Central Government Debt and Economic Growth: Evidence from 94 Countries

by

Sinem Hacıoğlu

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Abstract

This thesis analyzes the nature of the relationship between the central government debt and GDP per capita growth. I find an evidence for negative linear effect of public debt on economic growth. It is consistent with the other studies since high public debt decreases savings and investments which hinder the economic growth. Furthermore, I identify a structural break in the function that links public debt to economic growth. Since governments can benefit from low levels of public debt or low levels of debt might not have a considerable effect on growth, its initial effect is different on growth when compared to the high levels of public debt. I estimate the threshold level of public debt such that its effect on growth becomes negative when public debt level exceeds the threshold.

Keywords: Public debt, GDP per capita growth, panel data estimation, public debt threshold, System GMM.

Özet

Bu tez merkezi devlet borcu ile Gayri Safi Yurtiçi Hasıla büyümesi arasındaki ilişkiyi analiz ediyor. Kamu borcu ile ekonomik büyüme arasındaki lineer bir negatif ilişkiye dair kanıt buluyorum. Bu bulgu diğer çalışmalar ile de tutarlı çünkü kamu borcu tasarrufları ve yatırımları azaltarak ekonomik büyümeyi engelliyor. Ayrıca kamu borcunu ekonomik büyümeye bağlayan fonksiyonda yapısal bir kırılma belirliyorum. Hükümetler düşük seviyeli kamu borcundan yarar sağlayabildikleri ya da düşük seviyeli kamu borcu büyümeyi önemli ölçüde etkilemediği için, kamu borcunun başlangıçtaki etkisi yüksek seviyeli kamu borcunun etkisi ile karşılaştırıldığında farklı oluyor. Kamu borcunun üstünde olduğunda büyümeyi negatif etkilediği eşik değerini tahmin ediyorum.

Anahtar Kelimeler: Kamu borcu, kişi başına düşen GSYH büyümesi, panel data tahmini, kamu borcu eşik değeri, Sistem Genelleştirilmiş Momentler Yöntemi.

to my dear father, my dear mother

and

my dear sister

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1 Introduction

The public debt levels of most countries have shown a significant increase during the latest financial crisis. There are two main reasons for this increase. The first one is a growing need for fiscal stimulus packages to revive the economy. According to the Keynesian view, fiscal stimulus programs should be implemented to control the growing unemployment rate and the declining output level. These packages partly offset the negative effects of the crisis on the economic growth however, their drawback is an increasing public debt. The other reason is the institutional bailouts to save the financial sector from collapsing. These bailouts come in huge amounts, which lead to a sharp increase in government spending, and consequently a rise in the public debt. As a result, the increasing levels of public debt have become a serious problem in recent years. According to the IMF forecasts, the total public debt to GDP ratio of the advanced economies is expected to be above 100% in the next five years.

Public debt may be a dangerous source of funds for governments. The crucial points are the sustainability and the maturity of the debt. Temporary government deficits have a refreshing effect during recessions. However, if the public debt turns out to be chronic, then it becomes unsustainable and results in a slowdown, even a decline, in the economic growth. The importance of the sustainability and the maturity of the debt can be demonstrated in the following crises: Latin America, 1982; Russia, 1998; Argentina, 2001. The remarkable common point of these crises is an excessive and unsustainable debt. Latin American countries were unable to repay their debts, and the crisis ended up with the moratorium of Mexico. Similarly, Russia declared a moratorium due to its difficulty in sustaining a short-term maturity debt after government's revenues declined due to the capitalism. Argentina had to restructure its debt, which was caused by the Currency Board System, due to its inability to repay it.

The current global financial crisis has had similar characteristics in terms of its effect on public debt dynamics. Households and financial sector became indebted due to the liquidity crisis originating in the US economy. The government bailed out the problematic financial

institutions. Moreover, fiscal stimulus packages were introduced in order to revive the collapsing economy. Within the scope of these packages, tax allowances were implemented, which resulted in decreased government revenues. Moreover, spending on infrastructure, education and health increased and regulations to reduce unemployment were implemented. These measures resulted in a significant increase of the US public debt. Furthermore, the financial crisis in the US caused a global economic shock. It led to problems in the financial system of the Eurozone. Bailouts of banks and fiscal stimulus packages were introduced, which resulted in a considerable increase of the public debt of the Eurozone countries. All of the above support Carmen Reinhart and Kenneth Rogoff's view that severe banking crises are followed by sovereign debt crises.[1]

The first of the following figures indicates the central government debt to GDP ratio of the Eurozone countries and the US during the period 2001–2011, where the 2010 and 2011 values are forecasts. The initial level of debt in the US was below that of the Eurozone until 2007, but it exceeded the latter after that year. Namely, the public debt of the US was 6% higher than that of the Eurozone in 2009, whereas it was 13% lower in 2001. However, the striking point is that the Eurozone has faced more difficulties than the US in terms of managing the public debt. The main reason for it is that the Eurozone comprises countries with varying degrees of indebtedness. Since the EU is a economic and not a political union, it does not have a centralized budget. Therefore, it could not redistribute the budget of the problematic countries like the US did, and as a result, the public debt problem became more serious and spread by contagion to other countries. Portugal, Spain, Ireland, Italy, and Greece, whose debt levels are shown separately in the second figure below, are the countries which have mostly suffered from the sovereign debt crisis. Even though, Ireland and Spain managed their public debt successfully before 2007, all of their attempts seem to be reversed by the recent global crises.

[1]REINHART, C. M. AND K. S. ROGOFF (2008): "This time it is different: a panoramic view of eight centuries of financial crises," *NBER Working Paper*.

Figure 1: Central Goverment Consolidated Gross Debt to GDP – US and Euro Area and EU Members

Figure 1.a

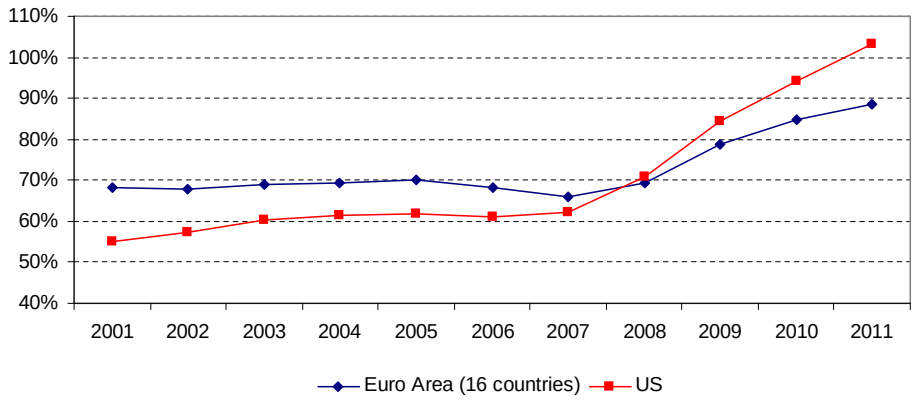
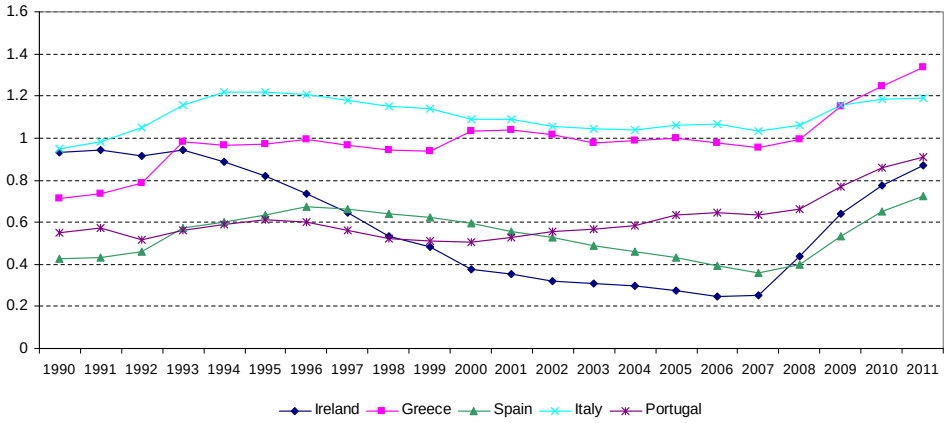


Figure 1.b

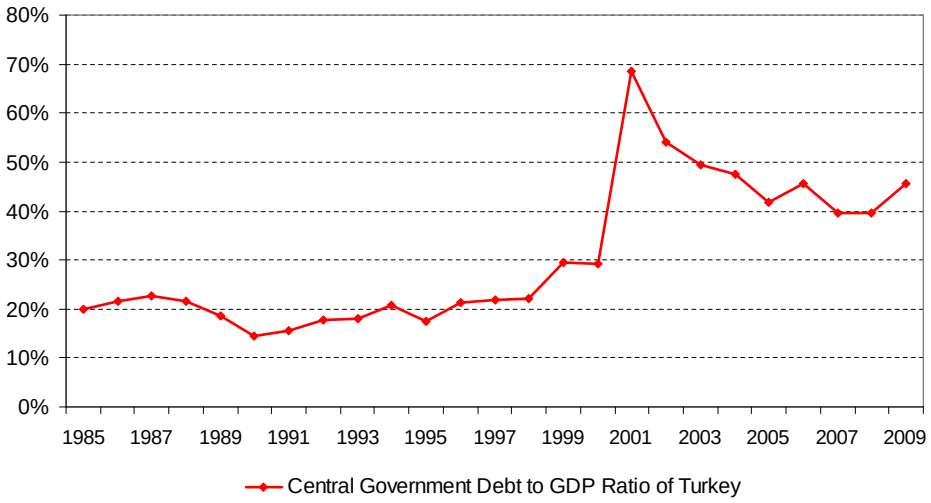


Turkey experienced a similar debt crisis a decade ago. A banking sector crisis due to the chronic public sector deficit, unregulated banking sector and chronic inflation raised doubts regarding the sustainability of its debt in the first half of 2001. The government used extra resources to bail out six privately owned banks only in 2000 and 2001. The public debt mounted above 60% of its GDP. A depreciation of the Turkish Lira accelerated the crisis dramatically. Consequently, average per capita income declined by almost 7%. The recovery of the economy was ensured by the rescue program of the IMF in May 2001. Therefore, Turkish financial sector

crisis did not turn into a debt crisis which is contradicting with the view of Reinhart and Rogoff. The main reason of it is the financial consolidation as a consequence of the IMF rescue packages.

Afterwards, Turkey was affected by the unfavorable environment in the recent global economic crisis. Since Turkey is linked to the international markets, the aggregate demand decreased as of 2008 as a consequence of the banking sector and sovereign debt crises in international markets. A decrease in tax revenues was caused by the contraction of the economy. Precautionary attempts to tackle the crisis such as cutting of some taxes, SME loan supports, and extra funds allocated to unemployment insurance increased the expenditures. Hence, the public debt burden of Turkey increased in the recent financial crisis. Figure 2 illustrates the central government debt to GDP ratio of Turkey over the period 1985-2009, which clearly shows the increase in debt both in the 2001 crisis and in the recent global crisis.

