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Debt and Economic Growth in the European Union: A Panel Granger Causality Approach

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Abstract This paper contributes to empirical investigation of the causality relationships between real gross domestic product (GDP) growth and the growth of three debt categories, namely public, foreign and private debt, in the universe of the 28 European Union (EU) countries during the past decade. Using panel Granger causality estimations, we find statistically relevant bidirectional causality relationships between public debt and economic growth for the periods both before and after the outbreak of the recent financial crisis. Moreover, there is clear evidence of economic growth's contribution to decreasing public debt.

Keywords Panel Granger causality · European Union · GDP growth · Public debt · Foreign debt · Private debt

JEL E42 · E62 · G15 · O40

Introduction

The recent global financial crisis increased concerns about the possible consequences of high debt levels for economic growth in many countries and regions around the world, especially in the European Union (EU). Authors such as Reinhart and Rogoff (2009, 2010) support the idea that not only may financial crises contribute to an increase in debt, particularly public debt, but also ways in which this debt builds up, as well as the defined payment strategies, can have important economic impacts,

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especially in cases of high debt levels, in which they constitute real restrictions to economic growth.

However, the issue of whether debt affects growth or, conversely, economic growth causes debt (or even whether there is support for both directions of causality) is still far from achieving consensus. Further, the possibility of the existence and the direction of causality relationships between debt and growth remain a timely object of theoretical discussion and empirical testing. Most of the known empirical studies concentrate on the importance of foreign debt in developing countries. Fewer works empirically test the influence of public debt on economic growth in advanced economies, and their results are inconclusive (as is well documented by Panizza and Presbitero 2013). Some of these analyses take into account the possibility that reverse causality from low growth to high public debt may exist and that an endogeneity problem may arise, and they attempt to overcome this problem by using the instrumental variable approach (see, among others, Pattillo et al. 2004; Cordella et al. 2005; Presbitero 2010).

Concerning the influence of private debt, Reinhart and Rogoff (2010) believe that, for the years immediately following the crisis, private debt, in contrast to public debt, tended to shrink sharply for an extended period. Checherita-Westphal and Rother (2012) also consider that the stock of private debt is an important additional variable to keep in mind when investigating the relationship between public debt and economic growth. In particular, the negative impact of public debt on growth could conceivably be stronger in countries with high private debt burdens. Meanwhile, Nersisyan and Wray (2010) underline that we should not consider that "debt is debt" because there are important differences between private and public indebtedness, namely the fact that for a government with a sovereign currency, there is no imperative to borrow.

This paper seeks to contribute to the literature by analysing the causality relationships between three different kinds of debt categories, namely public, foreign and private debt, and gross domestic product (GDP) growth in the 28 member states of the EU during the past decade. It also analyses possible differences after the outbreak of the recent financial crisis by considering the results of two panels: 2001–2012 and 2007–2012.

Relevant Theoretical and Empirical References

Theoretical Background

The theoretical literature mostly analyses the relationship between public debt and economic growth and tends to defend the assertion that, in the short-run and particularly with moderate levels of government debt, Keynesian effects exist, meaning that public expenses clearly contribute to economic growth (supported, among others, by Elmendorf and Mankiw 1999).

However, in the long-run and in the presence of high levels of government debt, non-Keynesian effects occur. There are fears that payment of this large debt will imply future increases in taxes, contributing to a reduction in private consumption and investment expenses and consequently slowing down economic growth, as supported by the neoclassical view (e.g. Modigliani 1961; Diamond 1965; Saint-Paul 1992; Aizenman et al. 2007).

There is also another theoretical explanation, which, in contrast to the two previous views, defends the proposition that public indebtedness does not affect economic growth. According to this vision (see, among others, Barro 1989; Galí et al. 2007), an increase in public expenses may accelerate the economic growth in one period. However, afterwards, economic agents will react and in the presence of tax increases and other austerity measures, they will decrease their consumption and investment expenses, slowing down the economic growth and compensating for the effect of public expense increases on economic growth.

Empirical Background

Empirically, few works test the relationship between debt and economic growth, and their findings are far from conclusive. Most of the known empirical studies address the relationship between external debt and growth, focusing on developing countries. Among these works, for instance, Pattillo et al. (2004) use a panel data set of 61 developing countries over the period 1969–1998 and conclude that, on average, for countries with high debt levels, doubling the debt reduces the output growth by about one percentage point.

Meanwhile, Cordella et al. (2005) analyse how the debt–growth relationship varies with indebtedness levels in an unbalanced panel of 79 developing countries over the period 1970–2002 and conclude that a negative marginal relationship exists between debt and growth with intermediate levels of debt but not with very low levels of debt.

Schclarek (2004) applies the system generalised method of moments (GMM) dynamic panel econometric technique to a data set consisting of a panel of 59 developing countries and 24 industrialised countries with data averaged over each of the seven five-year periods between 1970 and 2002. For developing countries, the author finds that lower total external debt levels are associated with higher growth rates and that this negative relationship is driven by the incidence of public external debt but not by private external debt. Moreover, the author does not find any support for an inverted U-shaped relationship between external debt and growth. Further, particularly for industrialised countries, he finds no robust linear or non-linear relationship between gross government debt and economic growth, suggesting that higher public debt levels are not necessarily associated with lower GDP growth rates in developed countries.

Pattillo et al. (2011), also using a panel for 1969–1998 but consisting of 93 developing countries, analyse the impact of external debt and debt reduction on growth with different panel estimation techniques (i.e. fixed effects and dynamic system GMM). They find that the average impact of debt on per capita growth seems to become negative for debt levels above 30–40 % of the GDP but that the marginal impact becomes negative for debt levels around 15–20 %. This study also concludes that, with low levels of external debt, the impact on economic growth seems to be positive.

