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Sovereign Debt and Economic Growth Revisited: The Role of (Non-)Sustainable Debt Thresholds

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Abstract

Contributing to the contentious debate on the relationship between sovereign debt and economic growth, I examine the role of theory-driven (non-)sustainable debt-ratios in combination with debt-ratio thresholds on economic growth. Based on both dynamic and non-dynamic panel data analyses in the euro area (EA) 12 countries over the period 1970-2013, I find that non-sustainable debt-ratios above and below the 60% threshold, have a detrimental effect on short-run economic growth, while sustainable debt-ratios below the 90% threshold exert a positive influence on short-run economic growth. In the long-run, both non-sustainable and sustainable debt-ratios above the 90% threshold, as well as non-sustainable debt-ratios below the 60% compromise economic growth. Robustness analysis supports these findings, and provides additional evidence of a positive effect of sustainable debt-ratios below the 60% threshold, as predicated by the Maastricht Treaty criterion, on (short- and long-run) economic growth. Overall, these results suggest that debt sustainability in addition to debt non-linearities should be considered simultaneously in the debt-growth nexus. In addition, the results indicate the importance of a timely reaction of fiscal policy in countries with non-sustainable debts, as implied by fiscal rules, in an attempt to ensure fiscal sustainability and, ultimately, promote long-run economic growth.

Keywords: Government debt, growth, sustainability, threshold, government budget constraint

JEL codes: C23; E62; F43; H63; O40

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1. Introduction

The link between sovereign debt and economic growth has been the subject of rigorous and ongoing scrutiny. The global financial and eurozone sovereign debt crises have led to a revival of the academic and policy interest on the impact of sovereign debt on economic growth, especially in the euro area (EA). Debt sustainability concerns of the debt-stricken euro area countries have also led to financial market pressure and anxiety over a series of potential defaults and contagion across the euro area. Despite the growing body of knowledge, there is still no unanimous consent reached on the true nature of the aforementioned relationship. Among others, this is due to the complicate and intricate relationship between sovereign debt and economic growth, from both theoretical and empirical grounds.

From a theoretical perspective, neoclassical and endogenous growth models indicate that government debt has a negative effect on long-run growth through a standard crowding-out effect (Diamond, 1965; Saint-Paul, 1992). However, back-of-the envelope calculations indicate that this effect is quantitatively small (see, for instance, Elmendorf and Gregory Mankiw, 1999; Panizza and Presbitero, 2013, 2014). In addition, the negative effect of public debt could be amplified if public debt increases sovereign risk (Codogno et al., 2003), it affects the productivity of public expenditures (Teles and Cesar Mussolini, 2014), it increases uncertainty or leads to expectations of future confiscation, possibly through inflation and financial repression (for a discussion of these issues, see Cochrane, 2011a,b). Nevertheless, hysteresis can lead to a situation in which expansionary fiscal policies have positive effects on short- and long-run growth (DeLong and Summers, 2012).[1]

From an empirical standpoint, the majority of the literature finds a negative (non-linear) correlation between public debt and economic growth.[2] Reinhart and Rogoff (2010), on an influential paper on the link between debt and economic growth for 20 advanced economies between 1946 and 2009, find that high levels of debt are negatively correlated with economic growth. However, this link disappears when public debt falls bellow the 90% of GDP threshold. The study of Reinhart and Rogoff (2010) was among the first to discover the existence of threshold effects of debt on growth.[3] The robustness of the 90% threshold finding in Reinhart and Rogoff (2010) was, however, challenged by Herndon et al. (2013), who uncovered a number of coding errors in the study of the former. Correcting for the coding errors and using a different weighting of the data, Herndon et al. (2013) showed that the threshold effect of 90% seems to vanish.

In an attempt to examine the existence of a non-linear relationship between debt and growth, Checherita-Westphal and Rother (2012) and Baum et al. (2013) examine potential

[1]For a comprehensive review and discussion of theoretical and empirical studies on the link between sovereign debt and economic growth, see Reinhart et al. (2012) and Panizza and Presbitero (2013).

[2]The presence of correlation between debt and growth, however, does not provide any information on the direction of causation. To address the potential endogeneity/simultaneity between debt and growth, studies have used either instrumental variable methodologies (see, for instance, Kumar and Woo, 2010; Checherita-Westphal and Rother, 2012; Furceri and Zdzienicka, 2012; Baum et al., 2013; Proaño et al., 2014; Panizza and Presbitero, 2014) or panel vector autoregressions (Lof and Malinen, 2014).

[3]Fully-fledged theoretical models on the non-monotonicity or threshold effects of public debt on growth are, however, relatively low key (Panizza and Presbitero, 2013).

thresholds effects of debt on growth in 12 euro area countries. Checherita-Westphal and Rother (2012) use non-dynamic panel methodology on growth expressed as a quadratic functional form of debt (and a battery of specifications and tests) for the EA12 countries over the 1990-2008 period, and find a non-linear impact of debt on (both short- and long-term) growth with a turning point at about 90%-100% of GDP. Baum et al. (2013) use dynamic panel threshold analysis for the same group of countries over the 1990-2010 period, and find a significant positive short-run impact of debt on growth for debt-to-GDP ratios below 67%, while a significantly negative effect for debt-to-GDP ratios above the 95% threshold.

The potential non-linear impact of debt on growth has also been broadly examined in other worldwide country samples (see, among others, Schclarek, 2004; Chang and Chiang, 2009; Reinhart and Rogoff, 2010; Kumar and Woo, 2010; Cecchetti et al., 2011; Padoan et al., 2012; Reinhart et al., 2012; Egert, 2013; Pescatori et al., 2014; Panizza and Presbitero, 2014; Proaño et al., 2014). However, the empirical literature has still not reached an unanimous consent on the non-linear impact of debt on growth. On the one hand, Cecchetti et al. (2011) using a panel of 18 OECD countries for the period from 1980 to 2010, find a debt threshold of 85% of GDP above which debt becomes a drag on growth. Padoan et al. (2012) report similar findings (90% debt threshold) for an unbalanced panel of 28 OECD countries over a longer period (1960 to 2011). Analogously, Kumar and Woo (2010) find evidence that levels of debt above the 90% of GDP have a significant negative effect on growth, while Egert (2013), using the dataset of Reinhart and Rogoff (2010), finds that the negative nonlinear effect kicks in at much lower levels of public debt, namely between 20% and 60%. Chang and Chiang (2009), using a multiple regime panel threshold methodology for a sample of 15 OECD countries over the period 1990-2004, find two debt-to-GDP thresholds, namely 32.3% and 66.25%; however, the impact of debt on growth is found significantly positive in all three regimes, higher in the middle regime and lower in the two outer regimes. On the other hand, Schclarek (2004) finds no relationship between debt and growth in a panel of 29 advanced economies between 1970 and 2002. Similarly, Panizza and Presbitero (2014) in a sample of OECD countries find no evidence of any particular debt threshold above which economic growth is dramatically compromised. A similar conclusion is reached in the study of Pescatori et al. (2014) for a sample of 34 advanced economies. Last but note least, Proaño et al. (2014) investigate non-linearities in the relationship between debt and economic growth in 16 OECD countries over the 1981–2013 period, based on dynamic country–specific and dynamic panel threshold regression techniques. Their results indicate no find evidence for a robust and significant debt threshold beyond which a rise in debt reduces growth, when financial stress is ignored as a source of non-linearities in the debt-growth nexus. They argue that only at high levels of financial stress, debt-to-GDP ratio may negatively affect growth, regardless of the level of debt.

