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CONTENTS

ARTICLES

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CONTENTS

ARTICLES

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Growth-maximizing public debt in Turkey: An empirical investigation[1]

Gokay Canberk Bulus[2]

Abstract: The aim of the paper is to empirically estimate the growth-maximizing debt-to-GDP ratio in the case of Turkey. To calculate the growth-maximizing debt-to-GDP ratio FMOLS, DOLS, and CCR estimators are used for the period from 1960–2013. According to the empirical findings the growth-maximizing debt-to-GDP ratio varies between 34.3% and 38.7%. Based on a comparison of these ratios to current data (29.1% for 2018), Turkey has the capacity for additional borrowing to achieve a growth-maximizing debt-to-GDP ratio. If this additional borrowing capacity is used for public investment with a return greater than the interest cost of the additional debt economic growth will be maximized and public debt sustainability supported.

Keywords: public debt, economic growth, fiscal rule, Turkish economy.

JEL codes: H63, H68, 040.

Introduction

Public spending is managed by the government to ensure economic growth and stability, to justify the distribution of income and wealth in society and enhance the welfare of its citizens. If the public's main sources of revenue are inadequate to finance public expenditures the government typically prefers to borrow. In other words, countries lacking sufficient savings can finance their capital needs and public expenditures by borrowing (Soylu, 2019). Also economic theory proposes that sustainable levels of borrowing by a country are likely to enhance its economic performance (Egbetunde, 2012). According to economic theory the moderate level of public debt increases economic growth in line with the typical Keynesian approach. However expected tax increases at high public debt levels limit the positive results of public expenditures and

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reduce investment and consumption expenditures. Thus it increases unemployment and decreases economic growth (Ferreira, 2009). For most countries the share of public debt stock in the gross domestic product (GDP) became particularly prominent following the 2008 economic crisis and continues to be one of the most important problems on the agenda. The main reason for this importance is that this share reached a significant ratio in both developed and developing countries in the years following the global financial crisis that began in the United States in 2008 and spread all over the world. For example, in 2010 the share of public debt-to-GDP was 207.9% in Japan, 150.5% in Greece, 141.9% in Jamaica, 112.9% in Italy, 95.4% in the United States, 48.5% Poland, 40.1% in Turkey, 38.6% in Sweden, 30.8% in South Korea (International Monetary Fund (IMF), 2019). The deterioration in macroeconomic indicators that occurred during the crisis required the public sector to intervene in the process and in the post-crisis period the public debt stock was a potential threat indicator that created problems for all economies (Greiner, 2011). Because in response to the financial crisis most of the governments have used fiscal measures to stimulate aggregate demand by recapitalizing banks and adopting sizeable fiscal stimulus packages mostly based on higher government expenditures (Mencinger, Aristovnik, & Verbic, 2014). Thus in some developed or developing countries the ratio of public debt stock to GDP exceeds 100%, whereas in other cases it is only 30%. When the shares vary so much it raises the question of whether an optimal public debt stock level for economies exists. Both the variety in public debt stocks in the global economy and inconsistency in implemented fiscal policies around the world increase the importance of this question. According to a literature review (see next section), few empirical cross-country and country-specific studies have been conducted on this topic. The desire to contribute to this literature is the main driver in determining the research question. Consequently the research question for the current study is "what is the ratio of public debt that will maximize economic growth in Turkey?". This question has not been previously investigated in the context of Turkey's economy which increases the original value of the study. By calculating this ratio for the Turkish economy the possibility of opening a policy debate is the main motivation for the study. The desire to guide policy makers in the context of the empirical findings is another reason.

The paper is organized as follows. The next section provides a review of the literature, Section 2 defines the data and the model and Section 3 provides the empirical results. Finally, some concluding remarks are provided in the last section.

