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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 various subsets of monetary, public finance, institutional and macroeconomic variables. Our results show a maximum negative impact of around –0.04% and –0.03% for each 1% increment of public debt, for annual and 5-year average growth rates, respectively. 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.

Keywords: government debt, economic growth, debt thresholds.

JEL Classification: E62, H63, O47.

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 and Rogoff (2010) study about the effect of government debt on

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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.

One of our main contributions is to dissect the government debt role on economic growth and to provide new exogenous thresholds values, accounting for several variables subsets. Additionally, and besides previous related work (see Checherita-Westphal and Rother, 2012), we contribute with a precise analysis of public debt effects on economic behaviour, using also institutional events, as the signature of Maastricht Treaty and the Stability and Growth Pact, and other macroeconomic factors, which lead to lower computed thresholds. Our main results show a detrimental effect of government debt on economic 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 theoretical literature, regarding the importance of public debt on economic growth, divided into multiple aspects on how debt can influence economic performance. With respect to theoretical articles on government debt, 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), 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.

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 future generations could benefit from Ponzi schemes by 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 wage rigidity is assumed, the conclusion is different: public debt does not affect long-run economic growth or employment, but only the stability of the economy.

Regarding the channels through which government debt may affect growth, Checherita-Westphal and Rother (2012) study twelve Euro area countries from 1970 until 2010 and conclude that private saving, public investment and Total Factor Productivity are the channels where public debt is found to have a non-linear impact on growth (the negative effect of government debt on growth stands between 70% and 80%). However, Schclarek (2004) does not find any correlation, either linear or non-linear, between government debt and growth for developed countries.

On the other hand, Puente-Ajovín and Sanso-Navarro (2015) reach an opposite conclusion: economic activity affects government debt through automatic stabilizers and through the decrease of tax collection when economic growth is slower. Furthermore, Chen (2014) shows that while debt is neutral for the US economy, the debt channels of the UK economy are the national saving rates, real investment and stock of capital. Lastly, Sutherland and Hoeller (2012) highlight the transmission channels through which high levels of debt can hamper macroeconomic stability, namely, reducing the possibility of a government to respond efficiently to adverse shocks.

Looking at the literature on debt-growth relationship and debt thresholds, Reinhart and Rogoff (2010) explore the possibility of a persistent relationship between high gross central government debt levels, economic growth and inflation.[1] The authors report the existence of a weak link between growth and low levels of debt, but when debt 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 and Jaejoon (2010) reach two important conclusions: an inverse relationship between the initial level of government debt and economic growth rate.

Afonso and 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. Fur-

thermore, higher debt ratios could benefit Total Factor Productivity (TFP) growth. Cecchetti *et al.* (2011), who analyse the debt damage effect for 18 OECD countries over a 30 years' time span, reaching 85% government debt-to-GDP ratio thresholds.

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 the debt ratio is greater than 70%. Gnegne and 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. In fact, 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 report the evidence of an inverse relationship of the degree of democracy on threshold effects.

In a related strand of literature Ghosh *et al.* (2013) apply a stochastic model to assess debt sustainability for 32 advanced economies. They find a non-linear primary balance response to lagged government debt, and estimate a range of debt limit that varies between 150% and 250% in GDP-ratio terms. Fincke and 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 seem to follow a sustainable debt policy. For Greece, the conclusion of a sustainable debt policy is rejected, whilst for Italy, the results are not conclusive.

Moreover, Westerlund and 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. In the same vein, 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. Wahab (2004) and Kolluri and 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 indicating that public expenditures increase less than proportionately during a growth period, and proportionately decrease more during a recession.

On the other hand, Fölster and 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 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 and 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. Afonso and 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.

Considering political variables, Elgin and Uras (2012) relate the higher informal sector size with a higher probability of sovereign default risk and with a country's public indebtedness, using data for 155 countries from 1960 to 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).

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 and 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.