The aim of this paper is to shed more light on the ambiguous non-linear relation of debt on growth by paying particular attention to the effect of (non-)sustainable debt-ratios in close relation to debt-ratio thresholds. In contrast to previous studies, I simultaneously examine the effects of (non-)sustainable debt-ratios and debt non-linearities on economic growth. To my best knowledge, only Dreger and Reimers (2013) examines explicitly the effects of (non-)sustainable debt on economic growth. Based on annual data for the euro area 12 countries, Dreger and Reimers (2013) find that non-sustainable debt regimes have a negative impact on short-run economic growth, while debt levels in the sustainable regime exert no significant impact on short-run growth. However, the aforementioned study does not consider, in great depth, the effects of debt sustainability, as well as the specific level of debt thresholds above and below which debt could compromise economic growth. Put differently, I argue that debt sustainability, in addition to debt non-linearities (debt-ratio thresholds), should be simultaneously considered when examining the link between debt and growth. That is, the purpose of this study is to examine whether non-sustainable debt-ratios, above and/or below a certain debt threshold (e.g. 90% or 60%), are detrimental to economic growth; and whether sustainable debt-ratios above and/or below a certain debt threshold have no potential harmful effects on economic growth.

The intuition is straightforward. If the government budget constraint is satisfied, then countries, regardless of the debt-to-GDP ratio, will be able to service their debt, leading to debt reductions, and thus, debt sustainability, that ultimately promotes (or does not impede) growth. This is in line with Pescatori et al. (2014), who argue that "*the trajectory of debt appears to be an important predictor of subsequent growth, buttressing the idea that the level of debt alone is an inadequate predictor of future growth*" (Pescatori et al., 2014, p. 10). It is also in line with Chudik et al. (2013), who find significant threshold effects only in the case of countries with rising debt-to-GDP ratios. Put differently, both studies argue that only increasing levels of debt will have a detrimental effect on economic growth, while temporary and declining levels of debt will not compromise economic growth. Thus, it seems warranted to examine the role of (non-)sustainable debt-to-GDP ratios in combination with non-linearities on economic growth.

To conduct my analysis, I unify and extend the studies of Checherita-Westphal and Rother (2012), Baum et al. (2013) and Dreger and Reimers (2013), so as to examine the role of debt sustainability, in addition to debt non-linearities, on economic growth in the euro area 12 countries over the period 1970–2013. This is the main contribution of this study. Based on theory-driven (non-)sustainable debt-ratios and with the use of both dynamic and non-dynamic panel data analyses, and a battery of robustness checks, the results of this study can be summarized as follows. In the short-run, non-sustainable debt-ratios above and below the 60% threshold have detrimental effects on economic growth, while sustainable debt-ratios below the 90% threshold exert a positive influence on economic growth. In the long-run, both non-sustainable and sustainable debt-ratios above the 90% threshold, as well as non-sustainable debt-ratios below the 60% compromise economic growth. Furthermore, there is evidence that sustainable debt-ratios below the 60% threshold, as predicated by the Maastricht Treaty criterion, promote (short- and long-run) economic activity. Overall, the results indicate that debt sustainability in addition to debt non-linearities should be considered simultaneously in the debt-growth nexus analysis. More importantly, the results indicate the importance of a timely reaction of fiscal policy in euro area countries with non-sustainable debts, as implied by fiscal rules, in an attempt to ensure fiscal sustainability and promote economic growth.

The rest of the paper is organized as follows. Section 2 discusses the criteria for fiscal sustainability and defines the (non-)sustainable debt-ratio thresholds; Section 3 discusses the methodology employed and the data used; Section 4 presents the empirical findings, and Section 5 concludes this note.

2. Fiscal sustainability criteria and (non-)sustainable debt-ratio thresholds

The sustainability of government debt-to-GDP ratio (and its potential effects on economic growth), depends, among others, on the macroeconomic conditions embedded in the nominal interest rate, GDP growth, and the primary government budget. For instance, if the nominal interest rate exceeds nominal output growth, debt-to-GDP ratio will be sustainable so long as the primary surplus covers the difference between the interest rate and growth of GDP.

Following Dreger and Reimers (2013) very closely, this can be easily demonstrated with the use of the government budget constraint. According to this constraint, the change of government debt (ΔD) is equal to the difference of government spending (G) and government revenues (R), plus the interest paid on government debt (iD):

$$\Delta D = G - R + iD. \tag{1}$$

By diving eq. (1) by nominal GDP (Y), one can obtain this relationship in terms of GDP as follows:

$$\Delta D/Y = G/Y - R/Y + iD/Y = g - r + i \times d = p + i \times d, \tag{2}$$

where p is the primary deficit-to-GDP ratio, i the nominal interest rate, and d the debt-to-GDP ratio. Differentiating the debt-to-GDP ratio with respect to time and rearranging yields:

$$\partial(D/Y)/dt = p + (i - y)d. \tag{3}$$

Based on eq. (3), one can distinguish between sustainable and non-sustainable debt-ratios with the use of the following dummy variable:

$$z_t = \begin{cases} 1, & \text{if } -p_t < (i_t - y_t)d_t \\ 0, & \text{otherwise.} \end{cases} \tag{4}$$

that is equal to one if the primary surplus is less than the product of the debt-to-GDP ratio and the difference between the interest rate and the growth rate of nominal GDP (i.e. debt is not sustainable), and zero otherwise. Multiplying this dummy by the debt-to-GDP ratio, one can obtain the sustainable and non-sustainable debt-ratios, d_t^s and d_t^{ns}, respectively, as in Dreger and Reimers (2013), i.e.:

$$d_t^s = d_t \times (1 - z_t) \tag{5}$$

$$d_t^{ns} = d_t \times z_t \tag{6}$$

One can also distinguish between sustainable and non-sustainable debt-ratios above and below certain thresholds (so as to examine their effects on growth), with the use of the following four indicators:

$$
\begin{aligned}
d_t^{sat} &= d_t^{at} \times (1 - z_t) && (7)\\
d_t^{nsat} &= d_t^{at} \times z_t && (8)\\
d_t^{sbt} &= d_t^{bt} \times (1 - z_t) && (9)\\
d_t^{nsbt} &= d_t^{bt} \times z_t, && (10)
\end{aligned}
$$

where d_t^{sat} (d_t^{sbt}) denotes sustainable debt-ratios above (below) a certain threshold, while d^{nsat} (d_t^{nsbt}) denotes non-sustainable debt-ratios above (below) a certain threshold. I consider the following two cases. In the first case, I set the debt-to-GDP ratio threshold equal to 90%, for comparison purposes with previous literature (see, for instance, Reinhart and Rogoff, 2010; Checherita-Westphal and Rother, 2012; Baum et al., 2013), while in the second case, I set it equal to 60%, so as to assess the Maastricht Treaty criterion of 60% debt-to-GDP ratio on growth, as well as for comparison purposes with previous studies (e.g. Baum et al., 2013).

Figure 1 plots the (non-)sustainable debt-ratios above and below the 90% and 60% thresholds. It is clear from this figure that in most of EA12 countries with debt-to-GDP ratios above the 90% threshold, debt has been at the non-sustainable regime. This is evident in all Eurozone peripheral countries, especially since the global financial and Eurozone debt crises, and in Belgium between 1980s and mid1990s. The only exception is France, wherein debt has recently exceeded the 90% threshold; however, it still remains sustainable. In Greece, government debt has been above the 90% threshold and non-sustainable since the mid1980s. Nevertheless, the entry of Greece to the euro area and the adoption of the euro in 2001, resulted in a dramatic reduction in the interest rates. Together with its fast growth rate of around 4% on annual basis between 2000 and 2007, Greece was able to service its debt despite its high budget deficits, that ultimately rendered its debt sustainable (even though debt being above the 90% threshold) during that period.

