Cansin Kemal Can
Istanbul Medeniyet University
Faculty of Political Sciences
34720 Kadikoy/Istanbul, Turkey
kemal.can@medeniyet.edu.tr

Emin Efecan Aktaş
Kırşehir Ahi Evran University
Vocational School of Social Sciences
40100 Kırşehir/Merkez, Turkey
efecanaktas@yahoo.com

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QUANTIFYING THE OPTIMAL LONG-RUN LEVEL OF GOVERNMENT EXPENDITURES IN TURKEY: 1968-2019

Abstract

Purpose: This paper gauges the nexus between government expenditures and the output level in Turkey. Our primary research objective is to evaluate the extent to which government expenditures give rise to an increase in GDP taking the Armey curve theory as a basis for the analysis. Succinctly speaking, this theory suggests that the expansionary impact of government expenditure on income level has diminishing nature and beyond a certain threshold public spending impairs rather than accelerates economic activities for several reasons including crowding out, rent-seeking, tax hikes, and public debt surges.

Methodology: In order to test the validity of this theory, we use a dataset with annual frequency covering the 1968-2019 period, which is the longest dataset used to carry out this analysis in the literature for Turkey. We set up an ARDL model to estimate the long-run coefficients required for quantifying the optimal level of government spending in Turkey.

Results: According to our findings, the estimated function exhibits a concave down functional form, which implies a diminishing marginal effect of government spending on GDP, suggesting thereby that the Armey curve theory is valid for Turkey. In addition, even though government expenditure has topped out in recent years, it is still below the GDP maximising optimal level, which indicates that there is sufficient room for expansionary fiscal policies, with the caveat of a potential negative marginal impact on GDP once the optimal threshold is exceeded.

Conclusion: The long-run coefficients from the ARDL estimation reveal that despite a consistent upward trend, government expenditures are still below their optimal level, which implies that there is fiscal space available to the government as far as output maximisation is concerned. However, government expenditures have been on a downward trend recently, which is contrary to output maximisation.

Keywords: Armey curve, optimal size of governement, output level, public expenditure, ARDL

1. Introduction

There is a long-standing controversy in the academic literature as to whether government spending will cause disruption or growth in the economy. Determining the ideal size of the public sector has been a primary research objective for several studies during the recent decades. The fiscal policy arsenal has tools to promote growth, so scarce public resources can be used to achieve the optimal level of government spending to maintain the output level in a countercyclical manner. This is particularly crucial for developing countries since their resources and financial expertise are limited compared to Western economies. In addition, the size of government spending also varies among countries, and their impact is also country-specific, which further arouses interest in the analysis of the nexus between the output level and fiscal policy.

One of the contributions in line with this renewed interest is Armey (1995), who examines the nonlinearity in the relationship between government expenditure and the output level. According to this theory, a nonlinear (concave down) functional form implies that the magnitude of the impact of government spending on the output level exhibits a decreasing trend and beyond a certain threshold level the marginal effect becomes negative causing deterioration rather than improvement in the output level. Some of the reasons for this adverse outcome include crowding out of the private sector, consequent tax hikes, budget deficit, public debt surges, etc. The size of the public sector can contribute to economic growth through regulations for the protection of property rights, infrastructure services, and the provision of basic public goods. However, diminishing marginal productivity of government spending hinders economic growth beyond a certain threshold level.

For developing countries like Turkey, determining this threshold level is crucial since fiscal space and capacity are limited and therefore any level of profligacy not only depletes scarce fiscal resources but also decreases the output level due to the aforementioned reasons.

In view of this context, the importance of determining and quantifying the optimal level of government spending inspires our motivation for this study. To accomplish this objective, we carry out an empirical analysis in this study to find out whether the nonlinearity assumption is valid for Turkey in the long run, using a dataset for the 1968-2019 period which covers the longest range for the Turkish economy in the literature. In addition, we intend to determine the optimal level of long-run government spending which maximizes the long-run output level in Turkey.

The rest of the paper is developed in three sections. The first section discusses the theoretical issues related to the Armey curve theory. It sheds light on the underlying principles of the theory and its importance. The second section is devoted to a review of the empirical literature on the Armey curve. This section assesses country-specific findings from several sources to gain an understanding of the existing empirical literature. The third section deals with empirics. This section introduces salient data features and presents the design and implementation of the model along with the discussion of empirical findings. The final part concludes.

2. Theoretical background

There are opposing views in the literature on the nexus between government expenditure and the output level. Many authors, including Ram (1986), for example, claim that government spending has a positive effect on growth, while some other authors like Scully (1994) argue that after a certain threshold level, the growth-inducing impact of public spending vanishes, and then government expenditures give rise to an economic downturn instead of economic promotion.

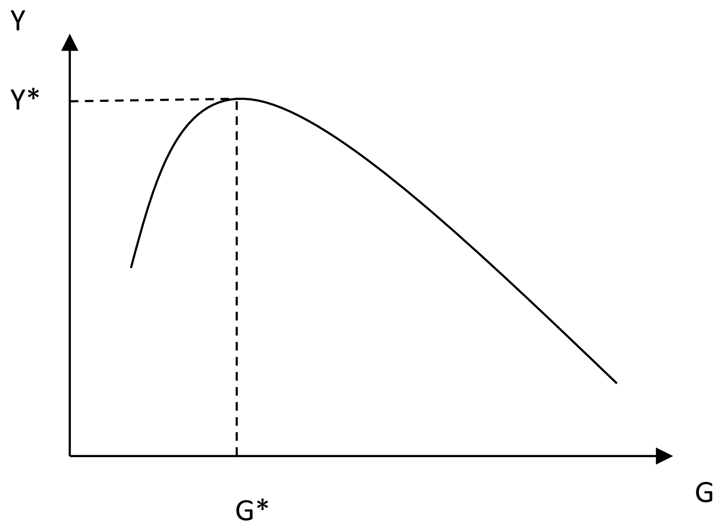
Advocates of higher government spending argue that social expenditures of the government, such as education and health, improve labour productivity, which in turn increases economic growth. Furthermore, according to this view, government expenditures on infrastructure facilitates economic expansion by reducing production costs, which stimulates private investment and promotes economic growth.

