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The Role of Government Debt in Economic Growth

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Abstract

We study the effect of public debt on economic growth for annual and 5-year average growth rates, as well as the existence of non-linearity effects of debt on growth for 14 European countries from 1970 until 2012. We also consider debt-to-GDP ratio interactions with monetary, public finance, institutional and macroeconomic variables. Our results show a negative impact of -0.01% for each 1% increment of public debt, although debt service has a 10 times worse effect on growth. In addition, we find average debt ratio thresholds of around 75%. Belonging to the Eurozone has a detrimental effect of at least -0.5% for real *per capita* GDP, and the banking crisis is the most harmful crisis for growth.

JEL Codes: E62**,** H63, O47.
Keywords: government debt, economic growth, debt thresholds.

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1. Introduction

In 2007, a financial crisis emerged from the U.S. financial system, namely from the banking sector with the bankruptcy of Lehman Brothers. As a result, the fiscal imbalances of several countries grew in such a way that caused a sovereign debt crisis, beginning in Greece and then affecting all Euro-area countries, especially the peripheral countries such as Portugal, Italy, Ireland and Spain.

In addition to this more bleak economic performance, a controversy arose in 2010 from the findings of the Reinhart & Rogoff (2010) study about the effect of government debt on economic growth. Discussions regarding the evidence of mistakes in this paper fuelled the debate. Even though economists and policymakers had focused their main debate on this central macroeconomics question, there has been no precise definition of the real source of this problem in economic and policy discussions to date. The multiple attempts taken by governments up to now have, in effect, just prolonged poor economic performance, and have increased costs in general for societies. Citing Buchanan (1966), the actual discussion around public debt has been a "murky battleground". In his article, Buchanan presents an important point, which could be the main question faced by social scientists and politicians: "When and who pays for public expenditure financed by debt issue, instead of by taxation or the printing of money?"

Wright (1943) says that even though "our problem, let me again repeat, is not: Can deficits someday roll up an intolerable debt? Our problem is: What are the maladjustments that are making continued deficits necessary? (…) Are the taxes too heavy or too light, or are they poorly distributed and levied?"

In contrast with this reality, economic theory tells us that government debt could be an important vehicle for inducing economic growth, and this paper assesses this hypothesis. Besides this interaction, we also want to study possible evidence of an inverted U-shape relationship between debt and growth.

Our main results show that debt has a detrimental effect on growth, although the debt service represents a larger damaging consequence for growth. We also find evidence of debt thresholds around 75% and 74% for annual and 5-year average growth rates, respectively.

The remaining of this paper is organised as follows. Section Two provides a literature review of the related theoretical viewpoints and empirical studies. Section Three presents the methodology, several robustness tests, the data and its sources. Section Four provides the empirical analysis. The last section presents the conclusions.

2. Literature Review

There is quite a lot of literature of economic theory about the importance of public debt on economic growth. Diamond (1965) describes a model that examines the long-run competitive equilibrium in a growth model and then explores the effects of government debt on that same equilibrium. The author concludes that taxes have the same impact on individuals living during a long-run equilibrium, whether they are used to finance internal or external debt. According to Feldstein (1985), in theoretical terms, if the stock of capital is initially at an optimal level, it is better to finance a temporary increase in spending through debt, because the excess burden of taxation depends on the square of the tax rate. When capital is below the optimal level, it is preferable to finance the amount of spending with taxation. These conclusions are taken from the relationship between capital intensity and the golden rule level: when capital intensity is less than the golden rule level, it implies that the government spending-labour force ratio is smaller than taxation *per capita* and therefore the increase of debt must be financed by taxation.

On the other hand, Martin (2009) tries to explain the level of debt by affirming that the crucial determinant of this level is the compliance of households in substituting goods that are being taxed by inflation. Despite the fact that the welfare in an economy with debt is lower than that of an economy without debt, Wigger (2009) concludes that generations could benefit from Ponzi schemes for issuing debt, depending on their preferences and on technology. Greiner (2012) relates a higher public debt ratio with a smaller long-run growth rate. However, in Greiner (2013), when the author assumes wage rigidity, the conclusion is different: public debt does not affect long-run economic growth or employment, but only the stability of the economy.

Focusing now on empirical studies, Schclarek (2004) investigates both linear and non-linear correlation among growth and government debt for developing and developed countries. Regarding developed countries, the author does not find any relationship between these two variables. Reinhart & Rogoff (2010) explore the possibility of a persistent relationship between high gross central government debt levels, economic growth and inflation, based on a new database.[1] The authors affirm the existence of a weak link between growth and low levels of debt, but when debt-to-GDP

[1] Database presented in Reinhart & Rogoff (2009) and Reinhart & Rogoff (2011).

ratio is over 90%, the economies' growth rates are on average one percent lower than otherwise.

When exploring the influence of high public debt on long-run growth, based on a panel data of advanced and developing countries over 38 years, Kumar & Jaejoon (2010) reach two important conclusions: an inverse relationship between initial debt and growth; and the possibility of some non-linearity effects of debt on growth. Reinhart & Rogoff (2011) compiled a database of domestic debt which allows for a better comprehension about the question as to why economies default on external debts at low thresholds of public debt. Afonso & Jalles (2013) analyse the linkages between growth, public debt and productivity, throughout the analysis of 155 countries between 1970 and 2008. The authors conclude that there is a negative effect of debt ratio and financial crisis on economic growth. Furthermore, higher debt ratios could benefit Total Factor Productivity (TFP) growth.

Another empirical study that contributes to understanding the role of public debt in economic growth is provided by Cecchetti et al. (2011), who analyse the debt damage effect for 18 OECD countries over a 30 years' time span, reaching a 85% government debt-to-GDP ratio threshold.

However, whilst investigating the same causality, but this time for twelve Euro area countries between 1990 and 2010, Baum et al (2013) conclude that there is a threshold at the 67% public debt ratio (above 95% there is a negative impact on economic growth) and that interest rates are pressured upwards when debt ratio is greater than 70% of GDP. Checherita-Westphal & Rother (2012) study twelve Euro area countries from 1970 until 2010, and conclude that the negative effect of government debt on growth starts between 70% and 80%, and private saving, public investment and TFP are the channels where public debt is found to have a non-linear impact on growth. Introducing some political variables, Elgin & Uras (2012) relate the higher informal sector size with a higher probability of sovereign default risk and a country's public indebtedness for 155 countries, using data from 1960 until 2008. Heylen, et al (2013), when analysing 132 fiscal episodes for 21 OECD countries over a twenty-eight year period, reach the conclusion that: consolidation programmes of public debt reduction are more successful when they are followed by product-market deregulation and when they are adopted by left-wing governments. Labour market deregulation could have an effect to the contrary on debt reduction, as well as causing wage bill cuts (this last point is only effective when government efficiency is low).

Gnegne & Jawadi (2013) investigate public debt and its dynamics for the UK and the USA, which proved to be asymmetric and nonlinear, concluding that public debt seems to be based on several threshold effects, which helps to understand its dynamics with more accuracy. Certain, macroeconomic events such as economic slowdowns, debt and financial crisis, as well as oil shocks, have proved to be important factors linked with structural breaks in public debt dynamics. In Kourtellos et al. (2013), a structural threshold regression methodology is used to investigate the heterogeneity causalities of public debt on economic growth. Reviewing the effect of political variables, the authors highlight the evidence of an inverse relationship of democracy degree on threshold effects.

In the related literature on the sustainability of public finances, Westerlund & Prohl (2010) examine both public revenues and expenditures for eight OECD countries through a non-stationary panel data approach, for which the sustainability hypothesis is not rejected by the authors. Fincke & Greiner (2011) study the reaction of primary surplus (in percentage of GDP) to variations in debt to GDP ratio for some Euro area countries. When considering the group of PIIGS countries, their results show that only Ireland, Portugal and Spain give the impression of following a sustainable debt policy. For Greece, the conclusion of a sustainable debt policy is rejected, whilst for Italy, the results are slightly dubious. On the other hand, Afonso and Rault (2010), use a panel analysis, to conclude that fiscal sustainability is an issue in some countries, but that fiscal policy was sustainable both for a EU15 panel set, and within sub-periods (1970-1991 and 1992-2006).

Using a Keynesian framework, Leão (2013) affirms that under the full employment level, a rise in public spending may diminish the level of public debt-ratio. Teica (2012), for instance, proposes an analysis of public debt sustainability in the Euro area countries and states that debt sustainability can be achieved throughout a mix of budgetary and fiscal policies, to reduce budget deficits and increase primary balances.

Wahab (2004) and Kolluri & Wahab (2007), distinguish the relationship between government expenditures in different periods of economic growth (expansionary and recessionary movements) for OECD and Euro area countries. The first article suggests an inverse relationship, namely the results indicate that public expenditures increase less than proportionately during a growth period, and proportionately decrease more during a recession. The second article evidences the increase of government expenditure during periods of a negative economic growth, and

also highlights the Wagner's proposition, which is less evident for Euro area members. On the other hand, Fölster & Henrekson (2001) conclude that for all countries sampled, there is evidence of both government expenditure and taxation being negatively related to growth.

Campos et al. (2006) stress the importance of stock-flow reconciliation, which, despite being commonly considered by many economists as being a negligible entity for explaining the dynamics of public debt growth, they found it to be a crucial determinant for debt dynamics. Contingent liabilities and balance-sheet effects, based on econometric tests carried out by the authors themselves, explain this variable. Gruber & Kamin (2012) examine the effect of debt level and fiscal balance for some OECD countries between 1988 and 2008, leading to a statistically significant impact of one percent rise in the structural budget balance and net debt on bond yield rates. Finally, Afonso & Jalles (2012), using a panel data of developed and emerging countries over 39 years, found lower economic growth in the presence of increased fiscal policy volatility. Government spending presents symptoms of rigidity, when compared with revenue during financial crisis periods.

3. Methodology and Data

3.1. Analytical Framework

This study uses the neoclassical growth model as the essential framework, represented by the aggregate production function $Y=F(K,L)$, where Y is the aggregate output, K is the capital stock (both human and physical), and L is the labour force or population. Admitting the hypothesis of heterogeneity across economies, and therefore the existence of different steady states from the analysis of this production function, the concept of convergence arises. According to Barro & Sala-i-Martin (2004), "an economy grows faster the further it is from its own steady-state value" or, in other words, the model expects that economies with a lower starting value of real *per capita* income tend to grow faster than economies with higher values of real income.

However, we consider different variables, especially the government debt-to-GDP ratio, as there are other aspects that can explain the convergence phenomena, rather than just considering the initial *per capita* income. The aggregate production is now $F=(K,L,D)$, D being the debt-to-GDP ratio variable, which can be represented by the following equation:

(1) $$g_{it} = \alpha_{it} + \beta_{0it} y_{i0} + \beta_1 x_{it}^j + \beta_2 D_{it} + \eta_t + \nu_i + \varepsilon_{it}, t = 1,...,T; i = 1,...,N,$$

where g_{it} represents the real *per capita* GDP growth rate; y_{it} the real *per capita* income of 1970, the initial year of our time-span analysed; x_{it}^j, j=1,2 is a vector of control variables; D_{it} the government debt, in ratio to GDP terms; η_t and ν_i are, respectively, the time effect and the country-specific effect; ε_{it} is an unobserved zero mean white noise-type column vector, satisfying the standard assumptions; α, β_0, β_1 and β_2 are unknown coefficients to be estimated.

