PUBLIC DEBT AND ECONOMIC GROWTH

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ABSTRACT

This thesis builds on the paper of Reinhart and Rogoff, named 'Growth in a Time of Debt'. However, this study is focused on Western Countries. It uses another database than the one analyzed by Reinhart and Rogoff. This thesis starts with a simple analysis similar to that of the above mentioned authors. Subsequently, the research is extended by using Panel Data Models. The influence of debt on annual GDP growth is examined. Tax revenues, government expenditure, inflation and real interest rate are taken into account. This is done for an unbalanced panel, a balanced panel and a panel without outliers. The general conclusion is that based on this study it cannot be determined whether debt has a significant impact on the annual GDP growth. All other added variables have a regression coefficient which is expected based on economic theory.

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• Panel without outliers

INTRODUCTION

The public debt is one of the most discussed subjects at this moment in the European Union. European countries are not allowed to have a deficit that exceeds 3% of the Gross Domestic Product (GDP) and a public debt that exceeds 60% of the GDP (European Commission, 2013). At this moment, most countries have a budgetary deficit that is too high and have too much public debt (Eurostat, 2014). The question is whether these counties must cut their deficits. Most politicians state that it is necessary to cut deficits, for example the German Chancellor Angela Merkel. On the other hand, Paul Krugman described the disadvantages of cutting deficits in his blog in The New York Times (Krugman, 2013). Also Coen Teuling and Jean Pisani-Ferry published an article about the detrimental impact of large deficit cuts on the economy (Teulings & Pisani-Ferry, 2012). There seems to be a lack of consensus on the economical necessity to reduce public debt and cut budgetary deficits.

An interesting question is why everybody assumes that the public debt is such an important figure. Some politicians cite the research of Reinhart and Rogoff (2010). This paper is for example cited in the Dutch 'Miljoenennota' to explain why cutting deficits is inevitable (Rijksoverheid, 2013). Reinhart and Rogoff, economists from the University of Maryland and the Harvard University, respectively, wrote a paper entitled 'Growth in a Time of Debt'. The key conclusion was that the median growth rate of countries with a debt above 90% of the GDP falls with 1%, and the average growth falls even more (Reinhart & Rogoff, 2010).

Thomas Herndon, Michael Ash and Robert Polin of the Massachusetts Amherst tried to replicate the research of Reinhard and Rogoff but failed. They asked Reinhard and Rogoff for their data and reported three problems in the analysis of Reinhard and Rogoff: 1) a selective exclusion of data, 2) an unusual method to weight the countries and 3) coding errors which led to excluding countries with a high debt but nevertheless high growth rate. In their evaluation, Herndon, Ash and Polin reported that there is no discontinuity in the debt/GPD ratio versus growth curve when debt/GPD-ratio reaches 90% (Herndon, Ash, & Polin, 2013).

These publications triggered a new wave of discussions about the impact of the public debt on fundamental economic conditions. There were also responses from many different economists. For example, Paul Krugman commented on this topic in his blog on the website of the New York Times (Krugman, The New York Times, 2013). Some economists and econometricians also did their own research based on the data from Reinhart and Rogoff (Dube, 2013). However, there still remains a lot of controversy about cutting deficits and the impact of an increasing debt.

I did my own research on the impact of a high debt on some important economic conditions in Western countries. I might have added yet another perspective to the debate. My research included all Western countries in the period 1990 to 2012, another database than used by Reinhart and Rogoff. This study starts with the same simple analysis as done by Reinhart and Rogoff. However, in this thesis the research was extended with Panel Data Models. Due the Panel Data Models, different countries and different years were included in the analysis. In this way, it was not necessary to use an average of the years for each country. Thus, changes over the years within in a country were also included in the analysis. Besides the fact that these two dimensions of the data were taken into account, other variables could be added to the analysis. These are variables that can affect both GDP and Debt, for example inflation and interest rate. This provides more insight in how Debt affects GDP which should lead to more reliable and detailed conclusions. With all the ongoing commotion in the world one would expect that a high government debt has a negative influence on the GDP (growth). In addition, this study builds on the paper of Reinhart and Rogoff. They associate a high public debt with a lower GDP (growth). The research question of this paper is therefore:

Have Western countries with a high public debt a lower annual GDP growth in the period 1990-2012?

This research focused on Western countries only, because those could be compared relatively well to one another and because data from Western countries are comparatively reliable. The criterion for Western countries which was used in this study is member of the EU and/or member of the OECD. The period 1990-2012 was studied as for this timeframe data are available for almost all essential variables.

In the section related literature below, the research of Reinhart and Rogoff is reviewed more detailed, including a review of earlier papers of these authors. Then the critique from other economists on their work is presented, together with the publications of a few econometricians who based their work on the dataset of Reinhart and Rogoff. Finally, a summary of the literature and theory about in which ways the public debt could influences the GDP is presented.

After the literature there is a section about the data and methodology. Data from the database of the World Bank and the OECD were used for this research. This database contains data for all Western countries in the period 1990-2012. First some simple calculations were used, such as averages which were depicted in bar charts. Analysis was done using Panel Data Models. The Hausman test was used to select a fixed effects model or a random effects model.

The results from the above mentioned research are presented and discussed in the section 'results'. The results of the simple analysis might suggest that a high Debt/GDP-ratio may lead to a lower annual growth. However, the results of the Panel Data Models indicate that there is no clear effect from Debt on annual GDP growth. The section 'results' is followed by the section 'discussion and extensions'. First, the shortcomings of this study are discussed. The simple analysis has quite a few shortcomings, but also the Panel Data Models are not perfect. For some countries or variables a lot of data are missing in the database. On the other hand, the available data may also be biased, because many of the countries which are used are European Countries and there is a severe crisis during a large part of the period that is studied. Secondly, the extensions for further research are discussed, such as working with a more complete database, adding more variables to the analysis or adding more countries to the analysis.

This thesis ends with a conclusion based on the research question. The general conclusion is that, based on this study, it cannot be concluded whether debt has a significant impact on the annual GDP growth. All other added variables have regression coefficients that are expected based on economic theory.

RELATED LITERATURE

As mentioned in the introduction, Reinhart and Rogoff wrote a well-known paper about public debt and GDP. They based their research on data coming from forty-four countries and a time span over two hundred years. Their key conclusion is that the relationship between debt and GDP is weak if a country has a debt/GDP-ratio lower than 90%. Countries with a debt/GDP-ratio above the 90% face a median growth¹ rate that falls with 1% and average growth rates fall even more. In other words, they report a threshold at a 90% debt/GDP-ratio. Second, they looked to external debt. According Reinhart and Rogoff it can be concluded that if external debt reaches 60% of the GDP, the annual growth declines with about 2%. If the external debt/GDP-ratio rises even more, the annual growth rates are halved. The last major finding reported in their paper is the difference in the relation between inflation and public debt for advanced countries and developing countries. For the group of developed countries they found no clear relationship between inflation and public debt. On the other hand, developing countries face a rising inflation if the public debt increases (Reinhart & Rogoff, 2010).

Reinhart and Rogoff wrote earlier papers on similar topics. These papers are frequently referenced in the paper 'Growth in a Time of Debt'. The first paper is from 2003 and focuses on emerging markets. In this paper Reinhart and Rogoff introduce the term 'Debt Intolerance', meaning that emerging markets are not able to manage a certain level of external debt, while developed countries can manage the same level of external debt under the same circumstances. It is concluded that the economic impact of the level of external debt varies between countries, depending mainly on their history. They suspect that a default is detrimental for the trust in the institutions of a country, which makes future defaults more likely (Reinhart, Rogoff, & Savastano, NBER WORKING PAPER SERIES, 2003).