Nevertheless, according to the opponents of the view of big government, part of the explanation for the reduction in the positive growth rate resulting from government expenditures can be found in public choice theory. In particular, an increase in government expenditures may give rise to rent-seeking behaviour among individuals and firms. In addition, excessive government spending often results in crowding out of the private sector, which is mostly more productive than government investments. As public sector size increases, efficient resource distribution deteriorates, private sector investments are crowded out and as a result, productivity decreases, and economic growth is negatively affected.

Proponents of reducing government spending productivity also posit that in order to service increasing public expenditures, the government will eventually implement a tax hike which in turn will lead to disincentives for the economy as real wages and investment returns will fall dramatically. As a result, economic activity will slow down in contrast to the planned economic expansion through a decline in aggregate demand. By increasing production costs, increased taxes reduce financial space for investors, which also contributes to a decline in economic activity. Another channel through which government expenditure impedes economic growth is the financing method implemented by the government. If the government raises borrowing (which it often does), financial funds are withdrawn from the market and transferred to the unproductive government sector leaving the productive private sector with scarce financial resources. Consequently, a lack of sufficient financial resources caused by government intervention prevents the private sector from undertaking their planned investments (Mitchell, 2005).

All these factors jointly lead to a declining marginal impact of government spending on income level, which leads to an inverted U-shaped relationship between public sector size and the economic growth rate. Figure 1 below illustrates the concave down functional form which represents the nonlinear relationship between government spending and income level. G on the horizontal axis denotes government spending, while Y on the vertical axis stands for the output level. In the graph, the G* represents the level of government spending corresponding to the optimal level of government spending which maximizes the output level in the economy. Any movement in either direction from this point results in a lower income level due to the aforementioned reasons.

Figure 1 Armey curve



Source: Armey (1995)

This argument presented in the graph is underlined by several theorists in the literature. Barro (1990), for instance, is a seminal contribution to the literature in terms of the discussion of the inverted-U shaped relationship among government spending and the output level. Barro (1990) stated that the private sector is insufficient to provide public services and emphasised that the public sector should carry out activities that will increase the efficiency of the private sector, such as education, health, infrastructure investments, dissemination of R&D activities, technology transfer, strengthening of communication networks, protection of property rights, etc. Barro's study not only emphasises the relationship between public sector size and economic growth, but also leads to the emergence of a large body of literature on this subject.

Another economist who points out that there is an "inverted-U" relationship between public sector size and economic growth is Richard Armey. Armey (1995) argued that there is a nonlinear relationship between public sector size and economic growth, similar to the Kuznets and Laffer curves confirming Barro's discourses. The Armey curve theory suggests that public sector size encourages economic growth to some extent, and when that point is exceeded, the continuum of public sector growth negatively affects economic growth. The high growth rate occurs initially as a result of the public sector's growth-promoting goods and services. In other words, the delivery of public goods and services fully increases economic efficiency of the private sector. The increase in efficiency occurs due to the positive externalities that the public provides to the private sector through the performance of public activities, i.e., unpaid benefits. According to the theory, marginal productivity of public spending will be equal to marginal productivity of private spending up to the point where economic growth reaches its maximum. After this point, the continued increase in public expenditures will either have no contribution or will have a negative contribution to economic growth and an additional increase in public expenditures would only mean an economic contraction. Therefore, it is important to accurately determine the relationship between public sector size and economic growth for the purpose of an effective division of tasks among the public and the private sectors.

3. Review of the empirical literature

A vast literature has been developed in this field with a large array of country-specific findings. A large number of studies focus on quantification of the optimal level of economic activity, while others concentrate on the existence and direction of the nexus between economic output and government spending.

- One of the contributions related to the first strand of studies is Rahn and Fox (1996). In this study, the authors carried out empirical analysis reconfirming the existence of an optimal size of government, graphically represented through an inverted U-shaped curve. The theory is used to investigate a decrease in overall government spending and taxation. The inverted-U-shaped curve suggests that the optimal level of government spending is 15-25% of GDP.
- Another contributor in this category is Scully, who analysed the relationship between public revenue, tax rates, and economic growth for many countries several times (Scully, 1994, 1995, 1996, 1998, 2000, 2002, 2003). According to him, excessive increases in expenditure have a substantially depressive effect on economic growth and the economic growth rates are maximised when public expenditure is approximately equal to one-fifth of national income (Scully, 1994, pp. 1-10).
- In addition, Pevcin (2004) found that the optimal ratio of government expenditure to GDP is between 36.6% and 42.1% for 12 European countries.
- Furthermore, in the analysis for Taiwan, Chen & Lee (2005) estimated the optimal ratio of total government expenditure as 22.84%, the optimal ratio of public investment expenditures as 7.30%, and the optimal ratio of public consumption expenditures as 14.97%.

The second strand of literature tests the validity of the Armey curve theory using several techniques for different countries.

- One of the leading empirical studies of this sort was carried out by Richard Rubinson. Rubinson (1977) revealed that the effect of public revenues on GNP in 45 developed and developing countries for the period from 1955 to 1970 is incompatible with the theory. Accordingly, the impact of public revenues on GNP is more notable in poor countries compared to rich countries (Rubinson, 1977, p. 26).
- Landau (1983) examined the effect of government consumption expenditures on the

increase in real per capita income during the 1961-1976 period for 104 countries with different income levels. The study is based on the share of real government consumption in GDP as an indicator of public sector size. A negative effect for the sample countries is asserted according to estimation results of the study (Landau, 1983, p. 791).