To test public debt's influence on economic growth empirically, Reinhart and Rogoff (2010) use simple correlation statistics to analyse the evolution of gross central government debt and the growth rate of the long-term real GDP in a sample of 20 developed countries over a very long time period (1790–2009). They conclude that the relationship between public debt and economic growth depends on the level of indebtedness. More precisely, this relationship is relevant only in the presence of debt/GDP ratios above 90 %.

However, the conclusions of Reinhart and Rogoff's (2010) paper are refuted, among others, by Herndon et al. (2014), who replicate Reinhart and Rogoff's work and find not only that the relationship between public debt and GDP growth varies significantly by period and country but also that there is clear evidence that GDP growth when the public debt levels exceed 90 % of the GDP is not dramatically different from when the public debt/GDP ratios are lower.

Nevertheless, the same kinds of concerns, pointing to the importance of the level of indebtedness, are expressed by other authors (Kumar and Woo 2010) who use econometric techniques to analyse a sample of emerging and advanced economies for 1970–2007. These authors also confirm the existence of a linear inverse relationship between debt and economic growth. Similar conclusions are obtained by Checherita-Westphal and Rother (2012) using data sourced from the Annual Macroeconomic Database of the European Commission (AMECO) database and considering a sample of 12 Eurozone countries for the period 1970–2011. They indicate the existence of a concave, inverted U-shaped relationship between public debt and the economic growth rate, with the debt turning point at about 90–100 % of the GDP.

Closely in line with this research, Baum et al. (2013), also using the AMECO database and data for 12 Eurozone countries but for the interval 1990–2010, conclude that the short-run impact of debt on GDP growth is positive and highly statistically significant but decreases to around zero and loses significance beyond public debt-to-GDP ratios of around 67 %. Furthermore, for debt to GDP ratios above 95 %, additional debt has a negative impact on economic activity.

Afonso and Jales (2013), using a panel of 155 countries over the period 1970–2008, assess the links between economic growth, total factor productivity and government debt. They conclude that there is a general negative effect of government debt on growth. In particular, for the subsample including Organisation for Economic Co-operation and Development (OECD) countries, there is evidence that the average growth rates of the countries with low debt to GDP ratios (lower than 30 %) are similar to those of countries with high debt ratios (higher than 90 %).

Égert (2013) tests Reinhart and Rogoff's (2010) data set by using formal econometric methods to determine whether public debt has a negative non-linear effect on growth if the public debt exceeds 90 % of the GDP. The author concludes that the negative relationship between debt and growth is sensitive to modelling choices (including the time dimension, country coverage considered, data frequency and assumptions on the minimum number of observations required).

Concentrating on advanced economies, Panizza and Presbitero (2013) survey the recent literature on the links between public debt and economic growth and conclude that, although most empirical works using simple back-of-an-envelope calculations suggest the existence of a negative effect on economic growth, this effect is likely to be small. Furthermore, when more sophisticated models are used, they yield uncertain results regarding the relationship between debt and growth. In addition, concerning the correlations and possible causality relationships between debt and growth, Panizza and Presbitero (2012, 2013) point out the fact that a negative correlation between debt and growth does not by itself imply causality because low levels of economic growth lead to high levels of debt.

More Empirical Results: *The Causality Relationships between Debt and Growth*

Regarding the empirical estimations concentrating on causality relationships between debt and growth, recent empirical tests provide some answers but they are still rather inconclusive. On one side, there are works supporting the (mostly negative) causality running from debt to economic growth. Among these contributions, Chowdhury (2001) uses panel causality tests to analyse the impact of foreign debt on growth in low- and middle-income countries, covering the time span 1982–1999, and concludes that the causality runs from debt to growth, with a significant negative causal impact of debt on growth.

Pattillo et al. (2004) find evidence of a negative and significant causality effect running from total external debt to economic growth (even after accounting for the possible endogeneity of debt to the growth process). These authors also state that their results are compatible with a simultaneous significant effect of growth on debt ratios, as suggested, for instance, by Easterly (2001).

On the other side, some authors find empirical evidence that confirms the existence of causality occurring between output growth and debt ratios. Representing this strand of the literature, Easterly (2001) maintains that lower growth decreases tax revenues and primary surpluses, and without adjustment, debt ratios will explode, as occurred after the worldwide slowdown in growth in the 1970s. This growth slowdown was an important cause of the debt crises in middle-income countries in the 1980s, the crisis in highly indebted poor countries in the 1980s and 1990s and the increased public debt burden of industrialised countries in the same decades.

Finally, there is also empirical support for both directions of causality between debt and growth. For instance, Abbas and Christensen (2007) use a specific public domestic debt database, covering 93 low-income countries and emerging markets from 1975 to 2004, and apply Granger causality regressions and panel data methods to test the relationship between debt and economic growth. They conclude that there is bidirectional and statistically significant causality. Public domestic debt has a strong positive impact on per capita income and, although not as statistically strong, economic growth has a clear positive impact on public domestic debt.

Jayaraman and Lau (2009) apply panel Granger causality estimations to examine the relationship between external or public debt and economic growth in six Pacific island countries during the period 1985–2004. Their empirical results indicate a lack of evidence of a long-run Granger causality relationship between the real output and the external debt to GDP ratio or between the same output index and the budget deficit to GDP ratio. However, in the short run, there is a significant causal relationship running from external debt and budget deficit to output. In regard to the reverse relationship, in the long run, the results also indicate the absence of causality. In the short run, there is evidence of Granger causality running from output to external debt but not from output to public deficit.