1. Literature review

1.1. Public debt—growth nexus

Economic growth has been one of the main concerns for all economies, especially for developing countries. To realize economic growth through borrowing the return on investments made through borrowing must be higher than the cost of the debt. In this case an increase in production capacity in the borrowing economy can be observed (Ajayi & Khan, 2000). Chowdhury (2001) argued that the key factor in the relationship between borrowing and economic growth is the increase in capital accumulation. According to him a reasonable level of borrowing brings with it productivity gains in capital accumulation and ultimately economic growth. As insufficient capital stocks of developing countries which are in the early stages of economic development are available investment opportunities are limited. Soludo (2003) claimed that countries borrow for two main purposes: for macroeconomic reasons such as higher investment and higher health spending and to overcome budget constraints. Significant increases in the public debt stock of economies and negative long-term expectations also affect countries' macroeconomic performance. If public borrowing is not sustainable the impact of public borrowing on prices and interest rates can lead to a decrease in budget flexibility, inefficient implementation of fiscal policies, increased and diversified public goods and services as a result of population growth and inadequate economic growth (Montanino & Mrsnik, 2004). The debate on the relationship between public debt and economic growth has been stimulated by a growing series of empirical studies. Also, this issue has become highly topical since the outbreak of the debt crisis in 2010 (Stanek, 2014). Some country-specific studies have examined the relationship between public debt stock and economic growth. Balassone, Francese and Pace (2011) claimed that Italy's public debt stock has negatively affected economic growth in the long run. A similar result was found by Rais and Anwar (2012). According to the findings of their study high public debt stock decreased economic growth in Pakistan. Lee and Ng (2015) examined the relationship between public debt stock and economic growth and found that an increase in public debt stock had a negative effect on economic growth in Malaysia. However other studies in the literature have claimed that public debt stock has a positive impact on economic growth. According to Al-Zeaud (2014), public debt had a positive and statistically significant effect on economic growth in Jordan. Spilioti and Vamvoukas (2015) concluded that public debt supported economic growth in Greece. Nantwi-Owusu and Ericson (2016) asked the same research question for Ghana and found a positive and statistically significant long-term relationship between public debt and economic growth. The above studies found either a positive or a negative relationship between public debt stock and economic growth. However according to Emmanuel (2012), the re-

lationship between public debt stock and economic growth in Nigeria varied between the short and long term. Public debt stock had a short-term budget-closing effect, but it reduced economic growth in the long run because of debt management failures in Nigeria.

In cross-country studies different results have been reached regarding the relationship between public debt stock and economic growth. For instance Scharlek (2004) concluded that a low level of public debt in developing countries increased economic growth. Bökemeier and Greiner (2015) examined the same research question in seven developed countries and found a statistically significant and negative relationship between public debt stock and economic growth in these countries. Panizza and Presbitero (2014) concluded that a negative relationship between public debt stock and economic growth existed in member countries of the Organization for Economic Co-operation and Development (OECD). Onafowora and Owoye (2019) suggested that higher public debt and inflation rates hampered growth in five Caribbean countries over the period 1975–2015. However Baum, Checherita-Westphal and Rother (2013) stated that public debt stock has a positive effect on economic growth in the short term according to an analysis of data from twelve EU member states. Also, Mencinger, Aristovrik and Verbic (2015) studied 25 EU member states and eleven OECD member countries finding that low public debt stock positively affected economic growth, whereas public debt stock above a specific threshold hampered economic growth. In the literature it is accepted that high public debt stock prevents economic growth in the long run. The reason is that high public debt stock will increase interest rates (Tanzi & Fanizza, 1995; Vamvoukas, 1997), create a higher tax burden on households and disrupt tax collection composition (Aizenman, Kletzer, & Pinto, 2007) and increase inflation rates (Vickrey, 1961; Missale, 1997; Maitra, 2019), which will lead to a contraction in the banking sector and rapid fluctuations in exchange rates (Aghion & Kharroubi, 2007) and as a consequence negatively affect economic growth.

The more recent literature has suggested that the relationship between public debt and growth is non-linear. Because the effect of debt could be positive at low levels of debt and become negative when total indebtedness becomes excessive (Fseifes & Warrad, 2020). According to Swamy (2020) there is a negative relationship between public debt and economic growth. The point estimates of the study assert that a ten percentage point increase in the debt-to-GDP ratio is associated with 23 basis point decrease in average growth in 252 countries over the period 1960–2009. Khanfir (2019) employed panel data for four North African countries over the period 2003–2012. The results indicate that the public debt threshold stands at 42.8% of GDP for these countries. The public debt increases economic growth when its level is less than this turning point. Above this threshold an increase in public debt would decrease economic growth. Sanusi, Hassan and Meyer (2019) claimed that the public debt threshold stands at 57% of GDP for the Southern African Development Community

over the period 1998–2016. This result shows that public debt drives economic growth before counteracting it upon reaching the threshold level.