In order to study the non-linearity effect of government debt on economic growth, we add the squared debt-to-GDP variable:

(2) $$g_{it} = \alpha_{it} + \beta_{0it} y_{i0} + \beta_1 x_{it}^j + \beta_2 D_{it} + \beta_3 D_{it}^2 + \eta_t + \nu_i + \varepsilon_{it}, t = 1,...,T; i = 1,...,N.$$

Moreover, we will add several variables described in Section 3.3, in order to determine the effect of debt-to-GDP ratio in real *per capita* income, whilst interacting with the above-mentioned variables.

3.2. Econometric approaches

3.2.1. Panel techniques

Instead of using cross-section methods to analyse the public debt effects on growth, we use panel data techniques to compute those dynamics on real *per capita* growth. One of the important advantages of using panel data estimation is that it highlights individual heterogeneity, if there are some differentiating features across cross-sections. These particularities might not be constant across time, in such a way that time series or cross-sectional approaches do not take this heterogeneity into account, which leads to biased results. With respect to data panel techniques, the other advantages that are especially important for our study are: 1) the availability of a large data set, which allows for the identification and more accurate measurement of the individual effects of the sample, contrary to cross-section and time-series methods; 2) less co-linearity, and; 3) a greater efficiency in obtaining the estimation results.

On the other hand, we should also stress some of the problems related with panel data approaches, such as: 1) the possibility of an impact caused by unobserved

heterogeneity; 2) the lack of some particular data[2] and; 3) biased estimators due to incorrect specification of the model. We should especially take into account problems related with endogeneity and cross-section dependence.

3.2.2. Heterogeneity

In order to analyse the unobserved effects presented in equation (1), it is possible to apply a fixed effects or a random effects model. Admitting the existence of omitted variables and making the assumption of zero correlation between the explanatory variables and the unobserved variables, the best way to examine unobserved effects is by using a random effects model. On the other hand, if the omitted variables and the explanatory variables are correlated, it then becomes preferable to apply a fixed effects model in order to cater for omitted variable bias.

Therefore, we apply the Hausman test to choose the best methodology for solving the problem of unobserved effects. The basic idea of this test is to examine whether we can accept the null hypothesis, which means that random effects is the best solution, and if we reject it, on should use a fixed effects estimation. Through the Hausman test, the null hypothesis is rejected and thus we opt to use the fixed effects estimation.[3]

3.2.3. Endogeneity

As mentioned earlier, the endogeneity problem is one of the main issues that arises from panel data analysis. Should it be present in regressors, then one of the main objectives is to solve this problem, in order to obtain unbiased estimators.

Endogeneity can emerge from omitted variables, measurement errors or simultaneity. This problem could lead to a rejection of "Type 1 errors", or cause a failure when we reject the null hypothesis. Country-specific properties may be responsible for some unobserved omitted variables, such as, for instance, the misspecification of the model and the natural consequence of obtaining biased estimators, but this specific effect does not solve the potential problem of endogeneity**.**

The Two Stage Least Squares estimator (2SLS) enables the correction of this problem of endogeneity, even for multiple endogenous explanatory variables.

[2] There are some variables for which there is no data available for some countries, during particular years.
[3] To maximise parsimony, the results for this test are not presented here. However, they are available in Appendix C – Additional econometric tests statistics, Table C1.

According to Wooldridge (2009), order condition should be used when there is more than one endogenous variable, as this could lead to a failure in the identification of the endogenous explanatory variable of our model. This referred condition uses the White diagonal covariance matrix, in order to assume a residual heteroskedasticity.

3.2.4. Cross-sectional dependence

Sarafidis & Wansbeek (2010) mention that "one major issue that inherently arises in every panel data study with potential implications on parameter estimation and inference, is the possibility that the individual units are interdependent." The presence of cross-sectional dependence causes misspecification of the model, once the explanatory variables have been correlated with shocks or unspecified variables. The authors propose several methods for solving this problem for the weak and strong cross-sectional dependence, including the LM statistic test, which is also proposed by Breusch & Pagan, (1980). When *N* is large, the LM statistic presents "poor size properties", citing Sarafidis & Wansbeek (2010) article. Taking into account the nature of our study and the number of variables, years and countries, this statistical methodology is not adopted.

According to Chudik, et al. (2009), the common correlated effects (CCE) estimator, studied by Pesaran (2006), allows for the estimations to remain consistent and also enables the asymptotic normal theory to still be applied for a large number of weak and semi-weak factors in panel data studies. Therefore, we used the Pesaran's CD test statistic in all of the methods used in the estimation. Lastly, we use the Generalised Least Squares (GLS) methodology to deal with cross-sectional dependence. As we will observe later in all the results obtained, we conclude that there is no cross-section dependence phenomenon when the values computed for Pesaran's CD test statistic reject this hypothesis.

3.3. Data

The model is estimated for a period between 1970 and 2012 for 14 European countries: Austria (AT), Belgium (BE), Denmark (DK), Finland (FI), France (FR), Germany (DE), Greece (GR), Ireland (IE), Italy (IT), the Netherlands (NL), Portugal (PT), Spain (ES), Sweden (SE) and the United Kingdom (UK). The dataset excludes

some Euro-area and OECD countries with poor availability of data, in order to avoid a large measurement error.

The database[4] was collected from several sources: Real GDP (RGDP) *per capita* and Real GDP growth rate (RGDPGR); urbanization rate (URB); domestic credit to private credit sector as a percentage of GDP (CREDIT); inflation as the percentage change in the cost for the average consumer of acquiring a basket of goods and services (INFLATION); and trade openness throughout the sum of exports and imports of goods and services as a percentage of GDP (TRADEOPE). These were retrieved from the World Bank's World Development Indicators[5]. From the AMECO database we collected the following variables: general government gross debt in percentage of GDP at market prices (DEBT); nominal short-term interest rate (SHORTINT); cyclically adjusted primary balance (CAPB); Gap between actual and potential GDP at constant market prices (OUTPUTGAP); general government total expenditure (EXP); primary budget balance (PBB); total budget balance (TBB); and debt service (DEBTS), which was constructed through the subtraction of the total budget balance from the primary budget balance.

Population levels in thousands (POP); gross fixed capital formation growth rate (GFCF); average hours actually worked (AVH); annual growth rate as a percentage of unit labour costs in the total economy (ULC); the annual growth rate of labour compensation per unit of labour input in the total economy (LC); current account balance as a percentage of GDP (CURRENT); long-term interest rates (LONGINT); the rate of unemployment as a percentage of the total labour force (UNEM); taxes on goods and services as a percentage of GDP (TGOODS); taxes on income and profit as a percentage of GDP (TINC); and also life expectancy at birth, measured in number of years (LE), were all sourced from the OECD.[6]

From Beck, et al (2009).[7] we used the liquid liabilities in percentage of GDP (M3). Other variables, such as the index of human capital per person (HC); capital stock

[4] The database used in this study is available on the following website: https://aquila2.iseg.ulisboa.pt/aquila/homepage/l37655/base-de-dados---tfm.-the-role-of-government-debt-on-economic-growth

[5] This dataset is available on the following website: http://data.worldbank.org/data-catalog/world-development-indicators

[6] This dataset is available on the following website: http://stats.oecd.org/#

[7] Data is available to download from the following website: http://econ.worldbank.org/WBSITE/EXTERNAL/EXTDEC/EXTRESEARCH/0,,contentMDK:20696167~pagePK:64214825~piPK:64214943~theSitePK:469382,00.html

at constant 2005 national prices (K); and total factor productivity at constant national prices (TFP) were based on Feenstra et al. (2013)[8].

In addition, we also use dummy variables. From Reinhart & Rogoff's (2009)[9] database we consider banking crises (BANKINGC); currency crises (CURRENCYC); inflation crises (INFLATIONC); and stock market crashes (STOCKMARKETC) as dummies that take the value "1" for the specific year in which the referred crises occurred). Another variable from the same source that we take into account is crises tally (CRISESTALLY), which represents the sum of each crisis in a particular year. Lastly, applying the criteria of (Afonso, 2005), we built Euro-zone (EURO), Maastricht Treaty (MAAS) and Stability and Growth Pact (SGP) dummies (the variable takes the value "1", for each year the country is affected by such an event). The descriptive statistics for all variables can be found in Table A1, in Appendix A.[10]

4. Empirical Analysis

We use two dependent variables: the real *per capita* GDP annual growth rate, and the 5-year average of real *per capita* GDP growth rate. In the latter case, that variable takes into account the cyclical fluctuations in the real GDP path. In this study we use several explanatory variables to understand the behaviour of economic growth in the presence of public debt, as described before in sub-section 3.3. As government debt will be interacting with different types of variables, we decided to group them into four areas: 1) monetary variables, namely interest rates; 2) public finance variables; 3) institutional variables; and 4) macroeconomic variables. The variables used are presented in each table of results, with the respective code as previously explained. To maximise parsimony, we only show four tables in this section, namely those regarding results where annual growth rate is the dependent variable. The other results are presented in Appendix B.

[8] The referred is available to download on http://www.rug.nl/research/ggdc/data/penn-world-Table

[9] The collected variables are available on http://www.reinhartandrogoff.com/data/browse-by-topic/topics/7/. We would like to thank Mr. Kenneth S. Rogoff who, due to the lack of data in the referred website, provided me with such data.

[10] It is important to highlight that some variables which are the logarithmic growth rates (computed by the author) of those variables not presented in this sub-section, are, in fact, shown in the Table of the descriptive statistics. To identify those variables, the suffix "GR" is added to the final of the respective variable acronym.

4.1. Debt-growth relationship

Looking at all the results, we can confirm the existence of the β-convergence process. The expected negative coefficient for the real *per capita* GDP is obtained and, in most cases, that coefficient is statistically significant at 99% level, meaning that the countries used in our sample converge for their own steady-state in the analysed time span. In the case of 5-year average of economic growth, some coefficients have a positive signal, but once they have no statistical significance for growth (with at least a 90% level of significance), the relevance of those coefficients is not discussed.

In both cases of annual and 5-year average growth rates, we obtain the expected negative sign for the debt coefficient. The detrimental effect of the debt-to-GDP ratio is around -0.01% for each level of 1% of government debt. For example, the level of debt in Greece in 2011, which was about 170.32%[11], has a negative impact of about -1.7%.

Regarding interest rates variables, short-term nominal interest rate presents a statistical significance in the majority of the regressions, with a positive sign at the 99% level in both cases of annual and 5-year average growth rates. It is likely that this means that an increase in short-term interest rates could lead to higher saving, and thus greater creation of capital, in order to leverage growth rates in the short term. On the other hand, long-term interest rates have a negative sign (see Table 1)[12].

Regarding the results of the influence of debt on real growth, and the interaction with public finance variables, the main factor to highlight is the debt service coefficient. It is notable that the results in all regressions exhibit a large detrimental impact for growth when compared with the debt variable by 10 times, in absolute terms (see Table 3)[13]. Primary budget balance, cyclically adjusted primary balance and total budget balance all have the expected positive sign, which follows on from the theory that balanced public finances contribute positively to economic growth.

However, institutional variables demonstrate that countries belonging to the Eurozone suffer a decrease in growth of more than -0.5%, with cases where this event presents an even more negative impact of -1%. The number of crises occurring in a certain year has a negative sign, as could be expected.