Butts (2009) also empirically tests the direction of the Granger causality relationship between economic growth and short-term external debt in 27 Latin American and Caribbean countries over the period 1970–2003. The main results of this work suggest the existence of bidirectional causality relationships between the two variables for several countries, which means that the performance of the two variables is interrelated. There is also clear evidence that, in the short and the long run, Granger causality from

economic growth to short-term external debt is present in 13 Latin American and Caribbean countries.

Ferreira (2009) addresses the Granger causality relationship between public debt and GDP. More precisely, the paper investigates the link between the growth in real GDP per capita and the public debt, represented by the current primary surplus/GDP and gross government debt/GDP ratios. Using OECD annual data for 20 countries between 1988 and 2001, clear Granger bidirectional causality is found.

Methodology and Data

We use a methodology based on panel Granger causality tests because we want to analyse the direction of the causality relationship between economic growth and different debt categories. More precisely, we intend to test whether the evolution of debt precedes economic growth or, on the contrary, whether economic growth precedes the different kinds of debt (or even whether these relationships are bidirectional).

We follow the conventional Granger causality test (Granger 1969) as well as the more recent approaches developed to analyse the existence of causality relationships among variables in panels by such authors as Nair-Reichert and Weinhold (2001); Kónya (2006) and Bangake and Eggoh (2011). According to this Granger causality concept, correlation does not imply causality and a cause cannot come after its effect. This means that a variable, X, is said to Granger cause another variable, Y, if the current value of this variable Y (Y_t) significantly depends on the past values of the variable X, that is, $X_{t\text{-}1}$, $X_{t\text{-}2}$, … (but not on its present value, X_t). Under these conditions, the starting point of our methodology is the estimation of a general linear panel Granger causality model with two equations:

$$y_{i,t} = \alpha_1 + \sum_{k=1}^{K} \gamma_{1,i,k} y_{i,t-k} + \sum_{k=1}^{K} \beta_{1,i,k} x_{i,t-k} + \varepsilon_{1,i,t} \quad (1)$$

$$x_{i,t} = \alpha_2 + \sum_{k=1}^{K} \gamma_{2,i,k} x_{i,t-k} + \sum_{k=1}^{K} \beta_{2,i,k} y_{i,t-k} + \varepsilon_{2,i,t} \quad (2)$$

where $i = 1,..., N$ cross units; $t = 1,..., T$ time periods; $\alpha_{1,2}$ = intercepts; $k = 1,...K$ lags; and $\varepsilon_{1,2}$ = error terms (including not only the disturbance terms, but also the individual cross-unit specific effects). To ascertain the strength of the Granger causality relationships in each estimated equation, it is possible to analyse the joint significance by conducting a Wald test of the obtained β_i for the different time lags.

Our data are sourced from the AMECO, which is based on a commonly agreed methodology that guarantees the time and country consistency of the statistical information provided. To represent economic growth (*GROWTH*), we use the series "Real GDP growth rate – 1 year % change." Taking into account the availability of the data provided in the AMECO database for the time period considered and the 28 EU member states, the debt categories considered are proxied by the three following series: first, "General government gross debt (Maastricht debt) as a % of GDP – annual data," representing

public debt (*PUBDEBT*); second, the country's "Net external debt as a % of GDP – annual data," representing foreign debt (*FORDEBT*); and third, "Private debt as a % of GDP - consolidated – annual data," representing private debt (*PRIVDEBT*).

The data set consists of two balanced panels, both including all 28 EU countries. The first panel is for 2001–2012 and the second one is only for the subinterval of 2007–2012, as we aim to analyse the possible changes provoked by the outbreak of the recent global financial crisis.

Results

To analyse the causality relationships between *GROWTH* and the three debt categories presented in the previous section, we use panel estimations, which are particularly adequate for cross-sectional studies, in our case, covering short or medium time periods. In our estimations, we use the first differences of the four series taken from the AMECO database and we compare the results obtained, for both panels, with three panel estimations, namely panel random-effects estimations (which the Hausman test shows are preferable to panel fixed-effects estimations[1]), ordinary least squares (OLS) robust panel estimations and dynamic GMM panel estimations, which control for the potential endogeneity of the explanatory variables and reduce the potential bias in the estimated coefficients.

With random effects, the variation across entities is assumed to be random and uncorrelated with the independent variables included in the model. If we have reason to believe that the differences across entities have some influence on our dependent variable (as we believe to be the case in our estimations), then we should use random-effects estimates. Moreover, random effects allow us to generalise the inferences beyond the sample that we use in our estimations. Next, we present the results obtained for the panel Granger causality relationships between the economic growth and the three debt proxies.

Panel Granger Causality between Economic Growth and Public Debt

Table 1 reports the results obtained with random-effects, OLS robust and dynamic GMM two-step system robust panel estimates for the causality relationships between the growth of the proxy chosen to represent public debt and the real GDP growth rate. In the first half of Table 1 (1-A, which presents the results for the causality running from public debt to economic growth), there is evidence that public debt contributes positively to the increase in the real GDP growth rate, namely the positive values of the Granger coefficients, representing the sums of the betas obtained with the estimation of equation (1). Nevertheless, for Panel 1 (which encompasses 2001–2012), the influence of public debt on economic growth is statistically significant only when we use the dynamic GMM two-step system robust panel estimates. In this case, the Wald tests indicate that not only the growth of $PUBDEBT_{t-1}$ alone but also the joint influence of

[1] The results obtained using the panel fixed-effects estimations and the Hausman test are not reported in the paper but they are available on request.