1.2. Optimal debt level—theoretical approach and its previous applications

Although scholars have concluded that high public debt stock impedes economic growth there is no consensus on the optimal level of debt stock. Aschauer (2000) developed a non-linear theoretical relationship between public capital and economic growth in order to attain estimates of the growth-maximizing ratio of public capital to private capital in the US economy. The conclusion from this paper is that to maximize the speed of growth in the US the ratio of public to private capital stock lies between 60% and 80%. Kamps (2005) also used this model to derive optimal public capital stock ratios in the 22 OECD member countries, among these fourteen EU countries, for the period 1960–2001. According to the results of the study the growth maximizing ratio of public to private capital stock ranges from 32 to 52 percent. Aschauer (2000) and Kamps (2005) research would allows the determination and estimation of the best level of public debt for any specific country or sample period (Checherita-Westphal, Hallett, & Rother, 2012).

Checherita-Westphal, Hallett and Rother (2012, 2014) taking the Aschauer (2000) model as a starting point developed a theoretical model the determination of the level of public debt stock that would maximize the rate of economic growth.[3] The model started with a standard Cobb–Douglas production function:

$$Y = (L^{\beta} K_p^{1-\beta})^{1-\alpha} (K_g)^{\alpha} \tag{1}$$

where Y is output, L is labour, K_p is private capital, and K_g is public capital. The production function indicates constant returns to scale in K_p and K_g. Therefore the economy is capable of endogenous growth. For simplicity there is no labour choice, population growth, technological progress, or depreciation of private capital and public capital. In addition, under the golden rule of financing that government borrowing is merely the formation of capital stock, it is possible to calculate the growth-maximizing long-run value of the public debt-to-GDP ratio, as expressed in:

$$d^{\star} = \phi^{1-\alpha} = \left[\frac{\alpha}{(1-\alpha)^2} \right]^{1-\alpha} \tag{2}$$

where $d^{\star}$ is the long-run optimal debt ratio for use if all inputs and input ratios take their optimized values. This is the representation which generates a sequence of debt targets $d^{\star}$ in transitioning from an extreme debt position to long-term optimal debt targets.

[3] The employed theoretical model is exactly the same as in Checherita-Westphal and others (2012) and it has been presented in detail in the Appendix.

Checherita-Westphal and others (2012) examined the debt rate that maximized economic growth for 22 OECD member countries, thirteen EU member states and eleven other European countries. According to the analysis results the share of public debt stock in GDP that maximized economic growth was 55.1% for the OECD countries, 42.5% for the EU member states and 48.9% for the other European countries. In addition Checherita-Westphal and others (2012) claim that OECD would need debt targets of about 67% of GDP and the euro area should target debt levels of around 50% of GDP if member states are to have common targets. The more recent study by Pradhan (2020) concludes that growth optimizing public debt to GDP ratio stands around 65–67% in India for the period 1980-2012.

2. The evolution of debt-to-GDP ratio in Turkey

The optimal public debt ratio would differ for each country because the underlying causes of the public debt of each economy vary. The reasons for public borrowing and the borrowing conditions may vary according to the characteristics and needs of the economy. For instance in economies where the aging population density is high such as Japan and Germany a significant share of public debt is expected to be applied to health expenditures and pensions, whereas in developing countries with a large young population , such as Turkey and Argentina, public debt is expected to be applied to the education, infrastructure, and industrial sectors.

Figure 1 shows the route of government debt-to-GDP ratio for advanced economies, emerging markets and developing economies and Turkey from 2001–2018.

Turkish public debt was at 43.32% on average in the last twenty years. The ratio reached a high of 76.1% in 2001 when the banking crisis occurred and decreased to 29.1% in 2018 (IMF, 2019). The public debt-to-GDP ratio tended to