In addition, the banking crisis has the most negative crisis effect on economic growth, representing a negative effect on growth of more than -1%. Although stock

[11] This information was obtained from Appendix A – Data Statistics.
[12] Other results regarding monetary variables are available in Tables B1, B2 and B3 of Appendix B.
[13] Appendix B, Tables B4, B5 and B6, also show the results related to public finance variables.

market crashes are bad for growth, they present themselves as not being statistically significant. Inflation crises and currency crises also have an undesirable and expected effect, the latter representing crises with about half the negative effect of inflation crises.

Another important result to mention is the positive impact of the Stability and Growth Pact (SGP), which leads to the conclusion that the SGP led to better performance of public finances and consequently, to a positive impact on economic growth.

However the Maastricht Treaty had a dubious effect on the dependent variable, and, in most cases, it is not significant, at a minimum of 90%.

Table 1: Growth equations with linear debt effect in real GDP growth rate and with monetary variables, 5-year average.

	OLS			OLS-FE			2SLS			GLS		
	1	2	3	4	5	6	7	8	9	10	11	12
$rgdp_{it-1}$	-1.548*** (0.183)	-1.208*** (0.189)	-1.397*** (0.315)	-3.450*** (0.314)	-2.787*** (0.334)	-4.075*** (0.511)	-3.832*** (0.346)	-3.820*** (0.363)	-5.846*** (0.706)	-1.706*** (0.144)	-1.419*** (0.156)	-1.798*** (0.262)
$debt_{it}$		-0.017*** (0.003)	-0.011*** (0.003)		-0.011*** (0.003)	-0.004 (0.004)		-0.000 (0.004)	0.008** (0.004)		-0.009*** (0.002)	-0.009*** (0.002)
$shortint_{it}$			0.121*** (0.027)			0.090*** (0.029)			0.071 (0.051)			0.076** (0.031)
$longint_{it}$			-0.147*** (0.035)			-0.229*** (0.037)			-0.282*** (0.058)			-0.111*** (0.041)
Obs:	558	545	402	558	545	402	544	523	382	558	545	402
R-squared	0.082	0.136	0.182	0.245	0.254	0.301	0.244	0.247	0.286	0.180	0.203	0.223
DW-statistic	0.385	0.415	0.462	0.468	0.480	0.517	0.473	0.480	0.508	0.404	0.417	0.443
Pesaran CD statistic	15.825	16.638	14.553	7.455	10.715	10.679	7.221	7.384	6.549	15.088	15.277	13.922

Notes: *, ** and *** represent statistical significance at levels of 10%, 5% and 1% respectively. The robust standard errors are in brackets. The White diagonal covariance matrix is used in order to assume residual heteroskedasticity, except for the Generalised Least Squares methodology. The DW-statistic is the Durbin-Watson statistic and the Pesaran CD statistic is the Pesaran cross-section dependence statistic.

Table 2: Growth equations with debt linear effect on real GDP growth rate and with institutional variables, 5-year average.

	OLS			OLS-FE			2SLS			GLS		
	1	2	3	4	5	6	7	8	9	10	11	12
$rgdp_{it-1}$	-1.270*** (0.180)	-1.192*** (0.179)	-0.946*** (0.202)	-2.770*** (0.344)	-2.857*** (0.344)	-4.018*** (0.619)	-3.793*** (0.372)	-3.694*** (0.377)	-5.775*** (0.717)	-1.381*** (0.157)	-1.286*** (0.157)	-1.209*** (0.185)
$debt_{it}$	-0.014*** (0.003)	-0.011*** (0.003)	-0.007*** (0.003)	-0.008** (0.004)	-0.002 (0.004)	-0.000 (0.004)	0.002 (0.004)	0.007* (0.005)	0.007 (0.005)	-0.007*** (0.002)	-0.004** (0.002)	-0.002 (0.002)
$crisestally_{it}$	-0.527*** (0.098)			-0.441*** (0.097)			-0.418*** (0.101)			-0.374*** (0.066)		
$inflationc_{it}$		-0.850* (0.474)	-0.914** (0.462)		-0.831* (0.428)	-0.829* (0.436)		-0.898* (0.461)	-0.898** (0.468)		-0.407 (0.490)	-0.504 (0.485)
$stockmarketc_{it}$		0.125 (0.194)	0.157 (0.193)		0.153 (0.191)	0.194 (0.190)		0.251 (0.201)	0.264 (0.199)		0.050 (0.105)	0.124 (0.102)
$currencyc_{it}$		-0.611*** (0.205)	-0.581*** (0.211)		-0.419** (0.205)	-0.425** (0.196)		-0.376* (0.215)	-0.420** (0.204)		-0.488*** (0.129)	-0.487*** (0.140)
$bankingc_{it}$		-1.407*** (0.165)	-1.330*** (0.162)		-1.270*** (0.156)	-1.098*** (0.163)		-1.348*** (0.164)	-1.103*** (0.171)		-1.107*** (0.138)	-1.016 (0.138)
$euro_{it}$			-0.935*** (0.187)			-1.054*** (0.202)			-0.945*** (0.203)			-0.970*** (0.169)
sgp_{it}			0.547** (0.216)			1.204*** (0.231)			1.504*** (0.234)			0.596*** (0.198)
$maas_{it}$			-0.403** (0.195)			0.181 (0.252)			0.352 (0.267)			-0.250 (0.163)
Obs:	517	515	515	517	515	515	495	493	493	517	515	515
R-squared	0.140	0.179	0.204	0.246	0.275	0.301	0.239	0.272	0.300	0.205	0.257	0.318
DW-statistic	0.484	0.532	0.556	0.537	0.579	0.620	0.534	0.590	0.637	0.522	0.591	0.658
Pesaran CD statistic	13.804	12.801	9.976	10.173	8.208	8.390	8.446	6.870	7.125	13.203	11.469	8.648

Notes: *, ** and *** represent statistical significance at levels of 10%, 5% and 1% level respectively. The robust standard errors are in brackets. The White diagonal covariance matrix is used in order to assume residual heteroskedasticity, except for the Generalised Least Squares methodology. The DW-statistic is the Durbin-Watson statistic and the Pesaran CD statistic is the Pesaran cross-section dependence statistic.

Analysing the results of the macroeconomic variables presented in Table 4[14], we can observe that taxation on capital and profit presents a negative sign when statistically significant. Thus, this allows us to speculate about the possible burden of this type of taxation, given that less wealth would be available to generate more capital. On the other hand, the values obtained for taxation on goods and services do not follow the same constant pattern, as they assume positive and negative statistical results.

Another interesting result is with regards to the growth rate of credit to the private sector. When this variable present a statistical significant coefficient, it induces a reduction in economic growth of more than 0.01% per each 1% increase of credit. According to Sassi & Gasmi (2014), this result is due to the proportionally larger amount of credit given to households, rather than to firms. The values reported in this paper confirm our results, in the sense that the effect of householder credit on real *per capita* GDP is negative and it has a major role, in absolute terms, on economic growth. This is in contrast to firms, wherecredit is used to invest in productivity, in that the growth of credit to households is followed by financial instability, as well as an increase of external debt. A positive effect for the growth rate of *per capita* GDP is created by several variables, namely: annual growth rate of gross fixed capital formation; current account balance; trade openness; average hours worked; and urbanisation rate. Contrary to these results, the following have an undesirable effect on economic growth and are significant in statistical terms: net liabilities, life expectancy, the level of government expenditure and its annual growth rate, and the unemployment rate.

According to economic theory, the output gap and total factor productivity variables present positive coefficients when the same are significant. In fact, a 1% output gap beyond potential GDP will contribute to more than 0.5% of *per capita* GDP growth rate. Inflation, which is considered to be a detrimental factor for real economic growth rate, follows a consistent pattern in the majority of cases, presenting the expected negative effect on growth in the regressions displayed in Tables 4, B10, B11 and B12.

Another result that needs to be highlighted is the fact that the level of population and the labour compensation per unit of labour have an important and positive explanation in the long-run (these results are only valid for regressions with 5-year average *per capita* growth rate as a dependent variable). Even though the unit labour

[14] Other results associated with macroeconomic variables are in Tables B10, B11 and B12 in Appendix B.

costs variable is significant, both in the short and long term, its effect differs across time – in annual terms, labour costs are negative for growth, but for a 5-year average, they have a positive effect on economic growth. Lastly, human capital and the stock of capital do not present a constant sign across the several econometric tests, which do not lead us to a feasible conclusion for these two variables.

4.2. Non-linearities of government debt on growth

As seen in the previous section, government debt has a negative effect on growth, both during the short and long term. Despite this tendency, some papers study the existence of a non-linear relationship between debt ratio and economic performance. As already mentioned, the evidence of an inverted U-shape is also detailed in our paper. The threshold is associated with the level of government debt that most contributes to economic growth. Supposing a threshold of 60% of public debt-to-GDP ratio, for each additional increment of debt of 1% from that point forward, the positive effect of debt on growth will consequently be lower, as its level continues to increase. These positive threshold effects may be related to the preference of governments to release capital for the private sector and not to rely only on taxation. This way governments are able to stimulate investment and consumption by companies and households.

By adding the squared debt-to-GDP variable, equation (2) allows us not only to study the non-linearity effect of government debt on economic growth, but also to analyse the values of government debt thresholds. Firstly, we calculate these thresholds only when both coefficients of debt and debt squared are statistically significant, at least of 90% level; secondly, we derive equation (3); and thirdly, we equalise to zero the first-derivative to obtain equation (4):

$$(3) \qquad \frac{\partial g_{it}}{\partial (D_{it})} = \frac{\partial (\alpha_{it} + \beta_{0it} y_{it-1} + \beta_1 x_{it}^j + \beta_2 D_{it} + \beta_3 D_{it}^2 + \eta_t + \nu_i + \varepsilon_{it})}{\partial (D_{it})}$$

$$(4) \qquad 0 = \beta_2 + 2\beta_3 D_{it} \Leftrightarrow D_{it} = \frac{-\beta_2}{2\beta_3}.$$

To obtain the debt thresholds, we expect a negative β_3, i.e., a concave function of public debt effect on economic growth – the inverted U-shape. We present some results for thresholds[15] in Tables 3 and 4.

Although we obtain threshold values that range from 49.49% to 108.24%, which depend on the econometric method used and on the set of variables, on average, the most observed threshold value is about 74.84% for annual growth rates.

For the 5-year average growth rate, we obtain a maximum effect of debt on growth of 74.44%, which is a similar value to the one we obtained for annual growth rates.

However, when we analyse the estimated coefficients for the debt and debt-square with the individual set of variables, we reach different conclusions about the thresholds. For annual growth rates, we obtain, on average, a maximum threshold of 95.84% with institutional variables, which is different from the macroeconomic variables case, where we only get a value of 66.21%. The average thresholds attained for the remaining monetary and public finance variables are 74.16% and 69.82%, respectively. In the case of 5-year average growth rates, we find a higher threshold of 91.27% for institutional variables (not on average, as there is only one result for this sample). Regarding public finance variables, we achieve a mean threshold of 63.11%.

[15] Appendix B also exhibits the other results obtained for debt on the tables containing the debt-squared term.

Table 3: The non-linearity effect of public debt on real GDP growth rate, with public finance variables, 5-year average.