$PUBDEBT_{t-1}$ and $PUBDEBT_{t-2}$ are relevant to the evolution of the real GDP annual growth rate.

In general, the results are statistically more significant for Panel 2, which considers only the years after the outbreak of the recent financial crisis (2007–2012). As before, the statistically more solid results are obtained with the dynamic GMM two-step system robust panel estimates, confirming the potential adequacy and qualities of this estimation method in this kind of model and with the variables used.

On the other side, for the causality running from economic growth to public debt, the results reported in the second half of Table 1 (1-B) clearly show that, for both panels, the real GDP growth rate contributes negatively to public debt, although this effect is statistically stronger in the short term (t-1) than afterwards (t-2). Regarding Panel 2 (for 2007–2012), and still according to the values of the Granger coefficients and the Wald test results reported in Table 1(1-B), there is clear and statistically strong evidence that public debt (in t-1 and jointly in t-1 and t-2) contributes positively to the real GDP growth rate. Moreover, this applies to the results obtained with all three panel estimation methods.

Panel Granger Causality between Economic Growth and Foreign Debt

Table 2 presents the results of the random-effects, OLS and GMM robust panel estimations of the Granger causality relationships between the economic growth and the proxy used to represent the growth in *FORDEBT* (net external debt as a percentage of the GDP). Concerning the Granger causality running from *FORDEBT* to GDP, the results reported in Table 2 (2-A) show that, in general terms and for both time panels, the impact of external debt on economic growth is not statistically relevant as, with one exception (OLS estimations of Panel 2 and only in the short run), this causality is not statistically strong. Moreover, for Panel 2, the values of the Granger coefficients point to positive causality but the results for Panel 1 are rather ambiguous.

On the other side, for the reverse causality running from economic growth to foreign debt, the estimation results presented in Table 2 (2-B) allow us to conclude that, although not statistically strong, there is evidence of a positive causality relationship running from the real GDP growth rate to *FORDEBT* as all the Granger coefficients are positive. This positive impact is statistically more relevant in the short run (for t-1) in Panel 1 when we opt to use the GMM estimations and in both panels when using the random-effects estimations.

Panel Granger Causality between Economic Growth and Private Debt

As before, in the first part of Table 3 (3-A), we report the results obtained for the panel Granger causality now running from private debt (as a percentage of the GDP) to the real GDP growth rate. These results are neither unanimous nor statistically strong, but, according to the values of the Granger coefficients, there is a general tendency pointing to the negative causality of private debt on the GDP. Furthermore, the values of the Wald tests, namely those obtained with the dynamic GMM estimates, indicate that *PRIVDEBT* is relevant to explaining the evolution of economic growth, not only in the previous year (in t-1) but also jointly in t-1 and t-2.

Table 1 Causality between economic growth and public debt

	PANEL 1 (2001–2012)									PANEL 2 (2007–2012)								
Explanatory variables	RE			OLS (*)			GMM			RE			OLS (*).			GMM		
	coef.	z	P > |z|	coef.	t	P > |t|	coef.	z	P > |z|	coef.	z	P > |z|	coef	t	P > |t|	coef.	z	P > |z|
1 – A – FROM "PUBDEBT" TO "GROWTH"																		
GROWTH t-1	−.223	−4.08	0.000	−.132	−1.26	0.210	−.590	−3.63	0.000	−.405	−6.59	0.000	−.111	−1.09	0.280	−.634	−8.09	0.000
GROWTH t-2	−.346	−6.31	0.000	−.284	−3.59	0.000	−.409	−9.88	0.000	−.450	−7.63	0.000	−.305	−3.39	0.001	−.360	−8.05	0.000
PUBDEBT t-1	.032	0.05	0.963	.149	0.38	0.703	−11.062	−1.95	0.051	1.317	1.92	0.055	2.068	1.90	0.061	3.934	2.52	0.012
PUBDEBT t-2	.362	0.52	0.601	.136	0.28	0.783	16.727	2.76	0.006	3.941	5.65	0.000	2.430	3.67	0.000	11.652	3.95	0.000
Constant	−.260	−1.20	0.231	.449	0.56	0.574	−.167	−0.86	0.390	−.794	−2.37	0.018	−.418	−0.52	0.604	−.405	−0.55	0.585
R-squared overall	0.1571			0.7046						0.5605			0.8102					
	Wald chi2(4) = 56.09			F (41, 264) = 10.67			Wald chi2(4) = 113.47			Wald chi2(4) = 169.59			F(35, 102) = 11.68			Wald chi2(4) = 133.62		
	Prob > chi2 = 0.0000			Prob > F = 0.0000			Prob > chi2 = 0.000			Prob > chi2 = 0.0000			Prob > F = 0.0000			Prob > chi2 = 0.000		
Arellano–Bond test for in first differences AR(1)							z = −2.20									z = −2.94		
							Pr > z = 0.028									Pr > z = 0.003		
Arellano–Bond test for AR(2) in first differences							z = 1.17									z = 0.52		
							Pr > z = 0.242									Pr > z = 0.605		
Sargan test of overid. Restrictions							chi2(16) = 54.41									chi2(4) = 6.39		
							Prob > chi2 = 0.000									Prob > chi2 = 0.172		
Number of observations	306			306			306			138			138			138		
WALD TEST ($\beta_{t-1} = 0$)	chi2(1) = 0.00			F(1, 264) = 0.15			chi2(1) = 3.82			chi2(1) = 3.67			F(1, 102) = 3.60			chi2(1) = 6.33		
	Prob > chi2 = 0.9630			Prob > F = 0.7033			Prob > chi2 = 0.0508			Prob > chi2 = 0.0553			Prob > F = 0.0607			Prob > chi2 = 0.0119		
WALD TEST ($\beta_{t-1} = \beta_{t-2} = 0$)	chi2(2) = 0.28			F(2, 264) = 0.09			chi2(2) = 9.29			chi2(2) = 36.56			F(2, 102) = 7.52			chi2(2) = 15.60		
	Prob > chi2 = 0.8710			Prob > F = 0.9148			Prob > chi2 = 0.0096			Prob > chi2 = 0.0000			Prob > F = 0.0009			Prob > chi2 = 0.0004		
GRANGER COEFFICIENT	0.3946005			0.2847271			5.66531			5.258781			4.497878			15.58635		
1 – B – FROM "*GROWTH*" TO "*PUBDEBT*"																		