The paper from 2009 reviews financial crises in the history. The collapses of the asset markets during such a crisis are deep and prolonged. The housing prices decline on average with 35% in six years and the equity prices decline by about 55% in three and a half years. Banking crises are associated with an average rise in unemployment rates of 7%, a decline of the output of 9% and an increase in public debt of 86%. According to this paper, the reason for this enormous increase in public debt is not the expenditures for saving the banks, but large decline in tax revenues (Reinhart & Rogoff, NBER WORKING PAPER SERIES, 2009).

As described in the introduction, there were three economists who tried to replicate the research of Reinhart and Rogoff, but were unable to do so. They found three flaws in the work of Reinhart and Rogoff: 1) a selective exclusion of data, 2) an unusual method to weight the countries and 3) coding errors which led to excluding countries with a high debt but nevertheless high growth rate. According to these economists, there is no discontinuity at a debt/GDP-ratio of 90% (Herndon, Ash, & Polin, 2013).

After this publication, more economists and econometricians reviewed the data of Reinhart and Rogoff. Some economists, such as Paul Krugman, Josh Bivens and John Irons argued that the causation of Reinhart and Rogoff is the other way around: slow growth causes higher debt (Krugman, The Opinion Pages, 2010) (Bivens & Irons, 2010). Arindrajit Dube concluded after some basic calculations that simple correlations cannot be used to identify causal estimates in this case. The raw correlation between debt/GDP-ratio and GDP is probably for a part reverse causality (Dube, 2013). Andrew Bell, Ron Johnston and Kelvyn

¹ Ordering the countries with a debt/GDP-ratio above the 90% from lowest to highest growth rate and identify the middle score, the median. The growth rate of this median is 1% lower for countries with a Debt/GDP-ratio above 90% compared with the countries with a Debt/GDP-ratio below the 90%. The average growth rates of the countries with a Debt/GDP-ratio above the 90% falls even more than 1%.

Jones argue that the findings of Reinhart and Rogoff are too simplistic. They used multilevel models for realistic complex scenarios (Bell, Johnston, & Jones, 2014).

The impact of the public debt to GDP still is debated which is the reason for this thesis. First, in which ways can public debt influence GDP according to theory in literature? Or which variables can influence both, GDP and public debt?

A first mechanism is through the interest rates. If there is a large public debt in a country, the government has to borrow a lot of money resulting in a high demand for money. The law of supply and demand states that this high demand leads to an increase in price. The price of money is interest, so the interest rates will increase which has a negative effect on private investment. Private investors will borrow less money at these higher interest rates (CPB, 2013). Robert Ford and Douglas Laxton wrote an Oxford Review of Economic Policy about this topic. They conclude that the net Debt/GDP-ratio rose from 19% to 43% between 1978 and 1997 in the OECD-countries. This increase has a significant effect on the real interest rates in these countries. The increase in government debt would have led to an increase of the real interest rate of about 4% (Ford & Laxton, 1999).

Perhaps even more important is inflation (Seigniorage & Inflation tax). If the government neither wants to cut spending nor raise taxes, it can simply print more money to pay their debt. Currently, this is no longer a realistic situation in the in Western (European) countries. Today, independent central banks decide about the money production. In the past, however, the government could choose for this 'solution', resulting, for example, in the hyperinflation in Germany in 1922 and1923 (C.R., 2013). A recent example is Zimbabwe's hyperinflation in 2008 (The Economist, 2013), proving that that this 'solution' still causes problems in non-Western countries (Burda & Wyplosz, 2009).

However, increasing supply of money may also be beneficial as this leads to inflation. Inflation reduces the real value of the government debt. In nominal terms, the government must still pay the same amount of money, but in real terms the value of the debt has decreased due to inflation (Burda & Wyplosz, 2009).

Joshua Aizenman and Nancy Marion wrote a Working Paper about inflation. They first conclude that the Debt/GDP-ratio was 108% in de U.S. in the year 1946. Inflation eroded this Debt/GDP-ratio with about 40% in a single decade. Second, they designed a framework for determining the impact of a large debt on the temptation to induce inflation. This framework suggests that if the GDP growth in the U.S. stagnates the high Debt/GDP-ratio may trigger an increase in inflation of about 5%. This additional inflation would erode the U.S. Debt/GDP-ratio (Aizenman & Marion, 2009).

Robert J. Barro has researched the impact of inflation on economic growth/performance for about 100 countries between 1960 and 1990. The main conclusion of the research is that an average increase of 10 percent points in inflation per year leads to a decrease of 0,2-0,3 percent point growth rate of real per capita GDP per year (Barro, 1995).

Thirdly, taxes are important. The government has to pay more interest as the amount of debt increases. Besides, the government will attempt to pay off a part of the debt. For both these payments the government needs money, resulting in higher taxes (CPB, 2013). Signe Krogstrup wrote a paper on this subject. One of the conclusions of this paper is that EU countries with a higher debt have smaller public sectors and higher taxes than EU countries with a low debt (Krogstrup, 2002). However, there is also a trade-off between taxes and debt. If a specific amount of government spending must be financed, the government can choose between raising tax and borrowing money. Martin Feldstein described this trade-off already in his historical paper from 1984 (Feldstein, 1984). This means that a higher debt could also lead to lower taxes. How debt influences taxes and taxes influences debt is not completely clear, but it seems to be an important factor.

The public expenditures are also a mechanism that can affect both debt and GDP. If the government decides that they do not want to raise the taxes, but nevertheless want to reduce debt, they have to spend less. That results in lower public expenditures and lower public investment (CPB, 2013). The research of Krogstrup as mentioned above also provides evidence for this mechanism. According to that research, a small public sector in countries with a higher debt indicates that there are less public expenditures in countries with a high debt/GDP-ratio. However, a rising debt could also indicate that the government is investing. With a rising debt, the government has more money to invest than they would have had without the rise in debt (CPB, 2013). Also the effect of government expenditures is not clear, but it seems also an important factor for an investigation on Debt and GDP.

A rising debt could also lead to uncertainty and gloomy expectations among the country's inhabitants. A high public debt can lead to uncertainty among the citizen about the economic outlook, and especially the future economic policy. They might expect tax increases and spending cuts and anticipate on these expectations. All this could have a negative impact on the economic growth (CPB, 2013). Some researchers conclude that measures of consumer confidence do forecast future economic conditions. Sydney C. Ludvigson concluded that measures of consumer confidence do forecast future changes in labor earnings, non-stock market wealth and consumption growth (Ludvigson, 2004). Matsusaka and Sbordone reported a relation between the Michigan Index of Consumer Sentiment² and GDP growth (Matsusaka & Sbordone, 1995). However, Jeffrey C. Fuhrer concluded after his own research that most of the variation of the Michigan Index of Consumer Sentiment is explained by other macroeconomic aggregates/variables. There is a possibility that consumer sentiment just reflects the economic situation (Fuhrer, 1993). In short, there is little debate about the predictive value of measures of consumer confidence. However, there seems to be no convincing research for the fact that consumer sentiment has a noteworthy influence on GDP and/or Debt.

In addition, a government with a large debt could be unable to dampen fluctuations. A government with a large debt has to work towards a smaller debt with spending cuts and tax increases. As a result they may be unable to use a countercyclical policy and dampen fluctuations (CPB, 2013).

Ultimately, the focus on immediate needs can lead to low investments in long term projects. With a high debt, the government will focus on savings and increased taxes. This may mean that the government has less money to spend. The priority will not be on long-term projects, as for example renewable energy or research and development. In addition, companies often invest in long-term projects that are good for society because they are motivated by the government with favorable tax schemes or subsidies (CPB, 2013) reducing government income and increasing government's expenditures, respectively.