	OLS			OLS-FE		2SLS			GLS			
	1	2	3	4	5	6	7	8	9	10	11	12
$rgdp_{it-1}$	-1.570*** (0.296)	-1.629*** (0.325)	-2.022*** (0.262)	-3.474*** (0.599)	-4.617*** (0.727)	-4.326*** (0.456)	-3.957*** (0.644)	-5.623*** (0.783)	-4.938*** (0.467)	-1.572*** (0.215)	-1.686*** (0.243)	-2.160*** (0.206)
$debt_{it}$	-0.007 (0.012)	-0.006 (0.014)	0.009 (0.013)	0.007 (0.0149	0.020 (0.014)	0.028* (0.015)	0.020 (0.016)	0.047*** (0.017)	0.043** (0.017)	0.008 (0.007)	0.017** (0.008)	0.026*** (0.008)
$debt_{it}^2$	-0.000 (0.000)	-0.000 (0.000)	-0.000* (0.000)	-0.000* (0.0009	-0.000*** (0.000)	-0.000*** (0.000)	-0.000** (0.000)	-0.000*** (0.000)	-0.000*** (0.000)	-0.000*** (0.000)	-0.000*** (0.000)	-0.000*** (0.000)
pbb_{it}	0.121*** (0.023)			0.146*** (0.0239			0.152*** (0.029)			0.134*** (0.017)		
$debts_{it}$	-0.089** (0.043)	-0.103** (0.044)		-0.020 (0.057)	0.032 (0.060)		-0.017 (0.061)	0.091 (0.063)		-0.126*** (0.033)	-0.134*** (0.036)	
$capb_{it}$		0.120*** (0.028)			0.169*** (0.029)			0.213*** (0.035)			0.149*** (0.021)	
tbb_{it}			0.111*** (0.022)			0.141*** (0.023)			0.146*** (0.031)			0.125*** (0.017)
Debt Threshold						64.296		70.706	77.511		36.031	67.023
Obs:	454	420	454	454	420	454	434	401	434	454	420	454
R-squared	0.181	0.174	0.156	0.307	0.322	0.298	0.304	0.313	0.294	0.337	0.322	0.260
DW-statistic	0.356	0.349	0.339	0.422	0.430	0.412	0.467	0.487	0.456	0.530	0.521	0.459
Pesaran CD statistic	13.728	11.738	17.248	11.101	7.437	10.210	11.272	6.389	9.567	12.493	9.539	16.084

Notes: *, ** and *** represent statistical significance at levels of 10%, 5% and 1% respectively. The robust standard errors are in brackets. The White diagonal covariance matrix is used in order to assume residual heteroskedasticity, except for the Generalised Least Squares methodology. The DW-statistic is the Durbin-Watson statistic and the Pesaran CD statistic is the Pesaran cross-section dependence statistic.

Table 4: The non-linearity effect of public debt on real GDP growth rate, with macroeconomic variables, 5-year average.

	OLS			OLS-FE		2SLS		GLS				
	1	2	3	4	5	6	7	8	9	10	11	12
$rgdp_{it-1}$	0.365 (0.647)	-0.392 (0.277)	-2.491*** (0.424)	-8.206*** (3.103)	1.154 (1.042)	-4.089*** (0.837)	-16.268*** (5.097)	0.573 (8.661)	-4.732*** (0.916)	-0.720 (0.460)	-0.352 (0.242)	-2.876*** (0.424)
$debt_{it}$	0.007 (0.011)	0.011 (0.007)	0.010 (0.017)	-0.006 (0.021)	0.003 (0.011)	0.083*** (0.015)	-0.022 (0.030)	-0.015 (0.063)	0.083*** (0.016)	0.011 (0.009)	0.016*** (0.006)	0.031** (0.015)
$debt_{it}^2$	-0.000** (0.000)	-0.000** (0.000)	-0.000** (0.000)	0.000 (0.000)	-0.000 (0.000)	-0.000*** (0.000)	0.000 (0.000)	0.000 (0.000)	-0.000*** (0.000)	-0.000*** (0.000)	-0.000*** (0.000)	-0.000*** (0.000)
pbb_{it}	0.150*** (0.022)		0.043 (0.036)	0.065* (0.033)		-0.035 (0.043)	0.131*** (0.036)		-0.037 (0.043)	0.141*** (0.018)		0.058** (0.027)
$debts_{it}$	-0.080 (0.054)		-0.306*** (0.055)	0.135** (0.065)		-0.236*** (0.064)	0.133* (0.070)		-0.228*** (0.065)	-0.160*** (0.040)		-0.288*** (0.047)
$tinc_{it}$	-0.044 (0.027)			-0.001 (0.050)			-0.040 (0.063)			-0.020 (0.017)		
$tgoods_{it}$	-0.127** (0.054)			0.443*** (0.131)			0.410** (0.161)			-0.100** (0.044)		
$\log(k_{it-1})$	-0.430*** (0.128)			-2.726** (1.281)			1.463 (1.980)			-0.232*** (0.073)		
$\log(tfp_{it})$	-0.094 (0.800)			15.192*** (3.615)			21.810*** (5.853)			0.728 (0.615)		
$\log(hc_{it})$	-4.896*** (1.708)			11.345*** (3.158)			15.302*** (4.739)			-1.550* (0.930)		
$inflation_{it}$		-0.108*** (0.035)	-0.267*** (0.049)		-0.092*** (0.035)	-0.192*** (0.047)		-0.101 (0.198)	-0.192*** (0.048)		-0.106*** (0.021)	-0.274*** (0.040)
$\log(pop_{it})$		0.095 (0.061)			4.426 (3.769)			9.697 (8.665)			0.087* (0.050)	
$\Delta credit_{it}$		0.005 (0.007)			0.001 (0.006)			0.008 (0.199)			-0.003 (0.005)	
$m3_{it}$		-0.005 (0.003)			-0.015*** (0.004)			-0.009 (0.019)			-0.003 (0.002)	

	OLS			OLS-FE			2SLS			GLS		
	1	2	3	4	5	6	7	8	9	10	11	12
le_{it}		-0.375*** (0.072)			-0.514*** (0.117)			-0.561 (0.395)			-0.271*** (0.030)	
$gfcf_{it}$		0.058*** (0.015)			0.058*** (0.015)			0.149 (0.095)			0.072*** (0.009)	
ulc_{it}		0.022 (0.029)			0.020 (0.030)			0.039 (0.181)			0.066*** (0.017)	
$current_{it}$			0.146*** (0.025)			0.149*** (0.033)			0.149*** (0.033)			0.133*** (0.019)
$tradeope_{it}$			0.002 (0.002)			-0.004 (0.009)			-0.002 (0.009)			-0.001 (0.002)
exp_{it}			-0.072*** (0.015)			-0.208*** (0.046)			-0.212*** (0.046)			-0.064*** (0.012)
$expgr_{it}$			-0.031** (0.016)			0.018 (0.014)			0.021 (0.014)			-0.025** (0.012)
$unem_{it}$			-0.059** (0.028)			-0.192*** (0.038)			-0.200*** (0.038)			-0.078*** (0.025)
$outputgap_{it}$			-0.019 (0.049)			-0.029 (0.041)			-0.031 (0.040)			-0.034 (0.036)
avh_{it}			0.002*** (0.001)			0.013*** (0.002)			0.013*** (0.002)			0.002*** (0.001)
urb_{it}			0.014* (0.007)			0.000 (0.026)			0.006 (0.027)			0.023*** (0.008)
lc_{it}			0.115*** (0.039)			0.062* (0.034)			0.059* (0.033)			0.108*** (0.028)
Debt Threshold						117.246			117.890		64.952	43.006
Obs:	440	479	273	440	479	273	420	453	272	440	479	273
R-squared	0.192	0.320	0.598	0.402	0.376	0.745	0.375	0.305	0.744	0.330	0.473	0.603
DW-statistic	0.376	0.618	0.995	0.503	0.669	1.383	0.618	0.927	1.374	0.547	0.822	0.926
Pesaran CD statistic	14.074	7.624	11.987	11.491	9.071	11.038	14.936	14.479	9.058	14.335	7.083	11.936

Notes: *, ** and *** represent statistical significance at levels of 10%, 5% and 1% level respectively. The robust standard errors are in brackets. The White diagonal covariance matrix is used in order to assume residual heteroskedasticity, except for the Generalised Least Squares methodology. The DW-statistic is the Durbin-Watson statistic and the Pesaran CD statistic is the Pesaran cross-section dependence statistic.

5. Conclusions

Today academics and all factions of political spectrums debate the role of government debt on economic growth, and it seems that we live in a "time of debt". But the present "time of debt" that we are experiencing largely arose when the 2007 crisis emerged, with the bankruptcy of the some of the biggest financial companies in the world led to experiencing all of its consequences. What appeared to be a banking and financial crisis has become a sovereign debt crisis, which has affected in particular the peripheral countries of the Eurozone.

In this paper we have analysed the effect that government debt has on real *per capita* GDP growth, both annually and with 5-year average rates. We have also determined the effect of other variables when interacting with sovereign debt-to-GDP ratio.

For 14 European countries over 43 years (1970-2012), we can conclude that, as is usually affirmed, debt is negative for growth, both in the short and long-term. In addition to this fact, we highlight the process of convergence between our sample of countries. Turning to interest rates, short-term interest rate has a positive effect on growth, which is contrary to the case of long-term rate. When we analyse both debt-to-GDP ratio and debt service variables, the latter has a much more negative effect on economic performance when compared with debt.

Contrary to the signature of the Stability and Growth Pact, for which we have found evidence of positive contributions to the economy after it had a disciplinary effect on public finances, the signature of the Maastricht treaty, together with the introduction of the Euro were both institutional events that led to lower economic growth. We also stress the fact that a banking crisis is the worst type of crisis that can occur in an economy.

Another important conclusion is that when debt interacts with macroeconomic variables, we find evidence of the unfavourable effects of taxation on capital and profit and the growth of credit to the private sector, as well as on government expenditure. On the other hand, total factor productivity, current account balance and urbanisation are examples of variables that contribute positively to growth.

Finally, we provide results that show the existence of an inverted U-shape relationship between debt ratio and economic growth. During the computation of the two average thresholds for this non-linear relationship, we obtained annual and 5-year average growth rate thresholds of 75% and 74%, respectively. Therefore, and according

to these values, governments could keep debt levels under these values in order to avoid sovereign debt crises similar to those that most countries in our sample have recently experienced.

Although the effect of debt is undesirable, governments have to trade-off the increment of debt to stimulate aggregate demand and consequently growth. Debt would not be the main point on the political and academic agenda, if each economy possessed sufficient and structural mechanisms to deal with it. Surely the best way to prevent negative speculation about sovereign debt by financial markets is to concentrate on how efficiently each economy could improve its economic path, as can be seen in the case of Greece, Ireland and Portugal – all of which are countries that have recently experienced a severe period of economic austerity.

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Appendix A – Data Statistics

Table A1: Summary statistics for the panel of 1970-2012.