[Insert Figure 1 around here]

Yet, the sustainability of fiscal stance in Greece was relatively short-lived, as the global financial crisis in 2008, along with the Eurostat's upward revision of the underreported public deficit by the Greek statistical authorities to 15.4% in 2009, put Greece's debt into the non-sustainable regime. These developments are correctly captured by my adopted approach and shown in Figure 1. Conversely, in most of the core euro area countries, namely, Austria, Finland, Germany, Luxembourg and the Netherlands, debt has been below the 90% threshold throughout the sample period. Despite that, it has been switching between the non-sustainable and sustainable debt regime. Interestingly enough, since 2009, debt has been sustainable in all euro area core countries, according to Figure 1. A similar picture is observed in the bottom panel of Figure 1, based on the more strict 60% debt threshold as predicated by the Maastricht Treaty criterion. Even though the Stability and Growth Pact has been routinely broken by both EA peripheral and core countries, government debt in all EA core countries has been sustainable since 2009, while in EA peripheral countries debt non-sustainability has been of major concern since 2009.

To further illustrate the potential non-linearity of (non-)sustainable debt-to-GDP ratios, I present in Figure 2, the average and median annual growth rate of real GDP per capita during periods of (non-)sustainable debt-ratios above and below the 90% and 60% thresholds in the EA12. According to this figure, countries with sustainable debt-to-GDP ratios below the 90% or 60% debt thresholds experienced the highest economic growth rate, while countries with non-sustainable debt-to-GDP ratios below the 90% or 60% debt thresholds experienced the lowest economic growth rate. Interestingly, non-sustainable (sustainable) debt-ratios above the 90% (60%) threshold were associated with relatively higher (lower) economic growth compared to sustainable debt-ratios above the 90% (60%) threshold.

[Insert Figure 2 around here]

Thus, it seems warranted to examine in more depth the role of regime-dependent (non-) sustainable debt-ratios on economic growth.

3. Methodology and data

To perform my analysis, I collect annual data for the 12 euro area member countries, namely, Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal and Spain, over the period 1970–2013. In particular, I obtain the exact same data series as in Checherita-Westphal and Rother (2012) from the Annual Macro-Economic (AMECO) database of the European Commission, and the World Development Indicators (WDI) database maintained by the World Bank.

The empirical methodology builds on Checherita-Westphal and Rother (2012) and Dreger and Reimers (2013). Unlike the aforementioned studies, however, I include the (non-) sustainable debt-ratio above and below a certain threshold, as defined in eq. (7)-(10). Put differently, I unify and extend the two aforementioned studies.[4]

The general specification (that follows closely the notation of Checherita-Westphal and Rother, 2012, for direct comparison purposes) is:

$$\begin{aligned} g_{it+k} \;=\; & \alpha + \beta \ln(GDP/cap)_{it} + \gamma_1 d_{it}^{nsat} + \gamma_2 d_{it}^{sat} + \gamma_3 d_{it}^{nsbt} + \gamma_4 d_{it}^{sbt} + \delta saving/gfcf_{it} \\ & + \phi pop.growth_{it} + \text{other controls(fiscal; openness; int. rate)} + \mu_i + \nu_t + \varepsilon_{it} \quad (11) \end{aligned}$$

where g_{it+k} is the growth rate of real per capita GDP, where $k = 1, 5$ ($k = 1$ corresponds to the annual growth rate, g_{it+1}; in the case of $k = 5$, I consider both the 5-year cumulative overlapping growth rate, $g_{it/t+5}$ and the 5-year cumulative non-overlapping growth rate, g_{it+5}, where t receives the values at the start of each half-decade); d_{it}^{nsat}, d_{it}^{sat}, d_{it}^{nsbt} and d_{it}^{sbt}

[4] For robustness purposes, I have also replicated some of the results of Checherita-Westphal and Rother (2012) and Dreger and Reimers (2013) (please, see below). These results, which are presented in Tables A.2 and A.3 in the Appendix, are qualitatively very similar to those reported in Checherita-Westphal and Rother (2012) and Dreger and Reimers (2013), respectively. Any quantitative differences could be attributed to my more extended time period sample of 1970–2013, compared to that of 1970–2008 in Checherita-Westphal and Rother (2012) and 1991–2011 in Dreger and Reimers (2013).

are defined according to equations (7)–(10); α is a constant, μ_i is the country fixed effects, ν_t is the time fixed effects and ε_{it} is the error term; $\ln(GDP/cap)_{it}$ is the logarithm of the initial real GDP per capita; $saving/gfcf_{it}$ is the saving or investment rate (with the latter being proxied by the gross fixed capital formation) as a share of GDP. These two variables are used in the analysis in aggregate terms (total saving/investment rate), as well as on a disaggregated basis (public and private saving/investment rate); $pop.growth_{it}$ is the growth rate of population. As in Checherita-Westphal and Rother (2012), I also include other control variables, which can be classified in the following three categories: i) fiscal indicators, including a proxy for the average tax rate and the government balance (both in cyclically adjusted terms) so as to control for the effect of fiscal policy stance on economic growth; ii) the long term real interest rate, $LT\_real\_i_{it}$, controlling for the effects of the fiscal-monetary policy stance of economic growth, and finally iii) trade openness, *openness*, defined as the sum of exports and imports as a share of GDP, so as to extend the model to an open-economy setting. Detailed definitions and sources of the data used in this study are given in Table A.1 in the Appendix.

My estimation strategy includes a battery of techniques for both the non-dynamic and dynamic panel data analyses that serve for robustness purposes and comparison with previous closely related studies. In the case of the non-dynamic panel data approach, I proceed with instrumental variables techniques so as to control for potential endogeneity of the (non-) sustainable debt-ratio variables and other right-hand side regressors. In particular, I use two-stage least squares (2SLS) or generalized method of moments (GMM) estimators originally proposed by Holtz-Eakin et al. (1988) (and further developed and popularized by Arellano and Bond, 1991; Arellano and Bover, 1995; Blundell and Bond, 1998). In the case of the dynamic panel data analysis (as demonstrated below), the inclusion of the lagged dependent variable, g_{it+k-1} that is by construction correlated with the fixed effects, gives rise to 'dynamic panel bias' (Nickell, 1981) by attributing predictive power to the lagged dependent variable that actually belongs to the country's fixed effect. A potential solution to this bias (and to potential endogeneity of other right-hand side variables), is to use a generalised method of moments (GMM) approach, e.g. difference- or system-GMM (for a discussion, see Roodman, 2009). I thus employ the (one-step or two-step) difference-/system-GMM estimator (that is robust to substantial heteroskedasticity) derived by Arellano and Bond (1991), and further developed by Blundell and Bond (1998) and Arellano and Bover (1995).

The (non-)sustainable debt-ratio variables (constructed in eq. (7)–(10)) are instrumented through their time lags (up to 5 lags) for each country, and the rest of the explanatory variables are lagged by 1 or 5 years relative to the dependent variable so as to mitigate the endogeneity problem. While it is typical to use the lagged values of the regressors as instruments, this might be problematic due to the high persistence of the (non-)sustainable debt-ratio variables. In addition, as GMM estimates use a large number of instruments, this will weaken the power of standard tests of instrument endogeneity, such as those proposed by Sargan (1958) and Hansen (1982). Although I limit the instrument count, the Hansen test statistic is consequently improbably large, with p-values equal to one. This is not uncommon, given my data structure. In view of these weaknesses, and as an alternative diagnostic to establish the validity of the GMM results, I report autocorrelation of order one and two in the first-differenced residuals under the system-GMM approach. The results presented below indicate evidence in favour of the validity of the instruments if there is first-order but not second-order autocorrelation.

4. Empirical Results

4.1. Non-dynamic effects

I begin the analysis with the non-dynamic results of the effects of non-sustainable debt-ratio thresholds of 60% and 90% on annual (short-run), 5-year cumulative overlapping and 5-year cumulative non-overlapping (long-run) economic growth, which are presented in Tables 1, 2 and 3, respectively.

