BULLETIN
OF
ECONOMIC THEORY AND ANALYSIS

Journal homepage: https://dergipark.org.tr/tr/pub/beta

Testing the Armey Curve Hypothesis in Turkey: Evidence from the Provincial Data

Devran ŞANLI https://orcid.org/0000-0003-4106-3799

To cite this article: Sanlı, D. (2022). Testing the Armey Curve Hypothesis in Turkey: Evidence from the Provincial Data. *Bulletin of Economic Theory and Analysis*, 7(2), 425-443.

Received: 17 Nov 2022

Accepted: 25 Dec 2022

Published online: 31 Dec 2022

BETA — BULLETIN OF ECONOMIC THEORY AND ANALYSIS

Bulletin of Economic Theory and Analysis

Volume 7, Issue 2, pp. 425-443, 2022

https://dergipark.org.tr/tr/pub/beta

Original Article / Araştırma Makalesi

Received / Alınma: 17.11.2022 Accepted / Kabul: 25.12.2022

Testing the Armey Curve Hypothesis in Turkey: Evidence from the Provincial Data

Devran ŞANLI[a]

[a]Dr., Bartın University, Faculty of Economics and Administrative Sciences, Department of Economics, Bartın, TURKEY

https://orcid.org/0000-0003-4106-3799

ABSTRACT

This study aims to empirically test the Armey Curve hypothesis (optimal government size) for Turkey with panel data consisting of 81 provinces and 17 years. In this context, a quadratic model has been established in which economic growth is the dependent variable, and public expenditures are the independent variable. AMG estimates obtain the optimal size of public expenditures. The results indicate that the optimal level of public expenditures is 25.2%. Moreover, province-specific findings provide that the Armey curve is valid in 16 provinces, and the critical point of the curve takes values ranging from 12%(Istanbul) to 46%(Elazig). Considering the average volume of public expenditures is 31.6% throughout the panel, it is concluded that the expenditures exceed the optimal level. These results show that public expenditures are in the region of diminishing returns. Therefore, in order to maximize the growth rate, public expenditures should be reduced to an optimal level.

Keywords
Optimal Public Expenditures, Economic Growth, Armey Curve, Panel AMG.

JEL Classification
H50, O40, O47

CONTACT Devran ŞANLI ✉ devransanli@gmail.com Bartın University, Faculty of Economics and Administrative Sciences, Department of Economics, Bartın, TURKEY

1. Introduction

There have been significant changes in the historical process regarding the size of the public sector and its share in the economy. While it was the dominant view that public expenditures should be at a minimum level in the classical period, the influential role of the public on economic policies changed after the 1929 crisis, when Keynesian policies were dominant.

The ideas put forward on the size of the state are generally clustered around two main views. The first view, by making a statement on the crowding-out effect, argues that the public sector could not use resources effectively and that excluding productive investments deteriorates resource allocation and negatively affects economic growth. In this case, the economy is growing below its potential. According to the second view, the private sector does not have the power to provide the necessary infrastructure for economic activity. Some sectors, by their nature, operate in imperfectly competitive markets. For these reasons, using public power, the state should undertake functions that will provide the infrastructure, technology, physical and human capital accumulation needed by the sectors for development and growth. There is also the necessity of producing complete public goods that cannot be priced. However, even in this case, there must be a limit to the economic size of the state. Because as the economic size of the state increases, taxes, which are the primary financing of public expenditures, will have to increase, which will increase the tax burden on taxpayers.

Within the scope of the second hypothesis, this study investigates the optimal level of public expenditures that maximizes economic growth in Turkey. Although many time series analyses in the literature investigate the optimal level of public expenditures in Turkey, the main difference that distinguishes the study from previous studies is that it put forward findings based on panel data methodology with regional (provincial) level data. Therefore, it is the first known paper on Turkey based on regional data in the literature.

The study consists of four principal parts. First section draws the theoretical framework explaining the public expenditures-growth relationship. The second section present the literature that includes the periods, methodologies, and findings of previous studies. In the third section, the data set and the model source of the empirical application are introduced. In the fourth section, there are applications of econometric analysis. Finally, the last section discusses results and policy recommendations regarding the findings.

2. Theoretical Background

The current theoretical framework of the relationship between public expenditures and growth is based on the study of Barro (1989). Barro's rule states that optimal expenditure occurs when the marginal efficiency of public expenditure is equal to one. In an economy where the public sector is minuscule, an expansion in public expenditures causes the output to increase with increasing returns (Barro, 1990), while the diminishing return principle comes into play when the size of the expenditures is larger than the optimal level (Karras, 1997).

The optimal level of public expenditure, which brings economic growth to its maximum, is analysed analytically with the Armey curve (Armey, 1995). Armey's (1995) methodology suggests a quadratic functional relationship between public expenditure and economic growth. Therefore, the increase in public expenditures accelerates economic growth at the beginning. However, when the expenditure level exceeds the optimum, public expenditures function as a factor that reduces the growth rate. Any expansion in public spending in the economy is initially associated with an expansion in output, but as spending increases, additional government-funded projects and investments become increasingly less productive.

In this case, there is an inverted U-shape relationship between public expenditures and economic growth. The empirical literature defines this functional relationship as the Armey Curve or BARS Curve, referring to the studies of Barro (1989, 1990), Armey, (1995), Rahn and Fox (1996), and Scully (1994, 1995).

The existence of the Armey curve makes it significant to determine the critical public expenditures that optimize growth accurately. Because informed the optimal public expenditure level of policymakers and institutions prioritizing the economic growth purpose is critical information for the decision to expand or reduce expenditures.

Figure 1 provides the Armey Curve pointing to the relationship between public expenditures and economic growth.