Variable	Mean	S.D.	Min.	Max.	Observations
RGDP	26,641.64	9212.72	7,235.73 (PT, 1970)	51,676.84 (IE, 2007)	572
RGDPGR	1.78	2.49	-9.40 (FI, 2009)	10.59 (PT, 1973)	558
POP	26,238.88	25,317.20	2,957.25 (IE, 1970)	82,534.18 (DE, 2003)	601
GFCF	2.06	7.08	-33.51 (GR, 1974)	24.30 (GR, 1972)	594
ULC	5.62	6.34	-9.02 (AT, 1988)	39.34 (PT, 1975)	591
LC	5.98	5.02	-4.91 (GR, 2011)	31.26 (UK, 1975)	477
CURRENT	0.12	4.37	-14.96 (GR, 2008)	9.47 (NL, 2011)	348
LONGINT	7.26	3.46	1.40 (DK, 2012)	22.50 (GR, 2012)	445
AVH	1,712.48	176.87	1,381.00 (NL, 2010, 2012)	2,208.00 (GR, 1983)	484
UNEM	8.37	3.79	1.56 (SE, 1989)	25.06 (ES, 2012)	377
EXP	48.51	6.48	28.73 (PT, 1977)	71.72 (SE, 1993)	484
EXPGR	0.50	4.47	-32.83 (IE, 2011)	30.77 (IE, 2010)	470
TINC	12.72	5.82	2.37 (GR, 1973)	31.16 (DK, 2005)	601
TGOODS	11.54	2.12	4.46 (ES, 1975)	17.03 (DK, 1986)	601
LE	76.38	2.95	66.40 (PT, 1971)	82.70 (IT, 2011)	564
M3	69.51	26.52	6.87 (IE, 1981)	180.33 (UK, 2009)	543
DEBT	56.11	29.18	1.72 (FI, 1974)	170.32 (GR, 2011)	589
INFLATION	5.81	5.58	-4.48 (IE, 2009)	28.78 (PT, 1984)	561
HC	2.65	0.35	1.66 (PT, 1970)	3.32 (DE, 2010, 2011)	588

Variable	Mean	S.D.	Min.	Max.	Observations
K	1,866,761.22	2,099,888.36	41,184.71 (IE, 1970)	8,873,920.00 (DE, 2011)	588
TFP	0.94	0.11	0.63 (FI, 1971)	1.19 (ES, 1989)	588
URB	72.29	12.32	38.80 (PT, 1970)	97.51 (BE, 2012)	602
CREDIT	83.31	43.42	17.99 (GR, 1970)	232.10 (IE, 2009)	598
SHORTINT	7.52	4.99	0.57 (EMU, 2012)	24.56 (GR, 1994)	572
CAPB	0.96	3.35	-25.03 (IE, 2012)	10.46 (DK, 1986)	447
OUTPUTGAP	0.09	2.35	-11.92 (GR, 2012)	7.71 (PT, 1972)	580
PBB	0.84	3.59	-27.46 (IE, 2010)	11.62 (DK, 1986)	484
TBB	-3.27	4.22	-30.61 (IE, 2010)	7.73 (FI, 1976)	484
DEBTS	4.11	2.51	-12.60 (IT, 1993)	12.60 (FI, 1975)	484
TRADEOPE	72.19	33.21	25.79 (ES, 1970)	191.37 (IE, 2012)	602

Appendix B – Additional Results

Table B1: Growth equations with linear debt effect on real GDP growth rate and with monetary variables.

	OLS			OLS-FE			2SLS			GLS		
	1	2	3	4	5	6	7	8	9	10	11	12
$rgdp_{it-1}$	-1.548***	-1.216***	-2.396***	-3.287***	-2.751***	-6.846***	-3.606***	-4.513***	-12.013***	-1.888***	-1.575***	-2.479***
	(0.362)	(0.379)	(0.482)	(0.478)	(0.588)	(0.885)	(0.529)	(0.696)	(1.491)	(0.321)	(0.339)	(0.448)
$debt_{it}$		-0.013***	-0.012***		-0.007	-0.000		0.016*	0.009		-0.009**	-0.010**
		(0.004)	(0.004)		(0.007)	(0.007)		(0.009)	(0.009)		(0.004)	(0.004)
$shortint_{it}$			0.235***			0.206***			-0.261**			0.251***
			(0.056)			(0.060)			(0.116)			(0.054)
$longint_{it}$			-0.383***			-0.538***			-0.367***			-0.385***
			(0.061)			(0.070)			(0.135)			(0.061)
Obs:	558	545	402	558	545	402	544	523	382	558	545	402
R-squared	0.053	0.072	0.144	0.112	0.110	0.231	0.104	0.079	0.060	0.074	0.081	0.149
DW-statistic	1.260	1.293	1.268	1.321	1.329	1.388	1.320	1.289	1.290	1.390	1.400	1.318
Pesaran CD statistic	23.236	23.337	23.074	23.789	23.681	23.728	23.006	21.189	21.680	22.926	23.099	22.894

Notes: *, ** and *** represent statistical significance at the 10, 5% and 1% level respectively. Robust standard errors are in brackets. The White diagonal covariance matrix is used, in order to assume residual heteroskedasticity, except for the Generalised Least Squares methodology. The DW-statistic is the Durbin-Watson statistic and the Pesaran CD statistic is the Pesaran cross-section dependence statistic.

Table B2: The non-linearity effect of public debt on real GDP growth rate, with monetary variables.

	OLS			OLS-FE			2SLS			GLS		
	1	2	3	4	5	6	7	8	9	10	11	12
$rgdp_{it-1}$	-1.548***	-1.443***	-2.390**	-3.287***	-3.536***	-6.734***	-3.606***	-5.570***	-11.720***	-1.888***	-1.731***	-2.518***
	(0.362)	(0.374)	(0.484)	(0.478)	(0.601)	(0.879)	(0.529)	(0.734)	(1.511)	(0.321)	(0.346)	(0.447)
$debt_{it}$		0.023	0.009		0.050***	0.016		0.098***	0.065**		0.014	0.004
		(0.015)	(0.020)		(0.017)	(0.021)		(0.019)	(0.030)		(0.014)	(0.019)
$debt_{it}^2$		-0.000**	-0.000		-0.000***	-0.000		-0.001***	-0.000**		-0.000*	-0.000
		(0.000)	(0.000)		(0.000)	(0.000)		(0.000)	(0.000)		(0.000)	(0.000)
$shortint_{it}$			0.217***			0.187***			-0.343***			0.243***
			(0.054)			(0.063)			(0.124)			(0.052)
$longint_{it}$			-0.347***			-0.500***			-0.225			-0.367***
			(0.060)			(0.078)			(0.153)			(0.060)
Debt Threshold					61.787			84.490	76.195			
Obs:	558	545	402	558	545	402	544	523	382	558	545	402
R-squared	0.053	0.088	0.147	0.112	0.139	0.233	0.104	0.107	0.039	0.074	0.086	0.156
DW-statistic	1.260	1.311	1.273	1.321	1.364	1.390	1.320	1.320	1.295	1.390	1.399	1.314
Pesaran CD statistic	23.236	23.377	23.140	23.789	23.743	23.795	23.006	21.299	21.846	22.926	23.112	22.894

Notes: *, ** and *** represent statistical significance at levels of 10%, 5% and 1% respectively. The robust standard errors are in brackets. The White diagonal covariance matrix is used in order to assume residual heteroskedasticity, except for the Generalised Least Squares methodology. The DW-statistic is the Durbin-Watson statistic and the Pesaran CD statistic is the Pesaran cross-section dependence statistic.

Table B3: The non-linearity effect of public debt on real GDP growth rate, with monetary variables, 5-year average.

	OLS			OLS-FE			2SLS			GLS		
	1	2	3	4	5	6	7	8	9	10	11	12
$rgdp_{it-1}$	-1.548***	-1.250***	-1.393***	-3.450***	-3.016***	-4.023***	-3.832***	-4.120***	-5.831***	-1.706***	-1.495***	-1.789***
	(0.183)	(0.197)	(0.315)	(0.314)	(0.345)	(0.498)	(0.346)	(0.375)	(0.707)	(0.144)	(0.162)	(0.264)
$debt_{it}$		-0.010	0.001		0.006	0.003		0.023**	0.011		0.001	-0.005
		(0.008)	(0.011)		(0.009)	(0.011)		(0.011)	(0.014)		(0.006)	(0.009)
$debt_{it}^2$		-0.000	-0.000		-0.000**	-0.000		-0.000**	-0.000		-0.000	-0.000
		(0.000)	(0.000)		(0.000)	(0.000)		(0.000)	(0.000)		(0.000)	(0.000)
$shortint_{it}$			0.110***			0.081***			0.067			0.074**
			(0.030)			(0.031)			(0.058)			(0.031)
$longint_{it}$			-0.125***			-0.211***			-0.275***			-0.104**
			(0.041)			(0.042)			(0.073)			(0.042)
Debt Threshold								68.951				
Obs:	558	545	402	558	545	402	544	523	382	558	545	402
R-squared	0.082	0.137	0.184	0.245	0.258	0.302	0.244	0.250	0.286	0.180	0.206	0.220
DW-statistic	0.385	0.416	0.461	0.468	0.483	0.515	0.473	0.483	0.507	0.404	0.419	0.441
Pesaran CD statistic	15.825	16.901	14.811	7.455	9.587	10.315	7.221	6.853	6.421	15.088	15.494	14.045

Notes: *, ** and *** represent statistical significance at levels of 10%, 5% and 1% respectively. The robust standard errors are in brackets. The White diagonal covariance matrix is used in order to assume residual heteroskedasticity, except for the Generalised Least Squares methodology. The DW-statistic is the Durbin-Watson statistic and the Pesaran CD statistic is the Pesaran cross-section dependence statistic.

Table B4: Growth equations with debt linear effect on real GDP growth rate and with public finance variables.

	OLS			OLS-FE			2SLS			GLS		
	1	2	3	4	5	6	7	8	9	10	11	12
$rgdp_{it-1}$	-1.418***	-1.054**	-2.065***	-2.087***	-1.966**	-3.683***	-3.257***	-4.074***	-4.479***	-1.740***	-1.339***	-2.466***
	(0.440)	(0.461)	(0.420)	(0.791)	(0.941)	(0.700)	(0.988)	(1.170)	(0.762)	(0.402)	(0.432)	(0.404)
$debt_{it}$	-0.017**	-0.024***	0.001	-0.017	-0.025**	0.006	0.002	0.003	0.017*	-0.015**	-0.022***	0.006
	(0.008)	(0.008)	(0.006)	(0.0119	(0.011)	(0.009)	(0.013)	(0.014)	(0.009)	(0.006)	(0.007)	(0.005)
pbb_{it}	0.214***			0.260***			0.128***			0.243***		
	(0.040)			(0.043)			(0.042)			(0.037)		
$debts_{it}$	-0.102	-0.191**		-0.116	-0.187*		-0.117	-0.058		-0.084	-0.177**	
	(0.076)	(0.082)		(0.095)	(0.106)		(0.115)	(0.131)		(0.065)	(0.069)	
$capb_{it}$		0.128***			0.178***			0.220***			0.155***	
		(0.040)			(0.046)			(0.054)			(0.039)	
tbb_{it}			0.195***			0.233***			0.107**			0.227***
			(0.038)			(0.042)			(0.045)			(0.038)
Obs:	454	420	454	454	420	454	434	401	434	454	420	454
R-squared	0.191	0.131	0.144	0.238	0.177	0.195	0.189	0.151	0.146	0.221	0.150	0.168
DW-statistic	1.333	1.311	1.244	1.407	1.385	1.296	1.338	1.351	1.257	1.440	1.420	1.363
Pesaran CD statistic	20.745	22.207	21.702	21.167	22.527	21.691	21.376	20.876	21.340	19.965	21.790	20.862

Notes: *, ** and *** represent statistical significance at levels of 10%, 5% and 1% respectively. The robust standard errors are in brackets. The White diagonal covariance matrix is used in order to assume residual heteroskedasticity, except for the Generalised Least Squares methodology. The DW-statistic is the Durbin-Watson statistic and the Pesaran CD statistic is the Pesaran cross-section dependence statistic.