- Grier & Tullock (1989) argue that state growth in OECD countries and countries with interventionist regimes for the years 1951 and 1980. According to their results, government spending has a significantly negative effect on GDP growth (Grier & Tullock, 1989, p. 274).
- Tanzi & Schuknecht (1997a; 1997b; 1998a; 1998b; 2007) conclude that the long-term dynamics of public expenditure in small industrialised countries does not generally exhibit worse socio-economic and welfare indicators compared to large states.
- Borcherding et al. (2003) confirmed that public sector size has a statistically significant and negative effect on economic growth in 20 OECD countries over the period 1970-1997.
- AbuAL-Faul & Rafiq (2007) estimated the optimal size of the public sector for Jordan as 10.4% for the period 1975-1996.
- The nexus between growth and deficit for OECD countries from 1970 to 2007 was studied by Alesina & Ardagna (2009). They found that spending adjustments are more likely to cause a recession in the economy than taxes, and that tax cuts potentially have a higher growth-generating capacity than spending reductions (Alesina & Ardagna, 2009, p. 15).
- According to Olasode et al., 2014, the Armey curve assumption is valid and government consumption expenditure is statistically significant. The optimal government expenditure level is 11% for Nigeria for the 1983-2012 period.
- The optimal level of government expenditure needed to maximise Jamaica's economic growth is identified through the error correction model by Malcolm (2017). Quarterly data from 1993 to 2016 were used for the analysis. The optimal level of government expenditure maximising economic growth is 33.2% for Jamaica.
- Dobrescu (2015) examined the binomial relationship of the public budget and global output in the perspective of the Armey curve. Statistical data for Romania from 1990 to 2013 were used for the analysis. Three cointegrating regressions (fully modified least squares, canonical cointegrating regression, and dynamic least squares) and three algorithms based on instrumental variables (two-stage least squares, the generalised method of moments, and limited information maximum likelihood) were adopted for estimation. The Armey curve as a parabola with a maximum is consistent with the theory for Romania (Dobrescu, 2015, pp. 693-699).
- The role of public sector size for economic growth in selected South Asian countries was analysed by Ali & Khan (2017). Data from 1996 to 2016 are used for the panel cointegration test. It is concluded that the nonlinear nexus between economic growth and public sector size and the existence of the Armey curve is confirmed (Ali & Kahn, 2017, p. 11).
- Smooth transition regression (STR) was adopted for the nonlinearity effect of public sector size on economic growth in Iran by Rabiei et al. (2017). The existence of the Armey curve was tested using quarterly data from 1988 to 2008. There is a significant threshold value of GDP (14.29) for public sector size in Iran. Government consumption expenditures in Iran have a negative effect on economic growth below the estimated threshold value and a positive effect above the estimated threshold value (Rabiei et al., 2017, p. 1).
- The results of the ARDL cointegration test carried out by Vedder & Gallaway (1998) for G7 countries show that there is a long-run relationship between economic growth and government consumption expenditures. In addition, according to the findings of Bozma et al. (2019), the hypothesis is invalid for the United Kingdom, Japan, Germany, and

Italy, while it is valid for the USA, Canada, and France (Bozma et al., 2019, p. 58).

- The effect of government expenditure on economic growth for Spain from 1980 to 2016 was analysed by the time series method following the Armey curve assumption by Garcia (2019). Total public expenditure is an independent variable, while the rate of annual economic growth of per capita GDP at constant prices is a dependent variable. The existence of a nonlinear nexus between public sector size and economic growth is detected for the indicated period in Spain (García, 2019, p. 145).
- The inverted U-shape relationship between GDP growth and government purchases following the Armey hypothesis was examined by Vasilev (2020) for the Bulgarian economy from 2000 to 2018. A Keynesian model extended with a quadratic relationship between government expenditure and investment is established for empirical analysis. The existence of a nexus between economic growth and government spending (Armey curve) was verified for the selected period in Bulgaria (Vasilev, 2020, p. 25).

Finally, it is worthwhile to outline the existing literature on the Turkish economy in order to reconcile our contribution to the existing literature.

- Another study testing the nonlinearity between economic growth and public sector size for Turkey was presented by Varol Iyidogan & Turan (2017). Quarterly data from 1998:1 to 2015:1 were adopted for a threshold regression model. The findings indicate that an increase in public sector size causes a decline (rise) in the economic growth rate when public sector size is above (below) the threshold level, which indicates that the Armey curve hypothesis is confirmed (Varol Iyidogam & Turan, 2017, p. 142).
- According to Yamak & Erdem (2018), the Armey curve hypothesis was valid in Turkey from 1998 to 2016. An ARDL bounds test approach is applied for the purpose of analysis using the long-run series. It is noted that the nexus between long-run public sector size and long-run economic growth is quadratic and nonlinear (Yamak & Erdem, 2018, p. 335).
- For Turkey, the existence of the Armey curve was also tested by time series analysis using the FMOLS method by Bayrak (2019). The analysis covers the 1990-2017 period. The optimal ratio of defence expenditure is calculated as 2.5% of GDP.
- Altunc and Aydin (2012) tested the Armey hypothesis by time series analysis for Turkey between 1975 and 2010. It was confirmed that there is an inverted U-shaped relationship between economic growth and expenditure categories, except for government investment expenditures and total government expenditures. Moreover, the optimal level of total government expenditure for Turkey constitutes 16% of GDP. This ratio is below the level of 26.6%, which is the ratio of 2010 government expenditure to GDP (Altunc & Aydin, 2012, p. 79).
- Furthermore, Altunc and Aydin (2013) investigated whether there is an inverted U-shape relationship between economic growth and government expenditure in Romania, Bulgaria, and Turkey. The data for the period 1995-2011 and the ARDL bounds testing approach are used for the analysis. The theoretical nexus of the study is associated with the Armey curve. The share of current government expenditure in GDP for three countries exceeds optimal government expenditure (Altunc & Aydin, 2013, p. 66).
- Yüksel (2019) analyses the Armey curve for Turkey for the 1981-2018 period by adapting the ARDL bounds test approach. The findings indicate that the optimal size of government is 16% of GDP for the period under study. The results of the study, which indicate that this rate was on average 20% in the 1981-2018 period, indicate that from 1981 to 1992 public expenditure in Turkey was below the optimal level of 16%, and between 1993 and 2018 public expenditure was above the optimal level (Yüksel, 2019, p. 137).