According to the 90% (non-)sustainable debt threshold results, and across both instrumental variable (IV/2SLS and IV/GMM) estimators reported in columns (1)-(4) of Table 1, one can observe that, EA12 countries with sustainable debt-ratios below the 90% thresholds experience significant positive short-run economic growth, while non-sustainable debt-ratios above the 90% are do not significantly hamper short-run economic growth in the EA12.[5] Moreover, sustainable debt-ratios above the 90% threshold and non-sustainable ones below the 90% threshold do not exert any significant influence on short-run economic growth. In the case of the 60% threshold, as implied by the Maastricht Treaty criterion, the results across all specifications are quite revealing. In particular, in EA12 countries with non-sustainable debt-ratios above the 60% threshold, as well as non-sustainable debt-ratios below 60% threshold, debt has a negative effect on short-run economic growth, while in EA12 countries with sustainable debt-ratios, regardless of being above or below the 60% threshold, debt does not have a significant effect on short-run economic growth. These results provide some preliminary evidence that debt sustainability, in addition to debt non-linearities (debt-ratio thresholds), are relevant predictors of economic growth. Moreover, the sign of the other regressors are in line with theoretical predictions of the neoclassical growth model. For instance, the investment share exerts a positive, albeit insignificant effect on growth, while population growth and real GDP per capita exert a significantly negative impact. In addition, intensified trade, proxied by openness, leads to positive economic growth due to more efficient allocation of resources, while increases in the real long term interest rate dampens economic growth due to its adverse effect on demand.

[Insert Table 1 around here]

Turning the attention to the effects of (non-)sustainable debt-ratios on long-run economic growth one can observe the following empirical regularities. According to the cumulative 5-year overlapping growth rate results reported in Table 2, non-sustainable debt-ratios above and below the 90% threshold significantly compromise long-run economic growth, while sustainable debt-ratios, regardless of their level, have no significant effect on long-run economic growth (see columns (1)-(4) of Table 2). In terms of the 60% threshold results, one can

[5] These estimators are implemented in Stata with the *xtivreg*2 command developed by Schaffer (2010).

observe that only non-sustainable debt-ratios above the 60% have a significantly negative effect on long-run economic growth, while debt-ratios at the sustainable regimes, or even non-sustainable debt-ratios below the 60% threshold, do not hamper long-run economic growth (columns (5)-(8) of Table 2).

[Insert Table 2 around here]

Similar conclusions are reached based on the cumulative 5-year non-overlapping growth rates results reported in Table 3. Specifically, non-sustainable debt-ratios, regardless of their level, as well as sustainable debt-ratios above the 90% threshold exert a negative and significant impact on long-run economic growth, while no significant negative effects on long-run economic growth could be identified in the case of sustainable debt-ratios below the 90% threshold.

[Insert Table 3 around here]

Overall these findings suggest that the level of debt, as well as debt sustainability, are important predictors of both short-run and long-run economic growth. In the short-run, non-sustainable debt-ratios above and below the 60% threshold compromise economic growth, while sustainable debt-ratios below the 90% threshold are associated with positive economic growth. Intriguingly, non-sustainable debt-ratios above the 90% threshold do not have significantly detrimental effects on short-run economic growth. Nevertheless, non-sustainable debt-ratios above and below the 90%, or even the 60% threshold, as well as sustainable debt-ratios above the 90% threshold, have detrimental effects on long-run economic growth. These results are partly in line with Checherita-Westphal and Rother (2012) and Dreger and Reimers (2013) who also examine the effects of debt non-linearities and debt sustainability, respectively, on economic growth. However, my results point to the fact that the (non-)sustainability of debt-ratios, as well as debt non-linearities, should be considered simultaneously in the debt-growth nexus. This is in line with Pescatori et al. (2014), who show that "*the trajectory of debt appears to be an important predictor of subsequent growth, buttressing the idea that the level of debt alone is an inadequate predictor of future growth*" (Pescatori et al., 2014, p. 10).

4.2. Dynamic effects

In attempt to investigate the dynamic effects of non-sustainable debt thresholds on economic growth, I now control for the potential persistence of economic growth. To achieve that, I consider a dynamic panel data approach, that is directly suited to capture the short-run dynamics of non-sustainable debt thresholds on economic growth (as in Baum et al., 2013). Unlike Baum et al. (2013), I do not endogenously determine the debt threshold upon which debt acts as a drag on short-run economic growth. Instead, I examine the effect of (non-)sustainable debt-ratios above and below the exogenously determined thresholds of 60% and 90% on short-run economic growth.

In the case of the dynamic panel data analysis, the inclusion of the lagged dependent variable, g_{it+k-1}, that is by definition correlated with the fixed effects, gives rise to 'dynamic panel bias' (Nickell, 1981), by attributing predictive power to the coefficient of the lagged dependent variable that actually belongs to the country's fixed effect. A potential solution to this bias (and to potential endogeneity of other right-hand side variables), is to use a generalised method of moments (GMM) estimator, e.g. the difference- or system-GMM estimators (for a discussion, see Roodman, 2009).[6] I thus employ the (one-step or two-step) system-GMM estimator (that is robust to substantial heteroskedasticity) derived by Arellano and Bond (1991), and further developed by Blundell and Bond (1998) and Arellano and Bover (1995).[7]

First, I examine the robustness of the results to fixed effects OLS estimation and compare the coefficient on the lagged dependent variable under fixed effects with that under GMM. Since my emphasis on GMM is motivated by the downward bias in models that include a lagged dependent variable (LDV) and exhibit unit effects (Nickell, 1981), the LDV coefficient in a correctly specified GMM model should not lie below the LDV coefficient in the FE model (Bond, 2002). As a second diagnostic test, I report autocorrelation of order 1 and 2 in the first-differenced residuals. Given the lag structure of the instruments, this supports the validity of the instruments if there is first-order but not second-order autocorrelation.

Table 4 reports the results of the dynamic panel approach of the 90% and 60% (non-) sustainable debt-ratio thresholds, under different specifications and estimation techniques. Columns (1), (4), (7) and (10) comprise the results of the 'naive' pooled ordinary least squares (pooled-OLS) regressions, while columns (2), (5), (8) and (11) control for both fixed effects and time effects. According to the pooled-OLS results, non-sustainable debt-ratios above and below the 90% or even the 60% threshold, as well as sustainable debt-ratios above the 90% or even 60% threshold significantly compromise economic growth, while sustainable debt-ratios below the 90% or even the 60% do not have, in general, a significant impact on economic growth (with the only exception of specification under column (7), albeit, at the 10% level of significance).

However, columns (3), (6), (9) and (12), that report the results of the system-GMM estimator, indicate that only non-sustainable debt-ratios above and below the 60% threshold have a negative and significant impact on short-run economic growth, while sustainable debt-ratios above or below the 60% threshold do not have a significant impact on short-run economic growth. In the case of the 90% threshold, the coefficient of the (non-)sustainable debt-ratios above and below the 90% threshold are correctly signed (negative), albeit insignificant. Furthermore, as expected, the coefficients of the lagged dependent variable across all system-GMM specifications suggests that this estimator has correctly controlled for the bias induced by the persistence in the dependent variable. Had it failed to correct for the bias, one would have observed a significant lower coefficient in the lagged dependent variable in

[6] These estimators are implemented in Stata with the *xtabond*2 command developed by Roodman (2009).