Figure 2: Central Government Debt to GDP Ratio – Turkey



The unsustainable and excessive increase in public debt levels of countries causes the economic growth to slow down. Despite its importance, public debt and its effect on growth has not been the main object of empirical studies until recent years. Nevertheless, a number of studies have focused on the effects of public debt on growth. The negative effect of public debt on eco

nomic growth has been demonstrated in several papers; what is more, the threshold level past which the correlation between debt and growth changes has been determined. Those studies have shown that below the threshold level, public debt has a positive effect on economic growth, whereas above that the effect becomes negative.

In 2000, the European Commission published several reports and studies about the public debt and fiscal policy in the Economic and Monetary Union (EMU). The second chapter of the report dealt with the impact of large public debt in the European Union (EU). They identified six channels through which public debt affects growth in the long run.

Channel 1: If public sector deficit is high then public sector borrowing requirement (PSBR) lessen the private savings and crowds out investments consequently. Therefore high public debt leads to slowdown of the growth rate.

Channel 2: Due to the large public debt, governments have to make huge amounts of interest payments. There are three ways in which governments can react:

- They may not react to large public debt at all. However, this process has to be eventually terminated. Moreover, due to these policies' effects on expectations, large and growing public debt may abate the growth.

- A reduction of public debt may be achieved by decreasing public spending. Governments generally reduce spending on education and infrastructure. However, these cutbacks lower the growth potential along with the public debt. On the other hand, for political reasons it is difficult to reduce public spending on current expenditures.

- A government can increase its revenue by increasing the taxes. However, many studies have shown that an increase in taxation results in a reduction of savings, as well as it discourages investments and employment, with a negative impact on growth.

Channel 3: Friedman (1981) proposed that there needs to be a constant ratio of total debt (public plus private) to GDP. In his view, governments should try to keep the debt at a constant

level. If the optimal debt level is higher than the current debt level, governments should respond to this by increasing their public debt level as well. Hence, increasing levels of public debt are associated with low growth rates.

Channel 4: Governments of highly indebted countries may reduce the cost of interest payments by tax concessions to debt holders.[2]. These privileges would decrease the government revenue, and the growth rate would decrease accordingly.

Channel 5: Governments are able to force banks, public enterprises, and social security administrations to buy government bonds.[3] Since the funding opportunities for the private sector are allocated to the government bonds, investing in the remaining funding will be more costly for the private sector. This will hinder the economic growth.

Channel 6: If the central banks of the countries are not independent, the governments can force them to follow an expansionary monetary policy to decrease the cost of the public debt. Even though this unexpected expansion may reduce the interest rates and the cost of borrowing for a while, in the long run this effect will disappear.

The primary aim of this thesis is to identify the overall effect of central government debt to GDP per capita growth and to determine the threshold level of debt. Before the estimation, related literature about the debt and growth is explained in Section 2. In Section 3, the model and the variables with their implications are introduced. Then, the data and its sources are presented in Section 4. Section 5 constitutes a preliminary analysis of the data. The descriptive statistics and the figures related to the main topic, public debt and growth are displayed. The estimation methods as well as their advantages and disadvantages are explained in Section 6. In Section 7, linear and nonlinear models are constructed separately. The models are estimated by the different estimation methods introduced in Section 6. The first subsection deals with the negative effect of debt on economic growth, while the second subsection discusses the non-

[2]TANZI, V. AND N. CHALK (2000), "Impact of large public debt on growth in the EU: a discussion of potential channels," *European Economy, N2.*

[3]TANZI, V. AND N. CHALK (2000), "Impact of large public debt on growth in the EU: a discussion of potential channels," *European Economy, N2.*

linear effect of public debt on growth. On that basis, the threshold level is determined, past which debt begins to affect growth negatively. The conclusion (Section 8) summarizes the data, the methodology, and the estimation results. The appendix presents some figures related to estimations and lists regarding countries in the data set.

2 Literature Review

The literature on public debt started in 1974 with Barro's study regarding the industrialized countries. That study asserted that the optimal ratio of public debt to GDP lies between 30 and 70 percent. Then his study in 1979 made the simplest connection between the public debt and growth. According to this study, increased taxes in order to achieve the sustainability of the debt will eventually lower the potential output level.[4] Moreover, Jacques de Larosiére, the Managing Director of the IMF, made a speech at the 1984 Congress of the International Institute of Public Finance, emphasizing the rising level of public debt. Despite those studies and speeches, public debt did not attract so much attention for the following reasons:

- No data is available for such an analysis, which would require data gathered from longitudinal studies on many countries.
- Since the governments decide on its level, public debt is treated as endogenous.
- The external debt becomes the object of most studies.

There have been a great deal of studies focusing on the effect of the external debt on economic growth. Those have tried to determine how the external debt affects economic growth.

[4]REINHART, C. M. AND K. S. ROGOFF (2010): "Growth in a time of debt," *NBER Working Paper Series.*

2.1 External Debt and Growth

External debt has two major contrary effects on growth. First, a low level of debt has a positive effect on growth. If countries which do not have access to borrowing channels are able to borrow and their marginal product of capital is above the global interest rate, then investments lead to economic growth. As Cohen (1991) proposed, even in the case of a repudiation risk for governments, even a relatively low level of debt will result in economic growth. However, high levels of debt are associated with low growth rates. There are some explanations regarding this apparent fact. The most influential one are the debt overhang theories which were proposed by Krugman (1988). They are mainly used for countries which could have difficulties in repaying their debts. If a country's debt level is larger than its repayment ability, then the expected debt service is likely to become an increasing function of its output level.[5] Hence, the first precaution a government can take is to lessen its plans on regulatory and social reforms as a result, the ensuing poor macroeconomic environment causes the effectiveness of investments to diminish. Another aspect of the debt overhang theories is the expectation of tax increases. That expectation decreases the effectiveness of investments and reduces the growth rate. Uncertainty is another major factor which causes growth to decrease, as investors are willing to wait for longer-term investments.

Several studies have examined the aforementioned effects of external debt on growth. For instance, Cohen (1997) and Elbadawi et al. (1997) proposed that there is a nonlinear relationship between external debt and growth. While Cohen (1997) did not use the direct approach, a converse approach can be seen in Elbadawi (1997), who directly used the nonlinear specification and found a threshold above which the effect of debt becomes negative to be 97%. Calvo (1998) argued that high external debt causes the distortionary tax burden on capital and lowers the rate of return on capital, thus investment and growth decrease. Pattillo et al. (2002) proposed a model for panel data set of 93 developing countries and found a nonlinear relationship between

[5] CLEMENTS, B., R. BHATTACHARYA AND T. Q. NGUYEN (2003): "External debt, public investment, and growth in low-income countries," *IMF Working Paper*.

external debt and growth. Different than the Elbadawi's threshold, they found the threshold of external debt to GDP ratio to be 70%. Clements et al. (2003) made a similar analysis for low-income countries. With their data and model, they determined the debt to GDP ratio threshold between 30 and 37 percent. Schclarek (2004) worked on the data of 59 developing countries and 24 industrial countries over the period 1970–2002. Like the previous studies, he found that there is a negative effect of the external debt on growth however, he was not able find hard evidence to determine the debt threshold past which debt has a different impact on growth.

2.2 Public Debt and Growth

Since the main reason of external borrowing is to finance domestic deficits, there is a linkage between external and public debt. Actually, Yilmaz (2005) showed that there is a positive relationship between external and public debt levels. Public debt has an impact on external debt because when countries need sources of finance, they first try to find it internally. At the end of the process, public debt results in a demand for external sources of finance. In spite of the fact that the initial point is the public debt, relevant studies have only appeared in the recent years.

As a major factor, lack of data caused this silence in the literature of public debt. Studies trying to explain debt or inflation levels of countries cannot use domestic debt data as an explanatory variable since until recently it was hard to collect it. However, governments have now begun to compose their total debt by shifting from external debt to domestic debt. Recently, Reinhart and Rogoff (2008a) constructed a data set for 64 emerging and advanced countries over the period 1900–2006. The main purpose of their study is to show the share of domestic debt in all over the world, which is very high especially in emerging and advanced economies. Besides, they want to emphasize that public debt is a variable that should not be ignored.

Reinhart et al. (2003) also constructed a public debt data set for some developing sountries ad emerging markets over the period 1990–2002. Jeanne and Guscina (2006) gathered public

debt data of 19 emerging markets for 1980 to 2005. Cowan et al. (2006) constructed a data set for all the countries in the western hemisphere from 1980 to 2004.

Despite the fact that data has been unavailable until recent years, there have been certain comments and studies on public debt. In 2000, the European Commission published several reports and studies about the public debt and fiscal policy in the Economic and Monetary Union (EMU) where they identified six channels through which public debt affects growth.

Aside from the reports of the European Commission, there are many other studies on public debt and its effect on growth. For instance, Blavy (2006) constructed a model with the dependent variable of productivity growth of Jamaica and public debt as an independent variable. He found evidence of the negative impact of total public debt on productivity growth. Specifically, his study found that doubling the total public debt will cause a decline in productivity growth by 1.5%. Moreover, he provided evidence for the nonlinear relationship between growth and total public debt. Last but not the least, he identified the total public debt to GDP ratio threshold as 21%. The total public debt has a positive impact on growth below the threshold ratio, whereas above that it has a negative impact.

Abbas and Christensen (2007) investigated the effect of domestic debt on economic growth for low-income countries and emerging markets. The panel data includes 93 countries over the period 1975–2004. They tested the effect of public debt on growth and whether there is a nonlinear relationship between them. They used lagged GDP per capita, domestic debt to GDP ratio, population growth, inflation, fiscal balance to GDP ratio, external debt to GDP ratio and growth in terms of trade as explanatory variables. They concluded that public debt affects economic growth both negatively and positively. The turning points of the public debt vary among estimation methods but it is in the range of $35\% - 65\%$. Like Blavy (2006), they found that below the threshold level, public debt has a positive impact on economic growth, whereas above it the impact becomes negative.

Rogoff and Reinhart (2010) examined 44 countries over two centuries. They proposed that the effect of government debt on growth is not significant when the debt to GDP ratio is below the threshold. This threshold ratio of debt to GDP was estimated at 90%. Above this threshold level, high debt to GDP ratio causes growth rate to decrease. The threshold level is high because the countries in their data set generally have long-term public debts. Therefore, their vulnerabilities to sudden shocks and crises are low. As can be concluded, the negative effect of the high debt to GDP ratio disappears partially if the maturity of the public debt is long.

3 The Empirical Model

The main aim of this paper is to study the effect of debt to growth. However, I cannot use debt as a sole regression factor since there are other factors affecting growth as well. Aside from central government debt to GDP ratio as an independent variable, the lagged value of GDP per capita, the gross fixed capital formation to GDP ratio, the trade to GDP ratio and population growth are used as well.