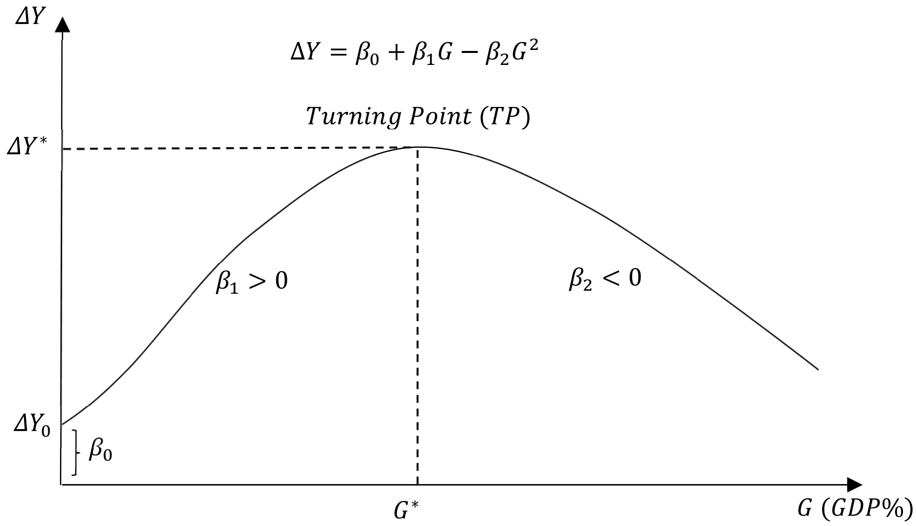

Figure 1. Armey Curve

Each country has its economic conditions and characteristics. Therefore, the general form of the curve is as given in the figure, although there are different optimal levels of public expenditure that maximize growth.

The policy of augmenting public expenditures in developing countries should be implemented cautiously and selectively. Developing countries have features of extensive government intervention, undemocratic political systems, inefficient public sector, high corruption, and rent-seeking activities. These qualities may lead to the failure of public expenditure policies for economic prosperity and growth (Hajamini & Falahi, 2014).

Many studies investigate the optimal public expenditure level that maximizes economic growth. Previous papers in different country samples and methodologies suggest various findings about the optimal level of public expenditure. Studies for Turkey show a similar structure. Empirical shreds of evidence essentially confirm the validity of the Armey Curve in Turkey but put forward different conclusions about where is the critical point at which public spending maximizes growth. The analyses for Turkey show that the critical point (Public Expenditures/GDP) varies between 8.8% and 25.2%.

The Turning Point (TP) provides information about the point at which the crowding-out effect caused by public expenditures begins to emerge. The low level of the turning point means that the weight of the public is small in the economies and that public expenditures are not qualified to stimulate economic growth structurally. The fact that the turning point is at a high level indicates that the crowding out emerges lagged, and public expenditures stimulate economic growth. One of the reasons for this study is that previous studies for Turkey calculated the critical point in an extensive range (8.8%-25.2%). The difference between the current and other time series studies for Turkey is that the data is collected at the provincial level, and the investigation is carried out with panel data analysis methods. At this point, the analysis will be able to present new findings in a larger sample. In this respect, the research differs from previous studies and investigates the validity of the Armey Curve and the threshold level of public expenditures with regional data. Table 1 illustrates the findings and methods of previous studies specific to different economies and Turkey.

Table 1.

Literature brief

Author(s)	**Economy / Period**	**Variables/ Dep.-Independent**	**Methodology**	**Findings**
(Karras, 1996)	118 Country 1960-1985	$\dot{Y}/Y$ - Marginal Efficiency of Public Expenditures	Panel GLS	Optimal Public Expenditure: Panel-overall: 23%, OECD: 14% Others: 22%.
(Günalp, 2003)	27 Transition Economy 1985-2000	$\dot{Y}/Y$ - Marginal Efficiency of Public Expenditures	Panel OLS-Panel FE, Panel RE	Optimal Public Expenditure: 23.8%
(Pevcin, 2004)	EU-12 1950-1996	Y- (G, G^2)	Panel FE, Panel LSDV, ECM	Armey Curve is supported, Optimal Public Expenditure: FE: 36.56%, LSDV: 40.03% ECM: 42.12%
(Forte & Magazzino, 2011)	EU-27 1970-2011	ΔY- (G, G^2)	Panel GMM	Armey Curve is supported, Optimal Public Expenditure: 37.79%
(Josheski et al., 2012)	OECD-12 1950-2007	Y- (G, G^2, TP, PC, GCF, POP, EXC)	Panel OLS	Armey Curve is supported, Optimal Public Expenditure: 8.98%
(Altunç & Aydın, 2012)	Turkey 1975-2010	Y- (G, G^2; G_C, G_I, and squares, U,t)	Time Series OLS	Armey Curve is supported, Optimal Public Expenditure 16%
(Altunc & Aydın, 2013)	Turkey, Bulgaria, Romania 1995-2011	Y- (G, G^2; G_C, G_I, and squares, U,t)	Time Series ARDL	Armey Curve is supported, Optimal Public Expenditure: Turkey: 25.2%, Romania: 20.4%, Bulgaria: 22.5%
(Hajamini & Falahi, 2014)	21 Low-Income and 11 Low Middle-Income Countries	ΔY - (G, TP, PC, GCF, POP, EXC)	Panel Threshold Analysis	Optimal Public Expenditures: 16.2% in Low-Income Countries, 16.9% in Low Middle-Income Countries. Panel Overall 17.7%.
(Turan, 2014)	Turkey 1950-2012 1970-2012	Y- (G, G^2,U,OPN)	Time Series OLS	Armey Curve is supported, Optimal Public Expenditure: First Period: 8.8%