Table 1 (continued)

	PANEL 1 (2001–2012)						PANEL 2 (2007–2012)								
PUBDEBT t-1	−.023	−0.75	0.453	−.077	−1.10	0.273	−.237	−1.57	0.116	−.053	−2.05	0.040	−.072	−1.21	0.230	−.471	−4.04	0.000
PUBDEBT t-2	.046	1.52	0.128	.011	0.50	0.615	.030	0.30	0.767	−.070	−2.65	0.008	−.046	−1.22	0.227	−.336	−3.69	0.000
GROWTH t-1	−.011	−4.74	0.000	−.013	−2.73	0.007	−.020	−5.22	0.000	−.006	−2.80	0.005	−.012	−2.71	0.008	−.011	−3.81	0.000
GROWTH t-2	−.002	−0.89	0.373	−.003	−0.66	0.512	−.005	−0.54	0.590	.0009	0.41	0.683	.003	0.52	0.602	−.010	−2.15	0.031
Constant	.037	3.88	0.000	.071	1.80	0.072	.038	4.30	0.000	.111	7.75	0.000	−.006	−0.15	0.883	.120	3.53	0.000
R-squared overall	0.0754	0.3264			0.1484	0.4677												
	Wald chi2(4) = 24.54			F(41, 264) = 6.07			Wald chi2(4) = 74.61			Wald chi2(4) = 26.11			F(35, 102) = 10.85			Wald chi2(4) = 42.88		
	Prob > chi2 = 0.0001			Prob > F = 0.0000			Prob > chi2 = 0.000			Prob > chi2 = 0.0000			Prob > F = 0.0000			Prob > chi2 = 0.000		
Arellano–Bond test for AR(1) in first differences							z = −1.53									z = 1.20		
							Pr > z = 0.127									Pr > z = 0.230		
Arellano–Bond test for AR(2) in first differences							z = 0.10									z = 1.98		
							Pr > z = 0.920									Pr > z = 0.048		
Sargan test of overid. Restrictions							chi2(16) = 202.42									chi2(4) = 27.00		
							Prob > chi2 = 0.000									Prob > chi2 = 0.000		
Number of observations	306			306			306			138			138			138		
WALD TEST ($\beta_{t-1} = 0$)	chi2(1) = 22.43			F(1, 264) = 7.47			chi2(1) = 27.25			chi2(1) = 7.83			F(1, 102) = 7.32			chi2(1) = 14.52		
	Prob > chi2 = 0.0000			Prob > F = 0.0067			Prob > chi2 = 0.0000			Prob > chi2 = 0.0051			Prob > F = 0.0080			Prob > chi2 = 0.0001		
WALD TEST ($\beta_{t-1} = \beta_{t-2} = 0$)	chi2(2) = 22.43			F(2, 264) = 4.14			chi2(2) = 61.24			chi2(2) = 8.88			F(2, 102) = 5.85			chi2(2) = 14.57		
	Prob > chi2 = 0.0000			Prob > F = 0.0169			Prob > chi2 = 0.0000			Prob > chi2 = 0.0118			Prob > F = 0.0039			Prob > chi2 = 0.0007		
GRANGER COEFFICIENT	−0.0135857			−0.0164532			−0.0248126			−0.0055294			−0.0084994			−0.0208284		

(*) Year and country dummies are included in these OLS robust estimations and their specific results are available on request

Dependent variable: "*PUBDEBT*" = *First difference of the natural logarithm of the general government gross debt, Maastricht debt* (*as a % of GDP – annual data*)

Explanatory variable: "*GROWTH*" = *First difference of the real GDP growth rate* (*1 year % change*)

Regarding the reverse causality from GDP to private debt, the results obtained are presented in the second part of Table 3 (3-B). In most situations, the results are not statistically strong, showing that the real GDP growth rate is not a relevant cause of the private debt as a percentage of the GDP. Nevertheless, in the majority of the estimations, we obtain positive Granger coefficients, indicating a general tendency towards positive causality of economic growth on private debt, and the results of the Wald tests clearly validate this conclusion, at least for Panel 1 and when we opt to use the dynamic GMM two-step system robust panel estimations.

Concluding Remarks

This paper contributes to the debate on the possible panel Granger causality relationships among three debt categories (public, foreign and private debt) and economic growth in the 28 EU countries during the past decade from 2001 to 2012 and, in particular, after the outbreak of the recent global financial crisis (2007–2012).The empirical results were obtained through three panel estimations: first, random-effects estimations (which, according to the Hausman test, are preferable to fixed-effects estimations), second, OLS robust estimations, and third, dynamic GMM robust estimations, which allow us to correct for the endogeneity problem. The results obtained prove the existence of statistically significant bidirectional Granger causality relationships between the public debt and the real GDP growth rate, at least in the short run. More precisely, the analysis finds evidence of some Keynesian effects as there is a positive impact of public debt on economic growth, which is particularly clear after the outbreak of the global financial crisis (our second panel). Moreover, the results obtained for both time panels (before and after the crisis) show that reverse causality (running from economic growth to public debt) is not only negative but statistically stronger.