[7] Standard errors for the two-step version are severely downward biased. However, Windmeijer (2005) provides a bias correction, which can result in two-step estimation that is superior to one-step estimation. In my estimation, however, I do not detect any efficiency gains from bias-corrected two-step estimation. I therefore focus on the robust one-step estimator. Using the difference-GMM estimator, I reach similar conclusions to those based on the system-GMM estimator. For the sake of brevity, the Difference-GMM results are not presented, but are available upon request.

the system-GMM estimations under columns (3), (6), (9) and (12), compared to those under the fixed effects estimations under columns (2), (5), (8) and (11) in Table 4, respectively. On the contrary, the coefficient of the lagged dependent variable under the system-GMM estimations (columns (3), (6), (9) and (12)) lies between the pooled-OLS ((1), (4), (7) and (10)) and fixed effects ((2), (5), (8) and (11)) coefficient, supporting the conclusion that the system-GMM is the most appropriate estimator.

Additional justification for the use of the system-GMM estimator is that the first and second order serial correlation tests are consistent with the validity of the GMM instruments. First order serial correlation in the first-differenced residuals, $AR(1)$, is significant and negative, while is no second order serial correlation is present, as $AR(2)$ is insignificant (see, lower panel of Table 4).

Last but not least, the other regressors under the system-GMM estimations are in line with the theoretical predictions, indicating that EA12 countries with higher population growth rates, initial level of real GDP per capita and real long term interest rates experience negative short-run economic growth, while more open EA12 countries undergo higher short-run economic growth.

[Insert Table 4 around here]

Again these results are partly in line with Baum et al. (2013) and Dreger and Reimers (2013). The former study finds that debt-to-GDP ratios above the 95% have a significant negative impact on short-run economic growth, while debt-ratios below (above) the 67% threshold have a positive (no significant) effect on short-run economic growth. The latter study, finds that only non-sustainable debt-ratios have a significantly negative impact on short-run economic growth. In my study, which essentially merges and extends the aforementioned two, I show that controlling for both debt sustainability and potential threshold effects, provides additional insights on the complex relationship between sovereign debt and economic growth.

4.3. Robustness analysis

In an attempt to check the robustness of the results presented above, I also estimate the potential effects of (non-)sustainable debt-ratios above the 90% and below the 60% threshold on economic growth, so as to compare the results to those reported in Baum et al. (2013). In particular, Baum et al. (2013) find that the short-run impact of debt on growth is positive and statistically significant for debt-to-GDP ratios up to around the 67% threshold, while debt-to-GDP ratios above 95% have a negative impact on economic growth. Their results are robust to various specifications under both dynamic and non-dynamic models.

Table 5 reports the results of the effects of (non-)sustainable debt-ratios above the 90% and below the 60% threshold on economic growth, using both dynamic and non-dynamic analysis. The results throughout most of the specifications, under both dynamic and non-dynamic models, suggest that only non-sustainable debt-ratios above the 90% and below the 60% threshold compromise (short- and long-run) economic growth, while sustainable debt-ratios below the 60% threshold, as implied by the Maastricht Treaty criterion, promote (short- and long-run) economic growth. These results, which are partly in line with those of Baum et al. (2013), provide additional justification to the argument that the sustainability of government debt, as well as debt thresholds, should be controlled for, in an attempt to uncover the potential non-linearities of debt on economic growth.

[Insert Table 5 around here]

As a final robustness check, I attempt to replicate the results of the previous key studies, so as to see whether I can reach similar conclusions. Such an attempt would provide additional credibility on the dataset collected and the results presented above.[8] In particular, I have tried to replicate the results of Checherita-Westphal and Rother (2012) and Dreger and Reimers (2013). The results of this analysis are presented in Tables A.2 and A.3, respectively, in the Appendix.

According to the results reported in Table A.2 in the Appendix, I indeed reach very similar conclusions to those of Checherita-Westphal and Rother (2012). In particular, I find a non-linear impact of debt on economic growth, with a turning point of about 84%-98% of GDP above which debt has a negative impact on economic growth. This is very close to the turning point of about 90%-100% found in Checherita-Westphal and Rother (2012). In addition, the confidence intervals of the debt turning point results of my replication strategy indicate that the negative impact of high debt on economic growth may well start already from levels of around 60% to 73% of GDP; this, again, is very similar to that of around 70% to 80% found in Checherita-Westphal and Rother (2012). The results of the regressors across all specification are qualitatively in line with those of Checherita-Westphal and Rother (2012). Any minor quantitative differences could be attributed to my more extended time sample ending in 2013 (which includes the recent global financial and Eurozone debt crises), as opposed to that of the aforementioned study ending in 2008.[9]

Table A.3 in the Appendix presents the results of the replication of Dreger and Reimers (2013), as well as some extensions. According to column (1) of Table A.3 in the Appendix, which presents the exact specification results of Dreger and Reimers (2013) for the EA12 countries, I reach similar conclusions. That is, only non-sustainable debt-ratios have a negative impact on short-run economic growth, while sustainable debt-ratios do not exert any significant influence on short-run growth. Any differences, could be again attributed to my more extended time period sample.[10] Finally, I extend the model of Dreger and Reimers (2013), by using different specifications and estimations. These results are presented in columns (2)-(10). Among them, the more appropriate instrumental variables estimators of both dynamic and non-dynamic panel data approaches point to similar conclusions. That is, only non-sustainable debt-ratios in EA12 countries compromise short-run economic growth.

[8] Replication files for all the results presented in this study are available upon request.

[9] Restricting the sample to 1970-2008, as in Checherita-Westphal and Rother (2012), I reach even more similar conclusions to their study.

[10] However, I have also experimented by restricting the sample to 1991-2011, as in Dreger and Reimers (2013) and I have reached similar conclusions to them. These results are available upon request.

5. Conclusion

The relationship between sovereign debt and economic growth has been contensiously debated due to its complex features. The global financial and eurozone sovereign debt crises have led to a revival of the academic and policy interest on the impact of sovereign debt on economic growth. Especially in the euro area (EA), wherein debt sustainability concerns of several debt-stricken euro area countries have led to financial turmoil over a series of potential defaults, contagion across the euro area countries, and, ultimately, the collapse of the Eurozone itself.

Contributing to the debate on the relationship between sovereign debt and economic growth, I examine the role of theory-driven (non-)sustainable debt-ratios in combination with debt-ratio thresholds on economic growth. Building on existing key studies, and using both dynamic and non-dynamic panel data analyses, and a variety of techniques and robustness checks in the euro area (EA) 12 countries over the period 1970-2013, I present systematic evidence that non-sustainable debt-ratios above and below the 60% threshold, have a detrimental effect on short-run economic growth, while sustainable debt-ratios below the 90% threshold exert a positive influence on short-run economic growth. In the long-run, both non-sustainable and sustainable debt-ratios above the 90% threshold, as well as non-sustainable debt-ratios below the 60% compromise long-run economic growth. Moreover, sustainable debt-ratios below the 60% threshold, as predicated by the Maastricht Treaty criterion, lead to positive economic growth.

Put differently, the sustainability of debt appears to be an additional important predictor of economic growth, buttressing the idea that the level (or the threshold) of debt alone is an inadequate predictor of economic growth. Overall, my results indicate the importance of a timely reaction of fiscal policy in euro area countries with non-sustainable debt levels, as implied by fiscal rules, in an attempt to ensure fiscal sustainability and, ultimately, promote economic growth.

A potential avenue, that is left for future research, is to endogenously determine the specific (non-)sustainable debt thresholds above and below which (and how) debt could affect economic growth. Furthermore, the investigation of both the direct and indirect channels through which debt (growth) could potential have an non-monotonic impact on economic growth (debt), through, e.g., a system of simultaneous non-linear equations approach, seems warranted.