In the model, I use lagged value of GDP per capita to capture the catching up effect. If a country has a low GDP level initially, its growth will be faster when compared to other countries whose initial GDP level is higher. This fact confirms the convergence hypothesis in the growth literature. Patillo et al. (2004) illustrated that the effect of debt on growth is through the investment channel thus, the gross fixed capital formation to GDP ratio is used to examine the effect of investment on growth. Trade to GDP ratio is another explanatory variable since it is a decisive indicator of GDP. Openness is used for the same purpose as trade, but it is used when trade is treated as endogenous. Population growth changes the per capita GDP therefore, it is used as a regressor as well. Schooling rate is used as an instrument in order to capture the effect of human capital to growth.

4 Data

In this thesis, panel data consisting of 2727 observations of 94 countries is examined over the period 1980–2007. The data of growth rate of GDP per capita, GDP per capita, the ratio of gross fixed capital formation to GDP, trade to GDP ratio, population growth, openness and schooling rate are from the World Bank's World Development Indicators (WDI) Online Database and Penn World Table. Data on the ratio of central government debt to GDP was obtained from Inter-American Development Bank.

Using the data, three-year averages have been calculated in order to remove the individual effects of the variables in the given periods. That is because, if a shock occurs, it will change the values of the variables significantly in the yearly data and affect the results of the estimation. Therefore, the data set in question captures three-year averages for the periods 1981–1983 and 2005–2007. In total, I have 846 observations available; however, there are missing values throughout this time, i.e. the data is unbalanced. GDP per capita is transformed by taking its logarithm, and throughout the analysis lagged value of log of GDP per capita is used. All other variables in the data are expressed in terms of percentages since they are either ratios of specific variables to GDP or growth rates.

5 Preliminary Analysis of the Data

The descriptive statistics for each variable are displayed in Table 1. Differences in the number of observations are due to the missing values in the series.

	Number of Obs.	Mean	Std. Dev.	Min	Max
GDP per Capita Growth	816	0.019	0.039	-0.264	0.217
Central Government Debt/GDP	700	0.560	0.404	0.000	2.809
Log (GDP per Capita)	714	8.443	1.257	5.417	10.966
Gross Fixed Capital Formation/GDP	804	0.218	0.070	0.032	0.617
Trade/GDP	796	0.774	0.481	0.093	4.479
Population Growth Rate	846	0.013	0.012	-0.052	0.073

Table 1

As in Patillo et. al (2002), it would be interesting to look at the graphs regarding per capita GDP growth and central government debt. Since I use three-year averages, I have to calculate the averages of the periods to look at the behavior of the series over time. For instance, for the period 1981–1983, I calculate the average growth rates and debt ratios. Namely, after calculating the three-year averages of the data country by country, I compute the average of averages by periods.

Figure 3 illustrates the behavior of the average per capita GDP growth throughout the sample periods. A slight increase can be observed in the first three periods, whereas the growth rate suddenly plummets in the forth period. It recovers in the following two periods, but another decrease occurs in the seventh period. In the eighth period, growth remains more or less constant and in the last – ninth – period, it shows a considerable rise to a level higher than its historical levels. Even though there are some periods with lower growth rates, the general trend of the growth rate is upward.

Figure 3: Average GDP per capita Growth

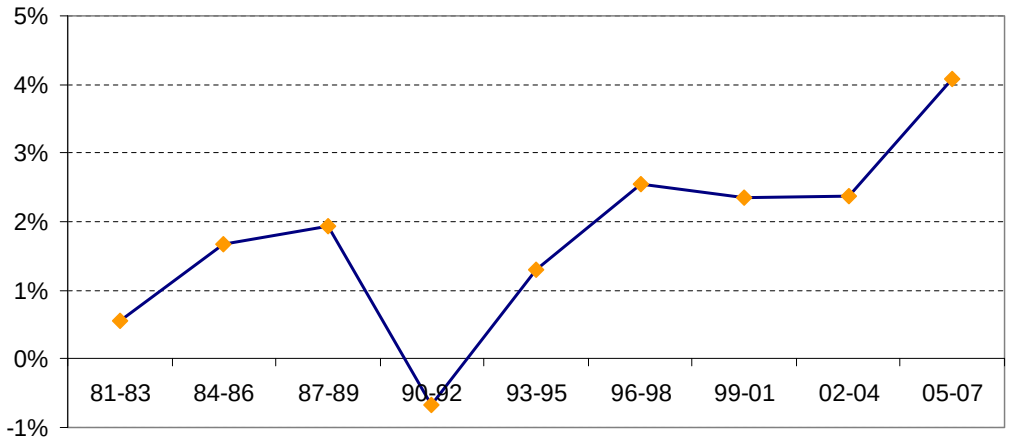


Figure 4 indicates the evaluation of the average central government debt to GDP ratio over time. It always shows an increase except for the years 1999–2001 and 2005–2007. As can be seen the figures, two series exhibit a negative relationship between growth and debt in some periods.

I can see this clearly by looking at the 2005–2007 period. The growth rate increases by almost 1.5%, while domestic debt to GDP ratio decreases by almost 8.5% between 2005 and 2007. As an early conclusion, I can argue that these two indicators are negatively correlated, i.e. as debt to GDP ratio decreases, GDP per capita growth increases by showing an indirect proportion.

Figure 4: Average Central Government Debt to GDP Ratio

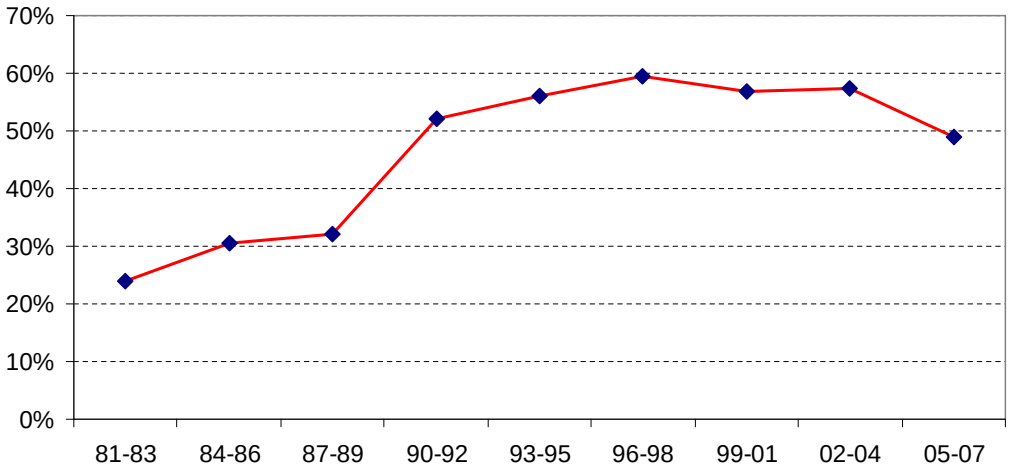


Table 2 is the correlation matrix which shows the pairwise correlations among the variables. Asterisks indicate that the values are significant at the 5% level. The negative correlation between growth and debt suggests that when debt increases, it leads to a decrease in economic growth. Furthermore, another striking point is that the correlation between them is higher than most of the other variables.

	GDP per Capita Growth	Central Government Debt/GDP	Log (GDP per Capita)	Gross Fixed Capital Formation/GDP	Trade/GDP	Population Growth Rate
GDP per Capita Growth	1.0000					
Central Government Debt/GDP	-0.2580*	1.0000				
Log (GDP per Capita)	0.0932*	-0.3323*	1.0000			
Gross Fixed Capital Formation/GDP	0.2901*	-0.2767*	0.1404*	1.0000		
Trade/GDP	0.1407*	-0.0676	0.2912*	0.2815*	1.0000	
Total Pop. Growth Rate	-0.0818*	0.2314*	-0.4799*	-0.1006*	-0.1272*	1.0000

* Significant at 5% level.

Table 2

6 Estimation Methods

The main aim of this thesis is to investigate the nature of the relationship between central government debt and growth. Therefore, the growth of GDP per capita is the dependent variable. My explanatory variables are similar to those in Pattillo et al. (2002) and Abbas and Christensen (2007). Aside from the ratio of central government debt to GDP, lagged value of GDP per capita, the gross fixed capital formation to GDP ratio, the trade to GDP ratio and the population growth are the other explanatory variables. Data includes values for openness and schooling rate, which are used as instruments for the trade to GDP ratio and population growth while performing Instrumental Variables (henceforth IV) and System Generalized Methods of Moments (henceforth System GMM).

I have a large panel data set. The main feature of such a data set is including the fixed effects. Fixed effects can be referred to as a constant term which does not change over time instead changes over countries in my model. However, the model might allow them to be correlated with the regressors whereas they should be still uncorrelated with residuals. Hence, I have to consider the presence of fixed effects while estimating the coefficients.

In my empirical analysis, I use several estimation methods that are similar to the Patillo et. al (2002) where they examine the effect of external debt on growth. Firstly, I start with the simplest Ordinary Least Squares Estimation (henceforth OLS) method. OLS is used in order to understand the basic facts about the data. However, it causes dynamic panel bias since lagged value of GDP per capita and fixed effects in the residual may be correlated, which causes endogeneity. Therefore I consider alternative, more sophisticated and realistic techniques.

I use Least Squares Dummy Variables Estimation (henceforth LSDV) as a second estimation tecnique to remove the fixed effects through assigning dummy variables to each country. However, both OLS and LSDV do not eliminate the endogeneity caused by the usage of the lagged variable. As a third step, Fixed Effects Estimation (henceforth FE) is executed. Although the fixed effects are removed, endogeneity still creates difficulty since lagged value of a variable and

residuals can be correlated. Hence, a model which eliminates the dynamic panel bias and also does not cause endogeneity is needed. Forth estimation method is IV where the endogenous variables, i.e. lagged GDP per capita growth and trade to GDP ratio are instrumented on the lagged values of themselves, concurrent values of the other explanatory variables and also openness and schooling rate. IV does not remove the endogeneity completely since I cannot use the deeper lags of the variables as instruments to avoid reducing the sample size.

Besides the abovementioned methods, an alternative estimation method, "Differenced GMM", which was introduced by Arellano–Bond (1991) could be used. It basically uses the first differences of the series as instruments. However, differenced instruments behave weakly due to the persistence of the time series and convey little information about future changes. Thus, to remove all abovementioned problems, as a fifth method I use System GMM, which is a recent method.

System GMM was proposed by Arellano–Bover (1995) and Blundell and Bond (1998). It estimates the system of equations in both differences and levels where the instruments used are lagged differences of the series.[6] System GMM produces consistent estimates even when the regressors are endogenous or some of them are not strictly endogenous but are predetermined. Moreover, I can still use it in the presence of fixed effects and the correlation between the contemporaneous and past values of dependent variables. Data with a short-time dimension with a large number of individuals can be examined with this procedure as well. It eliminates the fixed effects across countries hence, using the System GMM method makes coefficient estimates unbiased and allows the estimates to be consistent even in the presence of measurement error.