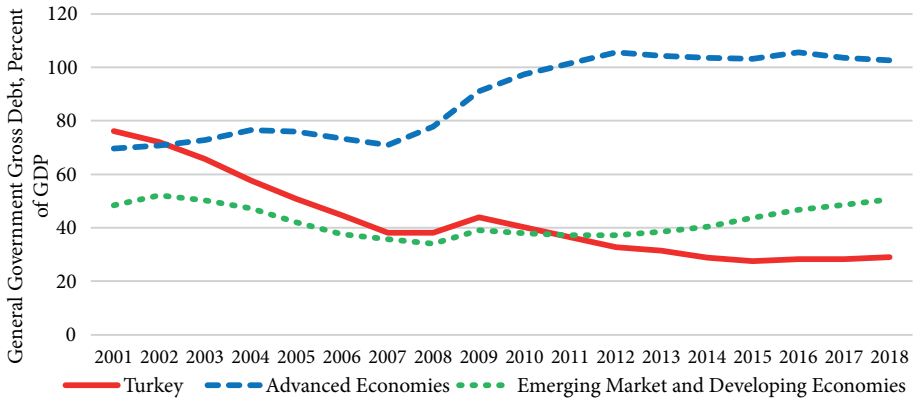

Figure 1. International comparison of Turkey's general government gross debt
Source: (IMF, 2019).

decrease over time except from 2008 to 2009. How did Turkey restrain public debt? At the beginning of the period some precautions were taken to maintain sustainable growth based on an IMF-oriented stabilization programme. The projected rate of GDP growth, for example, was consistently set at 5% for each coming year although the observed rapid expansion of the economy resulted in rates often surpassing 7% over the preceding year. The inflation targets of the central bank each year followed the predicted path starting with 20% in 2003 and falling to 5% in 2006 (Yeldan, 2008). According to the World Bank Report (2014) four main factors helped reduce the public debt-to-GDP ratio in Turkey: i) economic growth, ii) the stability of the primary budget balance, iii) appreciation of the real exchange rate and iv) falling interest rates. After the 2001 financial crisis, by implementing a programme to facilitate the transition to a strong economy Turkey achieved growth successfully. Implementing the reforms helped the Turkish economy to reduce the public debt-to-GDP ratio. Also, after the 2001 crisis, the government adopted a fiscal consolidation plan that focused mainly on the expenditure side of the budget. With this approach Turkey achieved a primary budget surplus of about 3% from 2002 to 2006. Stressing the transparency and predictability of public finances was particularly beneficial. Besides the plentiful of the global financial condition, appropriate monetary policy, falling inflation rates, positive expectations and confidence in the economy led to an increase in the real exchange rate. Furthermore a downward trend in global interest rates helped to reduce the cost of debt services in Turkey. Along with this exogenous development Turkey's successful implementation of the structural reforms enhanced transparency and fiscal stability.

Turkey in the last two decades has achieved stability in the stock of public debt except in times of crisis. This stability, as mentioned above, can be partly attributed to the successful implementation of the programme for the transition to a strong economy announced after the 2001 crisis. For example, from 2002 to 2018 Turkey's average growth rate was 5.66% approximately. Whereas the inflation rate was 68% in 2001 it was only 11% from 2002 to 2018. In addition with the successful transition to a strong economy the amount of foreign direct investment, which was 3.35 billion USD in 2001, increased to 12.35 billion USD from 2002 to 2018.

3. Data and empirical model

This section includes the descriptions of the data and model employed in the empirical analysis. Table 1 displays the variables, their descriptions and the data sources used in this study for the period from 1960 to 2013.[4]

[4] Because access to the data on Kp and Kg compiled from the IMF (ICSD) ended in 2013 the period covered by the data set ends with the same year.

Table 1. Variables, descriptions, and data sources of variables

Variables	Descriptions	Data Sources
GDP (Y)	Expenditure-side real gross domestic product at chained PPPs (in mn 2011 US$)	Penn World Table Version 9.1
Private-Sector Capital Stock (K_p)	Penn World Table's capital stock at current PPPs (in mn 2011 US$) multiplied by the coefficient representing the share of private-sector capital stock obtained from IMF-ICSD	Penn World Table Version 9.1 and IMF Investment and Capital Stock Dataset (ICSD)
Public-Sector Capital Stock (K_g)	Penn World Table's capital stock at current PPPs (in mn 2011 US$) multiplied by the coefficient representing the share of public-sector capital stock obtained from IMF-ICSD	Penn World Table Version 9.1 and IMF Investment and Capital Stock Dataset (ICSD)
Labor (L)	Number of persons employed (in millions)	Penn World Table Version 9.1

Table 2 summarizes the descriptive statistics of the data used in the empirical analysis. According to the Jarque–Bera normality test result all the data are normally distributed. Also all the series considered in the analysis are log-transformed. Thus the standard deviation of the series is small relatively. For example the standard deviation of Y, K_g, K_p, and L is 0.68, 0.74, 0.83, and 0.23, respectively.