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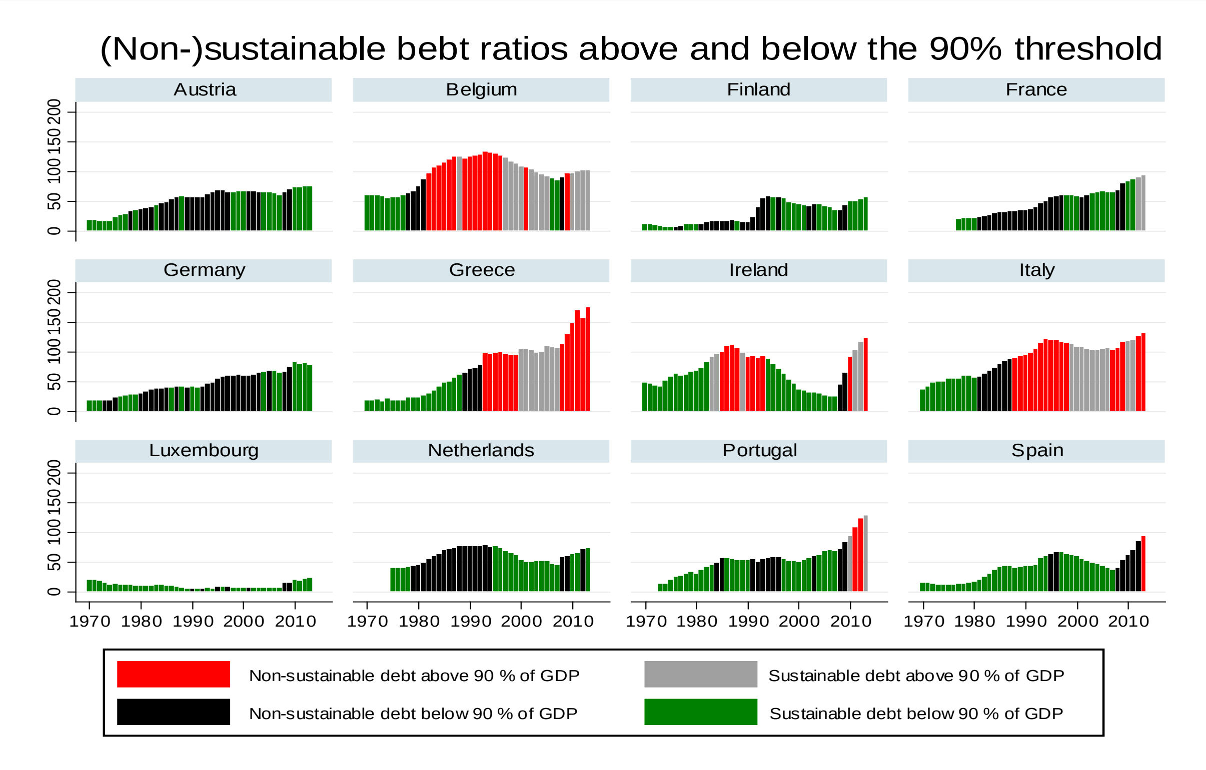
Figure 1: Periods of (non-)sustainable debt-to-GDP ratio above and below the 90%/60% threshold, EA12, 1970–2013



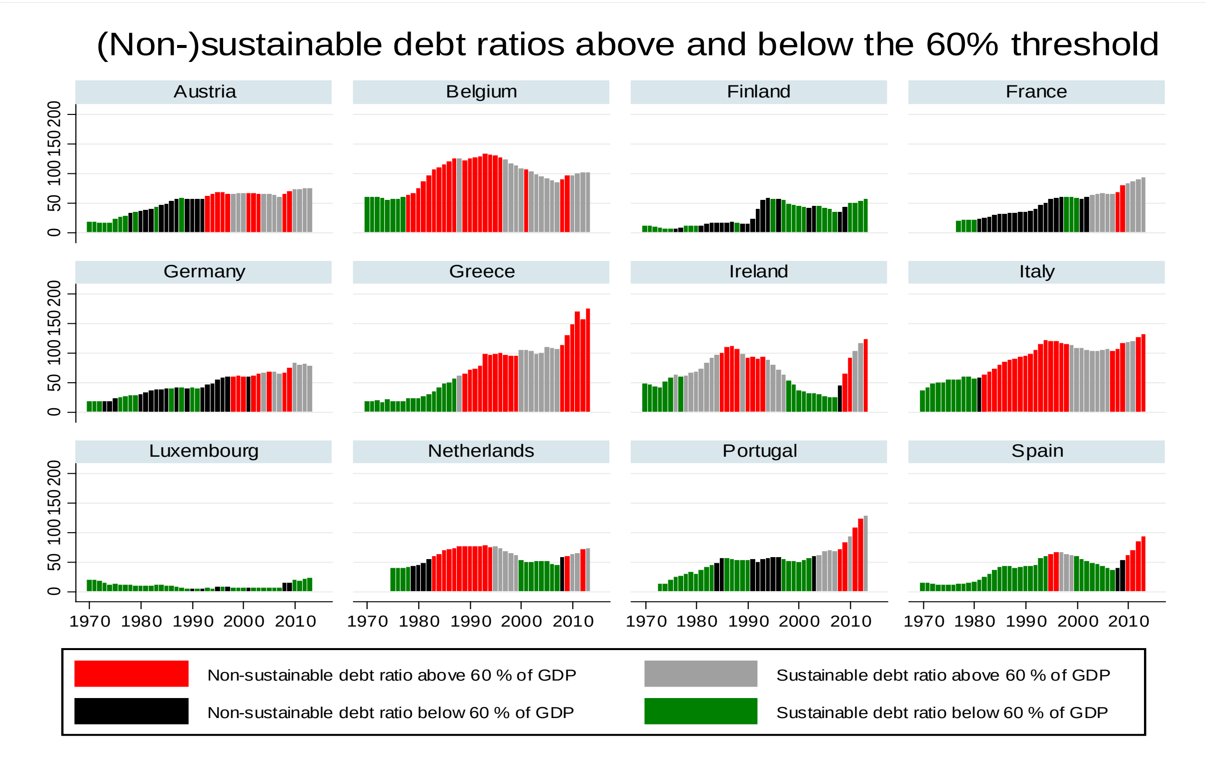
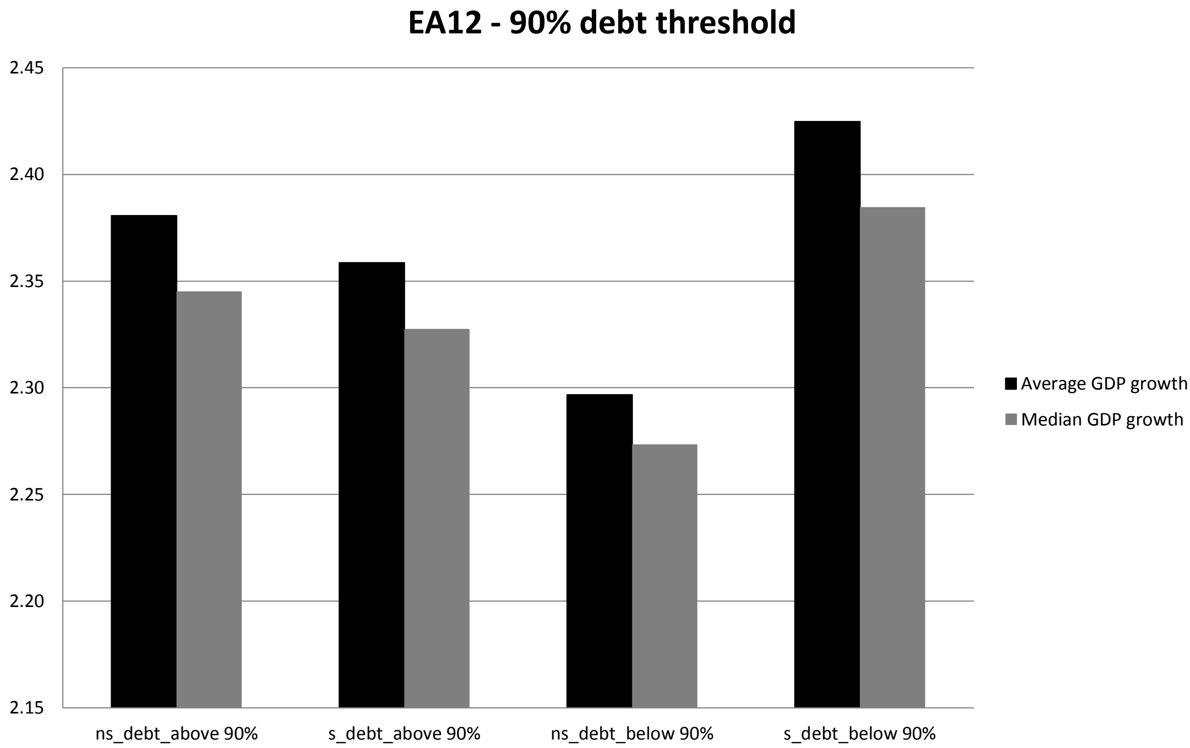