Lastly, the risk of decline of the solvency of a country with the ultimate consequence of a default. A high public debt can lead to skeptical investors. Investors will wonder whether a country will be able to pay the interest and to pay off its debts (sovereign default). This uncertainty will lead to higher interest rates. Investors want to be compensated for that risk. At a very high interest rate, it is almost impossible for a country to borrow money on the capital market (sudden stop), for example Greece between 2010 and 2014 (The Economist, 2014). The government is forced to stop paying interests. As a result, the investors lose their confidence in the country. They are no longer willing to lend money to the country or only at exceptionally high interest rates, as for example happened with Italy in 1926 and 1934 (Burda & Wyplosz, 2009).

² The index of Consumer Sentiment constructed by the Survey Research Center at the University of Michigan

DATA AND METHODOLOGY

DATA

The most important data for this research are the figures for public debt and GDP of the Western countries. It is very hard to obtain data for interest rates, inflation and other such variables before the year 1990. These variables restrict the research to the period 1990-2012. These data are available in the databases of the Worldbank/OECD/IMF.

Members of the European Union are: Belgium, Bulgaria, Croatia, Cyprus (the Greek part), Denmark, Germany, Estonia, Finland, France, Greece, United Kingdom, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, The Netherlands, Austria, Poland, Portugal, Romania, Slovenia, Slovakia, Spain, Czech Republic and Sweden. The OECD countries are: Australia, Austria, Belgium, Canada, Chile, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israël, Italy, Japan, Korea, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom and United States. Most countries that are a member of the European Union are also a member the OECD and the other way around. In total, the database consists of 41 countries and 23 years (1990-2012). The database is not complete. Some countries lack one or more data for one of more variables. However, most data are missing for the following countries and variables. Bulgaria misses data about the debt for almost all years. Croatia and Romania miss both all data for public debt. Lithuania and Malta miss both data for different variables for most of the years. Turkey has no data about the real interest rate for the whole period. Slovenia, Chile and Israel miss data for different variables of more years, but in my opinion there are enough data for these countries to include these countries in the analysis. Bulgaria, Croatia, Romania, Lithuania, Malta and Turkey have been omitted in the analysis with a balanced panel. Some descriptive statistics can be found in the appendix.

In the section 'related literature' a number of mechanisms through which the public debt could influence GDP are described. For some variables it was clear from the literature that there is no convincing evidence that these variables have a noteworthy influence on GDP and/or debt, such as consumer confidence/sentiment. Other discussed variables are very hard to measure, such as default. These mechanisms can therefore not be used in the analysis. The mechanisms that can be used are: real interest rate, inflation, tax revenue and government expenditure. These variables are also the most important for the impact of public debt on GDP, according to the literature, policy advice, research and theory (see the section 'related literature). The variables can be defined as follows:

- GDP growth is Annual percentage growth rate of GDP at market prices based on constant local currency
- Interest is real interest rate which is the lending interest rate adjusted for inflation as measured by the GDP deflator
- Inflation is measured by the consumer price index
- Tax revenue is defined as the compulsory transfers to the central government for public purposes
- Data for the government expenditure are general government final consumption expenditure³ (The World Bank Group, 2014)

³ All these definitions or information can be found on the website of the World. There can also be found further information about these data. This text only contains the information that is required for the paper.

The data of the government expenditure are in current US\$ for all countries, because the countries can be easy compared in this way. There is no need to take different currencies and different exchanges rates into account. However, the data of the tax revenue and the government debt are in current local currency units and data in different currencies cannot be compared. Therefore, the data is converted from current local currency into current US Dollars. For the Euro, this causes a problem. There is no exchange rate before 1999. The average exchange rate of the euro in the period 1999-2012 was calculated. This average exchange rate was used for the countries, with as current currency the Euro, for the period 1990-1999.

The database of the World Bank is not complete. Therefore, the missing data were, as far as possible, supplemented with data from the database of the OECD. If the database is supplemented with data from the database of the OECD, all the data for this variable of the country were obtained from the OECD database not only the missing data. These data are in US Dollars, so there was no need to take exchange rates in account.

DATA CLASSIFICATION

Reinhart & Rogoff (2010) divide their data into four different groups: debt/GDP below 30%, debt/GDP between 30% and 60%, debt/GDP between 60% and 90% and debt/GDP above 90%. They based these four groups on their interpretation of the literature and the policy discussion about what a low and a high debt is. This also parallels the World Bank country groupings according to four income groups. This grouping seems somewhat randomly chosen, as groups will contain different numbers of observations/countries.

I used a different plan to categorize my data. My approach is to make three groups. Ranking the data by value of the debt/GDP ratio and then include third of the data in group 1, the next 33,3% of the data in group 2 and the last third of the data in group 3. In this way each group contained the same number of data/countries which should have resulted in a more robust analysis. The first group includes Luxembourg, Estonia, Chile, Bulgaria, Korea, Czech Republic, Slovenia, Australia, Latvia, Mexico, Switzerland, Slovak Republic and Norway. This group has a Debt/GDP-ratio from about 6% to about 30%. These countries are in the second group: Lithuania, Turkey, Germany, New Zealand, Poland, Spain, Finland, Denmark, United States, United Kingdom, Sweden, Netherlands and Canada, with a Debt/GDP-ratio between about 30% and 59%. The last group consists of the following countries: Ireland, Austria, Iceland, France, Portugal, Hungary, Israel, Belgium, Italy, Japan, Greece, Malta and Cyprus. The Debt/GDP-ratio of Ireland is about 62% and the ratio of Cyprus is about 152%.

However, a t-test requires two groups. So the data were ranked by value of the debt/GDP ratio and include half of the data in group 1 and the rest of the data in group 2. Due to the odd numbers of countries has the first group one more country than the second group.

Romania and Croatia are omitted in both approaches because there are no data of Debt for Romania and Croatia. The debt/GDP-ratio cannot be calculated for these countries, so these countries could not be included in the analysis with the data classification on the basis of the Debt/GDP-ratio. The paper by Reinhart & Rogoff (2010) was used as a start. This thesis also started by calculating averages, display these values in bar graphs and scatter plots and discussing the results. This was done with the data divided in the three categories as described under the heading 'data classification'.

In addition an independent t-test was done to see if there was a substantial difference in GDP between the group with high public debt and the group with low public debt. For the t-test the classification in two groups by debt/GDP-ratio was useful. This classification is also described in 'data classification'.

These above described analysis could not take into account both different countries and different years. Therefore, for each country the average annual GDP growth and the average debt/GDP-ratio of the period 1990-2012 were used. In this way the various countries could be compared. The disadvantage of above described methods is that these methods do not take into account the difference within a country over the years. In addition, these methods take also not in account that there are other variables which influence debt, GDP or both.

However, based on the paper of Reinhart and Rogoff as described in the section related literature and the fuss about a high debt/GDP ratio as described in the introduction, is expected that a high debt/GDP-ratio has a negative influence on the annual GDP growth. This led to the first hypothesis: *the simple analysis similar to the analysis of Reinhart and Rogoff should show that Western countries with a high Debt/GDP ratio have a relatively low annual GDP Growth.*

These simple data visualization and analyses provided insight into the data. The results were compared with Reinhart and Rogoff. The database could subsequently be completed with the other variables, such as inflation and interest rates. The database consisted of data over a long time period and for lots of different countries, requiring both cross section and time series data. The best way to analyze this was with Panel Data Models. In this way, all data were included in a custom build regression model.

Key outcome was a regression model with as dependent variable annual GDP growth and as independent variable Log(Debt).

The variables that were added to the model next to debt and annual GDP Growth were: real interest rate, inflation, tax revenue and government expenditure. In the section 'related literature' is explained why and how these variables could have an important role by the impact from public debt on GDP based on literature, policy advice, research and theory.

There are several panel data models, including the pooled model, the fixed effect model and the random effects model.