Author(s)	Economy / Period	Variables/ Dep.-Independent	Methodology	Findings
				Second Period: 15.4%.
(Hok et al., 2014)	8 Asian Countries 1995-2011	ΔY- (G, G^2)	Panel MG-PMG	Armey Curve is supported, Optimal Public Expenditure: 28.5%.
(Pamuk & Dündar, 2016)	Turkey 1950-2006	ΔY- (T-G)	Time Series OLS-VECM	Armey Curve is supported, Optimal Public Expenditure: Time Series OLS: 18.5% and VECM: 23.5%
(Harb & Hall, 2019)	Egypt, Iran, Morocco,Tunisia and Turkey 1970-2014	ΔY- (G,GCF,INF,HC)	Panel Threshold Analysis	Armey Curve is supported, Optimal Public Expenditure: 17.25%
(Yamak & Erdem, 2018)	Turkey 1998: Q1-2016: Q2	ΔY- (G, G^2)	Time Series ARDL	Armey Curve is supported, Optimal Public Expenditure 16%
(di Matteo & Barbiero, 2018)	Canada and Italy 1871-2013	ΔY- (G, G^2,DBT,IR,X)	Time Series FGLS	Armey Curve is supported, Optimal Public Expenditure: Canada 22%, Italy: 33%
(Bozma et al., 2019)	G7 Countries 1981-2014	ΔY- (G, G^2; U,t)	Panel ARDL	Armey Curve Valid for America, France, and Canada Optimal Public Expenditure, respectively: 12.46%; 23.57%; 18.93%
(Bayrak, 2019)	Turkey 1990-2017	ΔY- (HE, HE^2; U)	Time Series-FMOLS	Armey Curve is supported, Optimal Public Expenditure 2.5%
(Binay, 2019)	21-OECD 1975-2012	Y_{pc}- (DE, DE^2)	Panel AMG	Armey Curve Not Valid in Canada, New Zealand and Turkey, Valid in Other Countries.
(Şen & Kaya, 2019)	Turkey 2006: Q1-2016: Q2	Y- (G)	Time Series Threshold Analysis	Armey Curve is supported, Optimal defense expenditure 2.5%
(Lich, 2019)	30 Country 2004-2013	Y- (G, G^2 ,HT,URB,GCF,LBR)	Driscoll-Kraay Panel FE, Panel RE	Armey Curve is supported, Optimal Public Expenditure: 19.38%
(Aydin & Esen, 2019)	26 Country 1993–2016	Y- (G, GCF, POP)	Panel GMM Threshold Analysis	Armey Curve is supported Optimal Public Expenditure is 17.54% in Developed Countries and 11.67% in Developing Countries.
(Altunakar & Buyrukoğlu, 2020)	Turkey 1980-2019	Y- (G, G^2)	Time Series ARDL	Armey Curve is supported Optimal Public Expenditure: 19%
(Yüksel, 2020)	Turkey 1981-2018	Y- (G, G^2)	Time Series ARDL	Armey Curve is supported, Optimal Public Expenditure 16%
(Nouira & Kouni, 2021)	MENA Countries 1988-2016	Y- (G, G^2)	Panel CS-ARDL	Armey Curve is supported, Optimal Public Expenditure changes between 20% and 30%

Author(s)	Economy / Period	Variables/ Dep.-Independent	Methodology	Findings
(Jain et al., 2021)	16 Developing Countries 2007-2016	Y- (G, G^2; G_C, G_I, and squares, OPN, LT, EFI,	Panel GMM	Armey Curve is supported, Optimal Public Expenditure: 24.31%. Optimal Public Consumption 12.92%; Optimal Public Investment 7.11%.
(Bayrak, 2021)	21 Developed and Developing Countries 1990-2019	Y- (G, G^2, U, GCF)	Panel AMG	Armey Curve is supported, Optimal Public Expenditure is 30.67% in Developed Countries and 25.43% in Developing Countries.
(Dada et al., 2021)	ECOWAS Countries 1991-2018	Y- (G, G^2 and various macro variables)	Panel OLS	Armey Curve is supported, Optimal Public Expenditure: 30.67%

Abbreviations: DBT: Public Debt EFI: Economic Freedom Index EXC: Exchange Rate G: Total Public Expenditures GC: Public Consumption Expenditures GCF: Fixed Capital GI: Public Investment Expenditures HT: Hi-Tech Exports IR: Interest Rate LBR: Labor Growth LT: Schooling Rate OPN: Openness PC: Private Consumption Expenditures POP: Population HE: Health Expenditures DE: Defense Expenditures TP: Global Prices U: Unemployment URB: Urban Population X: Exports Y: GDP ΔY: GDP Growth

The provided findings in the literature show that the critical point of the Armey curve takes different values in varied countries and country groups. While this critical value is between 14% and 42.12% in country groups, it is between 8.8% and 25.2% in Turkey.

3. Dataset and Model

The panel data set, the basis of the empirical application, was prepared in the NUTS-3 region of Turkey and at annual frequencies between the years 2000-2020. Accordingly, the validity of the Armey Curve in Turkey was investigated with regional data. The characteristics of the variables in the panel data set consisting of 81 provinces and 17 years are presented in Table 2.

Table 2

Information about variables

Variables	Abbreviations	Description	Data Source	Scale and Unit
GDP Growth	ΔY	Regional Real Gross Domestic Product Growth	Turkish Statistical Institute (TURKSTAT/TUIK)	Decimal, Level
Total Public Expenditures	G	Total Public Expenditure Items*	Turkish Ministry of Treasury and Finance	Ratio to GDP- Decimal, Level
Total Square of Public Expenditures	G^2	Total Public Expenditure Items*	Turkish Ministry of Treasury and Finance	Ratio to GDP- Decimal, Level

Price Level	P	Consumer Price Index (2003=1)	Turkish Statistical Institute (TURKSTAT/TUIK)	Endeks-Düzey

Note: The distribution of the price level from the regional level to the provincial level and the realization of the variables were made by the author.
*Personnel Expenses, Social Security Payments, Purchases of Goods and Services, Interest Expenditures, Current Transfers, Capital Expenditures, Capital Transfers, Lending.