[6]BOND, S., A. HOEFFLER AND J. TEMPLE (2001): "GMM estimation of empirical growth models," *Working Paper.*

7 The Estimation Results

According to studies of Blavy (2006), Abbas & Christensen (2007) and Reinhart & Rogoff (2010), I expect a negative linear and overall nonlinear relationship between public debt and economic growth. Therefore, first I assume that there is a *linear* relationship between them and I estimate the coefficients with the abovementioned methods. After obtaining the first results, I consider the *nonlinear* relationship and set up the model with respect to the assumption of nonlinear relationship between debt and growth. Hence, this section is separated into two main subsections, the first of which is the estimation of the linear model with different estimation methods and the other is the estimation of the threshold model.

7.1 Linear Specification

The model on which I assume the linearity is,

$$y_{it} = \alpha_i + \boldsymbol{\beta}\mathbf{X}_{it} + \varepsilon_{it}, \tag{1}$$

where y_{it} is the per capita GDP growth, α_i is a country specific fixed effect and $\mathbf{X}_{it}$ includes the explanatory variables, i.e. central government debt to GDP ratio, lagged value of log of GDP, ratio of gross fixed capital formation to GDP, trade to GDP ratio and population growth. I use the contemporaneous values of all variables except log of GDP per capita. I estimate this model by different estimation methods.

7.1.1 Ordinary Least Squares Estimation

The first estimation method is Simple OLS, which gives an idea about the model and the estimated coefficients. Table 3 displays the results of the OLS estimation. Since the coefficient of central government debt to GDP ratio has a negative value and it is significant even at the 5% significance level, I can conclude that growth is negatively related with debt. Investment and trade have positive and significant coefficients, which are expected because investment and trade both have a positive effect on growth. On the other hand, the coefficients of log GDP per capita and population growth are not significant.

OLS	Coefficients
Central Government Debt/GDP	-0.0147 (-2.89)
Log (GDP per Capita)	-0.0002 (-0.26)
Gross Fixed Capital Formation/GDP	0.1432 (3.97)
Trade/GDP	0.0074 (2.83)
Population Growth Rate	-0.223 (-1.36)
Number of Observation	621
R squared	0.4538

Table 3

Considering the OLS as a healthy estimation method can be misleading. Since the data includes panel data of 94 countries, each country may have an individual fixed effect. This problem arises due to the time invariant component in the model. It can be correlated with the lagged values of the variables since the shock occurred in the previous period affects the lagged values of the variables and has effects on fixed impacts in the next period as well. Hence, the OLS estimation cannot eliminate the dynamic panel bias which occurs in cases where fixed effects and lagged values of variables are correlated.

7.1.2 Least Squares Dummy Variable Estimation, Fixed and Random Effects Estimations

The fixed effects estimation assumes that every group in the panel data has an individual effect that is considered to be correlated with the explanatory variables. Thus, it depends and so changes over the individuals. If I assume fixed effects in the model, I can present the model in the following way where I can construct the LSDV model at the same time.

$$
\begin{aligned}
\mathbf{y}_i &= \mathbf{i}\boldsymbol{\alpha}_i + \mathbf{X}_i\boldsymbol{\beta} + \boldsymbol{\varepsilon}_i \\
\begin{bmatrix} \mathbf{y}_1 \\ \mathbf{y}_2 \\ \vdots \\ \mathbf{y}_n \end{bmatrix} &= \begin{bmatrix} \mathbf{i} & \mathbf{0} & \cdots & \mathbf{0} \\ \mathbf{0} & \mathbf{i} & \cdots & \mathbf{0} \\ \vdots & \vdots & \ddots & \vdots \\ \mathbf{0} & \mathbf{0} & \cdots & \mathbf{i} \end{bmatrix} \begin{bmatrix} \alpha_1 \\ \alpha_2 \\ \vdots \\ \alpha_n \end{bmatrix} + \begin{bmatrix} \mathbf{X}_1 \\ \mathbf{X}_2 \\ \vdots \\ \mathbf{X}_n \end{bmatrix} \boldsymbol{\beta} + \begin{bmatrix} \boldsymbol{\varepsilon}_1 \\ \boldsymbol{\varepsilon}_2 \\ \vdots \\ \boldsymbol{\varepsilon}_n \end{bmatrix} \\
\mathbf{y} &= \begin{bmatrix} \mathbf{d}_1 & \mathbf{d}_2 & \cdots & \mathbf{d}_n & \mathbf{X} \end{bmatrix} \begin{bmatrix} \boldsymbol{\alpha} \\ \boldsymbol{\beta} \end{bmatrix} + \boldsymbol{\varepsilon}_i \\
\mathbf{y} &= \mathbf{D}\boldsymbol{\alpha} + \mathbf{X}\boldsymbol{\beta} + \boldsymbol{\varepsilon} \qquad (2)
\end{aligned}
$$

where $\boldsymbol{\alpha}$ refers the fixed effects, $\mathbf{d}_i$ is a dummy variable which shows the groups –in my case, the countries– and $\mathbf{D}_{(nTxn)}$= $\begin{bmatrix} \mathbf{d}_1 & \mathbf{d}_2 & \cdots & \mathbf{d}_n \end{bmatrix}$. In the last equation $\boldsymbol{\beta}$ becomes the LDSV estimator. Therefore, it will be beneficial for me to perform LSDV before FE estimation. This method basically assigns dummy variables to each country to eliminate the fixed effects. The estimates of this method can be seen in Table 4. Coefficients of debt, investment and trade have the same signs as in the OLS estimation. Moreover, all of them are significant as well. Log of GDP per capita and population growth rate are again not significant.

LSDV	**Coefficients**
Central Government Debt/GDP	-0.0199 (-2.44)
Log (GDP per Capita)	-0.00095 (-0.26)
Gross Fixed Capital Formation/GDP	0.1338 (2.65)
Trade/GDP	0.0458 (2.97)
Population Growth Rate	0.0183 (0.05)
Number of Observation	621
R squared	0.6021

Table 4

Although I find similar results in LSDV compared to OLS, I cannot use it because Kiviet (1995) asserted that this method can only be used efficiently for balanced data. Hence, I should try to understand whether the fixed effects create a problem. The third and forth estimation methods are FE and RE respectively. I analyze both of them at the same time to decide on the appropriate model. If I conclude that there is a fixed effect then it will create a problem due to its correlation with the regressors and I should consider this correlation while estimating. If I find that the effects are random, then I assume that there is no correlation between regressors and $\boldsymbol{\alpha}_i$. The estimation results of both methods are presented in Tables 5 and 6 below.

FE	**Coefficients**
Central Government Debt/GDP	-0.0227 (-3.11)
Log (GDP per Capita)	-0.0228 (-4.22)
Gross Fixed Capital Formation/GDP	0.089 (1.88)
Trade/GDP	0.065 (4.26)
Population Growth Rate	-0.018 (-0.06)
Number of Observation	621
R squared	0.1406

Table 5

RE	**Coefficients**
Central Government Debt/GDP	-0.021 (-3.87)
Log (GDP per Capita)	-0.0042 (-2.6)
Gross Fixed Capital Formation/GDP	0.111 (3.07)
Trade/GDP	0.0126 (4.35)
Population Growth Rate	-0.328 (-1.32)
Number of Observation	621
R squared	0.4128

Table 6

After estimating the FE and RE models separately, I make the Hausman Test which is proposed by Hausman (1978) for deciding whether there is a fixed effect or not. It basically test the difference between estimates of FE and RE estimations whether they are significant or not. The null hypothesis proposes that difference is not significant, i.e. there is no fixed effect. Hence, rejecting the null hypothesis means that there are significant differences between the estimates of the coefficients in both methods that is to say there are fixed effects. Table 7 reports the estimated coefficient of both models again and additionally it shows the difference between the estimates and the standard errors of the differences. Under the abovementioned hypothesis, the corresponding test statistic is $24.88 \sim \chi^2_{(5)}$ (p-value: 0.0001), which allows me to reject the null hypothesis.

	(b) FE	(B) RE	(b-B) Difference	S.E.
Central Government Debt/GDP	-0.0227	-0.021	-0.0017	0.00506
Log (GDP per Capita)	-0.0228	-0.0042	-0.0186	0.0042
Gross Fixed Capital Formation/GDP	0.089	0.111	-0.022	0.035
Trade/GDP	0.065	0.0126	0.0524	0.0122
Population Growth Rate	-0.018	-0.328	0.31	0.221

Table 7

Rejecting the null hypothesis of the Hausman Test enables me to use FE estimation coefficients since the RE estimation is inconsistent. Table 5 reports them and the signs of the coefficients of debt/GDP, log GDP per capita, investment/GDP and trade/GDP are consistent with results in OLS and LSDV estimations in terms of their signs. The difference arises in the significance of the log GDP per capita. It becomes significant after eliminating the fixed effects. As usual, population growth has a negative coefficient which is insignificant. Although the coefficients seem sensible, I cannot use this method because it only removes the fixed effects. The endogeneity still affects the results.

7.1.3 Instrumental Variables Estimation

The next estimation method is IV, in which I use instruments in the estimation in order to eliminate the endogeneity caused by the correlation between the variables. Instead of IV estimation, Differenced GMM, which uses the first differences of the series as instruments, can also be used. Actually, taking the first differences of the variables will eliminate the fixed effects. However, Differenced GMM has a drawback which is caused by the persistence of the series over time. If the series strongly depend on their past values, their differences cannot be used as a good predictor for future changes. What is more, Differenced GMM cannot eliminate endogeneity between the first differences of dependent variable and the residuals, it only removes the fixed effect. Hence, using instruments for endogenous variables is the recommended methodology.

In IV estimation, lagged value of log GDP per capita and trade/GDP ratio are instrumented to the lagged values of themselves and investment, the contemporaneous values of the other regressors, openness and schooling rate. I treat log GDP per capita and trade/GDP ratio as endogenous because lagged value of GDP is affected by the past public debt burden and trade is closely related with investment and GDP per capita. Even though I can use the deeper lagged values of regressors, it is avoided in order to maximize the sample size.

The model is estimated by the Two Stage Least Squares (2SLS) method. The results of the estimation are shown in Table 8. Coefficients of debt/GDP, investment/GDP and trade/GDP have the expected signs, and they are all significant. Moreover, the population growth rate's coefficient is not significant which is consistent with the previous results. The interesting part is the coefficient of log GDP per capita which is negative and highly significant, as it is in the FE estimation.