Table 2. Descriptive statistics

	Y	K_g	K_p	L
Mean	26.83675	26.84996	27.18623	16.50556
Median	26.91500	27.05559	27.15022	16.50639
Maximum	28.13175	28.24905	29.06626	16.96040
Minimum	25.58320	25.36794	25.74893	16.14863
Std. Dev.	0.675734	0.742541	0.825008	0.226423
Skewness	–0.081350	–0.433329	0.331914	0.034345
Kurtosis	2.210120	2.486304	2.813109	1.937330
Jarque-Bera	1.463357	2.283702	1.070092	2.551467
Prob. (JB)	0.481101	0.319228	0.585642	0.279226
Sum	1449.185	1449.898	1468.056	891.3003
Sum Sq. Dev.	24.20067	29.22244	36.07378	2.717160
Observations	54	54	54	54

Note: All series used in the empirical analysis are log-transformed.

Source: All data presented in Table 2 and in the next tables are authors' calculations.

To calculate the d^* from equation (2), the estimated value of α is necessary. Taking the natural logarithm (ln), the transformation of equation (1) can be expressed as

$$\ln(Y) = (1-\alpha)\left[\beta \ln(L) + (1-\beta)\ln(K_p)\right] + \alpha \ln(K_g) \tag{3}$$

Using the notations $\gamma = \beta(1 - \alpha)$ and $\delta = (1 - \beta)(1 - \alpha)$, equation (3) can be expressed as

$$\ln(Y) = \gamma \ln(L) + \delta \ln(K_p) + \alpha \ln(K_g) \tag{4}$$
Expected sign: (+) (+) (+)

In this study time series analysis techniques were adopted in order to estimate the growth-maximizing debt-to-GDP ratio in the case of Turkey. The first step of the analysis is to determine the integration level of the variables. Therefore augmented Dickey Fuller (ADF) and Phillips–Perron (PP) unit root tests and regression analysis were employed in the next section.

4. Empirical results

To obtain reliable estimations in the econometric time series analysis the series must be stationary because non-stationarity may cause spurious regression problems (Granger & Newbold, 1974). In addition the series used should not contain a unit root. The *F*, chi-square, and *t*-statistics of analyses performed with a series containing a unit root becomes unreliable (Gujarati & Porter, 2009). Standard OLS regressions applied to non-stationary series may show inaccurate results (Asteriou & Hall, 2015). Granger and Newbold (1974) proposed $R^2 > DW$ control as a rule of thumb to detect spurious regression problems. Unit root tests are used to specify the integration level of the series. Such tests indicate that a series containing a unit root is not stationary. The literature on unit root tests began with the groundbreaking work of Fuller (1976) and the pioneering work of Dickey and Fuller (1979, 1981). Nelson and Plosser (1982) attracted attention of economists for the stationarity of macroeconomic time series. The most commonly used unit root test is the ADF (Dickey & Fuller, 1979, 1981) test. The ADF unit root test is frequently used alongside the Phillips and Perron (1988) test. These unit root tests have null hypotheses which states non-stationarity. In order to claim that there is a stationary series, it must be possible to reject the null hypothesis. ADF and PP unit root tests were employed in order to understand stationarity of the series. Results of the unit root tests are shown in the Table 3.

According to Table 3 the null hypotheses is rejected which implies the non-stationarity at the first differences for all the variables. Therefore it can be asserted that all the series in the analysis are I(1). It means that none of them

Table 3. Unit root test results

Variables		ADF Test Statistics	Phillips–Perron Test Statistics
Level			
Y	intercept	–0.047994	–0.081491
K_g		–0.765670	–0.764446
K_p		0.207248	0.533734
L		1.076651	1.066326
Y	trend and intercept	–1.681501	–1.891743
K_g		–3.064080	–1.552772
K_p		–2.472002	–0.961242
L		–1.722058	–1.984966
First difference			
Y	intercept	–6.509171***	–6.509146***
K_g		–4.179632***	–4.150881***
K_p		–3.705086***	–3.705086***
L		–6.733098***	–6.732173***
Y	trend and intercept	–6.444053***	–6.444054***
K_g		–4.134775**	–4.105475**
K_p		–3.760162**	–3.760162**
L		–6.872507***	–6.872786***

Notes: *, **, and *** represent statistical significance at 1%, 5%, and 10%, respectively. Lag lengths are determined by the Schwarz information criterion (SIC).

are stationary at this level. According to Granger and Newbold (1974) analysis with non-stationary series may cause a spurious regression problem. In order to avoid this problem cointegration analysis should be done. In this study ARDL Bounds testing procedure to cointegration has been employed for this purpose. Table 4 presents the empirical results of the ARDL bounds testing procedure for cointegration which is proposed by Pesaran, Shin and Smith (2001). According to Table 4 the value of the bounds test statistic (4.98) is greater than the upper I(1) bounds values of both Pesaran and others (2001) and Narayan (2005). However it must be noted that this cointegration relationship has a statistical significance at only the 10% level.