4. Data and methodology

4.1 Methodology

Since the aforementioned Armey curve theory on which our analysis relies analyses the extent to which government expenditure affects economic activity, the fundamental indicators to be included in the model are essentially some measures of government size and the level of output in the economy. In the literature, some other control variables are also included to avoid omitted-variable bias since there are numerous output level determinants in economic theory. The control variables used in the literature include the consumer price index, foreign direct investment, trade openness, and unemployment (Al-Abdurrazag & Mensi, 2021; Lupu & Asandului, 2017; Kleyhans & Coetzee, 2019). These variables are incorporated into the model based on country-specific conditions and data availability.

In addition, since the theory tests the existence of a threshold level of public spending that maximises the output, the equation to be estimated should be formulated in a quadratic manner involving the inclusion of public spending squared as an explanatory variable. This transformation geometrically enables the formulation to have a maximum with respect to government spending which can be calculated through algebraic derivations.

In view of these arguments, the model we used to test the Armey curve in Turkey is formulated as follows:

$$Y_t=\beta_0+\beta_1 G_t+\beta_2 G_t^2+CF_t+u_t,$$

where:

Y: Level of output (GDPCCUSD)

G: Government spending (GFCCUSD)

G^2: Government spending squared (GFCCUSD-SQR)

CF: Gross capital formation (GCFCUSD)

Geometrically, for the function to have a maximum value of output with respect to government spending, the function needs to have a concave form, which requires β_1 to be positive and β_2 to be negative. Furthermore, taking the first derivative of the function with respect to G_t, setting the differential equal to zero and solving for G_t we get $G^* = -\frac{\beta_1}{2\beta_2}$, which denotes the output-maximising level of government spending. In the literature, this point is also called the *Scully point*, and from an economic theory perspective, it represents the level of public spending beyond which the marginal impact of government expenditures on output level turns negative. Thus, any level of government spending below G^* opens space for expansionary fiscal policy, whereas values above G^* require contractionary fiscal policy provided that the output level is the primary concern of the government.

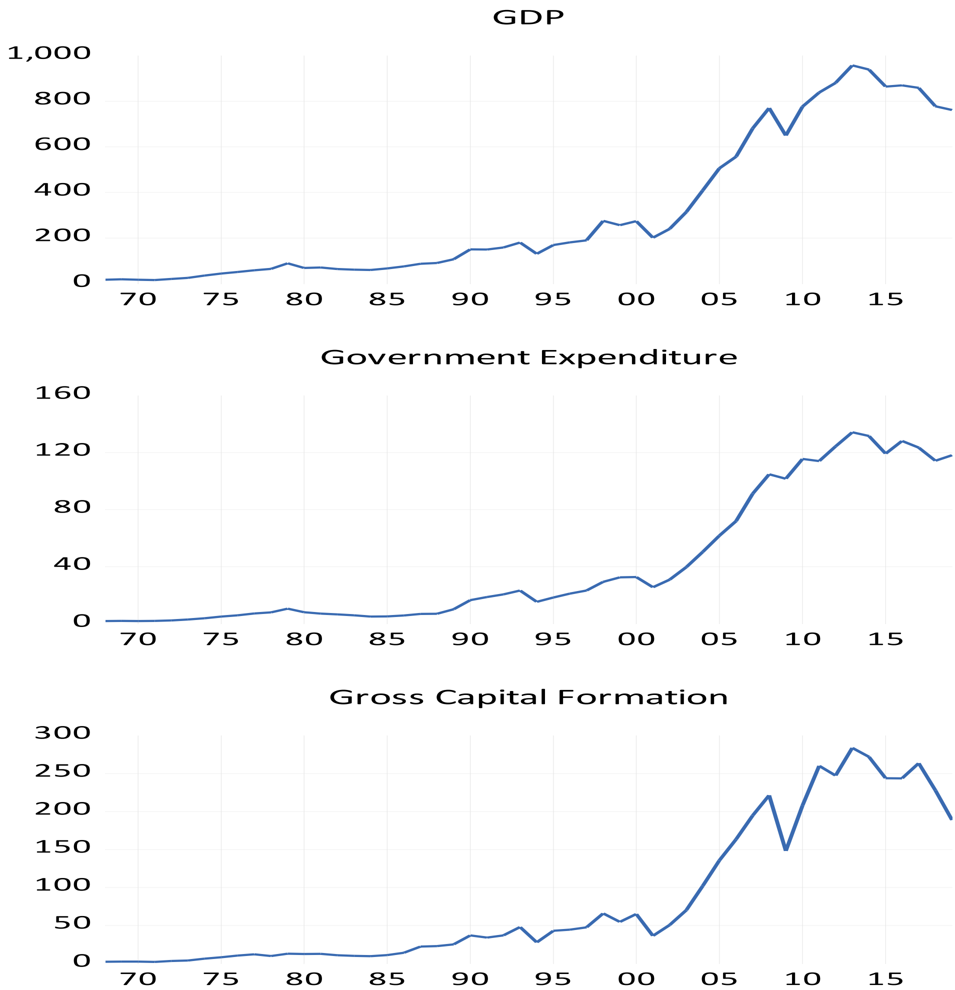
4.2 Salient data features

The dataset used for estimating the above model covers the 1968-2019 period with an annual frequency and was retrieved from the World Development Indicators Dataset of the World Bank. All values in the dataset are calculated with constant 2010 US dollar prices. The primary explanatory variable, government expenditures, is proxied by the government's final consumption expenditure to keep the span of the series as long as possible. Since our study is based on a single country, the number of observations plays a key role in the quality of estimations. Moreover, in Keynesian taxonomy, one of the components of the output equation is government spending, which is represented by the sum of expenditures on final goods and services by the government. Hence, we preferred this series as an indicator of government spending because it was the longest available data on government spending which fits the postulates of economic theory.

Furthermore, we include gross capital formation as a control variable in the model. According to the Keynesian paradigm, investment is an important determinant of the output level. Thus, to improve the accuracy of the model by reducing omitted-variable bias, we added this series to account for the impact of investments on GDP. According to the World Bank, this series was formerly known as *Gross Domestic Investment* and consists of additions to fixed assets and the level of inventories. Thus, it represents an investment in the economy.