IV	**Coefficients**
Central Government Debt/GDP	-0.0228 (-3.58)
Log (GDP per Capita)	-0.0355 (-4.17)
Gross Fixed Capital Formation/GDP	0.151 (3.41)
Trade/GDP	0.112 (6.01)
Population Growth Rate	0.1352 (0.60)
Number of Observation	438
R squared	0.0506

Table 8

7.1.4 System GMM

In the last estimation, I use System GMM for dealing with the endogeneity. System GMM is used by Blavy (2006) in order to explain the growth of Jamaica and also it is used by Abbas and Christensen (2007) to understand the effect of debt on growth of 93 low-income countries and emerging markets as well, over the years 1975–2004. In both papers, there is a problem of endogeneity caused by the usage of lagged value of a variable. Moreover, in Abbas and Christensen (2007), the fixed effects create problem due to the large data set for different countries.

System GMM works through assigning the instruments for endogenous regressors. First, endogenous or predetermined and strictly exogenous regressors are defined. If there are no strictly exogenous variables, instead there are variables that I suspect of their predeterminedness, then all of them defined in the same place. The main thing is taking the differences of the all variables, instrument exogenous ones to themselves and instrument endogenous and predetermined ones to the differences of them. The system of equations is estimated at levels where the instruments are lagged values of the differences. Thus, the endogeneity problem disappears and the methodology gives the consistent results which are shown Table 9.

System GMM	**Coefficients**
Central Government Debt/GDP	-0.0148 (-3.26)
Log (GDP per Capita)	-0.0019 (-2.46)
Gross Fixed Capital Formation/GDP	0.2221 (9.19)
Trade/GDP	0.0068 (1.81)
Population Growth Rate	-0.27 (-2.21)
Number of Observation	621
R squared	-

Table 9

Results are consistent with the other estimation methods. The signs of the first three variables are the same as the previous estimation results and are all significant. The difference lies in the last two variables. The significance level of trade/GDP declines and population growth rate becomes significant as a result.

7.1.5 Results of the Estimation of Linear Specification

Tables 3–6 and 8–9 show the results of the estimations of the linear specification of the model with different methods. Table 10 below displays all of the results.

	OLS	LSDV	FE	IV	System GMM
Central Government Debt/GDP	-0.0147 (-2.89)	-0.0199 (-2.44)	-0.0227 (-3.11)	-0.0228 (-3.58)	-0.0148 (-3.26)
Log (GDP per Capita)	-0.0002 (-0.26)	-0.00095 (-0.26)	-0.0228 (-4.22)	-0.0355 (-4.17)	-0.0019 (-2.46)
Gross Fixed Capital Formation/GDP	0.1432 (3.97)	0.1338 (2.65)	0.089 (1.88)	0.151 (3.41)	0.2221 (9.19)
Trade/GDP	0.0074 (2.83)	0.0458 (2.97)	0.065 (4.26)	0.112 (6.01)	0.0068 (1.81)
Population Growth Rate	-0.223 (-1.36)	0.0183 (0.05)	-0.018 (-0.06)	0.1352 (0.60)	-0.27 (-2.21)
Number of Observations	621	621	621	438	621
R squared	0.4538	0.6021	0.1406	0.0506	-

Table 10

In all estimation methods, all coefficients except population growth rate have the same signs and are significant through most of the time. Only the population growth rate is not significant in all estimation methods except System GMM.

As I have established in the preliminary analysis of the data in the previous parts, Figures 3 and 4 basically show the negative relationship of the debt/GDP ratio with GDP per capita growth. Consistently, the estimated coefficient of central government debt to GDP ratio is negative and always significant, which is to be expected. Therefore, my result is consistent with the findings of Tanzi and Chalk (2000), Blavy (2006), and Abbas and Christensen (2007).

When public debt increases, savings decrease, and this causes private investment to diminish. Increasing debt burden restricts the governments' incentives to implementing reforms, which creates an unhealthy investment environment and reduces investments and growth. Furthermore, the higher amount of interest payments must be made hence, it increases taxes, which will eventually limit growth. My estimation results are consistent with this fact. One standard deviation increase in public debt/GDP (40%) causes a 0.6% decrease in growth according to the coefficients of the OLS estimation. This value is 0.8% in LSDV, 0.92% in both FE and IV, and 0.6% in System GMM.

The lagged value of log GDP per capita affects economic growth negatively as well. Thus, it proves the convergence hypothesis.[7] As Barro (1991) verified, the initial level of the GDP per capita level is negatively related to the economic growth. Hence, my results are able to confirm this fact and so they do. Even though the coefficient is not significant in the first two estimation methods, in the results after eliminating the fixed country effects and endogeneity, it becomes significant.

The coefficient of investment is always positive and significant at the 10% significance level. It is a sensible result since investment increases the economic growth. In the meantime, I know that public debt and investment are related since an increasing amount of public debt decreases investments and lowers growth. Now, I have found out that investment positively affects economic growth, and the public debt's effect on growth is negative. This relationship between investment and public debt causes me to suspect the endogeneity of the investment. Therefore, it is treated as endogenous in the System GMM estimation. After this adjustment, the coefficient and its significance level increases as a result.

As expected, the trade to GDP ratio has a positive coefficient and it is always significant at the 10% significance level. The population growth rate has a negative coefficient, but it is insignificant in all estimations but in System GMM.

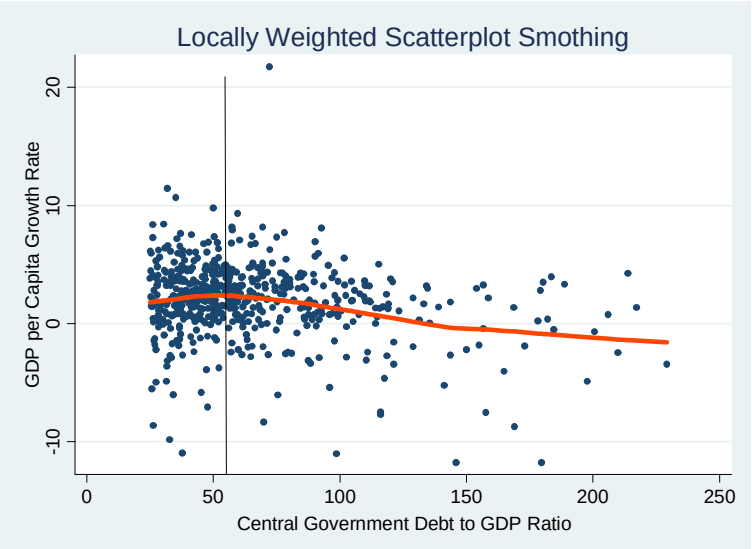
[7] PATTILLO, C., H. POIRSON AND L. RICCI (2002): "External debt and growth," *IMF Working Paper.*

7.2 Nonlinear Specification

Although I have shown the negative effect of debt on growth, there may be a threshold below which growth benefits from the debt or is silent to the effect of debt. As proposed by Blavy (2006), Abbas and Christensen (2007), and Reinhart and Rogoff (2010), there is a nonlinear relationship between public debt and growth. According to their studies, a debt level below the threshold causes economic growth to increase or it has no effect, whereas above this threshold it negatively affects the growth rate. Due to the structural break in the function which links growth to debt, the negative effect of debt cannot be seen for a long time. In the existence of such a threshold, it may be hard to detect the negative effect of debt until the debt exceeds the threshold level.

In this part, I determine the threshold level of the debt. Figure 5 shows the Locally Weighted Scatterplot Smoothing (LOWESS) for GDP per capita growth rate and central government debt to GDP ratio which is set to the range of $25\% - 250\%$. This method first introduced by Cleveland (1979) and developed by Cleveland and Devlin (1988). It basically estimates the polynomial which represents the relationship between variables with minimizing the variance of the residuals.

Figure 5: Locally Weighted Scatterplot Smoothing



At a first glance, it can be said that there is a slight positive relationship between debt and growth before the vertical line between 50% and 100%. After some point, the relationship becomes negative. It would be beneficial to recall that LOWESS cannot take into account the fixed effects and endogeneity. Hence, I need to find a suitable model and estimate it with relevant estimation methods in order to identify this relationship and the debt threshold level above which growth becomes negative.

The model used in this part is the spline function used by Pattillo et al. (2002) and then by Blavy (2006),

$$y_{it} = \alpha_i + \boldsymbol{\beta}\mathbf{X}_{it} + \gamma(D_{it} - D^*)Q + \delta(D_{it} - D^*)(1 - Q) + \varepsilon_{it}, \tag{3}$$

where $\mathbf{X}_{it}$ includes the explanatory variables, D_{it} and D^* indicates the debt for ith country in time t and the threshold level of debt, respectively, and Q is a dummy variable which takes value 1 when the debt is above the threshold level and 0 if debt is below the threshold. α_i is the country-specific effect which does not change over time.

I determine the threshold of debt to GDP ratio by estimating the Equation 3 for all possible integer threshold levels of debt to GDP ratio between 1% and 100%. Then I plot the residual sum of squares (RSS) values for all estimation methods except System GMM. The percentage value in each regression which minimizes the RSS is chosen as the threshold debt to GDP ratio. I perform regressions with all the estimation methods and report their threshold levels separately. The plots of the RSS values of the regressions are shown in Figures 6–10 in the appendix. Big red dots indicate the selected threshold level which minimizes the RSS values in each estimation. Since objective of System GMM is not minimizing the RSS, we have to take into account its methodology. It basically solves the minimization problem of the following equation.

$$\hat{\boldsymbol{\beta}}_{\mathbf{A}} = \arg\min_{\hat{\beta}} \left\| \mathbf{Z}'\hat{\mathbf{E}} \right\|_{\mathbf{A}},$$

where $\hat{\boldsymbol{\beta}}_A$ is the GMM estimate and $\mathbf{A}$ is a symmetric matrix, $\hat{\mathbf{E}}$, $\mathbf{Z}'$ indicate the residuals and exogenous regressors, respectively. After the relevant steps, the objective of the minimization

problem becomes minimization of $\hat{\mathbf{E}}'\mathbf{ZAZ}'\hat{\mathbf{E}}$. In my model, I try to minimize $\hat{\mathbf{E}}'\mathbf{ZZ}'\hat{\mathbf{E}}$ since $\mathbf{A}$ is same for all estimations with different threshold levels.

Table 11 shows the threshold levels of debt with different estimation methods. The first three methods give almost the same values for an optimal central government debt to GDP ratio, which is $66 - 67\%$. However, the last two methods give me different results. First, I find the threshold level to be 55% in IV estimation. This change is due to the instrumental variables used because they eliminate the endogeneity among the regressors to some degree. Using instruments are not able to eliminate the endogeneity completely since I cannot use the deeper lags of the variables as instruments to avoid reducing the sample size. In the System GMM which is more sophisticated and advanced technique I can eliminate the problems caused by both fixed effects and endogeneity. The threshold debt level is found to be 41% in this estimation. The difference of the thresholds between estimation methods is the same case as in Patillo et al. (2002), where they find the estimated threshold level in System GMM to be lower than the level in the other estimation methods. That is due to the eliminated endogeneity which makes System GMM more efficient than the IV since all variables are used as instruments in some form.