Figure 2: Average and median real GDP/cap growth during periods of (non-)sustainable debt-to-GDP ratio above and below the 90%/60% threshold, EA12, 1970–2013



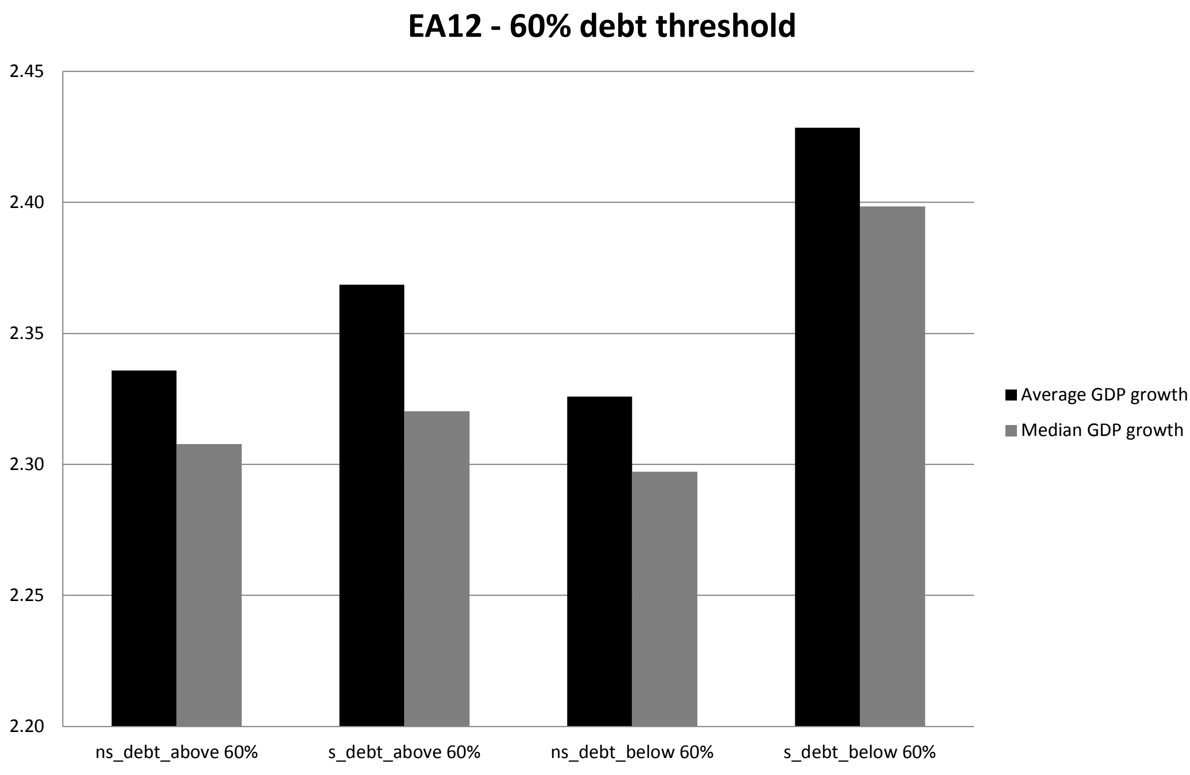


Table 1: The role of (non-)sustainable debt-ratio thresholds on annual economic growth, EA12 (1970-2013)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable	Annual growth rate	Annual growth rate	Annual growth rate	Annual growth rate	Annual growth rate	Annual growth rate	Annual growth rate	Annual growth rate
Instruments	$L(1/5).debt^{(n)s}$	$L(1/5).debt^{(n)s}$	$L(1/5).debt^{(n)s}$	$L(1/5).debt^{(n)s}$	$L(1/5).debt^{(n)s}$	$L(1/5).debt^{(n)s}$	$L(1/5).debt^{(n)s}$	$L(1/5).debt^{(n)s}$
Estimator	IV/2SLS	IV/GMM	IV/2SLS	IV/GMM	IV/2SLS	IV/GMM	IV/2SLS	IV/GMM
$debt^{nsa90\%}$	-0.0066	-0.0060	-0.0078	-0.0018				
	(0.0114)	(0.0116)	(0.0114)	(0.0143)				
$debt^{sa90\%}$	0.0060	0.0079	0.0101	0.0142				
	(0.0138)	(0.0121)	(0.0142)	(0.0148)				
$debt^{nsb90\%}$	0.0083	0.0056	0.0084	0.0121				
	(0.0162)	(0.0152)	(0.0165)	(0.0183)				
$debt^{sb90\%}$	0.0264*	0.0343**	0.0303*	0.0367**				
	(0.0160)	(0.0148)	(0.0160)	(0.0170)				
$debt^{nsa60\%}$					-0.0263**	-0.0201*	-0.0304***	-0.0207*
					(0.0112)	(0.0113)	(0.0115)	(0.0115)
$debt^{sa60\%}$					-0.0093	-0.0010	-0.0092	-0.0015
					(0.0125)	(0.0108)	(0.0129)	(0.0109)
$debt^{nsb60\%}$					-0.0469**	-0.0405**	-0.0544**	-0.0429**
					(0.0208)	(0.0184)	(0.0223)	(0.0193)
$debt^{sb60\%}$					0.0030	0.0168	0.0036	0.0165
					(0.0156)	(0.0147)	(0.0159)	(0.0147)
gov_rev_ca	0.0036	0.0172	0.0025	-0.0052	0.0318	0.0205	0.0415	0.0215
	(0.0419)	(0.0427)	(0.0425)	(0.0504)	(0.0434)	(0.0387)	(0.0460)	(0.0400)
gov_cab	0.0699*	0.0505	0.0716*	0.0751*	0.0222	0.0360	0.0175	0.0446
	(0.0402)	(0.0382)	(0.0427)	(0.0452)	(0.0355)	(0.0310)	(0.0378)	(0.0317)
$ln(GDP/cap)$	-3.0962**	-2.2218*	-2.6616*	-1.6926	-4.4194***	-3.4525***	-3.9769***	-3.1749***
	(1.4286)	(1.2555)	(1.4641)	(1.4437)	(1.3235)	(1.1682)	(1.3768)	(1.1441)
$pop.growth$	-1.6214***	-1.4560***	-1.6278***	-1.4835***	-1.7561***	-1.6371***	-1.8045***	-1.6730***
	(0.3180)	(0.3493)	(0.3235)	(0.4030)	(0.3186)	(0.3166)	(0.3300)	(0.3246)
$gfcf\_total$	0.0154	0.0086			0.0212	-0.0043		
	(0.0536)	(0.0605)			(0.0540)	(0.0575)		
$gfcf\_pub$			0.0138	0.0122			0.0203	0.0141
			(0.0176)	(0.0133)			(0.0190)	(0.0132)
$gfcf\_priv$			0.0021	0.0071			0.0102	-0.0197
			(0.0561)	(0.0664)			(0.0589)	(0.0606)
$openness$	0.0188***	0.0171	0.0201***	0.0202*	0.0226***	0.0153	0.0245***	0.0167
	(0.0073)	(0.0104)	(0.0074)	(0.0110)	(0.0072)	(0.0103)	(0.0075)	(0.0105)
LT_real_i	-0.1474***	-0.1248***	-0.1271**	-0.1061**	-0.1254**	-0.1272**	-0.1006*	-0.1259**
	(0.0511)	(0.0470)	(0.0520)	(0.0538)	(0.0515)	(0.0499)	(0.0540)	(0.0503)
$CountryFE$	YES	YES	YES	YES	YES	YES	YES	YES
$TimeFE$	YES	YES	YES	YES	YES	YES	YES	YES
Observations	374	370	382	382	374	370	382	370
R^2	0.689	0.673	0.687	0.680	0.695	0.675	0.687	0.673
R^2-adj	0.628	0.609	0.624	0.616	0.636	0.611	0.624	0.609