The pooled model: $Y_{it} = \beta_1 + \beta_2 X_{2it} + \beta_3 X_{3it} + \beta_4 X_{4it} + \beta_5 X_{5it} + \beta_6 X_{6it} + e_{it}$

With

Y_{it} is GDP

 β_1 is the constant

 X_{2it} is Log(Debt) with coefficient β_2

 X_{3it} is inflation with coefficient β_3

 X_{6it} is Log(Expenditure) with coefficient β_6 e_{it} is the error term

 X_{5it} is Log(Revenue) with coefficient β_5

 X_{4it} is the real interest rate with coefficient β_4

The pooled model simply pooled the data of the different countries together. This model didn't take in account that individual differences might lead to different coefficients. The pooled model seemed to be inappropriate as there was between and within variance in the data. Based on the literature and the data it was to be expected that there was a big difference in GDP and debt/GDP-ratio between the countries. For example, Cyprus has an average Debt/GDP-ratio of 1,52. On the other hand has Luxembourg a debt/GDP-ratio of 0,06. The same argument holds for the annual GDP Growth. Luxembourg has an average growth of 3,65% but Portugal has an average growth of only 1,58%. Therefore, the pooled model might not have been the best model for this research question.

The fixed effects model: $Y_{it} = \beta_{1i} + \beta_2 X_{2it} + \beta_3 X_{3it} + \beta_4 X_{4it} + \beta_5 X_{5it} + \beta_6 X_{6it} + e_{it}$

With

 β_4

Y _{it} is Annual GDP Growth	X_{5it} is Log(Revenue) with coefficient β_5
β_{1i} is the intercept/constant	X_{6it} is Log(Expenditure) with coefficient β_6
X_{2it} is Log(Debt) with coefficient β_2	e _{it} is the error term
X_{3it} is inflation with coefficient β_3	
X_{4it} is the real interest rate with coefficient	

The difference between the pooled model and the fixed effect model is the intercept. In a pooled model, all the countries have the same intercept. In the fixed effect model, every country has its own intercept. The difference between the countries (individual heterogeneity) is reflected in the intercept. That means that all the difference is in this one number. The intercept varies only between countries, but not for a country over time. The coefficients are for all countries the same.

The fixed effects model controls for all time-invariant differences between the countries. The coefficients of a fixed-effects model cannot be biased because of different characteristics of a country. Fixed effects models are there to study the causes of changes within a country. A characteristic of a country cannot cause a change, because it is constant for each country. By estimating the fixed effect model these characteristics have to be dropped. The random effects model that is discussed below can deal with these characteristics. However, the model that has been prepared for this study (and shown above) contains no characteristics of countries.

An advantage of the fixed effects model is that the individual fixed effect is allowed to be correlated with the other explanatory variables. In the content of this research, the individual fixed effect from countries (such as climate, population, level of development, government, availability of raw materials and ect.) is allowed to be correlated with public debt, interest, inflation, government expenditure and tax revenue. In this study, it is not unlikely that there is a connection or relationship between the fixed effect of a country and the independent variables. In that case, the fixed effect model is the best model. This can be determined with the test Hausman. This test is discussed below, following the outline of the alternative for the fixed effects model (the random effects model).

The random effects model: $Y_{it} = -\beta_{1i} + \beta_2 X_{2it} + \beta_3 X_{3it} + \beta_4 X_{4it} + \beta_5 X_{5it} + \beta_6 X_{6it} + (e_{it} + \mu_i)$

With

Y _{it} is Annual GDP Growth	X_{5it} is Log(Revenue) with coefficient β_5
$-\beta_1$ is the intercept/constant	X_{6it} is Log(Expenditure) with coefficient β_6
X_{2it} is the Log(Debt) with coefficient β_2	e_{it} is the error term
X_{3it} is inflation with coefficient β_3	μ_i is the random individual differences
X_{4it} is the real interest rate with coefficient β_4	from the population average

In the random effects model β_1 is the intercept which is the population average. μ_i is the random individual differences from the population average. e_{it} is the remaining random error. In contrast with the fixed effect model, this model assumes that the individual effect is random.

The random effects model assumes that the countries in the sample were randomly selected. The differences between the countries are treated as random instead of fixed. This may make it more appropriate to generalize the conclusion. On the other hand, the countries in the sample were not randomly selected because this study only examines Western countries and all Western countries are included in this research. Therefore, the random effects model seems not the best model for this analysis. This means that the fixed effect model seems to be the most useful for this research.

In addition the random individual difference μ_i must satisfy the standard assumptions as another error term, such as zero mean, uncorrelated across individuals/over time and a constant variance. The random (unobserved) individual effect has to be uncorrelated with the other explanatory variables. The difference between a fixed effect model and a random effect model is whether the unobserved characteristics of a country are correlated with the independent variables of the model. As described in the section of the fixed effect model, correlation between the individual effect and the other independent variables is not unlikely.

Revenue, Debt and Expenditure were added in the regression as a logarithm. In this way, the results are easier to interpret. The coefficient predicts how much the annual GDP growth will change when the respective variable increases/decreases with 1%. Additionally, the logarithm solves the problem of large differences in the real numbers of the Revenue, Debt and Expenditure. The United States has larger amounts of expenditures, debt and tax revenue than the Netherland, because The United States is bigger and has more inhabitants than the Netherlands. This would make the interpretation of the coefficients difficult.

Annual GDP growth rather than GPD was chosen as the independent variable. Bigger countries tend to have bigger GPDs. This has nothing to do with debt, revenue, inflation, interest or expenditure. This problem does not arise with annual GDP growth.

As described above, the pooled model may be less appropriation for this research question. Both a random effects model and a fixed effects model were developed. Based on the theory, it is expected that the fixed effects model is the best model for this research question. On the basis of the Hausman Test it was determined which model provided the best estimate. It was also possible to test whether there were significant random effects. The test that was used for this purpose was the Lagrange Multiplier test. On the basis of the above tests, it could be decided which model best fitted the data (Carter Hill, Griffiths, & Lim, 2012) and the coefficients of this model were interpreted. In addition, this study starts with an analysis of the unbalanced panel. The unbalanced panel consists of all the data that is collected in the database. This provides as much as possible observations. Again is expected on the basis of the paper of Reinhart and Rogoff and the noise in the world about cutting deficits that a high debt (debt/GDP-ratio) leads to a relatively low annual GDP growth.

This led to the second hypothesis: *the panel data model with an unbalanced panel shows that a higher public debt has a negative effect on the annual GDP growth.*

The above hypothesis provided a general overview. For some counties not all data were available. If there were much data missing for certain group of countries, this might have affected the reliability of the model. To get a more reliable result, the countries with a lot of missing data were removed. The countries which were removed are: Bulgaria, Croatia, Romania, Lithuania and Turkey. For some countries, there are no data available on public debt. These countries are Croatia and Romania. The database is missing all real interest rate data of Turkey. Bulgaria, Lithuania and Malta lack all data of different variables, but also mainly data on government debt. In my opinion, can these countries (except Malta) be characterized as the less developed countries of the Western world? If this is the case, the missing data are not random. This is extendedly discussed in the section 'Discussion and Extensions'.

This led to the third hypothesis: the panel data model with a balanced panel shows that a higher public debt had a negative effect on the annual GDP growth.

Except for that the study might be biased by missing data, the results might also have been influenced by outliers. This study would like to give a general idea of the impact from a high debt on GDP (growth). This works less well if the results are influenced by some extreme outliers. In order to get more general results and conclusions, outliers are removed from the analysis. Outliers were easy to detect with a scatter plot and removed from the analysis.

This led to the fourth and last hypothesis: *the panel data model based on a panel without the outliers shows that a higher public debt has a negative effect on the annual GDP growth.*

With these three different panels (three different hypothesis) can examine whether the results are robust. If the results changes when countries or outliers are omitted, the results are not robust. If there is little to no difference in the results of the difference panels, the results are quite robust. This says something about the reliability of the study.