Our panel Granger causality empirical estimations also confirm that foreign debt was not particularly relevant to the real GDP growth rate of the 28 EU countries during the past decade. The Granger coefficients obtained in general point to positive bidirectional causality between foreign debt and economic growth, but the results are not statistically strong.

Regarding private debt, there is evidence of the relevance of its negative impact on the real GDP growth throughout the decade (2001–2012). For the reverse causality running from economic growth to private debt, the results are not unanimous or statistically strong, but economic growth seems to contribute positively to private debt.

Summarising, our results are in line with the suggestions that we should never consider that "debt is debt." They confirm that, during the past decade, for the universe of the 28 EU countries, public debt was relevant to economic growth, but, at the same time and with even more strength, economic growth had clear negative causality effects on public debt, at least in the short run. Furthermore, these effects were statistically more relevant after the outbreak of the global financial crisis, when some EU countries faced problems with their sovereign debt. Not surprisingly, our estimates confirm that foreign debt is not a central issue for the economic growth of developed countries. Further, not as clearly as for public debt but with statistically greater relevance than for foreign debt, the results for private debt show the negative causality effects running

Table 2 Causality between economic growth and foreign debt

	PANEL 1 (2001–2012)						PANEL 2 (2007–2012)											
Explanatory variables	RE			OLS (*)			GMM			RE			OLS (*)			GMM		
	coef.	z	P > |z|	coef.	t	P > |t|	coef.	z	P > |z|	coef.	z	P > |z|	coef.	t	P > |t|	coef.	z	P > |z|
2 – A – FROM "*FORDEBT*" TO "*GROWTH*"																		
GROWTH t-1	−.221	−4.24	0.000	−.135	−1.28	0.203	−.270	−3.16	0.002	−.385	−6.27	0.000	−.108	−0.91	0.363	−.473	−6.02	0.000
GROWTH t-2	−.355	−6.81	0.000	−.295	−3.69	0.000	−.449	−16.52	0.000	−.587	−9.55	0.000	−.463	−4.49	0.000	−.743	−15.33	0.000
FORDEBT t-1	−.0002	−0.25	0.805	.0002	0.48	0.632	−.015	−1.19	0.236	.001	1.04	0.301	.001	5.83	0.000	.010	0.75	0.456
FORDEBT t-2	.0008	0.71	0.476	.0008	1.31	0.192	.008	1.25	0.212	−.0001	−0.09	0.927	−.000	−1.14	0.255	.001	0.21	0.837
Constant	−.262	−1.20	0.228	.559	0.69	0.488	−.230	−2.05	0.040	−.878	−2.33	0.020	.787	0.89	0.376	−.822	−1.15	0.251
R-squared overall	0.1579			0.7060						0.4442			R-squared =0.7822					
	Wald chi2(4) = 56.44			F(41, 264) = 10.49			Wald chi2(4) = 521.88			Wald chi2(4) = 106.29			F(35, 102) = 14.25			Wald chi2(4) = 364.25		
	Prob > chi2 = 0.0000			Prob > F = 0.0000			Prob > chi2 = 0.000			Prob > chi2 = 0.0000			Prob > F = 0.0000			Prob > chi2 = 0.000		
Arellano–Bond test for AR(1) in first differences							z = −2.21									z = −1.72		
							Pr > z = 0.027									Pr > z = 0.086		
Arellano–Bond test for AR(2) in first differences							z = 0.65									z = 2.74		
							Pr > z = 0.514									Pr > z = 0.006		
Sargan test of overid. Restrictions							chi2(16) = 125.28									chi2(4) = 57.45		
							Prob > chi2 = 0.000									Prob > chi2 = 0.000		
Number of observations	306			306			306			138			138			138		
WALD TEST ($\beta_{t-1} = 0$)	chi2(1) = 0.06			F(1, 264) = 0.23			chi2(2) = 1.67			chi2(1) = 1.07			F(1, 102) = 33.98			chi2(2) = 0.64		
	Prob > chi2 = 0.8054			Prob > F = 0.6316			Prob > chi2 = 0.4334			Prob > chi2 = 0.3006			Prob > F = 0.0000			Prob > chi2 = 0.7278		

Table 2 (continued)