Concerning the economic classification, the central government state budget consists of nine items: personnel expenditures, social security institution payments, goods and services purchases, interest expenditures, current transfers, capital expenditures, capital transfers, lending, and reserve payments. When distributing the price level (P) from the NUTS-2 (region) to the NUTS-3 (provincial), it is assumed that it does not change according to the provinces. A significant part of the public expenditure items is accounted for as a central payment by the Ministry of Treasury and Finance in government budget. Central payment is around 59% for 2020. The central payment item has been distributed to other expenditure items in proportion to their weight in the budget. “Lending” and “reserve payments” items in the budget are included in the total and are not defined as variables while the central payment item is allocated.

Based on the data at the provincial level of Turkey, the closed form of the model created to analyze the extent to which economic growth is affected by public expenditures and whether the Armey Curve is valid or not is given in Equation 1.

$$\Delta Y = f\left\{G, G^2\right\}$$

where, (1)

$\Delta Y : Output\ growth\ and\ G :\ Total\ public\ (government)\ expenditures$

Equation 2 shows the econometric equation from which the coefficients estimate.

$$(\Delta Y)_{i,t} = \alpha + \beta_1 (G)_{i,t} + \beta_2 (G^2)_{i,t} + \varepsilon_{i,t} \tag{2}$$

Theoretically, the expected signs of these variables that affect economic growth should be positive for public expenditures, and the square of public expenditures should be negative for the Armey curve to be valid. In the regression equation estimated in this direction, the coefficient of β_1 is positive $\frac{\partial(\Delta Y)}{\partial(G)} > 0$; The coefficient β_2 is expected to take negative values $\frac{\partial(\Delta Y)}{\partial(G^2)} < 0$.

Equation 3 indicate the optimal level of public expenditure that will maximize the growth rate based on the estimated regression coefficients. If a non-linear, U or inverted U-shaped functional structure is detected between economic growth and public expenditure, the critical value that gives the turning point (TP) of the curve is obtained as:

$$TP = -\frac{\beta_1}{2\beta_2} \tag{3}$$

4. Econometric Findings

Sooner than progressing to the findings of the empirical application, it will be beneficial to determine the relationships between the variables a priori and to introduce the variables. For this purpose, summary data are given in Table 3.

Table 3

Summary data

variables	**N**	**mean**	**sd**	**cv**	**min**	**max**	**range**
ΔY	1215	0.038	0.054	1.426	-0.136	0.275	0.412
G	1296	0.315	0.130	0.414	0.106	1.097	0.991
G^2	1377	0.117	0.111	0.954	0.011	1.204	1.193

The table above shows some of the main characteristics of the dataset. When the summary data consisting of the economic growth and public expenditures of the provinces of Turkey is examined, it is seen that the economic growth was 3.8% on average, and the public expenditures were 31.6% in the 2004-2020 period.

From this point forth, the validity of the regression assumptions will be investigated by diagnostic tests. First, regression residuals and variables were tested with the Pesaran (2004) CD cross-section dependency test, and the findings are presented in Table 4.

Table 4

Cross-section dependency test for variables and residuals

Variables	**Cd-Test**	**P-Value**	**Correlation**	**Absolute Correlation**
ΔY	104.980	0.000	0.476	0.482
G	120.420	0.000	0.513	0.526
G^2	122.890	0.000	0.524	0.535
Residual	*104.720*	*0.000*	*0.475*	*0.481*

Under the null hypothesis of no cross-sectional dependence (CD ~ N (0,1)), CD test statistics and probability values show that the null hypothesis should be rejected at a 1% significance level. The presence of cross-section dependence was found in both variables and model residuals.

This shows the necessity of using robust methods for cross-section dependence in both unit root tests and regression analysis. Greene (2012) modified Wald and Wooldridge (2002) F tests were used to determine whether other OLS assumptions (HAC-Heteroskdastictiy-Autocorrelation) were met. The results obtained are presented in Table 5.

Table 5

Diagnosis of heteroskedasticity and autocorrelation

	Test Type	**Test statistics**	**p-value**
Heteroskedasticity	Modified Wald Test	737.58	0.000
Autocorrelation	Wooldridge F Test	46.97	0.000

Note: The null hypothesis of the wald test (H0): No heteroscedasticity (homoscedasticity). The null hypothesis of the F test (H0): No autocorrelation.

The statistics obtained from the tests reveal that the null hypotheses should be rejected at the 1% significance level for both tests. Accordingly, there are heteroskedasticity and autocorrelation problems in the model. Table 6 provides the findings of Pesaran (2007) CADF unit root test, which considers the cross-section dependency problem, which is given.

Table 6

CADF unit root test

variables		**constant**			**constant + trend**	
(level)	**t-bar**	**Z[t-bar]**	**p-value**	**t-bar**	**Z[t-bar]**	**p-value**
ΔY	1.796	-0.704	0.241	1.700	31.540	1.000
G	-1.003	6.355	1.000	1.593	6.209	1.000
G^2	-0.800	8.127	1.000	-1.558	6.526	1.000
variables		**constant**			**constant + trend**	
(Δ)	**t-bar**	**Z[t-bar]**	**p-value**	**t-bar**	**Z[t-bar]**	**p-value**
ΔY	3.323	-13.200	0.000***	3.203	-7.508	0.000***
G	2.452	-6.309	0.000***	2.528	-2.122	0.017**
G^2	2.474	-6.504	0.000***	-2.564	-2.442	0.007***

Note: The null hypothesis (H0) assumes that all series are not stationary. (***) indicates that the null hypothesis was rejected at the 1% level. Constant term critical values: 10%: -2.000 5%:-2.070, 1%:-2.190. Constant term + trend critical values: 10%: -2.510, 5%: -2.590, 1%: -2.740.

The test statistics show that the variables are not stationary at the 1% critical level in the constant and constant+trend options. They become stationary at the first difference. The fact that all series are integrated I(1) allows the investigation of cointegration (long-run relationship). Westerlund (2005) test was used in the cointegration analysis. The process was performed by subtracting the cross-sectional averages from the series using the Levin et al. (2002) method. The results of the unit root analysis are set out in Table 7.