Figure 2 below shows the plots of each variable of the model. The first point to observe in the graph is that GDP is steadily increasing throughout the sample but the graph becomes steeper after the 2000s, indicating a sharper growth rate of output. The other two graphs show trends in the determinants of the GDP level and it is obvious that an increase in the output level largely stems from investment and government expenditure since investment and government expenditure also have an upward trend. In other words, the output level increased continuously in parallel with expansionary fiscal policies and investment spending hikes, which is evidenced by visually similar shapes of graphs in parts referring to post-2000s. At the beginning of the millennium, the government signed several agreements with the IMF and the single-party government firmly adhered to those recovery and transformation agreements signed by its predecessors, which resulted in significant improvements in economic activity represented by remarkable shifts in the graphs above. Nevertheless, in recent years, the performance of the economy is not on a par with previous years. The downward trend shown in the graphs might be interpreted as a signal of a looming recession in the economy.

Figure 2 Data plots



Source: All series retrieved from the World Development Indicators Database

4.3 Empirics

4.3.1 Stationarity tests

Tables 1 and 2 below show the results of formal stationarity tests for each series.

Table 1 Formal stationarity test results (level)

	ADF	PP	KPSS
GDP	0.00323	-0.20775	0.82045
1%	-3.56543	-3.56543	0.73900
5%	-2.91995	-2.91995	0.46300
10%	-2.59791	-2.59791	0.34700
Gov. Exp.	-0.86274	0.19580	0.80362
1%	-3.57445	-3.56543	0.73900
5%	-2.92378	-2.91995	0.46300
10%	-2.59993	-2.59791	0.34700
Gov. Exp.Sqr.	-1.73047	-0.11666	0.69072
1%	-3.59662	-3.56543	0.73900
5%	-2.93316	-2.91995	0.46300
10%	-2.60487	-2.59791	0.34700
Gr. Cap. For.	-0.65922	-0.65315	0.79341
1%	-3.56543	-3.56543	0.73900
5%	-2.91995	-2.91995	0.46300
10%	-2.59791	-2.59791	0.34700

Source: Authors' own calculations

Table 2 Formal stationarity test results (first difference)

	ADF	PP	KPSS
GDP	-2.91598	-6.31903	0.17246
1%	-3.60559	-3.56831	0.73900
5%	-2.93694	-2.92118	0.46300
10%	-2.60686	-2.59855	0.34700
Gov. Exp.	-2.16726	-5.62452	0.24620
1%	-3.57445	-3.56831	0.73900
5%	-2.92378	-2.92118	0.46300
10%	-2.59993	-2.59855	0.34700
Gov. Exp.Sqr.	-3.07461	-6.59411	0.22058
1%	-3.60559	-3.56831	0.73900
5%	-2.93694	-2.92118	0.46300
10%	-2.60686	-2.59855	0.34700
Gr. Cap. For.	-7.08902	-7.09019	0.12909
1%	-3.56831	-3.56831	0.73900
5%	-2.92118	-2.92118	0.46300
10%	-2.59855	-2.59855	0.34700

Source: Authors' own calculations

The test results indicate that all variables are non-stationary at the level and that their first differences are stationary. Thus, it is evident from the above results that all variables in the dataset are integrated of order one, or more formally, I(1). The existence of the same level of integration for each variable creates the potential for the variables to have a long-run relationship; thus, the next step in our analysis is to test the existence of a long-run cointegrating relationship between the variables. The validity of the Armey curve theory entails a long-run equation, where GDP is a dependent variable, the estimated coefficient for government expenditure has a positive sign, and the estimated coefficient for government expenditure squared has a negative sign. To test the existence of such long-run equation, we use the ARDL approach whose estimation results are presented in the next section.

4.3.2 Basics of the ARDL approach

The ARDL approach was designed by Pesaran (1997), Shin & Pesaran (1999) and Peseran et al. (2001). This approach consists of three stages. First, the existence of cointegration among variables is tested through the bounds test based on the following equation:

$$\Delta Y_t = \alpha_0 + \sum_{i=1}^{m} \alpha_{1i} \Delta Y_{t-i} + \sum_{i=0}^{m} \alpha_{2i} \Delta X_{1t-i} + \dots + \sum_{i=0}^{m} \alpha_{ki} \Delta X_{kt-i} + \alpha_1 Y_{t-1} + \alpha_2 X_{1t-1} + \cdots + \alpha_k X_{kt-1} + u_t$$

The F-bounds test simply examines the common importance of α_1,... α_k to confirm the existence of cointegration among variables. Once cointegration is detected, the long-term relationship between variables can be represented by the following formula provided that coefficient stability is established and the model does not suffer from serious deficiencies such as autocorrelation, heteroskedasticity, violation of normality for residuals, etc.

$$Y_t = \alpha_0 + \sum_{i=1}^{m} \alpha_{1i} \Delta Y_{t-i} + \sum_{i=0}^{n} \alpha_{2i} \Delta X_{1t-i} + \cdots + \sum_{i=0}^{r} \alpha_{ki} \Delta X_{kt-i} + u_t$$

In addition, the error correction model below represents the short-run dynamics of the model and the last term indicates the magnitude of error correction in each round. Thus, for a stable long-run equilibrium the coefficient needs to have a value between -1 and 0.

$$\Delta Y_t = \alpha_0 + \sum_{i=1}^{m} \alpha_{1i} \Delta Y_{t-i} + \sum_{i=0}^{n} \alpha_{2i} \Delta X_{1t-i} + \dots + \sum_{i=0}^{r} \alpha_{ki} \Delta X_{kt-i} + \mu ecm_{t-1} + u_t$$

4.3.3 Empirical findings

4.3.3.1 F-bounds test

The table below exhibits the test statistic for the F-bounds test along with critical values for several levels of significance.