After detecting the cointegration relationship among the variables three fully efficient estimation methods have been employed for estimating cointegrating regressions. Namely; fully modified OLS (Phillips & Hansen, 1990), dynamic

Table 4. ARDL bounds testing procedure results

Bounds Test *F*-Statistics: 4.982645 (*k* = 3)			
Asymptotic: *n* = 1000			
Pesaran et al. (2001)	Significance	I (0)	I (1)
	1%	5.17	6.36
	5%	4.01	5.07
	10%	3.47	4.45
Finite sample: *n* = 50			
Narayan (2005)	1%	5.995	7.335
	5%	4.368	5.545
	10%	3.673	4.715
Diagnostic test results			
Normality (JB)	0.812132 [0.6663]		
Breusch Godfrey Serial Corr. LM	0.442936 [0.8013]		
Heteroskedasticity (White)	5.396358 [0.8632]		
Heteroskedasticity (ARCH)	0.000507 [0.9820]		
Heteroskedasticity (Breusch Pagan Godfrey)	4.995156 [0.8915]		
Ramsey RESET	1.266860 [0.2672]		
F-Statistics	1288.729 [0.0000]		
R^2	0.99		
Cusum	Stable		
Cusum of squares	Stable		

OLS (Saikkonen, 1992; Stock & Watson, 1993) and canonical cointegrating regression (Park, 1992).[5]

Phillips and Hansen (1990) suggested an estimator that uses a semi-parametric correction to eliminate the problems arising from the long-term correlation between the cointegration equation and stochastic regressor innovations. The resulting fully modified OLS (FMOLS) estimator is asymptotically unbiased and has a fully influential mixture normal asymptotic permitting the use of standard Wald tests employing asymptotic chi-square statistical inference. Saikkonen (1992) and Stock and Watson (1993) suggested a simple, useful approach to constructing an asymptotically influential estimator

[5] For detailed information on this topic see Maddala and Kim (1999), Hayashi (2000), and Pesaran (2015).

that removes feedback in the cointegration system. This method is known as dynamic OLS (DOLS). Park (1992) proposed the canonical cointegrating regression (CCR) method which is closely related to FMOLS but instead uses stationary transformations of the data to attain OLS estimates to subtract the long-run dependence between the cointegrating equation and stochastic regressors innovations can be used. These methods require all I(1) series. Thus the FMOLS, DOLS, and CCR methods as long-run estimators. Table 5 summarizes the estimation results.

Table 5. Estimation results

Variable	FMOLS	DOLS	CCR
K_g	0.1814** (0.0677) [2.6817]	0.1977*** (0.0689) [2.8701]	0.1930*** (0.0685) [2.8196]
K_p	0.1406** (0.0681) [2.0652]	0.3213*** (0.0849) [3.7845]	0.1292* (0.0674) [1.9178]
L	1.8577*** (0.2009) [9.2482]	1.0695*** (0.2737) [3.9076]	1.8488*** (0.2000) [9.2409]
Intercept	–12.5238*** (1.8892) [–6.6290]	–4.8374* (2.6052) [–1.8568]	–12.3811*** (1.8795) [–6.5876]
Observations	53	51	53
R^2	0.98	99	0.98
Adjusted R^2	0.98	0.99	0.98

Notes: *, **, and *** represent statistical significance at the 10%, 5%, and 1% level, respectively. Standard errors (HAC standard errors are used for DOLS) reported in parentheses and *t*-values in brackets. In addition one lag and one lead has been used in the DOLS estimates. This means that first lags and leads of first differences of explanatory variables are employed as instruments.

According to Table 5 the FMOLS, DOLS, and CCR estimation results are consistent with the expected signs. The model's explanatory variables (K_g, K_p, and L) affect GDP positively. All the coefficients are statistically significant.

