frac{\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{v}_{itp}^2}{NT} \quad (13)$$

where $\hat{v}_{itp}$ implies the estimate of v_{itp}. The panel ADF test has a asymptotically $N(0,1)$ distribution.

Hence, in addition to the Kao test, we also employ Fisher's test to aggregate the p-values of the individual Johansen maximum likelihood cointegration test statistics. In the Fisher procedure which is a non-parametric test the homogeneity in the coefficients are not assumed (Maddala and Kim, 1998; Maddala and Wu, 1999).

3.3 Panel Granger Causality Test

If there is a cointegration relationship between the variables, this implies a causal relation between the variables. However, this does not show the direction of causality. To test the causal relations between the series, we can use a two-step process. In the first step the residuals are estimated from the long-run model. In the second step the estimated residuals are included to error correction model as an error correction term (*ECT*). This model is known as dynamic error correction model. The model is expressed as follows

$$\Delta LNGDP_{it} = \alpha_1 + \sum_{k=1}^{q} \theta_{1ik} \Delta LNGDP_{it-k} + \sum_{k=1}^{q} \theta_{2ik} \Delta LNGOV_{it-k} + \sum_{k=1}^{q} \theta_{3ik} \Delta LNGOV_{it-k}^{2} + \gamma ECT_{it-1} + \mu_{it} \quad (14)$$

where Δ and q represent the first difference operator and the lag length, respectively. *ECT* denotes the error-correction term which contains estimated residuals from the cointegration regression (Eq. 1). μ is the serially uncorrelated error term. γ reflects the long-run equilibrium relationship among the variables. If θ_2 or θ_3 is not equal to zero, it is determined to be a short run causal relationship. If γ is not equal to zero, it is determined to be a long run causal relationship. If γ and θ_2 or θ_3 are not equal to zero, it is determined to be a joint causal relationship.

4. Empirical Findings

Table 2 reports panel unit root test results. The findings indicate that the series are not stationary in level. After taking the first difference, the series are stationary. So, it is concluded that all variables are integrated at order of *I(1)*. These results enable us to apply the cointegration tests.

Table 2. Panel unit root test results

Variables	IPS test statistics	ADF-Fisher test statistics	PP-Fisher test statistics	Hadri test statistics
Panel A: Level				
LNGDP	4.576	5.851	5.293	11.799[a][0.000]
LNGOV	-0.805	29.220	21.627	8.704[a][0.000]
LNGOV²	-0.727	28.713	21.981	8.784[a][0.000]
Panel B: First difference				
ΔLNGDP	-9.257[a][0.000]	122.139[a][0.000]	133.135[a][0.000]	0.645
ΔLNGOV	-9.481[a][0.000]	128.351[a][0.000]	145.549[a][0.000]	0.092
ΔLNGOV²	-9.199[a][0.000]	124.941[a][0.000]	145.046[a][0.000]	0.045

Notes: The optimal lag lengths are selected automatically using Akaike information criteria (AIC). The LLC test uses Newey-West bandwidth selection with Bartlett kernel. [a] denotes significance at the 1 % level. *p*-values are given in parentheses.

Table 3 presents the results of Johasen-Fisher and Kao cointegration tests. Fisher statistics estimated from trace and maximum eigen tests indicate that there are two cointegration vectors implying the presence of a long-run relationship between the variables at the %1 level. Kao test results indicate the existence of a long-run relationship between te variables. All the findings provide an evidence that there is a cointegration relationship between per capita real income, government consumption expenditure and square of government consumption expenditure over the period.

Table 3. Panel cointegration test results

Cointegration tests	Fisher statistics (from trace test)	Fisher statistics (from max. eigen test)
Panel A: Johansen-Fisher		
None	255.6[a][0.000]	195.8[a][0.000]
At most 1	121.0[a][0.000]	120.0[a][0.000]
At most 2	32.88[0.106]	32.88[0.106]
Panel B: Kao	ADF statistics	
	1.876[b][0.030]	

Notes: The optimal lag length is selected using AIC. [a] and [b] denote significance at the 1% and 5% level, respectively. The values in parenthesis are *p*-values.