For heuristic purposes, and since we seek for the exogenous role of debt in economic activity, our production function is the type $F=(K,L,D)$, D being the debt-to-GDP ratio variable, which can be represented by the following equation:

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

where g_{it} represents the real *per capita* GDP growth rate; y_{i0} the real *per capita* income of the previous period, 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:

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

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 (see also Checherita-Westphal and Rother, 2012, and Afonso and Jalles, 2013).

3.2. Econometric approaches

3.2.1. *Panel techniques*

Instead of using cross-section methods to analyse the government 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 colinearity, 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]

In addition, to account for time developments, we estimate the equations using the OLS-FE with a time trend, and the conclusions do not change structurally our results. The greater consequence of introducing a trend is some loss of statistical significance of the GDP *per capita* logarithm. For reasons of parsimony these results are only available upon request.

Furthermore, we undertake tests regarding the presence of outliers using the Robust Least Squares with *M*-estimations methodology. The estimation of our equation using this methodology does not alter our conclusions regarding the significance or the signal of each variable.[4]

3.2.3. *Endogeneity*

As mentioned earlier, the endogeneity issue is one of the main questions 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), which is used, enables the correction of this problem of endogeneity, even for multiple endogenous explanatory variables. 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. Additionally, it is important to mention that we use as instruments the explanatory variables one-period lagged.[5]

3.2.4. *Cross-sectional dependence*

Sarafidis and 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 and Pagan (1980). When *N* is large, the LM statistic presents "poor size properties", citing Sarafidis and 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[6] 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[7]. 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.[8]

From Beck *et al.* (2009).[9] we used the liquid liabilities in percentage of GDP (M3). Other variables, such as the index of human capital per person (HC); capital stock at constant 2005 national prices (K); and total factor productivity at constant national prices (TFP) were based on Feenstra *et al.* (2013)[10].

In addition, we also use dummy variables. From Reinhart and Rogoff's (2009)[11] 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).[12]

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. In order to maximise parsimony, we only show results where annual growth rate is the dependent variable. The other results, namely the growth equations and the non-linearity effects of government debt with respect to annual and 5-year average growth rates, are available on request.

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 between the minimum of -0.006% and the maximum of -0.038% (macroeconomic variables) for each level of 1% of government debt, for annual growth rate (see table 1). Regarding 5-year average growth, the effect lies between -0.004% (institutional variables) and -0.028% (macroeconomic variables).

Concerning interest rates variables, the short-term nominal interest rate presents a statistical significance in the majority of the regressions, with a positive sign 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.

Relatively to 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. 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, when introducing institutional variables, we 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 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%. Nevertheless, it is important to highlight that whenever we compute the government debt effect with institutional variable, its negative impact on economic behaviour decrease.

Analysing the results of the macroeconomic variables, 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 and 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 household 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, where credit 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.

We obtain, according to economic theory, a positive coefficient for total factor productivity. Lastly, an increase in inflation, 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.

Table 1

GROWTH EQUATIONS WITH DEBT LINEAR EFFECT ON REAL GDP GROWTH RATE AND WITH INSTITUTIONAL VARIABLES (YEARLY DATA)

	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)
$crisestall\ y_{it}$	-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)
$stockmarke\ tc_{it}$		-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.*

4.2. Non-linearities of government debt on growth

As seen in the previous section, government debt has a negative effect on growth, both in 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):

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

$$0 = \beta_2 + 2\beta_3 D_{it} \Leftrightarrow D_{it} = \frac{-\beta_2}{2\beta_3} \tag{4}$$

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 the results for the thresholds in table 2. 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 rates, 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%.