Table 3 F-bounds test

Test statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1,000	
F-statistic	44.35219	10%	2.37	3.20
k	3	5%	2.79	3.67
		2.5%	3.15	4.08
		1%	3.65	4.66
Actual sample size	48		Finite sample: n=50	
		10%	2.54	3.40
		5%	3.05	4.00
		1%	4.19	5.33
			Finite sample: n=45	
		10%	2.56	3.43
		5%	3.08	4.02
		1%	4.27	5.41

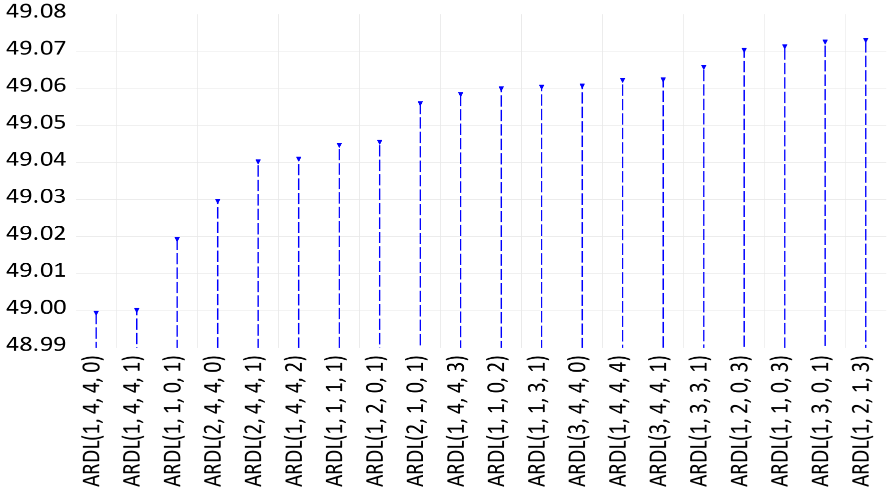
Source: Authors' own calculations

The F-bounds test results above clearly indicate that cointegration exists among the variables as the test statistic is higher than the upper bound value for all levels of significance.

4.3.3.2 Model selection

The graph below illustrates the AIC values for the top 20 models. According to the information given in the graph, the (1,4,4,0) model has the minimum AIC value, so it is the most appropriate model based on the information criteria.

Table 4 Akaike information criteria (top 20 models)



Source: Authors' own calculations

4.3.3.3 Diagnostics

Before analysing the estimation results, it is essential to verify whether the model passes certain diagnostic tests. Reasonable interpretations of the model imply that the model does not have autocorrelation, heteroskedasticity, non-normally distributed error terms, and unstable coefficients.

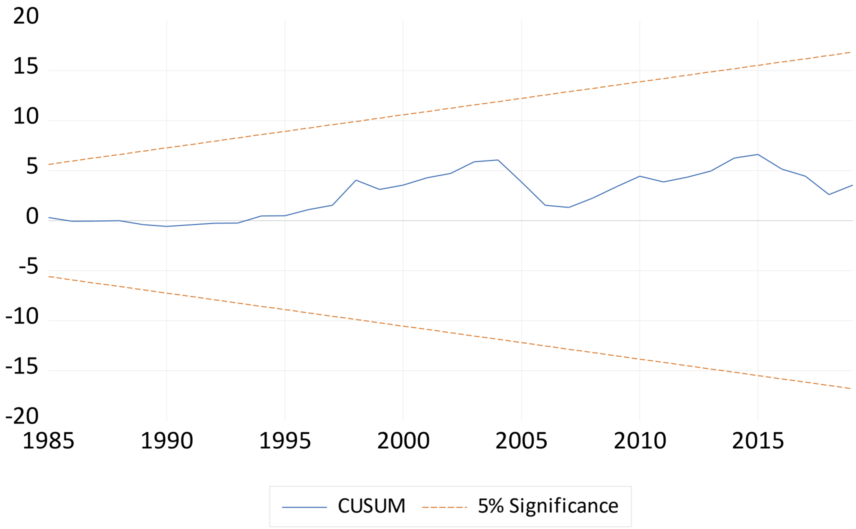
Table 5 Diagnostics

Diagnostic test	Test statistic	P-value
Normality test	JB: 5.401502	0.067
Serial correlation LM test	F-stat: 0.2261	0.7988
	$N*R^2$: 0.6491	0.7228
BPG heteroskedasticity test	F-stat: 0.8081	0.6403
	$N*R^2$: 10.4142	0.5797
	Scaled Exp.SS: 9.3214	0.6753
Ramsey RESET test	t-stat: 0.6894	0.4953
	F-stat: 0.4752	0.4953
	L.R: 0.6663	0.4143

Source: Authors' own calculations

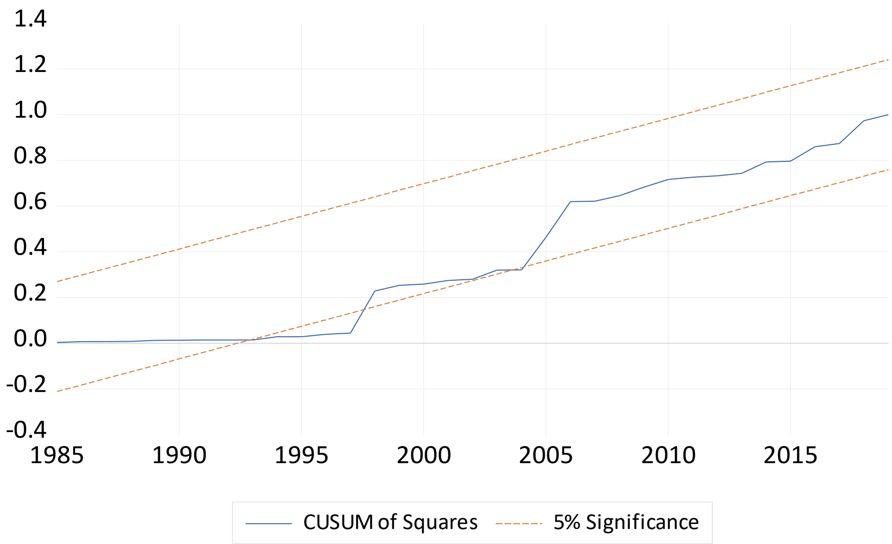
Table 5 above summarises the diagnostic test results. According to these tests, the model has no defects in terms of residuals and structure. However, for visual inspection of model stability, it is worth checking the behaviour of the recursive residuals.