Table B5: The non-linearity effect of public debt on real GDP growth rate, with public finance variables.

	OLS			OLS-FE		2SLS			GLS			
	1	2	3	4	5	6	7	8	9	10	11	12
$rgdp_{it-1}$	-1.912*** (0.441)	-1.562*** (0.441)	-2.531*** (0.438)	-4.134*** (0.827)	-4.320*** (0.884)	-5.187*** (0.744)	-5.479*** (1.037)	-7.260*** (1.174)	-5.791*** (0.794)	-2.260*** (0.401)	-1.789*** (0.425)	-2.998*** (0.409)
$debt_{it}$	0.061*** (0.016)	0.051*** (0.017)	0.081*** (0.017)	0.095*** (0.020)	0.092*** (0.021)	0.121*** (0.018)	0.128*** (0.026)	0.169*** (0.030)	0.135*** (0.022)	0.057*** (0.014)	0.046*** (0.016)	0.081*** (0.016)
$debt_{it}^2$	-0.001*** (0.000)	-0.000*** (0.000)	-0.001*** (0.000)	-0.001*** (0.000)	-0.001*** (0.000)	-0.001*** (0.000)	-0.001*** (0.000)	-0.001*** (0.000)	-0.001*** (0.000)	-0.000*** (0.000)	-0.000*** (0.000)	-0.001*** (0.000)
pbb_{it}	0.258*** (0.045)			0.309*** (0.045)			0.193*** (0.043)			0.290*** (0.038)		
$debts_{it}$	-0.030 (0.066)	-0.121* (0.069)		0.104 (0.086)	0.054 (0.088)		0.139 (0.103)	0.293*** (0.112		-0.045 (0.062)	-0.144** (0.065)	
$capb_{it}$		0.186*** (0.042)			0.254*** (0.046)			0.331*** (0.054)			0.208*** (0.041)	
tbb_{it}			0.244*** (0.042)			0.303*** (0.044)			0.191*** (0.044)			0.274*** (0.038)
Debt Threshold	59.647	51.813	75.585	70.533	66.259	78.990	82.339	83.684	84.117	58.299	49.493	77.063
Obs:	454	420	454	454	420	454	434	401	434	454	420	454
R-squared	0.250	0.185	0.211	0.308	0.247	0.296	0.269	0.216	0.264	0.274	0.195	0.228
DW-statistic	1.420	1.405	1.333	1.501	1.505	1.455	1.428	1.471	1.414	1.461	1.451	1.365
Pesaran CD statistic	20.583	22.070	21.259	20.951	22.621	20.886	20.885	19.977	20.798	19.632	21.547	20.265

Notes: *, ** and *** represent statistical significance at levels of 10%, 5% and 1% respectively. The robust standard errors are in brackets. The White diagonal covariance matrix is used in order to assume residual heteroskedasticity, except for the Generalised Least Squares methodology. The DW-statistic is the Durbin-Watson statistic and the Pesaran CD statistic is the Pesaran cross-section dependence statistic.

Table B6: Growth equations with debt linear effect on real GDP growth rate and with public finance variables, 5-year average.

	OLS			OLS-FE			2SLS			GLS		
	1	2	3	4	5	6	7	8	9	10	11	12
$rgdp_{it-1}$	-1.465*** (0.304)	-1.500*** (0.341)	-1.909*** (0.264)	-3.047*** (0.639)	-3.903*** (0.822)	-3.902*** (0.485)	-3.412*** (0.678)	-4.567*** (0.884)	-4.490*** (0.487)	-1.330*** (0.207)	-1.391*** (0.241)	-1.936*** (0.193)
$debt_{it}$	-0.023*** (0.004)	-0.025*** (0.004)	-0.011*** (0.004)	-0.017*** (0.004)	-0.015*** (0.005)	-0.005 (0.004)	-0.011** (0.005)	-0.008 (0.006)	0.002 (0.005)	-0.019*** (0.003)	-0.018*** (0.003)	-0.002 (0.002)
pbb_{it}	0.112*** (0.020)			0.136*** (0.022)			0.136*** (0.027)			0.120*** (0.015)		
$debts_{it}$	-0.105** (0.045)	-0.120** (0.047)		-0.066 (0.060)	-0.041 (0.068)		-0.080 (0.063)	-0.025 (0.073)		-0.143*** (0.034)	-0.147*** (0.037)	
$capb_{it}$		0.105*** (0.023)			0.146*** (0.026)			0.176*** (0.033)			0.125*** (0.018)	
tbb_{it}			0.099*** (0.019)			0.121*** (0.021)			0.118*** (0.028)			0.109*** (0.016)
Obs:	454	420	454	454	420	454	434	401	434	454	420	454
R-squared	0.178	0.170	0.152	0.303	0.314	0.288	0.297	0.302	0.277	0.324	0.298	0.241
DW-statistic	0.353	0.346	0.336	0.419	0.422	0.402	0.459	0.468	0.437	0.512	0.490	0.441
Pesaran CD statistic	12.666	10.704	15.887	10.884	7.421	10.341	11.014	6.614	9.761	11.717	9.253	15.241

Notes: *, ** and *** represent statistical significance at levels of 10%, 5% and 1% respectively. The robust standard errors are in brackets. The White diagonal covariance matrix is used in order to assume residual heteroskedasticity, except for the Generalised Least Squares methodology. The DW-statistic is the Durbin-Watson statistic and the Pesaran CD statistic is the Pesaran cross-section dependence statistic.

Table B7: Growth equations with debt linear effect on real GDP growth rate and with institutional variables.

	OLS			OLS-FE			2SLS			GLS		
	1	2	3	4	5	6	7	8	9	10	11	12
$rgdp_{it-1}$	-1.486***	-1.328***	-1.466***	-2.872***	-2.909***	-5.784***	-4.575***	-4.291***	-8.042***	-1.629***	-1.415***	-1.644***
	(0.373)	(0.375)	(0.430)	(0.600)	(0.587)	(0.958)	(0.722)	(0.696)	(1.133)	(0.337)	(0.312)	(0.370)
$debt_{it}$	-0.007**	-0.004	-0.004	-0.000	0.009	0.010	0.024***	0.031***	0.031***	-0.006*	-0.003	-0.002
	(0.004)	(0.004)	(0.004)	(0.007)	(0.007)	(0.008)	(0.008)	(0.008)	(0.008)	(0.003)	(0.003)	(0.003)
$crisestally_{it}$	-0.971***			-0.928***			-0.873***			-0.794***		
	(0.140)			(0.147)			(0.156)			(0.124)		
$inflationc_{it}$		-1.480*	-1.501*		-1.444*	-1.371*		-1.383*	-1.355*		-0.841	-0.896
		(0.785)	(0.789)		(0.771)	(0.744)		(0.820)	(0.793)		(0.762)	(0.770)
$stockmarketc_{it}$		-0.236	-0.199		-0.116	-0.077		0.115	0.106		0.010	0.044
		(0.217)	(0.218)		(0.223)	(0.221)		(0.238)	(0.238)		(0.194)	(0.197)
$currencyc_{it}$		-0.752**	-0.784**		-0.676**	-0.721**		-0.595*	-0.696**		-0.705**	-0.731**
		(0.323)	(0.331)		(0.335)	(0.316)		(0.352)	(0.333)		(0.296)	(0.307)
$bankingc_{it}$		-2.149***	-2.070***		-2.225***	-1.977***		-2.451***	-2.122***		-2.048***	-1.975***
		(0.312)	(0.315)		(0.315)	(0.316)		(0.325)	(0.327)		(0.295)	(0.297)
$euro_{it}$			-0.836***			-0.605*			-0.525			-0.792***
			(0.312)			(0.331)			(0.347)			(0.286)
sgp_{it}			0.726**			1.429***			1.898***			0.775**
			(0.362)			(0.356)			(0.367)			(0.345)
$maas_{it}$			-0.032			0.670*			0.618*			-0.064
			(0.308)			(0.349)			(0.367)			(0.295)
Obs:	517	515	515	517	515	515	495	493	493	517	515	515
R-squared	0.134	0.176	0.185	0.155	0.201	0.233	0.126	0.183	0.217	0.122	0.181	0.192
DW-statistic	1.607	1.597	1.608	1.621	1.614	1.628	1.569	1.576	1.580	1.634	1.637	1.648
Pesaran CD statistic	20.648	3.983	4.495	21.235	7.314	8.103	18.856	9.015	9.348	20.886	5.621	6.187

Notes: *, ** and *** represent statistical significance at the 10%, 5% and 1% level respectively. Robust standard errors are in brackets. The White diagonal covariance matrix is used in order to assume residual heteroskedasticity, except for the Generalised Least Squares methodology. The DW-statistic is the Durbin-Watson statistic and the Pesaran CD statistic is the Pesaran cross-section dependence statistic.

Table B8: The non-linearity effect of public debt on real GDP growth rate, with institutional variables.

	OLS			OLS-FE			2SLS			GLS		
	1	2	3	4	5	6	7	8	9	10	11	12
$rgdp_{it-1}$	-1.527***	-1.409***	-1.519***	-3.180***	-3.283***	-6.426***	-5.097***	-4.884***	-9.058***	-1.665***	-1.514***	-1.713***
	(0.374)	(0.376)	(0.426)	(0.628)	(0.614)	(0.976)	(0.774)	(0.745)	(1.210)	(0.346)	(0.324)	(0.371)
$debt_{it}$	0.000	0.010	0.010	0.025	0.039**	0.047***	0.068***	0.080***	0.089***	-0.001	0.010	0.011
	(0.014)	(0.013)	(0.014)	(0.018)	(0.018)	(0.017)	(0.020)	(0.020)	(0.020)	(0.013)	(0.013)	(0.013)
$debt_{it}^2$	-0.000	-0.000	-0.000	-0.000	-0.000*	-0.000**	-0.000**	-0.000***	-0.000***	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$crisestally_{it}$	-0.968***			-0.917***			-0.855***			-0.792***		
	(0.140)			(0.148)			(0.158)			(0.125)		
$inflationc_{it}$		-1.528*	-1.549*		-1.544**	-1.487**		-1.544*	-1.543**		-0.874	-0.930
		(0.786)	(0.789)		(0.756)	(0.719)		(0.797)	(0.755)		(0.773)	(0.781)
$stockmarketc_{it}$		-0.200	-0.167		-0.068	-0.016		0.193	0.198		0.041	0.076
		(0.219)	(0.221)		(0.223)	(0.220)		(0.240)	(0.237)		(0.199)	(0.202)
$currencyc_{it}$		-0.782**	-0.809**		-0.708**	-0.763**		-0.635*	-0.752**		-0.733**	-0.752**
		(0.323)	(0.331)		(0.336)	(0.315)		(0.354)	(0.334)		(0.298)	(0.309)
$bankingc_{it}$		-2.154***	-2.076***		-2.216***	-1.953***		-2.440***	-2.085***		-2.056***	-1.981***
		(0.312)	(0.315)		(0.315)	(0.316)		(0.325)	(0.327)		(0.295)	(0.295)
$euro_{it}$			-0.828***			-0.615*			-0.543			-0.801***
			(0.311)			(0.328)			(0.347)			(0.287)
sgp_{it}			0.713**			1.503***			2.019***			0.757**
			(0.362)			(0.352)			(0.371)			(0.345)
$maas_{it}$			-0.059			0.712**			0.690*			-0.083
			(0.310)			(0.347)			(0.365)			(0.297)
Debt Threshold					85.993	83.301	100.987	108.244	100.656			
Obs:	517	515	515	517	515	515	495	493	493	517	515	515
R-squared	0.134	0.178	0.187	0.161	0.208	0.244	0.130	0.189	0.226	0.122	0.182	0.193
DW-statistic	1.607	1.600	1.611	1.626	1.623	1.642	1.569	1.581	1.590	1.633	1.639	1.651
Pesaran CD statistic	20.635	4.246	4.772	21.236	7.718	8.654	19.005	9.171	9.712	20.871	5.849	6.499

Notes: *, ** and *** represent statistical significance at levels of 10%, 5% and 1% level respectively. The robust standard errors are in brackets. The White diagonal covariance matrix is used in order to assume residual heteroskedasticity, except for the Generalised Least Squares methodology. The DW-statistic is the Durbin-Watson statistic and the Pesaran CD statistic is the Pesaran cross-section dependence statistic.