	Central Govt Debt/GDP Threshold
OLS	66 - 67%
LSDV	67%
FE	66 - 67%
IV	56%
SYGMM	41%

Table 11

In this section, I use two series within the estimation different than the linear estimation. The first one is the difference between the actual debt and the possible debt threshold level in the corresponding regression when the actual debt is higher then the potential threshold. The second one occurs in the same way when the actual debt is lower than the threshold level

performed in that step. Therefore, there are two series corresponding to central government debt to GDP ratio in the nonlinear model. Since two series enter the equation at the same time in place of the debt to GDP ratio, coefficients are different from the ones I found in the linear specification. However, the signs and the significance levels of all are consistent with the linear model analysis. Table 12 shows the coefficients for all variables in corresponding threshold levels estimated in this method.

	OLS		LSDV		FE		IV		System GMM	
Central Government Debt/GDP	-0.0317	-0.003	-0.0294	-0.0083	-0.0319	-0.0034	-0.034	0.0135	-0.0167	-0.0139
	(-3.6)	(-0.192)	(-2.96)	(-0.44)	(-3.38)	(-0.26)	(-4.18)	(0.76)	(-2.85)	(-0.739)
Log (GDP per Capita)	-0.0233		-0.0022		-0.0233		-0.0361		-0.0024	
	(-5.43)		(-0.66)		(-4.42)		(-4.27)		(-3.374)	
Gross Fixed Capital Formation/GDP	0.09		0.129		0.09		0.1636		0.216	
	(2.1)		(2.51)		(1.89)		(3.69)		(8.77)	
Trade/GDP	0.0657		0.047		0.066		0.11		0.0075	
	(5.43)		(2.09)		(4.3)		(5.9)		(1.99)	
Population Growth Rate	-0.223		0.111		-0.018		0.1352		-0.275	
	(-1.36)		(5.979)		(-0.06)		(0.60)		(-2.24)	

Table 12

Significance levels of the coefficients in the two abovementioned series vary among estimation methods. In the first three estimation methods, second series are not significant whereas their significance levels increase in the last two estimation methods. Hence, the positive effect of debt cannot be seen in the first three estimation methods when debt is below the estimated threshold levels but the relationship of debt and growth is still different than that of after the threshold level debt. However, there is still an evidence of slight positive relationship in the last two estimation methods.

7.2.1 Countries Above the Threshold

The list of countries whose public debt to GDP ratio is above the threshold level of 41% according to System GMM are exhibited in the appendix. There are 31 countries, and the debt levels of some countries are well above the threshold levels during the period 1981–2007. The average debt to GDP ratio levels of each country are shown as well. Especially countries marked with a star have at least four periods of extreme debt to GDP ratios even if their averages are low.

Sudan is the most striking example because through five periods, i.e. 15 years, its debt/GDP ratio is more than 156%, and the average debt to GDP ratio is 218% during the whole period. Zambia is in a similar situation, but its average is 176% for the first 18 years. Malawi and the Democratic Republic of Congo are other examples whose average debt ratios are 189% and 164% respectively for 12 years. Japan has an average of 124% for the whole sample period. Burundi and Belgium have averages of 170% and 110% respectively in the last 15 years.

8 Conclusion

In 1980s, despite the growing public debt Latin American countries, especially Argentina, Brazil and Mexico, continued to provide the necessary funding from borrowing. Consequently, public debt burden became unsustainable and some debt was restructured. Today, some of the countries in the world are in the similar situation. Due to bailouts and fiscal stimulus packages, all have growing public debt levels which cause serious consequences eventually. This situation is referred as the worst recession since World War II and worst peacetime public finances ever known. Hence precautionary attempts have to be taken soon since this situation cannot be sustained.

In 2008 and 2009, it is obvious that powerful fiscal and monetary stimulus had to be implemented in order to prevent recession from being more severe. However, fiscal exit strategies should be introduced for accommodating the sustainable recovery as soon as possible since the scale and the acceleration of the debt accumulation is serious. The level and scope of the strategies should depend on the size of the country, implementation policy and the composition of the strategies and also the levels of deficits and national debts. Within the scope of these, governments should cut off the spending which ensures the sustainability of debt over the medium term. Additionally, highly indebted countries would have larger cuts than the others in order to guarantee solvency. Moreover, taxation is a good method to control public debt.

Success of the strategies can be achieved by first the more detailed plans and second by trust of households. Developing and developed countries are connected each other via international financial sector. Therefore, the policies for sustaining the debt should not be independent from

the others. Furthermore, as it was proven by the historical experiences cutting public spending is difficult and it deserves extremely careful planning. Meanwhile, if rebalancing of the budget is provided by the increase of the taxes, private consumption falls consequently due to the expectations of the households which cause the exit strategies to be worthless.

Public finance management is not a facile issue. The world and Europe need sustainable recovery. Hence, the timing of the exit strategies, their scope and clarity become extremely important. Countries should prefer the plans ensuring the long term persistence. The crises over the world are not due to the minor economic mistakes. Therefore, some plans completely different than historical ones and highly powerful are needed. These plans have to assure the return of the economic growth.

In this thesis, I tried to determine the effect of central government debt on GDP per capita growth in order to construct a link between public debt and economic growth. I used the panel data of 94 countries over the period 1981–2007. Three-year averages of the data were calculated, which gives me nine periods for each country. The first analysis was done by looking at the behavior of debt and growth over the given periods graphically. I calculated the averages of the given periods and found that there is a negative relationship between public debt and growth.

Following that, I constructed the linear model. The growth of GDP per capita is the dependent variable. Independent variables are the ratio of central government debt to GDP, lagged value of GDP per capita, gross fixed capital formation to GDP ratio, trade to GDP ratio and population growth. This model was examined with several econometric methods such as OLS, LSDV, FE, IV, and System GMM. A single estimation method could not be used because the data set is large and requires a detailed study otherwise, this would cause a fixed effect problem. Besides, I used the lagged value of GDP per capita, which causes endogeneity. By using various estimation methods, I expected to see the negative effect of debt on growth. The underlying hypothesis here is that the high levels of public debt decreases the savings and investments which lead to growth to decrease. Looking at the results, I can see that they confirm that hypothesis.

The coefficient of the debt/GDP in all estimations is negative and significant. The signs and significance levels of coefficients of the other variables are close to the expected values.

The next step was constructing the nonlinear model with which I determined the threshold level. The main objective was to find the public debt/GDP level above which growth becomes negative. I used the spline function used by Pattillo et al. (2002). In the model, there is a dummy variable which takes 1 when the debt level is above the possible threshold level and 0 if the situation is converse. I used all the estimation methods and tried the possible threshold levels from 1% to 100%. For every possible threshold level, I performed the regressions and reported the values of the residual sum of squares. In all estimation methods except System GMM, the threshold level which minimizes the residual sum of squares was chosen as the debt/GDP threshold. In System GMM, I chose the threshold debt level which minimizes the objective function. The chosen threshold levels are $66 - 67\%$ in OLS, LSDV, FE, 56% in IV and 41% in System GMM. Above these threshold levels of debt, the relationship between debt and growth changes and becomes negative.

There are some differences in the results when compared to similar studies such as Abbas and Christensen (2007) and Rogoff and Reinhart (2010). For instance, the coefficients and the threshold levels are different. This may be due to the difference in the data set and the periods. In addition, development levels, the maturities of the debts and country characteristics may also matter for such an analysis. Nevertheless, I found the main results, which are the overall negative effect of debt to GDP ratio and threshold levels of debt/GDP ratio above which growth is affected negatively.

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Appendix A: Country List

	CODE	COUNTRY	GDP per capita Growth	Central Government Debt/GDP	GDP per capita	Gross Fixed Capital Formation/GDP	Trade/GDP	Population Growth	Openness	Schooling Rate
1	ALB	Albania	1981-2007	1995-2005	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980,1985,1990-1991,1999-2004
2	DZA	Algeria	1980-2007	1991-2005	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980, 1985, 1990-1991, 1995, 1999-2007
3	ARG	Argentina	1980-2007	1990-2005	1980-2007	1993-2007	1980-2007	1980-2007	1980-2007	1980, 1985, 1990-1991, 1995, 1998-2006
4	AUS	Australia	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980,1985, 1990-1991, 1995, 1998-2007
5	AUT	Austria	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980,1985, 1990-1991, 1995, 1999-2007
6	BHS	Bahamas	1980-2007	1980-2005	1980-2007	1980-2004	1980-1987,1989-2004	1980-1987,1989-2004	1980-2007	1980,1985, 1990-1991, 1995, 1999-2007
7	BHR	Bahrain	1981-2005	1980-2005	1980-2005	1980-2006	1980-2006	1980-2007	1980-2006	1980,1985, 1990-1991, 1995, 1999-2006
8	BGD	Bangladesh	1980-2007	1990-2005	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980, 1985, 1990, 2005-07
9	BLR	Belarus	1991-2007	1992-2007	1990-2007	1990-2007	1990-2007	1980-2007	1994-2007	1980, 1985, 1990-1991, 1995, 1998-2007
10	BEL	Belgium	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980, 1985, 1990-1991, 1995, 1999-2007
11	BRA	Brazil	1980-2007	1991-2005	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980, 1985, 1990-1991, 1994, 1999-2005, 2007
12	BDI	Burundi	1980-2007	1980-2005	1980-2007	1980-2006	1980-2006	1980-2007	1980-2007	1980, 1985, 1990-1991, 1995, 1999-2007
13	CMR	Cameroon	1980-2007	1990-95,1998-99	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980,1985,1990-91,1995,1999-2007
14	CAN	Canada	1980-2007	1980-2007	1980-2007	1980-2006	1980-2006	1980-2007	1980-2007	1980,1985,1990-91,1995,1998-2000,2002,2004-06
15	CHL	Chile	1980-2007	1982,1998-2005	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980,1985,1990-91,1995,1998-2000,2002-07
16	CHN	China	1980-2007	1990-2005	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980,1985,1990-91,1995,2001-2003,2006-07
17	COL	Colombia	1980-2007	1990-2007	1980-2007	1980-1999	1980-2007	1980-2007	1980-2007	1980,1985,1990-91,1995,1998-2007
18	ZAR	Democratic Republic Of Congo	1980-2007	1980-82,1988-97	1980-2007	1980-2004	1980-2007	1980-2007	1980-2007	1980,1985,1990-91,1995,1999,2002,2007
19	CRI	Costa Rica	1980-2007	1980-2005	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980,1985,1990-91,1995,1998-2007
20	CIV	Cote d'Ivoire	1980-2007	1994-2005	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980,1985,1990-91,1995,1999-2003,2006-07
21	HRV	Croatia	1991-2007	1995-2005	1990-2007	1990-2007	1991-2007	1980-2007	1990-2007	1996,1999-2003,2005-07
22	CYP	Cyprus	1980-2007	1980-2007	1980-2007	1980-1999	1980-1999	1980-2007	1980-2007	1980,1985,1990-91,1995,1999-2007
23	CZE	Czech Republic	1991-2007	1993-2007	1990-2007	1990-2007	1990-2007	1980-2007	1990-2007	1980,1985,1990-91,1995,1999-2007
24	DNK	Denmark	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980,1985,1990-91,1995,1999-2007