Table 7

Cointegration test

Test Type	**Test statistics**	**p-value**
Variance Ratio	-5.257	0.000

Note: Null hypothesis (H0): Series are not cointegrated.

The results indicate that the null hypothesis is rejected at the 1% significance level. Accordingly, there is a significant long-term relationship between the series. Variance ratio test revealed that cointegration.

The validity of the OLS assumptions was investigated with diagnostic tests, and it was determined that the validity of the linear regression assumptions could not be ensured. Moreover, it was concluded that the series is not stationary. However, the series are cointegrated. That is, they move together in the long run. Due to bias from the regression assumptions, analysis was performed using the Augmented Mean Group Estimator (AMG) method. The AMG estimator is used when the best linear unbiased (BLUE) assumptions of the ordinary least squares method are not met. It has been shown in Monte-Carlo simulations that it allows the estimation of robust (unbiased and efficient) coefficients in panel series with non-stationary and cross-section correlations. The estimator in question forms part of the panel time series and non-stationary panel literature. However, it allows the estimation of robust coefficients in the unit root, cross-section dependence, parameter heterogeneity, autocorrelation, and heteroskedasticity (Eberhardt & Bond, 2009; Eberhardt & Teal, 2010, 2011). The unobservable effects parameter in the AMG method can be added as an explanatory variable to the regression as the dynamic process coefficient (cdp). The Cdp parameter is derived from the coefficients of different year dummies and represents the cross-sectional mean of the evolution of unobservable effects over time. The first difference of the extended pooled regression model with year dummies is based on OLS estimates. Table 9 shows AMG regression estimated coefficients and statistics.

Table 8.

Long-run coefficient estimates

variables	Model 1 (AMG-Robust)				Model 2 (AMG-Robust & cdp)			
	coefficients	**Conf. Interval**	**z**	**p-value**	**coefficients**	**Conf. Interval**	**z**	**p-value**
G	2.261* (1.186)	-0.064/4.587	1.91	0.057	4.062*** (1.285)	1.543/6.580	3.16	0.002
G^2	-4.776** (1.915)	8.529/-1.023	-2.49	0.013	-8.060*** (2.236)	-12.44/-3.677	-3.60	0.000
cdp					0.959*** (0.0419)	0.877/1.041	22.90	0.000
constant	-0.334* (0.190)	0.707/0.039	-1.75	0.080	-0.507*** (0.189)	0.878/-0.136	-2.68	0.007
Turning Point (TP)	*0.2367 %23.67*				*0.2519 %25.19*			
Wald chi2	9.85				22.98			
Wald p-value	0.0073				0.0000			
RMSE	0.0360				0.0342			
Obs.	1215				1215			
Groups	81				81			

Note: Values in parentheses are standard errors. The z values can be obtained by dividing the coefficients by the standard errors. cdp: common dynamic process. *** p<0.01, ** p<0.05, * p<0.1

Since it contains the cdp parameter and has a lower RMSE value, interpretations will be made based on Model 2 results. The Chi-Square and Wald probability values obtained from the model show that the model is generally significant. In addition, the confidence interval estimates obtained from the Model 2 coefficients do not change the sign at the ends. Hence, they do not present contradictory findings about the sign of the coefficient. Besides, the signs of the estimated long-run regression coefficients are consistent with economic theory. The findings show that public expenditures (G) and public expenditures quadratic terms (G^2) have statistically significant and economically compatible signs. A non-linear relation was found between public expenditures and income growth. The fact that the G coefficient itself is positive (+) and its square is negative (-) indicates that the Armey Curve is valid between growth and public expenditures in Turkey. According to Model 2 estimates, when public expenditures increase by 1 point, growth increases by 0.04 points. When public expenditures exceed the optimal level (TP=25.19%), which is defined as the turning point, public expenditures have a negative effect on economic growth. The share of optimal public expenditures in the product was estimated to be approximately 23.67% for Model 1 and 25.19% for Model 2 in the Turkish economy.

Moreover, the common dynamic process coefficient (cdp) was estimated as positive and statistically significant. This situation shows that an unobservable effect that increases economic growth in one province and occurs in different periods has an increasing effect on growth in other provinces or vice versa.

The most extensive panel regression models, like random and fixed effects models, accept that the regression slopes coefficients are identical to whole cross-sections (Blomquist & Westerlund, 2016). However, in most cases, there are no homogeneous slopes. Thus, slope heterogeneity should consider to avoid estimation bias.

Table 9

Slope homogeneity

Delta Test	**Test Statistics**
$\boldsymbol{\Delta}$	4.184*** (0.000)
Δ_{adj}	5.401*** (0.000)

Note: P-values are in parenthesis H_0: Slope coefficients are homogenous

Table 9 suggests both the two statistics reject the null hypothesis of slope homogeneity at a 1% level. Therefore, slope heterogeneity should be considered to avoid the estimation bias.

Therefore, heterogeneous coefficient estimates were performed. Appendix I presents the province-specific coefficients. The findings provide that the Armey curve is valid in 16 provinces. The critical point of the curve takes values ranging from 46% (Elazig) to 12% (Istanbul).