Table B9: The non-linearity effect of public debt on real GDP growth rate, with institutional variables, 5-year average.

	OLS			OLS-FE		2SLS			GLS			
	1	2	3	4	5	6	7	8	9	10	11	12
$rgdp_{it-1}$	-1.238***	-1.191***	-0.955***	-2.842***	-2.978***	-4.249***	-3.901***	-3.854***	-6.110***	-1.380***	-1.307***	-1.231***
	(0.190)	(0.189)	(0.208)	(0.359)	(0.360)	(0.615)	(0.390)	(0.394)	(0.711)	(0.164)	(0.163)	(0.189)
$debt_{it}$	-0.020**	-0.011	-0.005	-0.002	0.008	0.013	0.011	0.021*	0.027**	-0.008	-0.002	0.004
	(0.008)	(0.008)	(0.008)	(0.010)	(0.010)	(0.010)	(0.012)	(0.012)	(0.012)	(0.006)	(0.006)	(0.006)
$debt_{it}^2$	0.000	0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000**	0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$crisestally_{it}$	-0.530**			-0.439***			-0.414***			-0.375***		
	(0.098)			(0.098)			(0.101)			(0.066)		
$inflationc_{it}$		-0.850*	-0.922**		-0.863**	-0.871**		-0.941**	-0.960**		-0.416	-0.518
		(0.475)	(0.463)		(0.426)	(0.433)		(0.458)	(0.461)		(0.491)	(0.483)
$stockmarketc_{it}$		0.125	0.162		0.169	0.216		0.272	0.294		0.057	0.137
		(0.197)	(0.196)		(0.193)	(0.191)		(0.203)	(0.200)		(0.106)	(0.103)
$currencyc_{it}$		-0.611***	-0.585***		-0.429**	-0.441**		-0.387*	-0.439**		-0.494***	-0.498***
		(0.205)	(0.212)		(0.207)	(0.198)		(0.218)	(0.208)		(0.131)	(0.141)
$bankingc_{it}$		-1.407***	-1.331***		-1.267***	-1.089***		-1.345***	-1.090***		-1.113***	-1.026***
		(0.165)	(0.162)		(0.157)	(0.164)		(0.164)	(0.172)		(0.140)	(0.139)
$euro_{it}$			-0.934***			-1.058***			-0.951***			-0.973***
			(0.187)			(0.199)			(0.200)			(0.169)
sgp_{it}			0.545**			1.231***			1.544***			0.579***
			(0.217)			(0.229)			(0.231)			(0.199)
$maas_{it}$			-0.407**			0.196			0.375			-0.258
			(0.195)			(0.254)			(0.270)			(0.162)
Debt Threshold									91.271			
Obs:	517	515	515	517	515	515	495	493	493	517	515	515
R-squared	0.141	0.179	0.204	0.246	0.276	0.303	0.239	0.273	0.302	0.206	0.258	0.318
DW-statistic	0.484	0.532	0.557	0.537	0.583	0.626	0.535	0.594	0.646	0.523	0.593	0.662
Pesaran CD statistic	13.632	12.800	10.009	10.005	8.078	8.342	8.344	6.768	7.066	13.170	11.503	8.650

Notes: *, ** and *** represent statistical significance at levels of 10%, 5% and 1% level respectively. The robust standard errors are in brackets. The White diagonal covariance matrix is used in order to assume residual heteroskedasticity, except for the Generalised Least Squares methodology. The DW-statistic is the Durbin-Watson statistic and the Pesaran CD statistic is the Pesaran cross-section dependence statistic.

Table B10: Growth equations with debt linear effect on real GDP growth rate and with macroeconomic variables.

	OLS			OLS-FE			2SLS			GLS		
	1	2	3	4	5	6	7	8	9	10	11	12
$rgdp_{it-1}$	-2.219***	-0.851***	-2.725***	-36.017***	-1.334	-9.101***	-27.051***	-2.717***	-7.917***	-2.193***	-0.821***	-2.421***
	(0.709)	(0.261)	(0.826)	(3.243)	(0.910)	(1.967)	(4.253)	(1.024)	(2.000)	(0.654)	(0.251)	(0.664)
$debt_{it}$	-0.023***	-0.008***	-0.041***	-0.018**	-0.019***	-0.021	0.011	-0.020***	-0.021	-0.021***	-0.006**	-0.038***
	(0.008)	(0.002)	(0.007)	(0.009)	(0.004)	(0.014)	(0.014)	(0.004)	(0.014)	(0.008)	(0.002)	(0.006)
pbb_{it}	0.224***		-0.150**	0.278***		-0.132*	0.207***		-0.129*	0.236***		-0.146***
	(0.044)		(0.068)	(0.040)		(0.074)	(0.046)		(0.074)	(0.041)		(0.041)
$debts_{it}$	-0.111		-0.374***	0.178**		-0.243*	0.248**		-0.259*	-0.115		-0.349***
	(0.080)		(0.093)	(0.072)		(0.134)	(0.100)		(0.137)	(0.074)		(0.077)
$tinc_{it}$	0.014			-0.100*			-0.161**			-0.013		
	(0.030)			(0.054)			(0.068)			(0.026)		
$tgoods_{it}$	-0.102			0.149			0.491***			-0.029		
	(0.083)			(0.111)			(0.180)			(0.076)		
$\log(k_{it-1})$	-0.164			11.873***			7.369***			-0.203*		
	(0.125)			(1.748)			(2.314)			(0.122)		
$\log(tfp_{it})$	5.717***			39.876***			29.119***			5.375***		
	(1.314)			(2.822)			(3.885)			(1.279)		
$\log(hc_{it})$	2.564*			25.842***			18.577***			2.283		
	(1.532)			(2.108)			(2.892)			(1.390)		
$inflation_{it}$		0.103***	-0.376***		0.087**	-0.375***		0.071**	-0.375***		0.112***	-0.376***
		(0.036)	(0.114)		(0.034)	(0.124)		(0.035)	(0.123)		(0.025)	(0.081)
$\log(pop_{it})$		0.024			0.072			1.386			0.004	
		(0.065)			(2.563)			(2.761)			(0.060)	
$\Delta credit_{it}$		-0.016*			-0.018**			-0.016*			-0.011**	
		(0.007)			(0.008)			(0.008)			(0.006)	
$m3_{it}$		-0.003			-0.001			-0.000			-0.000	
		(0.003)			(0.004)			(0.004)			(0.003)	

	OLS			OLS-FE			2SLS			GLS		
	1	2	3	4	5	6	7	8	9	10	11	12
le_{it}		-0.161***			-0.133			-0.059			-0.171***	
		(0.041)			(0.090)			(0.098)			(0.033)	
$gfcf_{it}$		0.259***			0.256***			0.255***			0.261***	
		(0.012)			(0.012)			(0.012)			(0.009)	
ulc_{it}		-0.192***			-0.212***			-0.207***			-0.189***	
		(0.033)			(0.033)			(0.033)			(0.021)	
$current_{it}$			0.133***			0.135**			0.135**			0.110***
			(0.041)			(0.053)			(0.054)			(0.032)
$tradeope_{it}$			0.009**			0.025*			0.020			0.006
			(0.005)			(0.014)			(0.015)			(0.004)
exp_{it}			-0.031			-0.045			-0.038			-0.029*
			(0.019)			(0.063)			(0.063)			(0.016)
$expgr_{it}$			-0.220***			-0.178***			-0.182***			-0.309***
			(0.065)			(0.067)			(0.068)			(0.038)
$unem_{it}$			-0.025			-0.115			-0.099			-0.036
			(0.046)			(0.081)			(0.080)			(0.040)
$outputgap_{it}$			0.589***			0.631***			0.634			0.522***
			(0.078)			(0.085)			(0.086)			(0.053)
avh_{it}			0.004***			0.005			0.006			0.003***
			(0.001)			(0.004)			(0.004)			(0.001)
urb_{it}			0.034***			0.143***			0.133**			0.039***
			(0.013)			(0.054)			(0.054)			(0.012)
lc_{it}			0.019			-0.044			-0.038			0.029
			(0.061)			(0.066)			(0.065)			(0.054)
Obs:	440	479	273	440	479	273	420	468	272	440	479	273
R-squared	0.219	0.735	0.651	0.558	0.752	0.700	0.503	0.750	0.698	0.234	0.748	0.718
DW-statistic	1.367	1.737	1.596	1.098	1.787	1.510	1.266	1.780	1.547	1.432	1.700	1.672
Pesaran CD statistic	20.043	7.277	13.579	13.604	6.913	13.890	16.528	6.769	14.201	19.715	7.739	9.635

Notes: *, ** and *** represent statistical significance at levels of 10%, 5% and 1% level respectively. The robust standard errors are in brackets. The White diagonal covariance matrix is used in order to assume residual heteroskedasticity, except for the Generalised Least Squares methodology. The DW-statistic is the Durbin-Watson statistic and the Pesaran CD statistic is the Pesaran cross-section dependence statistic.

Table B11: The non-linearity effect of public debt on real GDP growth rate, with macroeconomic variables.