4.1. Growth-maximizing debt-to-GDP ratio (d^*)

Using equation (4) and the estimate for the elasticity of output with respect to public capital stock (αK_g) the point estimate for the growth-maximizing level of public capital stock can be calculated as shown in Table 6.

Table 6. Calculation of growth-maximizing debt-to-GDP ratio (d^*)

Estimation method	Formulization	Value of d^* (%)
FMOLS	$d^* = \left[\frac{\alpha}{(1-\alpha)^2}\right]^{1-\alpha}$	34.3
DOLS		38.7
CCR		37.4

Using the point estimate the growth-maximizing ratio of public capital to GDP can then be calculated; for the Turkish economy it varies from 34.3% to 38.7%. Turkey's public debt-to-GDP ratio has been 32.8% on average in the last decade (IMF, 2019). However the estimated d^* value is considerably lower than the country's highest debt-to-GDP ratio of 76.1% in 2001.

5. Discussion

There are some limitations to consider in evaluating the empirical findings of this study. First, estimations rest on the assumption that public debt is incurred to finance public investments solely. However there is no explanation regarding the purposes for which the resource obtained through borrowing is used in the official data and reports. For this reason it is not possible to reach a clear result regarding the usage areas of the resource obtained by borrowing in the effect of public debt on growth. Second, debt interest payments are assumed to benefit domestic private agents in the theoretical model. However this fact is not matched exactly in today's open-economies. The public sector does not only prefer domestic borrowing for public financing but also prefers to borrow from external sources. For instance, Turkey's public sector external debt stock stood at 91.2 billion US dollars by the end of 2018. This amount corresponds to 45 percent of the total public debt stock of Turkey. Third, estimations rely on the assumption that the contribution of all types of public investment to GDP growth is the same. However different public investments have different characteristics and may, therefore, have different impacts on economic growth. For instance, public investment can increase economic growth directly by providing various public goods such as education and health or indirectly by creating a convenient environment for entrepreneurs. Fourth, although the efficiency of public investment management is in all likelihood a dynamic process the contribution of all public investment to growth is not time-varying in the model. In other words the contribution of all public investment to GDP growth is assumed to be constant over time.

Conclusions

The share of public debt stock in GDP is crucial in determining the proper fiscal policies for economies. A literature review showed that the level of public debt stock that would maximize economic growth had not yet been calculated for Turkey. To fill this gap in the literature for the 1960–2013 period the level of public debt that would maximize economic growth in Turkey was investigated. The FMOLS, DOLS, and CCR estimation methods were used in the analyses. Results showed that the ratio that would maximize economic growth in Turkey is between 34.3% and 38.7%. The public debt ratio of Turkey was 29.1% in 2018. Thus it can be concluded that Turkey possesses a public debt below the optimal ratio. According to the empirical findings additional public debt would increase economic growth in Turkey. Expanding the ratio by 5.2–9.6 pp of GDP would help to maximize the growth rate of the Turkish economy.

The data set used in the study ended in 2013 although it covers a wide range (1960–2013). Also the estimators used in the study do not take into account linear and structural breaks. Based on these constraints it is possible to make some suggestions for future researchers: first, data sets containing additional data can help achieve more comprehensive results. Second, new studies could be classified by countries' debt stock histories; good or bad, they can contribute to the implementation of more specific policies for countries and groups of countries. Third, the use of econometric techniques that take into account non-linearity and/or potential structural breaks may also lead to better empirical findings.

Appendix

Theoretical model

The theoretical model of this paper is the same as the paper conducted by Checherita-Westphal, Hallett and Rother (2012). They begin with an infinitely living representative agent who has preferences on consumption, c, as defined by the lifetime utility function:

$$V = \int_0^{\infty} (C^{1-\sigma} - 1) / (1-\sigma) e^{-\rho t} dt \tag{5}$$

where σ is the reverse of the elasticity of intertemporal substitution and ρ is the agent's rate of time preference. The agent has access to a Cobb–Douglas production function:

$$Y = (L^{\beta} K_p^{1-\beta})^{1-\alpha} (K_g)^{\alpha} \tag{6}$$

where Y is output, L is labour, K_p is private capital, and K_g is public capital. The production function indicates constant returns to scale in K_p and K_g. Therefore the economy is capable of endogenous growth (Kamps, 2005). For simplicity there is no labour choice, population growth, technological progress or depreciation of private capital and public capital. However employment may vary.