5. Conclusion

The Armey Curve hypothesis was tested in this study, which was conducted using data at the level of 81 provinces in the Turkish economy. The coefficients of the relationship between the size of public expenditures and economic growth were estimated by the panel AMG method in the quadratic model. The primary contribution of this study to the literature and the aspect that distinguishes it from other papers is based on the applied empirical methodology and regional panel data. The empirical findings support the validity of the Armey Curve in Turkey with regional data. However, the optimal level of expenditure differs from other studies. Considering the size of the spending volume, even the minimal differences in the results are essential. The calculated optimal level of public expenditure is 25.2% of GDP. Public expenses exceed this point, which slows down growth. This finding confirms the results of Şen and Kaya's time series study for Turkey and Jain panel data study, which covers developing economies, including Turkey. Considering that size of the government at the provincial level is 31.6% overall panel, it is concluded that the expenditures exceed the optimal level. This information provides a basis for assessing whether public spending is stimulating growth. According to the models' results, policymakers who want to maximize the growth rate need to optimize public expenditures. It is expected that the use of the existing government expenditure potential in productive investment areas that will increase the accumulation of human-physical capital, health and technology, apart from current transfer and interest expenditures, will contribute more to growth. This includes rational restructuring of not only the volume of public expenditure but also the composition. However, the current coronavirus pandemic era has once again shown the importance of public expenditures in crisis management and social welfare protection. Nonetheless, the current coronavirus pandemic term has once again demonstrated the importance of public expenditures in crisis management and social welfare protection. It is seen that the governments have the opportunity to significantly reduce the negative economic consequences created by the pandemic conditions if they adopt good management (especially in the fields of health, education, manufacturing and logistics) and an effective-rational incentive-support policy.

References

Altunakar, Ş., & Buyrukoğlu, S. (2020). Türkiye'de Abrams ve Armey eğrilerinin geçerliliği. *Elektronik Sosyal Bilimler Dergisi*, *19*(76), 1862–1878. https://doi.org/10.17755/esosder.730089

Altunç, Ö., & Aydın, C. (2012). Türkiye'de kamu sektörü büyüklüğü ve ekonomik büyüme ilişkisinin ampirik analizi. *Ekonomik Yaklaşım*, *23*(82), 79–98. https://doi.org/http://dx.doi.org/10.5455/ey.20003

Altunc, O. F., & Aydın, C. (2013). The relationship between optimal size of government and economic Growth: empirical evidence from Turkey, Romania and Bulgaria. *Procedia - Social and Behavioral Sciences*, *92*, 66–75. https://doi.org/10.1016/j.sbspro.2013.08.639

Armey, D. (1995). The freedom revolution. In *Regnery Publishing*.

Aydin, C., & Esen, Ö. (2019). Does too much government spending depress the economic development of transition economies? Evidences from dynamic panel threshold analysis. *Applied Economics*, *51*(15), 1666–1678. https://doi.org/10.1080/00036846.2018.1528335

Barro, R. J. (1989). *A cross-country study of growth, saving, and government* (No. w2855; NBER Working Paper). https://ssrn.com/abstract=227242

Barro, R. J. (1990). Government spending in a simple model of endogenous growth. Journal of Political Economy. *Journal of Political Economy*, *98*(S5), 103–125.

Bayrak, R. (2019). Does the optimal size of defense expenditure exist? An empirical study on Turkey. *Savunma Bilimleri Dergisi The Journal of Defense Sciences*, *18*(1), 135–160. https://doi.org/https://doi.org/10.17134/khosbd.561221

Bayrak, R. (2021). How does the development level of countries affect optimal size of government: An empirical study with panel data analysis. *Nevşehir Hacı Bektaş Veli Üniversitesi SBE Dergisi*, *11*(1), 391–405. https://doi.org/10.30783/nevsosbilen.870485

Binay, M. (2019). OECD Ülkelerinde sağlık harcamalarının ekonomik büyümeyi maksimize edecek şekilde optimizasyonu. *Sosyal Güvenlik Dergisi*, *9*(2), 449–476. https://doi.org/10.32331/sgd.658899

Blomquist, J., & Westerlund, J. (2016). Panel bootstrap tests of slope homogeneity. *Empirical Economics*, *50*(4), 1359–1381. https://doi.org/10.1007/s00181-015-0978-z

Bozma, G., Başar, S., & Eren, M. (2019). Investigating validation of armey curve hypothesis for G7 countries using ARDL model. *Doğuş Üniversitesi Dergisi*, *20*(1), 49–59. https://doi.org/10.31671/dogus.2019.416

Dada, M. A., Posu, S. M. A., Adedeji, O. A., & Ojo, O. T. (2021). Government size and economic growth in ECOWAS sub-region: A test of the non-monotonic hypothesis. *Ife Social Sciences Review*, *29*(1), 100–116. https://issr.oauife.edu.ng/index.php/issr/article/view/128 di Matteo, L., & Barbiero, T. (2018). Economic growth and the public sector: A comparison of Canada and Italy, 1870-2013. *Review of Economic Analysis*, *10*(3), 221–243. https://doi.org/10.15353/rea.v10i3.1445

Eberhardt, M., & Bond, S. (2009). *Cross-section dependence in nonstationary panel models: a novel estimator*. https://EconPapers.repec.org/RePEc:pra:mprapa:17692

Eberhardt, M., & Teal, F. (2010). Productivity analysis in global manufacturing production. In *Eco-nomics Series, 2010* (Issue 515). https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.983.4340&rep=rep1&type=pdf

Eberhardt, M., & Teal, F. (2011). Econometrics for grumblers: A new look at the literature on cross-country growth empirics. *Journal of Economic Surveys*, *25*(1), 109–155. https://doi.org/10.1111/j.1467-6419.2010.00624.x

Forte, F., & Magazzino, C. (2011). Optimal size government and economic growth in EU countries. *Economia Politica*, *28*(3), 295–322. https://doi.org/10.1428/35913

Greene, W. H. (2012). Econometric analysis. In *Prentice Hall* (7th ed.). Prentice Hall.

Günalp, B. (2003). Gelişmekte olan ülkelerde optimal devlet hacmi. *Hacettepe Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi*, *21*(2), 1–20. https://dergipark.org.tr/en/pub/huniibf/issue/7881/103557

Hajamini, M., & Falahi, M. A. (2014). The nonlinear impact of government consumption expenditure on economic growth: Evidence from low and low-middle income countries. *Cogent Economics and Finance*, *2*(1). https://doi.org/10.1080/23322039.2014.948122

Harb, N., & Hall, S. G. (2019). Does foreign aid play a role in the maintenance of economic growth? A non-linear analysis. *The Quarterly Review of Economics and Finance*, *73*, 192–204. https://doi.org/https://doi.org/10.1016/j.qref.2018.12.002

Hok, L., Jariyapan, P., & Buddhawongsa, P. (2014). Optimal size of government spending: Empirical evidence from eight countries in southeast asia. *The Empirical Econometrics and Quantitative Economics Letters*, *3*(4), 31–44.