RESULTS

ANALYSIS SIMILAR TO THE ANALYSIS OF REINHART AND ROGOFF

BAR GRAPH



Debt/GDP ratio

The data are ranked from lowest Debt/GDP-ratio to highest Debt/GDP-ratio. The first 33% of the data is in Bar 1, the second 33% of the data are in Bar 2. The last third of the data is in Bar 3. For each group the mean annual GDP growth is calculated. On the Y-axis is the annual GDP growth. Romania and Croatia are not included in this analysis, because there are no data for debt for these countries. The Debt/GDP-ratio could therefore not be calculated.

The 33% of the countries with the lowest Debt/GDP-ratio have an average growth of 2.88% over the period 1990-2012. The next 33% has an average growth of 2.34%. The 33% of the countries with the highest Debt/GDP-ratio have 2.29% growth. The difference between the second and the third group is very small. However, the difference between the first and the second group is about 0.5%. This suggests that a relatively higher Debt/GDP-ratio leads to a relatively lower annual GDP growth. However, this difference can be coincidence.

SCATTER PLOT



In this scatter plot the Debt/GDP ratio and the annual GDP growth are plotted against each other for all countries. Romania and Croatia are again not included in this analysis as there were no data for debt, the debt/GDP-ratio cannot be calculated and these countries cannot be plotted.

Based on the scatter plot not much can be concluded. However, the regression line shows a slight downward trend. This suggested that a lower Debt/GDP-ratio is associated with a higher annual GDP Growth rate. Again, this may be coincidence. A t-test is done to test if the differences (in the bar graph and the scatter plot) are significant (see below).

T-TEST				
Levene's P-value	0,159			
P-value t-test	0,141			

For the t-test the data were ranked on Debt/GDP-ratio from low to high. The first 50% of the data was in the first group. This is the group with the relatively low Debt/GDP-ratio. The remaining half of the data was in the second group, which is the group with the relatively high Debt/GDP-ratio. For these two groups an independent sample t-test was done. The Levene's test has a p-value of 0,159 meaning that the assumption that both groups had equal variance cannot be rejected.

The p-value is 0,1414.

This is an independent sample t-test with Ho: no difference between the two groups and HA: difference between the two groups. The p-value is 0.141. Ho cannot be rejected (assuming that a p-value higher than 0.1 is not significant). This means there is not a statistically significant difference between the group 1 and of group 2. According to the t-test there is no difference in the mean of the annual GDP growth between the group with the 50% of the low Debt/GDP-ratio and the group with the 50% of the high Debt/GDP-ratio.

On the basis of the bar graph, the scatter plot and the t-test the first hypothesis can be assessed. The first hypothesis was: *the simple analysis similar to the analysis of Reinhart and Rogoff should show that Western countries with a high Debt/GDP ratio have a relatively low annual GDP Growth.*

The bar graph and the scatter plot suggest an association between higher Debt/GDP-ratio and lower annual GDP growth. However, it is not clear whether these differences are significant. On the other hand, the t-test indicates that there is no significance difference between the group with the high debt/GDP ratio and the group with the low debt/GDP ratio. Therefore the first hypothesis cannot be accepted.

⁴ The extended output is to be found in the Appendix

Variable	Fixed	Random	Hausman P-value
LogDebt	-0,52	-1,27 **	0,000
LogRevenu	2,89 **	3,45 ***	
LogExpenditure	-9,02 ***	-3,42 ***	
Inflation	-0,27 ***	-0,05 *	
Interest	-0,13 ***	-0,17 ***	
Constant	74,82 ***	16,47 ***	

UNBALANCED PANEL

The regression of the unbalanced panel was calculated using all available data from the countries of the European Union and the members of the OECD⁵.

The second hypothesis was: *the panel data model with an unbalanced panel shows that a higher public debt has a negative effect on the annual GDP growth.*

The Hausman test for the fixed effects model or the random effects model has a p-value of 0,000. This means that the fixed effects model best fits the data. The coefficient of debt suggests that a one percent increase in Debt leads to a half percent decrease of the annual GDP growth. However, the p-value of this coefficient is 0,507. So this coefficient is not significant (assuming that all coefficients with a p-value higher than 0.1 are not significant). The 95% confidence interval has a lower bound of -2,05 and a upper bound of 1,01. For a country there is a big difference between a 1% increases in Debt that leads to a 1.01% increases in annual GDP growth, or that this leads to a 2.05 decrease in annual GDP growth. This interval is around zero, an increase in debt can have either a positive effect or a negative effect. The effect could also be very small or even zero. That the coefficient is slightly negative does not mean anything because this coefficient is not significant.

A 1% increase in tax revenue leads to a 2.89% increase in annual GDP growth. That is one way to interpret the regression. On the basis of the theory as described in 'related literature', it seems more likely that a higher annual GDP growth leads to more tax revenue for the government (the public debt could decrease). According to the theory the relationship is the other way around.

A 1% increase in government expenditure leads to 9.02% decrease in annual GDP growth Also on the basis of the theory as described in 'related literature', is to be expected that the government expenditures increase if the annual GDP growth declines, because the government is trying to stimulate the economy (the public debt increases). However, the theory is not clear. A cut in public spending can also have a negative effect on the GDP. This relationship can work both ways.

A 1% increase in the real interest rate leads to a 0,27% decrease in annual GDP growth and a 1% increase in inflation leads 0,13% decrease in annual GDP growth. An increase in interest

⁵ The extended output is to be found in the Appendix

rate makes it more difficult to borrow money and make more attractive to save money, as described in the section 'related literature'. Therefore, a decline in annual GDP growth as a result of the increase of interest rate seems very plausible. The interpretation of the coefficient of inflation is less straight forward. Inflation is generally beneficial to the public debt as described in the section 'related literature'. However, inflation causes life to become more expensive, so inflation could have, in spite of its positive impact on the public debt, a negative impact on the annual GDP growth.

The constant cannot be interpreted. Besides the coefficient of debt, all coefficients are significant.

Hypothesis 2 cannot be accepted. A higher government debt can either have a positive effect or a negative effect on the annual GDP growth. On the basis of the panel data model with the unbalanced panel it cannot be concluded which impact the public debt has and whether this influence is significant.

Variable	Fixed	Random	Hausman P-value
LogDebt	-0,22	-0,89 *	0,000
LogRevenu	2,62 **	3,13 ***	
LogExpenditure	-8,88 ***	-3,75 ***	
Inflation	-0,13 ***	-0,05 ***	
Interest	-0,24 ***	-0,16 ***	
Constant	73,11 ***	19,34 ***	

In the database used for this study data for certain countries were missing (e.g. data on the national debt for Romania and Croatia). For the balanced panel, the countries for which a lot of data were missing or essential data were missing (data about the national debt), were removed. These six countries are: Bulgaria, Croatia, Lithuania, Romania, Malta and Turkey. This was done in order to make the analysis is more robust and was already described in the section 'data and methodology'.⁶

The third hypothesis was: *the panel data model with a balanced panel shows that a higher public debt had a negative effect of the annual GDP growth.*

The coefficients of the tax revenue, the government expenditure, the inflation and the interest rate hardly differ from the coefficients in the panel data model with the unbalanced panel. For the interpretation of these coefficients please refer to the second hypothesis.

The coefficient of debt is -0,22. This means that a 1% increase in debt leads to a 0,22% decrease in annual GDP growth. However, the p-value of the coefficient is 0,778. The coefficient is again not significant. The 95% confidence interval has a lower bound of -1,74 and a upper bound of 1,31. The effect of an increase in debt is slightly less negative with the balanced panel when compared to the unbalanced panel. The difference between a 1,74% decrease or a 1,31 increase in annual GPD growth if the debt increases with 1% is still very large.