	PANEL 1 (2001–2012)						PANEL 2 (2007–2012)								
WALD TEST ($\beta_{t-1} = \beta_{t-2} = 0$)	chi2(2) = 0.57 Prob > chi2 = 0.7508			F(2, 264) = 0.88 Prob > F = 0.4163			chi2(1) = 1.41 Prob > chi2 = 0.2356			chi2(2) = 1.09 Prob > chi2 = 0.5800			F(2, 102) = 24.33 Prob > F = 0.0000			chi2(1) = 0.56 Prob > chi2 = 0.4560		
GRANGER COEFFICIENT	−0.0005013			0.0010242			−0.0094345			0.001083			0.0008487			0.0115659		
2 – B – FROM "*GROWTH*" TO "*FORDEBT*"																		
FORDEBT t-1	−.011	−0.77	0.440	−.019	−1.10	0.271	−.087	−0.80	0.424	−.035	−1.77	0.077	−.014	−0.44	0.661	.173	2.62	0.009
FORDEBT t-2	−.034	−2.25	0.024	−.044	−1.59	0.114	−.131	−1.74	0.082	.054	2.65	0.008	.088	1.13	0.263	−.006	−0.13	0.893
GROWTH t-1	2.017	2.73	0.006	1.154	0.87	0.385	20.963	1.44	0.150	1.997	1.87	0.061	−.110	−0.15	0.882	36.525	1.92	0.054
GROWTH t-2	.013	0.02	0.985	1.136	0.75	0.454	−3.318	−0.61	0.543	.159	0.15	0.882	3.121	1.41	0.161	−15.815 -1.93 0.053		
Constant	−.166	−0.05	0.957	−19.288	−1.14	0.253	−2.820	−0.60	0.551	1.295	0.20	0.843	−24.262 -0.80 0.423			−13.953	−2.33	0.020
R-squared overall	0.0433			0.0778						0.1020			0.1817					
	Wald chi2(4) = 13.61			F(41, 264) = 0.81			Wald chi2(4) = 180.32			Wald chi2(4) = 15.10			F(35, 102) = 1.74			Wald chi2(4) = 37.06		
	Prob > chi2 = 0.0086			Prob > F = 0.7925			Prob > chi2 = 0.000			Prob > chi2 = 0.0045			Prob > F = 0.0169			Prob > chi2 = 0.000		
Arellano–Bond test for AR(1) in first differences							z = −1.28 Pr > z = 0.200									z = −1.87 Pr > z = 0.062		
Arellano–Bond test for AR(2) in first differences							z = −1.33 Pr > z = 0.183									z = −1.86 Pr > z = 0.063		
Sargan test of overid. Restrictions							chi2(16) = 37.92 Prob > chi2 = 0.002									chi2(4) = 4.41 Prob > chi2 = 0.354		
Number of observations	306			306			306			138			138			138		

Table 2 (continued)

	PANEL 1 (2001–2012)			PANEL 2 (2007–2012)		
WALD TEST ($\beta_{t-1} = 0$)	chi2(1) = 7.47 Prob > chi2 = 0.0063	F(1, 264) = 0.76 Prob > F = 0.3855	chi2(1) = 2.07 Prob > chi2 = 0.1501	chi2(1) = 3.50 Prob > chi2 = 0.0612	F(2, 102) = 1.60 Prob > F = 0.2061	chi2(1) = 3.70 Prob > chi2 = 0.0543
WALD TEST ($\beta_{t-1} = \beta_{t-2} = 0$)	chi2(2) = 7.71 Prob > chi2 = 0.0211	F(2, 264) = 0.51 Prob > F = 0.6029	chi2(2) = 2.71 Prob > chi2 = 0.2582	chi2(2) = 3.65 Prob > chi2 = 0.1616	F(1, 102) = 0.02 Prob > F = 0.8824	chi2(2) = 4.38 Prob > chi2 = 0.1120
GRANGER COEFFICIENT	2.030623	2.290539	17.64606	2.1559861	2.920993	20.71023

(*)Year and country dummies are included in these OLS robust estimations and their specific results are available on request

Dependent variable: "*FORDEBT*" = *First difference of the net external debt as a % of the GDP* (*annual data*)

Explanatory variable: "*GROWTH*" = *First difference of the real GDP growth rate* (*1 year % change*)

Table 3 Causality between economic growth and private debt

	PANEL 1 (2001–2012)									PANEL 2 (2007–2012)								
Explanatory variables	RE			OLS (*)			GMM			RE			OLS (*)			GMM		
	coef.	z	P > |z|	coef.	t	P > |t|	coef.	z	P > |z|	coef.	z	P > |z|	coef.	t	P > |t|	coef.	z	P > |z|
3 – A – FROM "*PRIVDEBT*" TO "*GROWTH*"																		
GROWTH t-1	−.258	−4.86	0.000	−.144	−1.31	0.190	−.735	−6.01	0.000	−.403	−6.44	0.000	−.141	−1.17	0.245	−.808	−4.37	0.000
GROWTH t-2	−.404	−7.58	0.000	−.336	−3.99	0.000	−.603	−9.65	0.000	−.558	−8.94	0.000	−.453	−4.16	0.000	−.442	−3.41	0.001
PRIVDEBT t-1	−1.021	−1.41	0.157	−.402	−1.10	0.274	−49.985	−2.77	0.006	−2.043	−1.70	0.089	−1.061	−1.01	0.314	−49.201	−1.75	0.080
PRIVDEBT t-2	−2.381	−3.29	0.001	−1.824	−3.80	0.000	−1.650	−0.96	0.335	2.273	1.89	0.059	.770	0.70	0.486	20.925	1.84	0.066
Constant	−.249	−1.17	0.243	.759	0.94	0.350	.095	0.14	0.886	−.868	−2.35	0.019	.749	0.82	0.412	−.029	−0.03	0.974
R-squared overall	0.1911			0.7165						0.4654			0.7801					
	Wald chi2(4) = 71.11			F(41, 264) = 10.86			Wald chi2(4) = 178.95			Wald chi2(4) = 115.79			F(35, 102) = 9.80			Wald chi2(4) = 366.41		
	Prob > chi2 = 0.0000			Prob > F = 0.0000			Prob > chi2 = 0.000			Prob > chi2 = 0.0000			Prob > F = 0.0000			Prob > chi2 = 0.000		
Arellano–Bond test for AR(1) in first differences							z = −1.27									z = −1.75		
							Pr > z = 0.205									Pr > z = 0.081		
Arellano–Bond test for AR(2) in first differences							z = −1.44									z = 0.26		
							Pr > z = 0.151									Pr > z = 0.793		
Sargan test of overid. Restrictions							chi2(16) = 14.36									chi2(4) = 4.41		
							Prob > chi2 = 0.572									Prob > chi2 = 0.353		
Number of observations	306			306			306			138			138			138		
WALD TEST ($\beta_{t-1} = 0$)	chi2(1) = 2.00			F(1, 264) = 1.20			chi2(1) = 7.68			chi2(1) = 2.89			F(1, 102) = 1.02			chi2(1) = 3.07		
	Prob > chi2 = 0.1573			Prob > F = 0.2736			Prob > chi2 = 0.0056			Prob > chi2 = 0.0892			Prob > F = 0.3142			Prob > chi2 = 0.0796		
WALD TEST ($\beta_{t-1} = \beta_{t-2} = 0$)	chi2(2) = 12.95			F(2, 264) = 7.21			chi2(2) = 10.33			chi2(2) = 6.41			F(2, 102) = 0.87			chi2(2) = 5.50		
	Prob > chi2 = 0.0015			Prob > F = 0.0009			Prob > chi2 = 0.0057			Prob > chi2 = 0.0405			Prob > F = 0.4221			Prob > chi2 = 0.0640		
	−3.401978			−2.2254673			−51.634869			0.229842			−0.2906386			−28.27636		