Jain, M., Nagpal, A., & Jain, A. (2021). Government size and economic growth: An empirical examination of selected emerging economies. *South Asian Journal of Macroeconomics and Public Finance*, *10*(1), 7–39. https://doi.org/10.1177/2277978720979889

Josheski, D., Lazarov, D., & Koteski, C. (2012). Analysis of the optimal size of the government consumption. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.1880905

Karras, G. (1996). The optimal government size: Further international evidence on the productivity of government services. *Economic Inquiry*, *34*(2), 193–203. https://doi.org/10.1111/j.1465-7295.1996.tb01372.x

Karras, G. (1997). On the optimal government size in Europe: Theory and empirical evidence. *Manchester School*, *65*(3), 280–294. https://doi.org/10.1111/1467-9957.00057

Lich, H. K. (2019). The optimal public expenditure in developing countries. *VNU Journal of Science: Economics and Business*, *35*(2), 13–23. https://doi.org/10.25073/2588-1108/vnueab.4228

Nouira, R., & Kouni, M. (2021). Optimal government size and economic growth in developing and MENA countries: A dynamic panel threshold analysis. *Middle East Development Journal*, *13*(1), 59–77. https://doi.org/10.1080/17938120.2021.1898231

Pamuk, Y., & Dündar, U. (2016). Kamu harcamalarının optimal boyutu: Türkiye örneği. *Hacettepe Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi*, *34*(3), 23–50. https://doi.org/10.17065/huniibf.259128

Pesaran, M. H. (2004). *General diagnostic tests for cross section dependence in panels* (No. 1240; IZA Discussion Paper).

Pesaran, M. H. (2007). A simple panel unit root test in the presence of cross-section dependence. *Journal of Applied Econometrics*, *22*(2), 265–312. https://doi.org/https://doi.org/10.1002/jae.951

Pevcin, P. (2004). Economic output and the optimal size of government. *Economic and Business Review for Central and South - Eastern Europe*, *6*(3), 213–227. https://search.proquest.com/docview/219420425?accountid=14681

Rahn, R., & Fox, H. (1996). *What is the optimal size of government?* Vernon K. Krieble Foundation.

Scully, G. W. (1994). What is the Optimal Size of Government in the US? (No. 188). http://www.ncpathinktank.org/pdfs/st188.pdf

Scully, G. W. (1995). The "growth tax" in the United States. *Public Choice*, *85*(1–2), 71–80. https://doi.org/10.1007/BF01047902

Şen, H., & Kaya, A. (2019). Alternatif göstergeler bazında Türkiye'de optimal kamu kesimi büyüklüğünün tahmini. *Bankacılar*, *30*(109), 49–81. http://search/yayin/detay/354676

Turan, T. (2014). Optimal size of government in Turkey. *International Journal of Economics and Financial Issues*, *4*(2), 286–294.

Wooldridge, J. M. (2002). Econometric analysis of cross section and panel data. In *Booksgooglecom* (1st ed., Issue 2).

Yamak, R., & Erdem, H. F. (2018). Türkiye ekonomisinde Armey eğrisi geçerli midir? *Uluslararası İktisadi ve İdari İncelemeler Dergisi*, *Prof. Dr. Harun TERZİ Özel Sayısı*, 335–346. https://doi.org/10.18092/ulikidince.442807

Yüksel, C. (2020). The size of the public sector and the armey curve: The case of Turkey. In *Critical Debates in Public Finance* (pp. 137–154). Peter Lang AG.

Appendix I. Group-specific coefficients

id	province	variables	Coef.	Std.Err.	Prob	id	province	Coef.	Std.Err.	Prob
1	Adana	G	6.385	5.344	0.232	42	Konya	5.753	15.718	0.714
		G2	-15.653	10.529	0.137			-13.958	29.805	0.640
2	Adıyaman	G	2.767	3.084	0.370	43	Kütahya	15.951	14.189	0.261
		G2	-4.511	3.919	0.250			-38.375	29.524	0.194
3	Afyonkarahisar	G	1.848	13.264	0.889	44	Malatya	1.952	9.609	0.839
		G2	-6.179	25.686	0.810			-3.759	13.132	0.775
4	Ağrı	G	-5.144	5.420	0.343	45	Manisa	-0.938	8.740	0.915
		G2	5.233	5.525	0.344			-6.234	23.854	0.794
5	Amasya	G	14.989	16.210	0.355	46	Kahramanmaraş	-3.471	11.766	0.768
		G2	-23.762	24.798	0.338			4.053	20.590	0.844
6	Ankara	G	7.628	19.962	0.702	47	Mardin	-6.008	5.443	0.270
		G2	-11.110	27.623	0.688			6.604	7.237	0.361
7	Antalya	G	59.013	29.327	0.044	48	Muğla	2.729	25.994	0.916
		G2	-171.203	81.803	0.036			-12.242	65.720	0.852
8	Artvin	G	3.763	8.263	0.649	49	Muş	-1.728	7.401	0.815
		G2	-6.283	11.434	0.583			1.523	9.527	0.873
9	Aydın	G	6.650	18.740	0.723	*50*	*Nevşehir*	*32.596*	*18.949*	*0.085*
		G2	-17.357	38.213	0.650			*-63.664*	*36.221*	*0.079*
10	Balıkesir	G	14.786	14.586	0.311	51	Niğde	-5.703	8.829	0.518
		G2	-34.610	30.103	0.250			7.734	15.064	0.608
11	Bilecik	G	10.799	8.773	0.218	*52*	*Ordu*	*-19.095*	*8.355*	*0.022*
		G2	-34.316	23.075	0.137			*28.880*	*14.497*	*0.046*
12	Bingöl	G	1.357	2.860	0.635	53	Rize	0.432	6.992	0.951
		G2	-1.479	2.558	0.563			-2.305	13.956	0.869
13	Bitlis	G	3.045	4.167	0.465	54	Sakarya	4.806	7.592	0.527
		G2	-3.240	3.895	0.405			-17.228	18.481	0.351
14	Bolu	G	-1.192	7.047	0.866	55	Samsun	-8.196	7.941	0.302
		G2	-1.601	14.260	0.911			9.478	11.735	0.419
15	Burdur	G	1.126	4.146	0.786	56	Siirt	6.423	8.239	0.436
		G2	-3.951	8.711	0.650			-6.164	8.434	0.465
16	Bursa	G	32.173	26.905	0.232	57	Sinop	3.407	8.739	0.697
		G2	-104.738	81.729	0.200			-7.575	14.179	0.593
17	Çanakkale	G	9.649	8.114	0.234	58	Sivas	-0.801	2.972	0.788
		G2	-22.347	16.709	0.181			0.560	4.053	0.890
18	Çankırı	G	6.570	9.912	0.507	*59*	*Tekirdağ*	*46.559*	*11.440*	*0.000*
		G2	-11.415	15.673	0.466			*-167.144*	*38.795*	*0.000*
19	*Çorum*	*G*	*31.140*	*13.224*	*0.019*	*60*	*Tokat*	*24.621*	*13.841*	*0.075*
		G2	*-60.168*	*24.933*	*0.016*			*-37.156*	*20.738*	*0.073*
20	*Denizli*	*G*	*21.169*	*9.835*	*0.031*	61	Trabzon	-13.089	15.765	0.406
		G2	*-57.121*	*24.149*	*0.018*			15.808	19.518	0.418