Again, it cannot be concluded that the debt has a positive effect, negative effect or any effect on the annual GDP growth based on the panel data model with the balanced panel. Therefore, hypothesis 3 can also be rejected.

⁶ The extended output is to be found in the Appendix

WITHOUT OUTLIERS

Variable	Fixed	Random	Hausman P-value
LogDebt	0,44	-1,19 *	0,000
LogRevenu	2,55 **	3,12 ***	
LogExpenditure	-8,64 ***	-3,48 ***	
Inflation	-0,13 ***	-0,06 **	
Interest	-0,23 ***	-0,16 ***	
Constant	63,54 ***	19,72 ***	



The scatter plot above shows the annual GDP Growth and the logarithm of the variable debt plotted against each other for all countries. Both above the line and below the line, there are three countries that can be considered as outliers. These dots belong to the countries: United States, Japan, Italy, Luxembourg, Estonia and Latvia. For the regression 'without outliers', these countries have been removed to obtain a more reliable view which is not influenced by outliers.⁷

The fourth hypothesis is: *the panel data model based on a panel without the outliers shows that a higher public debt has a negative effect of the annual GDP growth.*

Again the coefficients for tax revenue, government expenditure, inflation and interest rate do not differ substantially between the balanced/unbalanced model and the model without outliers. For the interpretation please refer to hypothesis 2.

⁷ The extended output is to be found in the Appendix

The coefficient of debt is 0,44. That would mean that a 1% increase in debt leads to a 0,44% increase in annual GDP growth. However, the p-value is 0,610. This coefficient is again not significant. The confidence interval has a lower bound of -1.24 and a upper bound 2.12. The impact of debt on annual GDP growth seems less negative than with hypothesis 2 and 3. However, it is still impossible to say whether there is a positive effect, a negative effect or any significant impact from debt on annual GDP growth. Hypothesis 4 is also rejected.

Variable	Unbalanced	Balanced	Without outliers
LogDebt	-0,52	-0,22	0,44
LogRevenu	2,89	2,62	2,55
LogExpenditure	-9.02	-8,88	-8,64
Inflation	-0,13	-0,13	-0,13
Interest	-0,27	-0,27	-0,23
Constant	74,82	73,11	63,54

OVERVIEW

Since the Hausman test for all the regressions has a very low p-value (below 0,001), the fixed effect model is the best model in all the three situations. The table provides a summary of the three fixed effect models. However, the coefficient of LogDebt is never significant (assuming that coefficients with a p-value higher than 0,1 are not significant).

DISCUSSION

The simple analysis that is similar to the analysis done by Reinhart and Rogoff

The simple analysis that is similar to the analysis done by Reinhart and Rogoff has a several drawbacks. These disadvantages are already discussed in het sections 'introduction' and 'related literature' because these emerge in the comments on that paper which were published. The most important disadvantage based on my research is that the simple analysis does not take other factors such as tax revenue or inflation into account. According to the theory, these variables are very relevant mechanisms in the economy related to GDP and debt. The simple analysis also does not take into account the difference in one country over the years. While the national debt in 1990 is probably completely different from the debt in 2012 for many countries. For example Austria with an average debt/GDP ratio of 62,9% but the debt/GDP-ratio in 1990 was 48,9% and in 2012 81,1%, a difference of almost a factor two. The same argument holds for the annual GDP growth of this country. The average growth is 2,1%, but the highest growth is 4,35% in 1990 and the lowest is -3,82% in 2009. This is a difference in growth of about 8% within one country.

In addition, all Western Countries are lumped together for this research. However, there are major differences between the Western countries, in terms of development but also in terms of the reliability of the government and the stability of the economic system. These circumstances also have an impact on both GDP and Debt. The less developed Western Countries are likely to have a higher annual GDP growth because these countries are still developing. While the most developed countries have a lower but more stable growth, because these countries are not developing rapidly anymore. Think of the difference between Mexico or Chile and the Netherlands. This difference might also be important in the public debt. Highly developed Western countries can borrow money relatively easy on the capital market at lower interest rates because they are trustworthy countries. These countries are likely to have a higher public debt. For the less developed Western countries are seen as less trustworthy countries. These effects and differences are not taken into account in this research.

Panel Data Models

In an attempt to resolve these problems, the investigation was extended to Panel Data Models. However, there is still some room for improvement. Even though it has been attempted to complete the database, there are still many missing data for some countries. These are mainly the countries that are a member of either the EU or the OECD, but not of both. Mainly because of the lack of data, assumptions had to be made in order to perform the research. For example the assumption about the exchange rate EURO/US Dollar for the period 1990-1999. These exchanges rates were not available and therefore it is set on the average of the exchange rate for the period 1999-2012.

Secondly, the countries that were left out for the balanced panel were not random. The countries were: Bulgaria, Croatia, Lithuania, Malta, Romania and Turkey. In my opinion, these countries (except Malta) can be characterized as the less developed countries of the Western World. The removal of these countries could lead to a bias in the research. Perhaps, there was a different relationship between debt and growth for these countries than the more developed Western Countries.

Ultimately, the database contains a lot of European Countries. This could also have resulted in a bias in the output. European Countries must meet certain budgetary rules to become and to stay a member of the EU. These countries are all working towards a smaller debt. Some countries do this only to comply with the rules. The lower debt is not a result of the idea that a lower debt is better for the economy and it is also not a result of the operation of other economic variables such as tax revenue and inflation. This may give a manipulated view, especially since more than half of the database consists of European Countries.

Last, during a substantial part of the examined period there was an intense crisis ongoing. Recessions and crises are normal in the economy. However, this crisis was strong and lasted very long. This crisis also had a large influence on the national debt. This could also produce a distorted result in the current research. Therefore, results might have been more reliable if only the period before 2008 had been used. However, for this period insufficient data were available.

EXTENSIONS

The best way to improve this thesis is by using a larger database and a more complete database. Many of the above mentioned shortcomings disappear when a larger and more complete database would be used.

Secondly, this study focuses mainly on a short period and many countries. For some countries there are already data available from 1900. A study with fewer countries but over a longer period may provide different results, because changes over time are investigated.

Moreover, this study added only the most important mechanisms to the regression. As described in the section 'related literature' there are more variables and mechanisms that could be important in the relationship between public debt and GDP. It is hard to find data for these variables or these variables are even not measurable. However, if these variables would be added, new (and better) results might be obtained.

In none of the analyses the coefficient for debt was significant, so perhaps it makes sense to omit other variables instead of adding even more. There is a possibility that the other variables explain the impact from debt on GDP Growth and that debt only influences GDP growth through these mechanisms. The coefficient of debt is no longer significant. With the omission of other variables might get debt a significant coefficient.

Ultimately, the conclusions of this research only apply to Western Countries. It is even doubtful whether these results do also apply to the less developed Western Countries, because for these countries few data were available in the database (as discussed above). To generalize the conclusions or to draw even conclusions for the whole world, the investigation should be extended to more countries. There are important economies in the world, such as Russia and China, which are not easy comparable with most Western Countries. However, these countries are also very interesting for this issue of national debt and GDP growth.

Last, for hypothesis 4, some countries have been removed because these were identified as outliers. There seem to be countries with a high national debt but also a relatively high annual GDP growth. On the other hand there also seem to be countries that have a low national debt but also a relatively low economic growth. In this study, these countries were removed from the analyses. New studies could investigate why some countries have a high debt and a high growth and the other way around. Which factors/variables/mechanisms are important? Maybe it has to do with the difference between highly developed trusted Western countries with a relatively stable economic growth and still rapidly developing less trusted Western countries with a relatively higher economic growth, as described in the section 'discussion of the results'.