Figure 3 Recursive residuals (CUSUM)



Source: Authors' own calculations

Figure 4 Recursive residuals (CUSUMSQR)



Source: Authors' own calculations

The two graphs above show the behaviour of the recursive residuals via CUSUM and CUSUMSQR values. According to these graphs, residuals are well-behaved in general with a slight deviation evidenced by CUSUMSQR in the mid-90s. The short deviation in those years is not constant and it can be assumed that the residual variance is generally stable.

4.3.3.4 Estimation results and discussion

Now that we have implemented lag selection and diagnostic control procedures, in the final stage we report the estimation results and make discussions in line with our research objectives.

Table 6 ARDL regression

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GDPCCUSD(-1)	0.25096	0.049639	5.05574	0.0000
GFCCUSD	5.12176	0.556897	9.19696	0.0000
GFCCUSD(-1)	-2.81466	0.878993	-3.20215	0.0029
GFCCUSD(-2)	0.10361	0.500666	0.20693	0.8373
GFCCUSD(-3)	-0.54252	0.740792	-0.73236	0.4688
GFCCUSD(-4)	1.57469	0.912259	1.72615	0.0931
GFCCUSDSQR	-9.06E-12	2.58E-12	-3.51249	0.0012
GFCCUSDSQR(-1)	4.17E-12	4.36E-12	0.95541	0.3459
GFCCUSDSQR(-2)	2.04E-12	2.72E-12	0.74821	0.4593
GFCCUSDSQR(-3)	3.52E-12	3.82E-12	0.92299	0.3623
GFCCUSDSQR(-4)	-1.13E-11	4.33E-12	-2.60349	0.0134
GCFCUSD	1.47281	0.085656	17.19441	0.0000
C	1.02E+10	2.30E+09	4.41989	0.0001
R-squared	0.999354	Mean dependent var	3.36E+11	
Adjusted R-squared	0.999132	S.D. dependent var	3.20E+11	
S.E. of regression	9.44E+09	Akaike info criterion	48.99938	
Sum squared resid	3.12E+21	Schwarz criterion	49.50616	
Log likelihood	-1162985.00000	Hannan-Quinn criter.	49.19089	
F-statistic	4510.560	Durbin-Watson stat	20.96181	
Prob(F-statistic)	0.000000			

Source: Authors' own calculations

Table 7 Error correction model

Dependent variable: D(GDP)				
ECM regression				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(GFCCUSD)	5.12176	0.60467	8.47032	0.00000
D(GFCCUSD(-1))	-1.13578	0.57980	-1.95890	0.05810
D(GFCCUSD(-2))	-1.03217	0.58703	-1.75831	0.08744
D(GFCCUSD(-3))	-1.57469	0.58330	-2.69965	0.01062
D(GFCCUSDSQR)	9.06E-12	2926.86392	-3.09442	0.00386
D(GFCCUSDSQR(-1))	5.70E-12	3027.98965	1.88361	0.06795
D(GFCCUSDSQR(-2))	7.74E-12	3077.76843	2.51487	0.01665
D(GFCCUSDSQR(-3))	1.13E-12	3117.21336	3.61354	0.00094
CointEq(-1)*	-0.74904	0.04765	-15.71958	0.01963
R-squared	0.97339	Mean dependent var	1.55E+10	
Adjusted R-squared	0.967928	S.D. dependent var	4.99E+10	
S.E. of regression	8.94E+09	Akaike info criterion	48.83271	
Sum squared resid	3.12E+21	Schwarz criterion	49.18356	
Log likelihood	-1162.985	Hannan-Quinn criter.	48.96530	
Durbin-Watson stat	2.096181			

Source: Authors' own calculations

Table 8 Long-run model

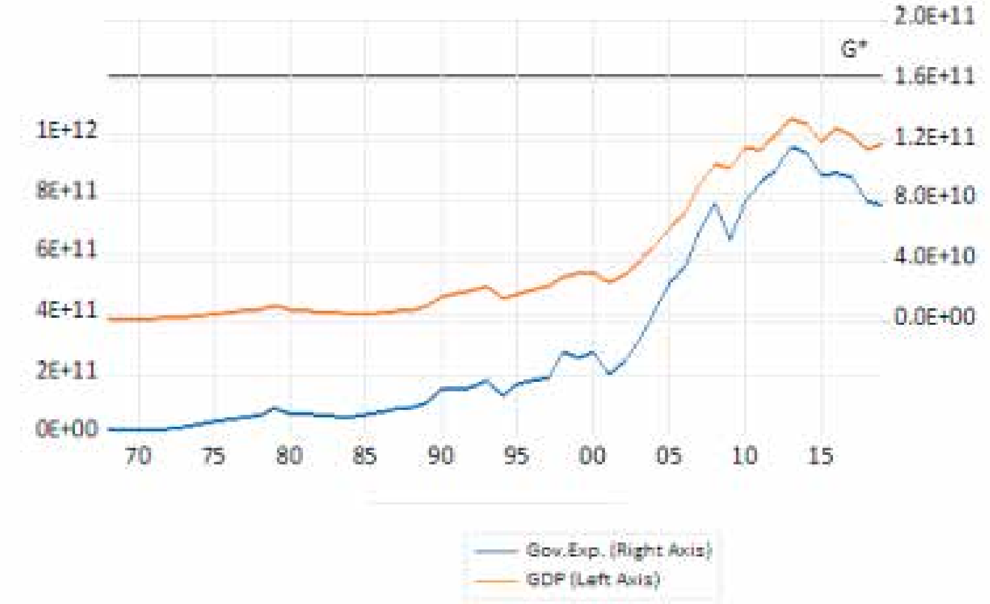
Variable	Coefficient	Std. Error	t-Statistic	Prob.
GFCCUSD	4.59640	0.45187	10.17186	0.00000
GFCCUSDSQR	-1.41E-11	2.96E-12	-4.78418	0.00000
GCFCUSD	1.96627	0.17574	11.18867	0.00000
C	1.36E+10	3.36E+09	4.04676	0.00003

Source: Authors' own calculations

According to the estimation result above, the error correction term is -0.74, which indicates that cointegration is stable and that the long-run equilibrium is mean-reverting. In addition, the estimated coefficient for government expenses squared is less than zero, while the coefficient for government expenses is greater than zero, which guarantees a concave down functional form for the estimated equation. As mentioned earlier, the concave down form proves the validity of the Armey curve for Turkey as it geometrically brings about a diminishing marginal effect of government expenditure, which in turn generates an income maximising level for government spending that can be calculated by the formula: $G^* = -\frac{\beta_1}{2\beta_2}$. The estimated long-run values for β_1 and β_2 are 4.59640 and -1.41E-11, respectively.