21 Diyarbakır	G	3.045	3.349	0.363	62 Tunceli	-2.145	3.074	0.485
	G2	-3.813	3.508	0.277		1.291	2.177	0.553
22 Edirne	G	11.274	10.103	0.264	63 Şanlıurfa	2.111	2.098	0.314
	G2	-18.861	16.306	0.247		-3.660	2.931	0.212
23 Elazığ	*G*	*8.877*	*5.314*	*0.095*	64 Uşak	15.169	13.001	0.243
	G2	*-9.573*	*5.450*	*0.079*		-36.298	28.658	0.205
24 Erzincan	G	8.320	12.362	0.501	65 Van	-0.483	3.269	0.883
	G2	-13.422	18.948	0.479		0.191	2.441	0.938
25 Erzurum	G	-4.740	4.207	0.260	66 Yozgat	3.801	8.253	0.645
	G2	4.367	4.048	0.281		-6.712	13.318	0.614
26 Eskişehir	G	9.325	10.866	0.391	67 Zonguldak	-6.866	11.565	0.553
	G2	-19.433	20.944	0.353		11.425	22.674	0.614
27 Gaziantep	G	3.854	5.779	0.505	68 Aksaray	-11.429	8.068	0.157
	G2	-12.580	12.810	0.326		21.699	16.435	0.187
28 Giresun	G	23.484	19.884	0.238	69 Bayburt	-14.392	12.071	0.233
	G2	-42.748	32.675	0.191		15.772	13.768	0.252
29 Gümüşhane	G	-2.191	9.215	0.812	*70 Karaman*	*24.729*	*13.480*	*0.067*
	G2	1.826	13.077	0.889		*-61.571*	*32.743*	*0.060*
30 Hakkari	G	-3.719	2.505	0.138	71 Kırıkkale	-3.880	9.666	0.688
	G2	2.011	1.463	0.169		3.331	15.973	0.835
31 Hatay	*G*	*11.666*	*6.626*	*0.078*	72 Batman	4.592	4.830	0.342
	G2	*-28.550*	*13.665*	*0.037*		-7.102	6.274	0.258
32 Isparta	G	2.848	11.418	0.803	73 Şırnak	5.988	7.600	0.431
	G2	-4.776	15.392	0.756		-6.231	7.289	0.393
33 Mersin	*G*	*26.646*	*10.529*	*0.011*	*74 Bartın*	*-12.347*	*7.152*	*0.084*
	G2	*-59.944*	*22.543*	*0.008*		*18.836*	*11.976*	*0.116*
34 İstanbul	*G*	*34.837*	*11.039*	*0.002*	75 Ardahan	4.458	6.723	0.507
	G2	*-146.568*	*43.390*	*0.001*		-6.477	8.312	0.436
35 İzmir	G	13.173	13.636	0.334	*76 Iğdır*	*-15.863*	*7.940*	*0.046*
	G2	-38.512	33.147	0.245		*18.538*	*10.169*	*0.068*
36 Kars	G	2.569	4.852	0.596	77 Yalova	53.591	33.929	0.114
	G2	-3.080	4.930	0.532		-150.546	91.899	0.101
37 Kastamonu	G	-1.120	2.681	0.676	78 Karabük	7.229	21.686	0.739
	G2	1.161	3.125	0.710		-18.197	41.126	0.658
38 Kayseri	*G*	*34.044*	*8.508*	*0.000*	79 Kilis	-7.822	6.841	0.253
	G2	*-70.345*	*16.519*	*0.000*		9.828	8.830	0.266
39 Kırklareli	*G*	*24.629*	*14.930*	*0.099*	80 Osmaniye	7.705	10.250	0.452
	G2	*-71.296*	*40.891*	*0.081*		-15.056	17.773	0.397
40 Kırşehir	G	-1.411	5.788	0.807	*81 Düzce*	*16.715*	*6.189*	*0.007*
	G2	1.736	9.059	0.848		*-47.447*	*15.599*	*0.002*
41 Kocaeli	G	-0.228	15.384	0.988				
	G2	-13.349	45.210	0.768				