	CODE	COUNTRY	GDP per capita Growth	Central Government Debt/GDP	GDP per capita	Gross Fixed Capital Formation/GDP	Trade/GDP	Population Growth	Openness	Schooling Rate
25	EGY	Arab Republic of Egypt	1980-2007	1991-2005	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980,1985,1990-91,1995,1999-2007
26	SLV	El Salvador	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980,1984,1991,1995,1998-2007
27	EST	Estonia	1981-2007	1996-2007	1980-2007	1987-2007	1992-2007	1980-2007	1990-2007	1981,1985,1990-91,1995,1999-2007
28	FJI	Fiji	1980-2007	1980-86,1990-98	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980,1985,1990-91,1998-2007
29	FIN	Finland	1980-2007	1990-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980,1985,1990-91,1995,1998-2007
30	FRA	France	1980-2007	1991-2007	1980-2007	1980-2007	1980-2007	1980-2007	1993-2007	1980,1985,1990-91,1995,1999-2007
31	GEO	Georgia	1980-2007	1996-2007	1980-2007	1990-2007	1987-2007	1980-2007	1980-2007	1981,1986,1991,1995,1999-2007
32	DEU	Germany	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1991,1995,1999-2007
33	GHA	Ghana	1980-2007	1980-85,1990-2005	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980,1985,1990-91,1995,1999-2007
34	GRC	Greece	1980-2007	1985-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980,1985,1990-91,1995,1998-2007
35	GTM	Guatemala	1980-2007	1990-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980,1985,1990-91,1995,1998-2007
36	HUN	Hungary	1980-2007	1991-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980,1985,1990-91,1995,1998-2007
37	ISL	Iceland	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980,1985,1990-91,1995,1998-2007
38	IND	India	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980,1985,1990-91,1995,1998-2007
39	IDN	Indonesia	1980-2007	1980-2005	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980,1985,1990-91,1995,1998-2007
40	IRL	Ireland	1980-2007	1981-2007	1980-2007	1980-2006	1980-2006	1980-2007	1980-2007	1980,1985,1990-91,1995,1998-2007
41	ITA	Italy	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980,1985,1990-91,1995,1999-2007
42	JAM	Jamaica	1980-2007	1980-2007	1980-2007	1980-2006	1980-2006	1980-2007	1980-2007	1980,1985,1990-91,1995,1999-2005,2007
43	JPN	Japan	1980-2007	1980-2007	1980-2007	1980-2006	1980-2006	1980-2007	1980-2007	1980,1985,1990-91,1995,1998-2007
44	JOR	Jordan	1980-2007	1980-20076	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980,1985,1989,1991,1996,1999-2000,2002-07
45	KAZ	Kazakhstan	1991-2007	1997-2003,2005-07	1990-2007	1992-2007	1992-2007	1980-2007	1993-2007	1981,1986,1990-91,1995,1998-2007
46	KEN	Kenya	1980-2007	1997-2005	1980-2007	1980-2007	1980-2007	1980-2007	1993-2007	1980,1984,1990-91,1995,1998-2000,2002-07
47	KOR	Korea Republic	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980,1985,1990-91,1995,1998-2007
48	LVA	Latvia	1980-2007	1994-2005	1980-2007	1980-2007	1990-2007	1980-2007	1980-2007	1981,1985,1990-91,1995,1999-2007
49	LSO	Lesotho	1980-2007	1984,1987-90,1995-2005	1980-2007	1980-2007	1980-2007	1980-2007	1990-2007	1980,1985,1990-91,1995,1998-2006

	CODE	COUNTRY	GDP per capita Growth	Central Government Debt/GDP	GDP per capita	Gross Fixed Capital Formation/GDP	Trade/GDP	Population Growth	Openness	Schooling Rate
50	LTU	Lithuania	1991-2007	1998-2007	1990-2007	1990-2007	1990-2007	1980-2007	1980-2007	1981,1986,1990-91,1995,1999-2007
51	LUX	Luxembourg	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980,1985,1991,1995,1999-2007
52	MWI	Malawi	1980-2007	1984-87,1998-2007	1980-2007	1980-2003	1980-2007	1980-2007	1980-2007	1980,1985,1990-91,1995,1998-2002,2004-07
53	MYS	Malaysia	1980-2007	1990-2005	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980,1985,1990-91,1995,1998-2006
54	MLD	Maldives	1996-2007	1981-2007	1995-1007	1980-1990,1995-2005	1995-2004	1980-2007	1980-2007	1980,1986,1990,1995,1998-2007
55	MLT	Malta	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1992-2007	1980,1985,1990-91,1995,1999-2005
56	MUS	Mauritius	1981-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980,1985,1990-91,1995,1998-2007
57	MEX	Mexico	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1990-2007	1980,1985,1990-91,1995,1999-2007
58	MDA	Moldova	1981-2007	1995-2007	1989-2007	1990-2007	1990-2007	1980-2007	1980-2007	1981,1986,1990-91,1999-2007
59	MNG	Mongolia	1982-2007	1992-2003,2006-07	1981-2007	1981-2007	1981-2007	1980-2007	1980-2007	1980,1985,1990-91,1995,1998-2007
60	MAR	Morocco	1980-2007	1980-85,1988-2005	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980,1985,1990-91,1995,1999-2007
61	NPL	Nepal	1980-2007	1985,1987-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980,1985,1990-91,1995,1999-2007
62	NLD	Netherlands	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980,1985,1990-91,1995,1999-2007
63	NZL	New Zealand	1980-2007	1980-2007	1980-2007	1980-2006	1980-2006	1980-2007	1980-2007	1980,1985,1990-91,1995,1998-2007
64	NOR	Norway	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980,1985,1990-91,1995,1998-2007
65	OMN	Oman	1980-2006	1980-2005	1980-2006	1980-82,1990-2007	1980-88,1990-2007	1980-2007	1980-2007	1980,1985,1990-91,1995,1999-2007
66	PAK	Pakistan	1980-2007	1980-2005	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980,1985,1990,1995,2000-07
67	PNG	Papua New Guinea	1980-2007	1980-2005	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980,1985,1990-91,1995,1998-2007
68	PER	Peru	1980-2007	1990-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980,1985,1990-91,1995,1998-99,2001-07
69	PHL	Philippines	1980-2007	1980-2005	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980,1985,1990-91,1995,1998-2007
70	POL	Poland	1991-2007	1992-2007	1990-2007	1985-2007	1990-2007	1980-2007	1990-2007	1980,1985,1990-91,1995,1999-2007
71	PRT	Portugal	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1990-91,1995,1999-2007
72	RUS	Russian Federation	1990-2007	1992-2007	1989-2007	1989-2007	1989-2007	1980-2007	2005	1980,1985,1990-91,1999-2007
73	RWA	Rwanda	1980-2007	1980-2003	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980,1985,1990-91,1995,1999-2007

	CODE	COUNTRY	GDP per capita Growth	Central Government Debt/GDP	GDP per capita	Gross Fixed Capital Formation/GDP	Trade/GDP	Population Growth	Openness	Schooling Rate
75	SLE	Sierra Leone	1980-2007	1980-2005	1980-2007	1980-2007	1980-2007	1980-2007	1990-2007	1980,1985,1990
76	SGP	Singapore	1980-2007	1990-2007	1980-2007	1980-2007	2001-2007	1980-2007	1980-2007	1995,1998-2007
77	SVK	Slovak Republic	1985-2007	1992-2007	1984-2007	1985-2007	1987-2007	1980-2007	1980-2007	1981,1985,1990-91,1995,1999-2007
78	SVN	Slovenia	1991-2007	1993-2005	1990-2007	1990-2007	1990-2007	1980-2007	1980-2007	1980,1986,1990-91,1995,1998-2007
79	ZAF	South Africa	1980-2007	1980-2005	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1991,1999-2007
80	ESP	Spain	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980,1985,1990-91,1995,1998,2001-07
81	LKA	Sri Lanka	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1991,1993,2000-2005,2007
82	VCT	St. Vincent and the Grenadines	1980-2007	1986-2005	1980-2007	1980-2005	1980-2005	1980-2007	1993-2007	1980,1985,1991,1995,1999-2007
83	SDN	Sudan	1980-2007	1991-2005	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980,1985,1990-91,1995,1999-2007
84	SWE	Sweden	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980,1985,1990-91,1995,1999-2007
85	CHE	Switzerland	1980-2007	1986-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1991,1995,1999-2007
86	THA	Thailand	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980,1985,1990-91,1995,1999-2005,2007
87	TTO	Trinidad and Tobago	1980-2007	1980-2005	1980-2007	1980-2007	1980-2007	1980-2007	1993-2007	1980,1985,1990-91,1995,1999-2007
88	TUN	Tunisia	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980,1985,1990-91,1995,2000-2007
89	TUR	Turkey	1980-2007	1980-81,1985-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980,1985,1990-91,1995,1998-2007
90	UGA	Uganda	1983-2007	1991-2005	1982-2007	1982-2007	1980-2007	1980-2007	1980-2007	1980,1985,1990-91,1994,1998-2007
91	GBR	United Kingdom	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980,1985,1990-91,1995,1998-2007
92	USA	United States	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980,1985,1990-91,1995,1998-2007
93	URY	Uruguay	1980-2007	1990-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980,1985,1990-91,1998-2007
94	ZMB	Zambia	1980-2007	1981-1998	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980,1985,1990-91,1995,2000-06

Appendix B: Figures of the RSS and R-squared Values in Threshold Estimation with Different Methods