	OLS			OLS-FE		2SLS			GLS			
	1	2	3	4	5	6	7	8	9	10	11	12
$rgdp_{it-1}$	-1.975***	-0.859***	-2.381***	-35.706***	-1.477	-8.682***	-19.918***	1.906	-7.140***	-1.959***	-0.817***	-2.338***
	(0.714)	(0.260)	(0.788)	(3.558)	(0.938)	(1.982)	(4.317)	(22.886)	(2.005)	(0.646)	(0.245)	(0.657)
$debt_{it}$	0.042**	-0.003	0.005	-0.012	-0.009	0.047*	0.105***	-0.040	0.048**	0.044**	-0.005	0.001
	(0.018)	(0.009)	(0.022)	(0.023)	(0.010)	(0.025)	(0.027)	(0.168)	(0.024)	(0.018)	(0.008)	(0.019)
$debt_{it}^2$	-0.000***	-0.000	-0.000**	-0.000	-0.000	-0.000***	-0.001***	0.000	-0.000***	-0.000***	-0.000	-0.000**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)
pbb_{it}	0.259***		-0.111	0.280***		-0.110	0.220***		-0.107	0.273***		-0.117***
	(0.047)		(0.076)	(0.040)		(0.076)	(0.047)		(0.077)	(0.042)		(0.045)
$debts_{it}$	-0.038		-0.344***	0.186***		-0.179	0.385***		-0.200	-0.042		-0.337***
	(0.072)		(0.095	(0.071)		(0.135)	(0.093)		(0.136)	(0.071)		(0.078)
$tinc_{it}$	0.014			-0.105*			-0.215***			-0.005		
	(0.029)			(0.057)			(0.071)			(0.026)		
$tgoods_{it}$	-0.135*			0.150			0.533***			-0.049		
	(0.081)			(0.110)			(0.189)			(0.076)		
$\log(k_{it-1})$	-0.260**			11.709***			3.468			-0.265**		
	(0.130)			(1.914)			(2.263)			(0.125)		
$\log(tfp_{it})$	4.176***			39.517***			21.621***			4.278***		
	(1.267)			(3.113)			(4.156)			(1.269)		
$\log(hc_{it})$	0.632			25.501			12.357***			-0.201		
	(1.635)			(2.409)			(3.237)			(1.506)		
$inflation_{it}$		0.103***	-0.309***		0.085**	-0.268**		-0.223	-0.265**		0.112***	-0.348***
		(0.036)	0.114		(0.034)	(0.124)		(0.354)	(0.122)		(0.030)	(0.081)
$\log(pop_{it})$		0.020			-0.472			2.010			0.005	
		(0.065)			(2.616)			(18.134)			(0.059)	
$\Delta credit_{it}$		-0.015**			-0.017**			-0.1585			-0.011*	
		(0.007)			(0.008)			(0.610)			(0.006)	
$m3_{it}$		-0.003			-0.000			0.004			-0.001	
		(0.003)			(0.004)			(0.050)			(0.002)	

	OLS-FE						GLS					
	1	2	3	4	5	6	7	8	9	10	11	12
le_{it}		-0.165***			-0.130			-0.365			-0.173***	
		(0.041)			(0.090)			(0.979)			(0.036)	
$gfcf_{it}$		0.258***			0.255***			0.333			0.261***	
		(0.012)			(0.012)			(0.217)			(0.010)	
ulc_{it}		-0.192***			-0.211***			0.063			-0.188***	
		(0.033)			(0.033)			(0.445)			(0.027)	
$current_{it}$			0.122***			0.130**			0.128**			0.105**
			(0.041)			(0.052)			(0.053)			(0.032)
$tradeope_{it}$			0.010**			0.014			0.009			0.005
			(0.005)			(0.014)			(0.015)			(0.004)
exp_{it}			-0.034*			-0.083			-0.076			-0.033**
			(0.019)			(0.064)			(0.064)			(0.016)
$expgr_{it}$			-0.210***			-0.164**			-0.169**			-0.302***
			(0.064)			(0.066)			(0.067)			(0.038)
$unem_{it}$			-0.007			-0.098			-0.078			-0.035
			(0.043)			(0.078)			(0.078)			(0.039)
$outputgap_{it}$			0.551***			0.593***			0.596***			0.490***
			(0.085)			(0.088)			(0.089)			(0.056)
avh_{it}			0.004***			0.005			0.006			0.004***
			(0.001)			(0.004)			(0.004)			(0.001)
urb_{it}			0.031**			0.134***			0.120**			0.040***
			(0.013)			(0.053)			(0.053)			(0.012)
lc_{it}			0.009			-0.079			-0.071			0.032
			(0.060)			(0.068)			(0.067)			(0.053)
Debt Threshold	53.242					59.714	102.472		60.169	55.460		
Obs:	440	479	273	440	479	273	420	453	272	440	479	273
R-squared	0,248	0.735	0.658	0.558	0.753	0.710	0.469	0.430	0.709	0.265	0.747	0.724
DW-statistic	1,440	1.738	1.654	1.107	1.790	1.627	1.400	2.081	1.675	1.469	1.702	1.693
Pesaran CD statistic	20,045	7.307	13.983	13.669	7.199	14.980	17.429	4.473	15.209	19.483	7.742	10.146

Notes: *, ** and *** represent statistical significance at levels of 10%, 5% and 1% respectively. The robust standard errors are in brackets. The White diagonal covariance matrix is used in order to assume residual heteroskedasticity, except for the Generalised Least Squares methodology. The DW-statistic is the Durbin-Watson statistic and the Pesaran CD statistic is the Pesaran cross-section dependence statistic.

Table B12: Growth equations with debt linear effect on real GDP growth rate and with macroeconomic variables, 5-year average.

	OLS			OLS-FE			2SLS			GLS		
	1	2	3	4	5	6	7	8	9	10	11	12
$rgdp_{it-1}$	0.274	-0.366	-2.780***	-7.725***	1.260	-4.468***	-14.735***	-1.450	-5.414***	-1.001**	-0.324	-3.016***
	(0.660)	(0.276)	(0.428)	(2.481)	(1.038)	(0.856)	(3.617)	(1.150)	(0.950)	(0.464)	(0.244)	(0.422)
$debt_{it}$	-0.017***	-0.005**	-0.028***	0.003	-0.005	0.022***	-0.002	-0.008*	0.022***	-0.023***	-0.002	-0.026***
	(0.005)	(0.002)	(0.005)	(0.006)	(0.004)	(0.008)	(0.006)	(0.004)	(0.008)	(0.004)	(0.002)	(0.004)
pbb_{it}	0.137***		0.011	0.069**		-0.055	0.134***		-0.057	0.122***		0.023
	(0.020)		(0.032)	(0.029)		(0.044)	(0.035)		(0.043)	(0.016)		(0.026)
$debts_{it}$	-0.107*		-0.332***	0.148*		-0.293***	0.162*		-0.280***	-0.192***		-0.296***
	(0.055)		(0.055)	(0.079)		(0.065)	(0.091)		(0.066)	(0.040)		(0.048)
$tinc_{it}$	-0.044			-0.008			-0.051			-0.013		
	(0.027)			(0.045)			(0.055)			(0.018)		
$tgoods_{it}$	-0.115**			0.444***			0.419**			-0.099**		
	(0.054)			(0.134)			(0.169)			(0.044)		
$\log(k_{it-1})$	-0.394***			-2.980**			0.624			-0.160**		
	(0.131)			(1.259)			(1.648)			(0.070)		
$\log(tfp_{it})$	0.480			14.636***			20.199***			1.228**		
	(0.807)			(2.744)			(4.082)			(0.584)		
$\log(hc_{it})$	-4.177**			10.817***			13.966***			-0.076		
	(1.765)			(2.232)			(3.119)			(0.863)		
$inflation_{it}$		-0.108***	-0.324***		-0.091***	-0.289***		-0.132***	-0.289***		-0.109***	-0.323***
		(0.036)	(0.048)		(0.035)	(0.0425)		(0.039)	(0.043)		(0.021)	(0.0394)
$\log(pop_{it})$		0.106*			4.830			7.240*			0.101**	
		(0.061)			(3.558)			(3.863)			(0.049)	
$\Delta credit_{it}$		0.003			0.000			0.005			-0.004	
		(0.007)			(0.006)			(0.006)			(0.006)	
$m3_{it}$		-0.004			-0.015***			-0.014***			-0.003	
		(0.003)			(0.004)			(0.004)			(0.002)	

	OLS			OLS-FE			2SLS			GLS		
	1	2	3	4	5	6	7	8	9	10	11	12
le_{it}		-0.364*** (0.072)			-0.517*** (0.117)			-0.386*** (0.125)			-0.257*** (0.031)	
$gfcf_{it}$		0.061*** (0.015)			0.059*** (0.015)			0.056*** (0.016)			0.074*** (0.009)	
ulc_{it}		0.020 (0.029)			0.019 (0.029)			0.033 (0.030)			0.066*** (0.016)	
$current_{it}$			0.155*** (0.025)			0.154*** (0.033)			0.155*** (0.033)			0.142*** (0.020)
$tradeope_{it}$			0.002 (0.002)			0.006 (0.009)			0.009 (0.009)			-0.001 (0.002)
exp_{it}			-0.069*** (0.015)			-0.174*** (0.046)			-0.179*** (0.046)			-0.060*** (0.013)
$expgr_{it}$			-0.040** (0.016)			0.006 (0.014)			0.009 (0.014)			-0.035*** (0.012)
$unem_{it}$			-0.074** (0.029)			-0.207*** (0.040)			-0.219*** (0.041)			-0.087*** (0.026)
$outputgap_{it}$			0.013 (0.044)			0.006 (0.041)			0.003 (0.040)			-0.004 (0.035)
avh_{it}			0.002*** (0.001)			0.013*** (0.002)			0.013*** (0.002)			0.001** (0.000)
urb_{it}			0.016** (0.008)			0.009 (0.027)			0.017 (0.028)			0.022*** (0.007)
lc_{it}			0.123*** (0.041)			0.094*** (0.036)			0.088** (0.035)			0.115*** (0.031)
Obs:	440	479	273	440	479	273	420	468	272	440	479	273
R-squared	0.188	0.316	0.584	0.401	0.375	0.721	0.380	0.381	0.719	0.317	0.467	0.574
DW-statistic	0.372	0.619	0.996	0.501	0.671	1.329	0.609	0.697	1.316	0.530	0.818	0.922
Pesaran CD statistic	14.061	7.734	11.610	11.447	8.908	10.558	14.777	8.292	9.150	13.901	7.494	11.078

Notes: *, ** and *** represent statistical significance at levels of 10%, 5% and 1% level respectively. The robust standard errors are in brackets. The White diagonal covariance matrix is used in order to assume residual heteroskedasticity, except for the Generalised Least Squares methodology. The DW-statistic is the Durbin-Watson statistic and the Pesaran CD statistic is the Pesaran cross-section dependence statistic.

Appendix C – Additional econometric-tests statistics

Table C1: Hausman-test results.

Method	OLS-FE		
Test	4	5	6
Table 1	28.970 (0.000)	15.452 (0.000)	36.203 (0.000)
Table 2	10.795 (0.013)	10.795 (0.0123)	29.513 (0.001)
Table 3	30.631 (0.000)	26.980 (0.000)	47.113 (0.000)
Table 4	289.094 (0.000)	29.949 (0.001)	95.846 (0.000)
Table B1	28.970 (0.000)	24.744 (0.000)	35.511 (0.000)
Table B2	23.808 (0.000)	11.286 (0.004)	34.071 (0.000)
Table B3	23.808 (0.000)	13.033 (0.005)	31.445 (0.000)
Table B4	19.489 (0.001)	14.969 (0.005)	19.836 (0.000)
Table B5	9.213 (0.056)	12.758 (0.013)	13.447 (0.004)
Table B6	12.979 (0.024)	16.417 (0.006)	19.782 (0.001)
Table B7	13.556 (0.009)	16.485 (0.021)	35.571 (0.000)
Table B8	12.106 (0.007)	11.869 (0.065)	22.317 (0.008)
Table B9	11.548 (0.021)	12.347 (0.090)	26.660 (0.003)
Table B10	326.161 (0.000)	28.399 (0.001)	83.483 (0.000)
Table B11	68.339 (0.000)	43.183 (0.000)	59.332 (0.000)
Table B12	97.205 (0.000)	41.179 (0.000)	69.741 (0.000)

Notes: The probabilities associated with the computed statistics are in brackets.