Table 2
THE NON-LINEARITY EFFECT OF PUBLIC DEBT ON REAL GDP GROWTH RATE, WITH PUBLIC FINANCE VARIABLES (YEARLY DATA)

	OLS			OLS-FE			2SLS			GLS		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
$rgdp_{it-1}$	-1.912***	-1.562***	-2.531***	-4.134***	-4.320***	-5.187***	-5.479***	-7.260***	-5.791***	-2.260***	-1.789***	-2.998***
	(0.441)	(0.441)	(0.438)	(0.827)	(0.884)	(0.744)	(1.037)	(1.174)	(0.794)	(0.401)	(0.425)	(0.409)
$debt_{it}$	0.061***	0.051***	0.081***	0.095***	0.092***	0.121***	0.128***	0.169***	0.135***	0.057***	0.046***	0.081***
	(0.016)	(0.017)	(0.017)	(0.020)	(0.021)	(0.018)	(0.026)	(0.030)	(0.022)	(0.014)	(0.016)	(0.016)
$debt_{it}^2$	-0.001***	-0.000***	-0.001***	-0.001***	-0.001***	-0.001***	-0.001***	-0.001***	-0.001***	-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)
pbb_{it}	0.258***			0.309***			0.193***			0.290***		
	(0.045)			(0.045)			(0.043)			(0.038)		
$debts_{it}$	-0.030	-0.121*		0.104	0.054		0.139	0.293***		-0.045	-0.144**	
	(0.066)	(0.069)		(0.086)	(0.088)		(0.103)	(0.112		(0.062)	(0.065)	
$capb_{it}$		0.186***			0.254***			0.331***			0.208***	
		(0.042)			(0.046)			(0.054)			(0.041)	
tbb_{it}			0.244***			0.303***			0.191***			0.274***
			(0.042)			(0.044)			(0.044)			(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.*

5. Conclusions

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 government debt has a negative effect on economic growth, both in the short and long-term. In addition, 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 government 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, the current account balance and urbanisation are examples of variables that contribute positively to economic growth.

Finally, we provide results that show the existence of an inverted U-shape relationship between the debt ratio and economic growth. We obtained annual and 5-year average growth rate thresholds of 75% and 74%, respectively. Therefore, and according to these values, governments could keep government debt ratios under these values in order to avoid sovereign debt crises similar to those that several countries in our sample have recently experienced.

In the end, and although the effect of government debt is undesirable, governments have to trade-off the increment of debt to stimulate aggregate demand and consequently growth, and the level of government indebtedness.

Notes

1. Database in Reinhart and Rogoff (2009) and Reinhart and Rogoff (2011).
2. There are some variables for which there are no data available for some countries, during some years.
3. For reasons of parsimony, the results for this test are not presented here. However, they are available upon request.
4. As we do not show the Robust Least Squares results here, we could provide them under request.
5. The results from applying the same 2SLS methodology but with more lags are available on request. Since the results do not change significantly, we will only focus on one-period lag instrumental variables.

6. 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
7. This dataset is available on the following website: http://data.worldbank.org/data-catalog/world-development-indicators
8. This dataset is available on the following website: http://stats.oecd.org/#
9. Data are available at: http://econ.worldbank.org/WBSITE/EXTERNAL/EXTDEC/EXTRESEARCH/0, conte ntMDK:20696167~pagePK:64214825~piPK:64214943~theSitePK:469382,00.html
10. The referred is available to download on http://www.rug.nl/research/ggdc/data/penn-world-Table
11. 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.
12. 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.

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Resumen

Se estudia el efecto de la deuda pública en el crecimiento económico de las tasas de crecimiento anuales y 5 años de promedio, así como la existencia de efectos no-linealidad de la deuda sobre el crecimiento de 14 países europeos desde 1970 hasta 2012. También consideramos la deuda-a-interacciones PIB con varios subconjuntos de variables monetarias, las finanzas públicas, institucionales y macroeconómicas. Nuestros resultados muestran un impacto negativo máximo de alrededor de -0,04% y -0,03% para cada incremento de 1% de la deuda pública, las tasas de crecimiento anuales y 5 años de promedio, respectivamente. Además, nos encontramos con promedio umbrales de relación de la deuda de alrededor de 75%. La pertenencia a la zona euro tiene un efecto perjudicial de al menos -0,5% para el PIB real per cápita, y la crisis bancaria es la crisis más perjudicial para el crecimiento.

Palabras clave: deuda gubernamental, crecimiento económico, umbrales de deuda.

Clasificación JEL: E62, H63, O47.