CONCLUSION

This study was done because there was commotion in the press about high public debt. A high government debt would have a negative impact on the economy. This basis for this study was found in a paper of Reinhart and Rogoff. The key conclusion of this paper was that the median growth rate of a country with a debt above 90% of the GDP falls with 1%, and the average growth falls even more. In order to investigate whether a high debt does indeed have a bad influence on GDP growth the following question was formulated:

Have Western countries with a high public debt a lower annual GDP growth in the period 1990-2012?

To properly investigate, there was first a literature review of earlier research. In addition, the theory about which variables/mechanisms are important for GDP, debt or both was discussed. Subsequently, the study was start with some simple analysis. The research was extended with Panel Data Models.

The simple analysis on the basis of the scatter plot and the bar graph seemed to suggest that there might be a negative relationship between debt and economic growth. The t-test showed that this difference was not significant. When the study was extended to panel data models there was no significant effect of debt on annual GDP growth. All other variables that were added to the regression had coefficients that would be expected on the basis of the theory.

On the basis of the study it cannot be concluded whether debt has a positive or negative influence on the GDP growth. When the factors tax revenue, government expenditure, inflation and real interest rate were included in the analyses, debt did not have a significant effect on GDP growth. There is a possibility that the other variables explained the impact from debt on GDP Growth and that debt only influenced GDP growth through these mechanisms. Therefore, the effect of the level of the public debt on the GDP remains unclear for the Western Countries in the period 1990-2012. It cannot be concluded that Western countries with a high public debt have a lower annual GDP growth in the period 1990-2012.

The basis for this thesis was the paper of Reinhart and Rogoff. These authors claimed that public debt has negative consequences for the economic growth of a country. Especially a Debt/GDP-ratio in excess of 90%, debt has a negative impact on the GDP. There was much criticism of the paper by Reinhart and Rogoff, as described in the sections 'related literature' and 'introduction'. This thesis has conclusions that are not in line with the conclusions in the paper of Reinhart and Rogoff. They found a negative impact from a high debt on GDP. According to this research, it is unclear whether debt does influence GDP growth. The assumption of the reversal point at a Debt/GDP-ratio of 90% cannot be reproduced in this study but that may be due the fact that there were only few countries in this database that had a Debt/GDP-ratio above 90%. However, more importantly, this thesis has not focused on finding such a reversal point. Overall, it might be inferred that the conclusions of Reinhart and Rogoff were overstated.

The second reason why this subject/study was chosen for this thesis was the worldwide commotion. As already described in the introduction, many political leaders have a strong opinion about the appropriate level of the government debt as do a lot of economist while there seems to be lack of consensus. The paper by Reinhart en Rogoff was mentioned by political leaders to underpin their presumption that the debt should be lowered. This study indicates that the conclusions about the influence of a high public debt may not be so clear. It seems prudent to investigate the effects of a high public debt on the GDP (growth) before drawing conclusions. Why do have some countries a high public debt but still a high economic growth? Perhaps this has to do with the characteristics/features of a country.

Perhaps, cutting deficits is not always necessary for every country that wants to optimize growth because the impact of a high debt is not always and in every country a relevant problem for the GDP (growth). It looks like a suitable topic for my master thesis in one or two years.

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APPENDIX

DESCRIPTIVE STATISTICS

 Variable	Obs	Mean	Std. Dev.	Min	Max
id	759	21.60606	12.23803	1	41
t	759	12	6.637624	1	23
Expenditure	752	8.50e+10	1.30e+11	4.13e+08	6.94e+11
GDP	759	4.31e+11	6.27e+11	2.55e+09	3.63e+12
Inflation	723	9.645787	49.95124	-4.479938	1058.374
Interest	704	5.559661	15.46158	-71.20532	374.309
Growth	755	2.543129	3.606613	-21.25897	12.27793
Debt	651	2.39e+11	3.84e+11	1.49e+09	2.71e+12
Revenu	704	1.60e+11	2.40e+11	1.45e+09	1.34e+12
logDebt	651	10.9679	. 652754	9.173326	12.43291
logRevenu	704	10.78943	.6639915	9.162615	12.12712
logExpendi~e	752	10.48608	. 6970222	8.616413	11.84166

T-TEST

Group Statistics

	Code	N	Mean	Std. Deviation	Std. Error Mean
Growht	1,00	19	2,8089	1,36319	,31274
	2,00	20	2,2147	1,09279	,24436

Independent Samples Test

		Levene's Test Varia	for Equality of Inces	t-test for Equality of Means						
							Mean	Std. Error	95% Confidenc Differ	e Interval of the rence
		F	Sig.	t	df	Sig. (2-tailed)	Difference	Difference	Lower	Upper
Growht	Equal variances assumed	2,071	,159	1,506	37	,141	,59421	,39461	-,20535	1,39377
	Equal variances not assumed			1,497	34,504	,143	,59421	,39688	-,21192	1,40033

Fixed-effects ()	within) regres	ssion		Number of	obs =	702
Group variable:	id			Number of	groups =	38
R-sq: within =	= 0.1836			Obs per g	roup: min =	1
between =	= 0.1386				avg =	18.5
overall =	= 0.0641				max =	23
				F(5,659)	=	29.64
corr(u_i, Xb) =	= -0.9334			Prob ≻ F	=	0.0000
Growth	Coef.	Std. Err.	t	₽> t	[95% Conf.	Intervall
logDebt	5192884	.781313	-0.66	0.507	-2.053451	1.014875
logRevenu	2.894219	1.152388	2.51	0.012	.6314247	5.157013
logExpenditure	-9.020513	1.441672	-6.26	0.000	-11.85134	-6.189689
Interest	2695147	.0352418	-7.65	0.000	3387144	200315
Inflation	1336184	.0277718	-4.81	0.000	1881503	0790865
_cons	74.81964	7.432042	10.07	0.000	60.2263	89.41297
sigma u	4.7021546					
sigma e	2.7306014					
rho	.74781598	(fraction	of varia	nce due t	o u_i)	
F test that all	u_i=0: F	(37, 659) =	5.23	1	Prob > F	= 0.0000

Number of obs =	702
Number of groups =	38
Obs per group: min =	1
avg =	18.5
max =	23
Wald chi2(5) =	76.81
Prob > chi2 =	0.0000
	Number of obs = Number of groups = Obs per group: min = avg = max = Wald chi2(5) = Prob > chi2 =

		— theta —		
min	5%	median	95%	max
0.0458	0.1213	0.4289	0.4464	0.4464

Growth	Coef.	Std. Err.	z	P≻∣z∣	[95% Conf.	Interval]
logDebt logRevenu logExpenditure Interest Inflation _cons	-1.270843 3.452444 -3.422963 1749261 0453502 16.46771	.4969332 .9505648 1.053919 .0336182 .0258819 2.702016	-2.56 3.63 -3.25 -5.20 -1.75 6.09	0.011 0.000 0.001 0.000 0.080 0.080	-2.244814 1.589371 -5.488605 2408167 0960777 11.17185	2968721 5.315517 -1.35732 1090356 .0053773 21.76356
sigma_u sigma_e rho	.85652654 2.7306014 .08957921	(fraction	of varia	nce due t	:o u_i)	

	Coeffi	cients ——		
	(b)	(B)	(b-B)	sqrt(diag(V_b-V_B))
	fixed	random	Difference	S.E.
logDebt	5192884	-1.270843	.7515549	.6029158
logRevenu	2.894219	3.452444	5582251	.6514783
logExpendi~e	-9.020513	-3.422963	-5.597551	.9837045
Interest	2695147	1749261	0945886	.0105733
Inflation	1336184	0453502	0882682	.0100699

b = consistent under Ho and Ha; obtained from xtreg B = inconsistent under Ha, efficient under Ho; obtained from xtreg