Throughout the steady-state growth path public capital will grow at a constant rate: $\Delta K_g = xK_g$ where x is the common growth rate of output, consumption, and private capital. The government must levy a tax on output at a rate θ to pay interest on its debt and meet present expenditures. Public investment is financed by public debt. The government's budget constraint is expressed as follows:

$$\Delta b = rb + \Delta K_g - \theta Y \tag{7}$$

where b is the debt level and r is the interest rate. Private agents at the same time maximize lifetime utility depending on their resource constraint:

$$\Delta K_p + \Delta b + C = (1 - \theta)Y + rb \tag{8}$$

The aim of the private sector is to maximize the current Hamiltonian function value:

$$H = [C^{1-\sigma} - 1]/(1-\sigma) + \lambda\left[(1-\theta)(L^{\beta}K_p^{1-\beta})^{1-\alpha}K_g^{\alpha} + rb - C\right] \tag{9}$$

Whereas in Aschauer (2000) employment levels are fixed, Checherita-Westphal and others (2012) replaced $L^{\beta}K_p^{1-\beta}$ with K_p as the single private input by normalizing L to 1 and adjusting the units of $(1 - \theta)$ by a factor of $(L/K_p)^{\beta}$ to represent the contribution of labour to the output at that assigned value. If L is not fixed, however, it is possible to optimize the equation (9) with regard to the private inputs $L^{\beta}K_p^{1-\beta}$ as a whole in addition to C and b from the first-order conditions:

$$\begin{gathered} C^{-\sigma} = \lambda \\ (1-\theta)(1-\alpha)\phi^{\alpha} = \rho - \Delta\lambda/\lambda \\ r = \rho - \Delta\lambda/\lambda \end{gathered} \tag{10}$$

Equation (10) represents the first-order condition of the maximization of equation (9). In equation (10), $\phi = K_g/L^{\beta}K_p^{1-\beta}$ is defined as the public-to-private input ratio. These conditions equate: the marginal utility of consumption to the shadow value of wealth and post-tax marginal product of private inputs, in addition the interest rate, to the rate of return on consumption. As a result the interest rate has to equal the post-tax marginal product of the private inputs. Thus from (10):

$$r = (1 - \theta)(1 - \alpha)\phi^{\alpha} \tag{11}$$

An unconstrained optimal value for ϕ must be specified. Using

$$K_t = (1-\delta)^t K_0 + \sum_{i-0}^{t-1}(1-\delta)^i I_{t-i}$$

and the golden rule of deficit financing $K_g = b$, the tax rate needed to service the debt in the long term is:

$$\theta = r\phi^{1-\alpha} \tag{12}$$

which after substituting equation (12) into $x = \dfrac{(r-g)d_{\min}}{d^{*} - d_{\min}}$ yields:

$$r = [(1 - \alpha)\phi^{\alpha}]/[1 + (1 - \alpha)\phi] \tag{13}$$

which, given suitable transversality conditions, implies a steady state growth of consumption and output. Differentiating the top and using the $pb = (r - g)d$, this steady state growth rate is:

$$x = \frac{\Delta C}{C} = \sigma^{-1}(r-\rho) = \sigma^{-1}\left[(1-\alpha)\phi^{\alpha} / 1 + (1-\alpha)\phi) - \rho\right] \tag{14}$$

Equation (14) which is the steady-state growth rate x based on ϕ, yields the expression for the optimal value of ϕ, given as follows:

$$K_g/K_p = \alpha/(1 - \alpha)^2 = \phi \tag{15}$$

Where using equation (2) is also possible:

$$K_g / Y = K_g / (L^{\beta}K_p^{1-\beta})^{1-\alpha} K_g^{\alpha} = K_g^{1-\alpha} / (L^{\beta}K_p^{1-\beta})^{1-\alpha} = \phi^{1-\alpha} \tag{16}$$

Replacing the optimal value of ϕ under the golden rule of financing that government borrowing is merely the formation of capital stock the growth--maximizing long-run value of the public debt-to-GDP ratio can be calculated, as expressed in:

$$d^{\star} = \phi^{1-\alpha} = \left[\frac{\alpha}{(1-\alpha)^2}\right]^{1-\alpha} \tag{17}$$

where $d^{\star}$ is the long-run optimal debt ratio for use if all inputs and input ratios take their optimized values.

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