Figure 6: Residual Sum of Squares in OLS Estimation

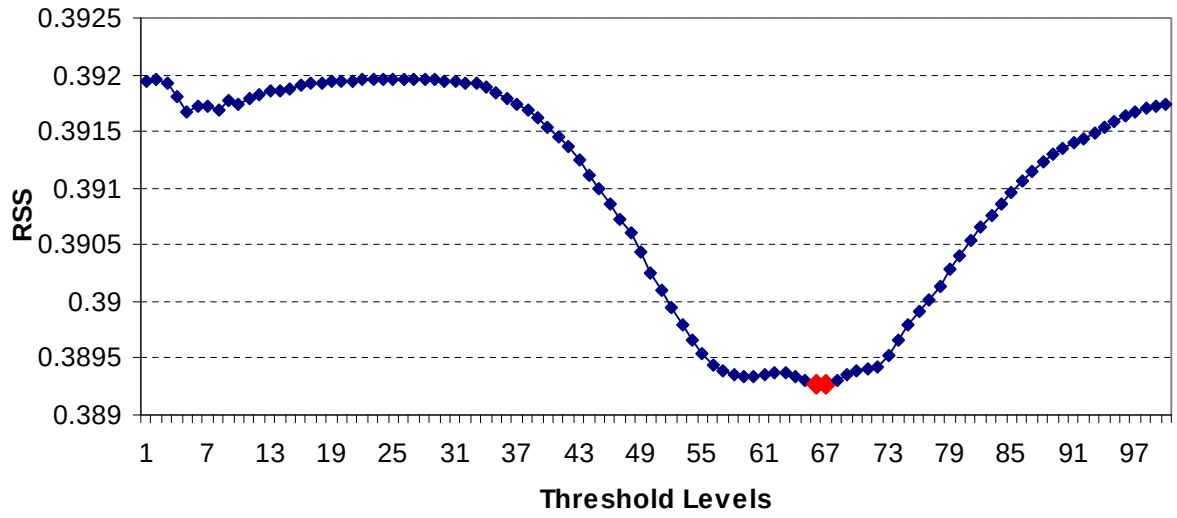


Figure 7: Residual Sum of Squared in LSDV Estimation

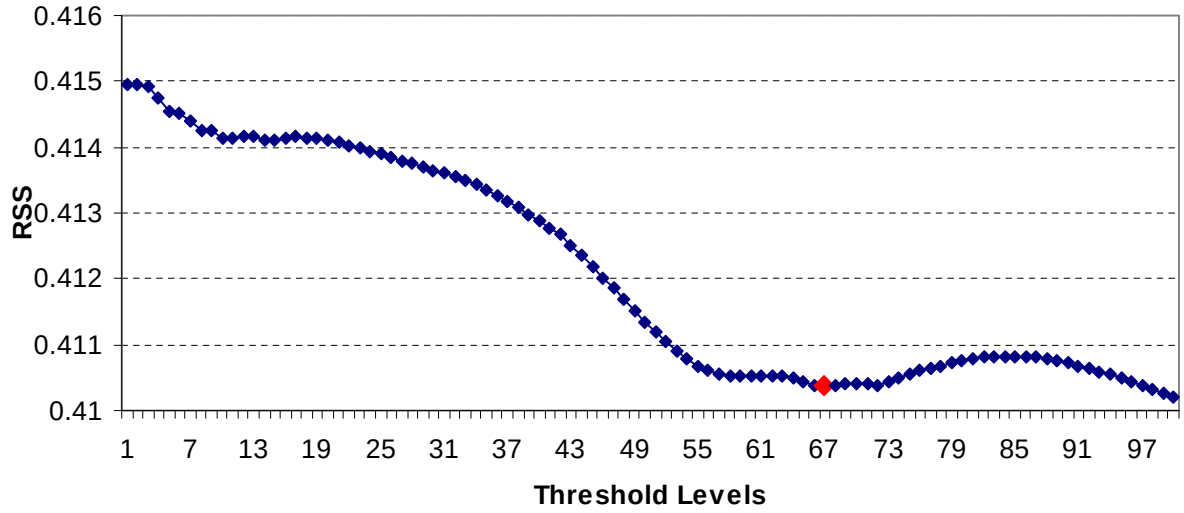


Figure 8: Residual Sum of Squares in FE Estimation

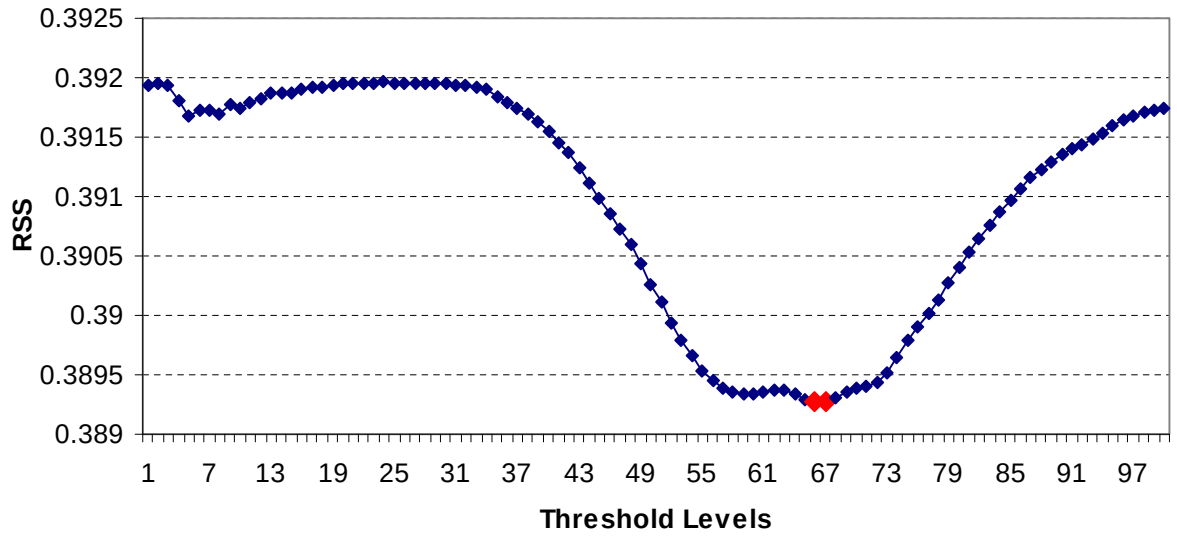


Figure 9: Residual Sum of Squares in IV Estimation

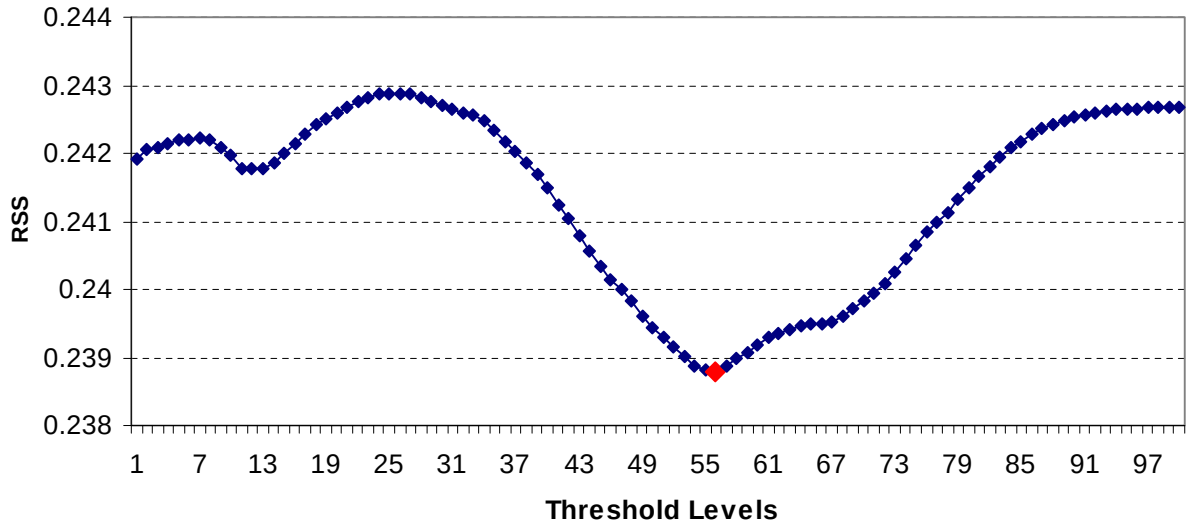
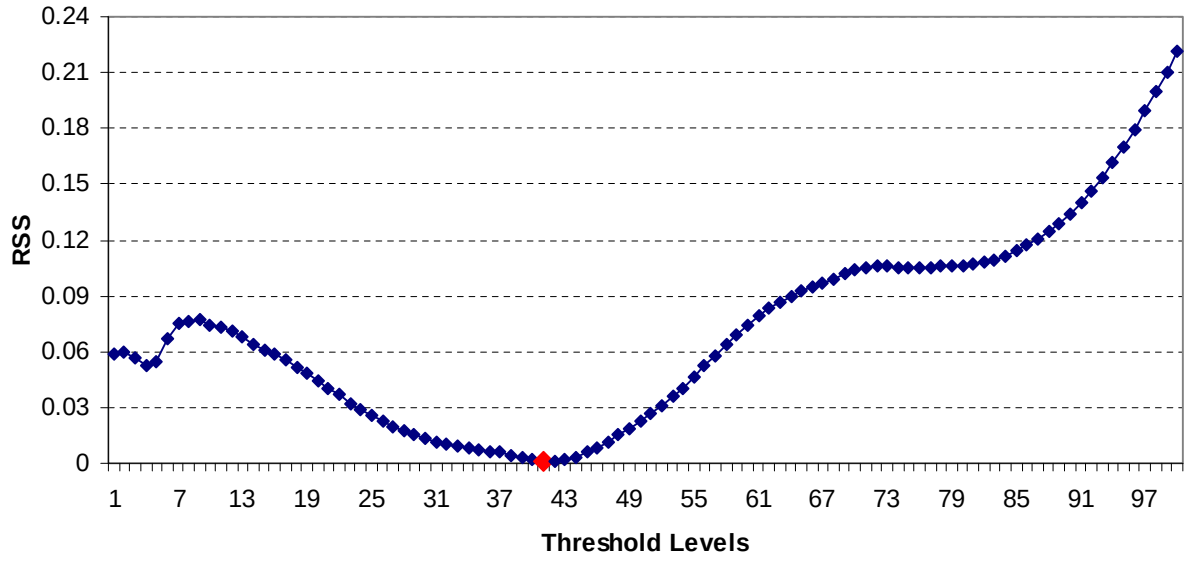


Figure 10: Minimization of Objective Function in System GMM



Appendix C: Countries Above the Threshold

	County Code	Countries	Averages of time periods
1	DZA	Algeria	96.29
2	BEL	Belgium	101.99
3	BGD	Bangladesh	51.30
4	BDI	Burundi	124.35
5	CMR	Cameroon*	76.29
6	CAN	Canada	54.75
7	ZAR	Democratic Congo Republic*	114.06
8	CIV	Cote d'Ivoire*	116.76
9	CYP	Cyprus	62.67
10	DNK	Denmark	60.98
11	EGY	Arab Republic of Egypt	96.21
12	GHA	Ghana	71.41
13	GRC	Greece*	99.97
14	HUN	Hungary	66.43
15	IRL	Ireland	67.06
16	ITA	Italy*	97.42
17	JAM	Jamaica*	124.62
18	JPN	Japan	81.15
19	JOR	Jordan*	103.94
20	KEN	Kenya	63.8
21	LSO	Lesotho	77.90
22	MWI	Malawi	160.62
23	MAR	Morocco	80.35
24	NPL	Nepal	55.94
25	PAK	Pakistan	79.46
26	PRT	Portugal	58.72
27	SLE	Sierra Leone	97.39
28	SGP	Singapore	90.10
29	LKA	Sri Lanka	92.87
30	SDN	Sudan*	197.01
31	ZMB	Zambia*	151.07