Test: Ho: difference in coefficients not systematic

Breusch and Pagan Lagrangian multiplier test for random effects

Growth[id,t] = Xb + u[id] + e[id,t]

Estimated results:

		Var	sd = sqrt(Var)
Gr	owth	10.15533	3.186742
	e	7.456184	2.730601
	u	.7336377	.8565265

Test: Var(u) = 0

chibar2(01) = 44.01 Prob > chibar2 = 0.0000

ixed-effects (within) regression				Number of	obs =	683 35
Group variable:	id		Number of groups =			
R-sq: within :	= 0.1717			Obs per g	roup: min =	1
between :	= 0.2216				avg =	19.5
overall :	= 0.0713				max =	23
				F(5,643)	=	26.65
corr(u_i, Xb) :	= -0.9279			Prob ≻ F	=	0.0000
Growth	Coef.	Std. Err.	t	P> t	[95% Conf.	. Interval]
logDebt	218985	.7765468	-0.28	0.778	-1.743859	1.305889
logExpenditure	-8.888202	1.46408	-6.07	0.000	-11.76316	-6.013248
logRevenu	2.623145	1.156678	2.27	0.024	.3518213	4.894468
Inflation	1315709	.0273382	-4.81	0.000	1852538	0778879
Interest	2364596	.0350093	-6.75	0.000	3052059	1677134
_cons	73.10971	7.346816	9.95	0.000	58.68306	87.53636
sigma_u	4.1883917					
sigma_e	2.6722207					
rho	.7107057	(fraction	of varia	ance due to	o u_i)	
F test that all	u_i=0: F	(34, 643) =	5.4	7	Prob > F	= 0.0000

<pre>test that all u_i=0:</pre>	F(34, 643) =	5.47	Prob > F = 0.000
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Random	-effects GLS regression	Number of obs	=	683
Group	variable: id	Number of groups		35
R-sq:	within = 0.1163	Obs per group: min	=	1
	between = 0.3241	avg	=	19.5
	overall = 0.1013	max	=	23
corr (u	_i, X) = O (assumed)	Wald chi2(5) Prob > chi2	=	73.27 0.0000

- theta min 5% median 95% max 0.0500 0.3068 0.4470 0.4644 0.4644

Growth	Coef.	Std. Err.	z	P≻∣z∣	[95% Conf.	Interval]
logDebt logExpenditure logRevenu Inflation Interest _cons	8863645 -3.753804 3.12699 053756 1577334 19.34396	.5141254 1.10466 .9748864 .0255658 .0336477 2.946516	-1.72 -3.40 3.21 -2.10 -4.69 6.57	0.085 0.001 0.001 0.035 0.000 0.000	-1.894032 -5.918898 1.216248 103864 2236816 13.5689	.1213028 -1.588711 5.037732 003648 0917851 25.11903
	.87857856 2.6722207 .09755252	(fraction	of varia	nce due t	:o u_i)	

	Coeffi	cients —		
	(b)	(B)	(b-B)	sqrt(diag(V_b-V_B))
	fixed	random	Difference	S.E.
logDebt	218985	8863645	. 6673795	.5819793
logExpendi~e	-8.888202	-3.753804	-5.134398	.9608619
logRevenu	2.623145	3.12699	5038455	. 6224962
Inflation	1315709	053756	0778149	.0096834
Interest	2364596	1577334	0787263	.0096685

b = consistent under Ho and Ha; obtained from xtreg B = inconsistent under Ha, efficient under Ho; obtained from xtreg

Test: Ho: difference in coefficients not systematic

chi2(5) = (b-B)'[(V_b-V_B)^(-1)](b-B) = 74.77 Prob>chi2 = 0.0000 (V_b-V_B is not positive definite)

Breusch and Pagan Lagrangian multiplier test for random effects

Growth[id,t] = Xb + u[id] + e[id,t]

Estimated results:

	Var	sd = sqrt(Var)
Growth	9.716652	3.117154
e	7.140764	2.672221
u	.7719003	.8785786

Test: Var(u) = 0

chibar2(01) = 52.19 Prob > chibar2 = 0.0000

WITHOUT OUTLIERS

Fixed-effects (within) regression			Number of	obs =	585	
Group variable:	Group variable: id			Number of	groups =	32
R-sq: within =	= 0.1558			Obs per gr	coup: min =	1
between =	between = 0.0469				avg =	18.3
overall :	= 0.0373				max =	23
				F(5,548)	=	20.22
corr(u_i, Xb) = -0.8800				Prob > F	=	0.0000
Growth	Coef.	Std. Err.	t	₽> t	[95% Conf.	Interval]
logDebt	. 4367658	.8558162	0.51	0.610	-1.244316	2.117847
logExpenditure	-8.636417	1.428786	-6.04	0.000	-11.44298	-5.82985
logRevenu	2.553838	1.130172	2.26	0.024	.3338381	4.773838
Interest	231349	.0369195	-6.27	0.000	30387	158828
Inflation	1282831	.0297762	-4.31	0.000	1867726	0697937
_cons	63.54456	7.712172	8.24	0.000	48.39553	78.6936
sigma u	3.5456488					
sigma e	2.6096208					
rho	. 64863224	(fraction	of varia	ance due to	o u_i)	
F test that all u i=0: F(31, 548) = 5.30 Prob > F = 0.0000					= 0.0000	

Random-effects GLS regression	Number of obs	=	585
Group variable: id	Number of groups	=	32
R-sq: within = 0.1101	Obs per group: min	=	1
between = 0.1176	avg	=	18.3
overall = 0.0672	max	=	23
	Wald chi2(5)	=	53.23
<pre>corr(u_i, X) = 0 (assumed)</pre>	Prob ≻ chi2	=	0.0000

		— theta —		
min	5%	median	95%	max
0.0628	0.1594	0.4941	0.5111	0.5111

Growth	Coef.	Std. Err.	z	₽≻ z	[95% Conf.	Interval]
logDebt	-1.186033	. 6543207	-1.81	0.070	-2.468478	.0964117
logExpenditure	-3.477761	1.0937	-3.18	0.001	-5.621373	-1.334148
logRevenu	3.121246	1.001421	3.12	0.002	1.158497	5.083996
Interest	1620109	.0352278	-4.60	0.000	2310561	0929658
Inflation	0601972	.0277696	-2.17	0.030	1146245	0057698
_cons	19.72436	3.49404	5.65	0.000	12.87617	26.57255
sigma u	.97103318					
sigma_e	2.6096208					
rho	.12161773	(fraction	of varia	nce due t	;o u_i)	

	(b)	(B)	(b-B)	<pre>sqrt(diag(V_b-V_B))</pre>
	fixed	random	Difference	S.E.
logDebt	. 4367658	-1.186033	1.622799	.551621
logExpendi~e	-8.636417	-3.477761	-5.158656	.9193741
logRevenu	2.553838	3.121246	567408	. 523875
Interest	231349	1620109	0693381	.0110478
Inflation	1282831	0601972	068086	.0107459

b = consistent under Ho and Ha; obtained from xtreg B = inconsistent under Ha, efficient under Ho; obtained from xtreg

Test: Ho: difference in coefficients not systematic

chi2(5) = (b-B)'[(V_b-V_B)^(-1)](b-B) = 58.46 Prob>chi2 = 0.0000

Breusch and Pagan Lagrangian multiplier test for random effects

Growth[id,t] = Xb + u[id] + e[id,t]

Estimated results:

		Var	sd = sqrt(Var)
	Growth	8.974772	2.995792
	e	6.810121	2.609621
	u	.9429054	.9710332
Test:	Var(u) = 0)	
		chibar2(01)	= 60.30

Prob > chibar2 = 0.0000