Table 3 (continued)

	PANEL 1 (2001–2012)						PANEL 2 (2007–2012)											
GRANGER COEFFICIENT																		
3 – B – FROM "*GROWTH*" TO "*PRIVDEBT*"																		
PRIVDEBT t-1	.010	0.53	0.594	−.007	−0.49	0.625	.085	2.59	0.010	.035	1.25	0.210	.019	0.33	0.745	.492	0.68	0.499
PRIVDEBT t-2	−.029	−1.55	0.120	−.052	−1.35	0.179	.032	1.15	0.248	−.032	−1.17	0.242	−.032	−1.03	0.306	−.637	−0.68	0.498
GROWTH t-1	.0001	0.09	0.932	−.001	−0.58	0.563	.012	4.47	0.000	.0007	0.54	0.591	−.004	−2.58	0.011	.006	1.10	0.272
GROWTH t-2	.0007	0.52	0.601	−.0003	−0.14	0.892	.002	0.73	0.464	.0007	0.55	0.579	.002	1.11	0.271	−.002	−0.18	0.859
Constant	.046	8.31	0.000	−.033	−1.10	0.274	.040	6.08	0.000	.024	2.80	0.005	−.0121	−0.50	0.621	.0199	1.71	0.087
R-squared overall	0.0122			0.3178						0.0265			0.4352					
	Wald chi2(4) = 3.73			F(41, 264) = 5.97			Wald chi2(4) = 33.62			Wald chi2(4) = 3.63			F(35, 102) = 6.73			Wald chi2(4) = 74.96		
	Prob > chi2 = 0.4437			Prob > F = 0.0000			Prob > chi2 = 0.000			Prob > chi2 = 0.4589			Prob > F = 0.0000			Prob > chi2 = 0.000		
Arellano–Bond test for AR(1) in first differences							z = −1.58									z = −0.70		
							Pr > z = 0.114									Pr > z = 0.485		
Arellano–Bond test for AR(2) in first differences							z = −1.39									z = 0.10		
							Pr > z = 0.164									Pr > z = 0.918		
Sargan test of overid. Restrictions							chi2(16) = 177.53									chi2(4) = 10.42		
							Prob > chi2 = 0.000									Prob > chi2 = 0.034		
Number of observations	306			306			306			138			138			138		
WALD TEST ($\beta_{t-1} = 0$)	chi2(1) = 0.01			F(1, 264) = 0.34			chi2(1) = 19.96			chi2(1) = 0.29			F(1, 102) = 6.63			chi2(1) = 1.21		
	Prob > chi2 = 0.9320			Prob > F = 0.5625			Prob > chi2 = 0.0000			Prob > chi2 = 0.5915			Prob > F = 0.0115			Prob > chi2 = 0.2718		
WALD TEST ($\beta_{t-1} = \beta_{t-2} = 0$)	chi2(2) = 0.27			F(2, 264) = 0.17			chi2(2) = 22.72			chi2(2) = 0.46			F(2, 102) = 5.89			chi2(2) = 1.88		
	Prob > chi2 = 0.8722			Prob > F = 0.8415			Prob > chi2 = 0.0000			Prob > chi2 = 0.7942			Prob > F = 0.0038			Prob > chi2 = 0.3915		
	0.0008489			−0.0016982			0.0139963			0.0015719			−0.0021887			0.0041108		

Table 3 (continued)

	PANEL 1 (2001–2012)	PANEL 2 (2007–2012)
GRANGER COEFFICIENT		

(*)Year and country dummies are included in these OLS robust estimations and their specific results are available on request

Dependent variable: "***PRIVDEBT***" = *First difference of the natural logarithm of the private debt as a % of the GDP* (*consolidated*, *annual data*)

Explanatory variable: "***GROWTH***" = *First difference of the real GDP growth rate* (*1 year % change*)

from this debt to economic growth as well as a general tendency towards positive causality from economic growth to private debt.

Further research is needed to gain a better understanding of the links between the relevant EU countries' debt levels and economic growth, not only in the short- but also in the long-run, as well as to analyse possible individual differences among the EU member states as they face different levels of indebtedness and do not evolve at the same growth rate.

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