The estimations of long-run parameters are conducted by using panel pooled OLS method. The results are presented in Table 4. Diagnostic tests show that there are the problems of serial correlation and heteroscedasticity in the model. We apply the processes of AR(1) and White cross-section to resolve these problems. The results show that economic growth is positively correlated with the government consumption expenditure. This indicate that an increase in government size can enhance economic growth. The results also show that economic growth is negatively correlated with the square of government consumption expenditure. These findings provide an evidence supporting the presence of an inverted U shaped relationship between government size and economic growth.

Table 4. Panel regression estimation results
(Dependent variable: LNGDP, Method: Pooled panel OLS)

Variables	Coefficients	t-statistics	Standart errors
LNGOV	1.084	3.252 [a][0.001]	0.333
$LNGOV^2$	-0.267	-4.114 [a][0.000]	0.065
Constant	8.158	18.202 [a][0.000]	0.448
AR(1)	0.968	251.622 [a][0.000]	0.003
Diagnostic tests			
R^2		0.996	
Adjusted-R^2		0.996	
F-statistic		22628.85 [a][0.000]	
Durbin-Watson statistic		1.420	
LM_h (χ^2) statistic	262.852 [a][0.000]		
Baltagi-Lee (χ^2) statistic	385.831 [a][0.000]		

Notes: [a] denotes significance at the 1% level. The values in parentheses are *p*-values

Table 5 reports the results of the long-run, short-run and joint Granger causality. The results suggest that the lagged error correction term is negative and statistically significant at 5 % level as expected. This implies a causality running from government consumption expenditure and the squares of government consumption expenditure to economic growth in the long run. It is found that there exists a causal relation running from government consumption expenditure and the squares of government consumption expenditure to economic growth in the short run. It is also found that there exists a joint causal relation running from the explanatory variables to economic growth. The Granger causality findings provide an evidence that government consumption expenditure (government size) causes economic growth in developing countries over the period.

Table 5. Panel Granger causality test results (Dependent variable: LNGDP)

Series	Short run *F*-statistic	Long run *ECT*(-1)	Joint (Short run and Long run) *F*-statistic
ΔLNGOV	2.621^{b}[0.051]		
ΔLNGOV^{2}	2.628^{b}[0.051]		
ECT_{it-1}		-0.020^{a}[0.000]	
ΔLNGOV/ECT			6.061^{a}[0.000]
ΔLNGOV^{2}*/ECT*			6.116^{a}[0.000]

Notes: The optimal lag length is selected using AIC. ^{a} and ^{b} denote significance at the 1 % and 5 % level, respectively. The values in parentheses are *p*-values.

5. Conclusion and Policy Implication

The determinants of economic growth have been discussed by theorists and econometricians for a long time. Growth literature presents two fundemental models: exogenous growth model and endogenous growth model. The first model suggests that there is a linear relationship between a number of variables and economic growth in the long-run. In this model, government policy cannot influence the steady-state growth rates. The second model is well known as new growth theory. In this model government policy can affect economic growth either directly or indirectly. In this contex, a fundemental strand of the new growth theory concentrates on the inverted U relationship between government size and economic growth. This is generally called as Armey curve.

The study investigates the cointegration and causal relationship between the government consumption expenditure and economic growth in the context of Armey curve. We employ panel data covering 1990-2012 for 12 developing countries. Panel unit root tests indicate that the series are integrated at order of *I(1)* implying that we can apply the cointegration tests. Panel cointegration tests reveal that there exists a lon run relationship between the variables. Panel pooled OLS estimations suggest that the coefficients of government consumption expenditure and the squares of government consumption expenditure are positive and negative, respectively as expected. Granger causality test based on VECM shows that there exists a causal relation running from government consumption expenditure and the squares of government consumption expenditure to economic growt in the long run and short run. All the empirical findings reveal that there exists an inverted U-shaped relationship between government consumption expenditure and economic growth. So, the study provides an empirical evidence that the Armey curve is valid for developing countries over the period.

The empirical results also imply that there is an optimal level of government consumption expenditure. Therefore, governments should avoid excessive consumption expenditure. Otherwise, these excessive expenditure hamper to economic growth. On the other hand, this study can be repeated by considering different kinds of government spending. This empirical study may also bring about new empirical studies. In this respect, a further empirical research may include the individual countries or the sub groups of the panel.

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