By inserting these values into the equation we get: G^* = 162.9 billion dollars, which is about 52% of the average GDP in the estimation period. The government expenditure series topped out in 2013 and reacheed 134.2 billion dollars, which is 82% of the optimal level of income maximisation. After that, it was in a downward trend that deviates even more from the optimal level, which indicates that the government has not given priority to economic growth in recent years through expansionary fiscal policy. In other words, despite the substantial improvement in government spending in the post-2000 phase of the estimation sample, there is still considerable room for expansionary fiscal policies in Turkey as far as fiscal space between the existing and the optimal level of government spending is concerned.

Figure 5 Optimal government spending level



Source: Authors' own calculations

Figure 5 above illustrates that government expenditure was below the optimal level for the entire sample and therefore ran parallel to the GDP series, with a recent downward trend in both series. However, once government expenditure exceeds the G* level in the near future, the two series are expected to move in opposite directions according to our estimation results. In order words, any movement in government expenditure beyond G* will correspond to the reverse movement of GDP due to the fact that the marginal effect of government expenditure on GDP will become negative for government spending levels greater than G*, as postulated by the Armey curve theory.

4.3.3.5 Robustness check

The findings in the diagnostics section and the recursive residual diagrams above indicate a stable model, but in this section, we run a secondary model to further test the robustness of the model parameters. To this end, we run a dynamic ordinary least squares (DOLS) version of the same model to calculate the long-run model parameters. Table 9 below summarises these estimates. The estimated coefficients in this version are significantly close to their ARDL counterparts in the original regression which supports the robustness of the results in the original model. Performing the same mathematics to calculate the optimal long-run level of government spending we get $G^* = -\frac{\beta_1}{2\beta_2}$ = 4.2948/-1.16E-11*2= 185.1, which is also quite close to the optimal level calculated in the original model. Despite the fact that this level corresponds to slightly larger fiscal space, the overall conclusion of the original model is verified by the results of the auxiliary model.

Table 9 DOLS estimation results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GFCCUSD	4.29448	0.83359	5.15178	0.00000
GFCCUSDSQR	-1.16E-11	2.99E-12	-3.87209	0.00040
GCFCUSD	2.00366	0.44369	4.51586	0.00010
C	1.19E+10	4.47E+09	2.66152	0.01150

Hansen Test (H_0: Series are cointegrated) LC Test Stat:0.0426 p>0.20
Park Test (H_0: Series are cointegrated) Chi-Sqr Test Stat:3.76314 p=0.0524
Source: Authors' own calculations

5. Conclusion

In this study, our main research objective is to test the existence of a diminishing marginal effect of government spending on the output level in Turkey. For this purpose, we used a dataset with annual frequency covering the 1968-2019 period, which is the longest dataset used for testing the Armey curve theory for Turkey in the literature. In this sense, our study contributes to the literature by incorporating this dataset into the analysis of the impact of government spending on GDP. The dataset comprises three variables: GDP, government final consumption expenditure, and gross capital formation, which is used as a control variable in the model. Since the model variables are non-stationary, we were forced to look for a long-run equilibrium among the variables. For this purpose, we applied the ARDL technique to calculate long-run coefficients. According to the Armey curve theory, the geometric shape of the estimated equation should be concave down for government spending to have a diminishing marginal impact on the economy. For this reason, we included a square form of the government spending variable in the model to take into account the nonlinear relationship. Geometrically, the validity of the Armey curve relationship implies a negative coefficient for the squared series and a positive coefficient for the normal series. Only then does the second derivative of the function become negative and a local maximum appears for the function which guarantees the diminishing impact of government spending on the economy.

Our findings are in line with the expected coefficient signs in that the estimated coefficients are 4.5964 and -1.41E-11 for normal and squared government spending series, respectively, which proves that the Armey curve theory is valid for the Turkish economy. In addition, our estimation results also indicate that there is currently significant room for expansionary fiscal policy in Turkey. More clearly, the level of government spending is seemingly below the optimal level, which creates the potential for the government to increase expenditures in an attempt to reach higher levels of GDP in the near future. However, it is worth noting the optimal level of government spending, which according to our calculations is 160.3 billion dollars. Any spending level above this threshold might instead lead to a drop in the output level as the marginal impact subsequently becomes negative.

Finally, it is worth mentioning that the arguments and findings in this study are tentative and experimental but by no means decisive. Thus, further studies might be carried out to enhance the scope of the research. For instance, with a comprehensive dataset from multiple countries it is possible to run panel regression to test the validity of the theory on a larger scale. Furthermore, the coverage of the data might be extended by incorporating other aspects of the economy in the form of control variables. As noted earlier, indicators associated with GDP growth such as unemployment, international trade openness, the consumer price index, and foreign direct investment, are potential candidates for inclusion in the model as control variables. In addition, the analysis can be carried out using a different social welfare indicator alongside GDP. In other words, the optimal level of government spending which maximised social welfare might be quantified using the same methodology. Finally, the use of alternative methodologies for estimation is an option to explore different aspects of the subject. Threshold regression, for example, can provide the researcher with the opportunity to analyse the subject more dynamically under different regimes, while the DSGE approach allows the researcher to incorporate microfoundations into the analysis.

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