Note: In specifications under columns (1)-(4) and (5)-(8), the threshold is set to 90% and 60%, respectively. The (non-)sustainable debt-ratios above and below the 60%/90% threshold are instrumented by their time lags (up to the 5th lag). All explanatory variables are lagged by 1 year relative to the dependent variable so as to avoid further endogeneity issues. Robust standard errors in parentheses. *, ** and *** indicate significance at 10%, 5% and 1% level, respectively.

Table 2: The role of (non-)sustainable debt-ratio thresholds on long-run (cumulative 5-year overlapping) economic growth, EA12 (1970-2013)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable	Cumulative 5-yr overlapping growth rate	Cumulative 5-yr overlapping growth rate	Cumulative 5-yr overlapping growth rate	Cumulative 5-yr overlapping growth rate	Cumulative 5-yr overlapping growth rate	Cumulative 5-yr overlapping growth rate	Cumulative 5-yr overlapping growth rate	Cumulative 5-yr overlapping growth rate
Instruments	$L(1/5).debt^{(n)s}$	$L(1/5).debt^{(n)s}$	$L(1/5).debt^{(n)s}$	$L(1/5).debt^{(n)s}$	$L(1/5).debt^{(n)s}$	$L(1/5).debt^{(n)s}$	$L(1/5).debt^{(n)s}$	$L(1/5).debt^{(n)s}$
Estimator	IV/2SLS	IV/GMM	IV/2SLS	IV/GMM	IV/2SLS	IV/GMM	IV/2SLS	IV/GMM
$debt^{nsa90\%}$	-0.1258***	-0.1120***	-0.1388***	-0.1298***				
	(0.0404)	(0.0407)	(0.0422)	(0.0423)				
$debt^{sa90\%}$	-0.0448	-0.0343	-0.0489	-0.0453				
	(0.0493)	(0.0472)	(0.0492)	(0.0467)				
$debt^{nsb90\%}$	-0.1092*	-0.1028*	-0.1211**	-0.1152**				
	(0.0617)	(0.0602)	(0.0593)	(0.0574)				
$debt^{sb90\%}$	0.0635	0.0556	0.0548	0.0462				
	(0.0730)	(0.0675)	(0.0778)	(0.0752)				
$debt^{nsa60\%}$					-0.1173***	-0.1062**	-0.1321***	-0.1276**
					(0.0421)	(0.0474)	(0.0457)	(0.0513)
$debt^{sa60\%}$					-0.0490	-0.0354	-0.0532	-0.0416
					(0.0536)	(0.0537)	(0.0524)	(0.0548)
$debt^{nsb60\%}$					-0.0723	-0.0534	-0.0985	-0.0806
					(0.0816)	(0.0790)	(0.0774)	(0.0791)
$debt^{sb60\%}$					-0.0725	-0.0659	-0.0257	-0.0066
					(0.0778)	(0.0752)	(0.0804)	(0.0818)
gov_rev_ca	0.1116	0.0762	0.1993	0.1805	-0.0461	-0.0750	0.2257	0.2544**
	(0.1821)	(0.1677)	(0.1829)	(0.1704)	(0.1408)	(0.1289)	(0.1431)	(0.1205)
gov_cab	-0.1529	-0.2365	0.3059	0.2402	-0.2310	-0.2868*	0.3922	0.4311*
	(0.2043)	(0.2040)	(0.2988)	(0.2731)	(0.1854)	(0.1662)	(0.2633)	(0.2546)
$ln(GDP/cap)$	-34.0928***	-35.4276***	-30.9920***	-32.4467***	-39.6223***	-40.3262***	-35.8162***	-37.5064***
	(5.2411)	(5.3549)	(5.5278)	(5.6582)	(4.9062)	(5.3726)	(4.7592)	(5.2588)
$pop.growth$	-0.9976	-1.5218	-0.2831	-0.4300	-2.3775**	-1.9568*	-1.4888	-0.8662
	(1.2829)	(1.4028)	(1.4277)	(1.5027)	(1.0718)	(1.1050)	(1.1745)	(1.2034)
$gfcf\_pub$	0.0229	0.0183			-0.0717	-0.0951*		
	(0.0768)	(0.0631)			(0.0650)	(0.0530)		
$gfcf\_priv$	0.0267	0.1147			-0.1175	-0.1554		
	(0.2183)	(0.2146)			(0.2041)	(0.2076)		
$saving\_pub$			-0.6064	-0.5971			-0.6745*	-0.7863**
			(0.3917)	(0.3834)			(0.3455)	(0.3246)
$saving\_priv$			0.1010	0.1518			0.3152*	0.3809**
			(0.1972)	(0.2198)			(0.1695)	(0.1752)
$openness$	0.0617**	0.0562	0.0442	0.0376	0.0737***	0.0603*	0.0521*	0.0438
	(0.0305)	(0.0391)	(0.0319)	(0.0390)	(0.0266)	(0.0335)	(0.0280)	(0.0344)
LT_real_i	0.0396	0.0225	-0.0309	-0.0735	0.0394	0.0063	-0.0198	-0.0368
	(0.2095)	(0.2223)	(0.2125)	(0.2223)	(0.1739)	(0.1808)	(0.1712)	(0.1753)
$CountryFE$	YES	YES	YES	YES	YES	YES	YES	YES
$TimeFE$	YES	YES	YES	YES	YES	YES	YES	YES
Obs.	334	334	334	334	334	334	334	334
R^2	0.666	0.687	0.660	0.682	0.758	0.749	0.758	0.743
R^2-adj	0.593	0.618	0.585	0.613	0.705	0.694	0.705	0.687

Note: In specifications under columns (1)-(4) and (5)-(8), the threshold is set to 90% and 60%, respectively. The (non-)sustainable debt-ratios above and below the 60%/90% threshold are instrumented by their time lags (up to the 5th lag). All explanatory variables are lagged by 5 years relative to the dependent variable so as to avoid further endogeneity issues. Robust standard errors in parenthesis. *, ** and *** indicate significance at 10%, 5% and 1% level, respectively.

Table 3: The role of (non-)sustainable debt-ratio thresholds on long-run (cumulative 5-year non-overlapping) economic growth, EA12 (1970-2013)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable	Cumulative 5-yr non-overlapping growth rate	Cumulative 5-yr non-overlapping growth rate	Cumulative 5-yr non-overlapping growth rate	Cumulative 5-yr non-overlapping growth rate	Cumulative 5-yr non-overlapping growth rate	Cumulative 5-yr non-overlapping growth rate	Cumulative 5-yr non-overlapping growth rate	Cumulative 5-yr non-overlapping growth rate
Instruments	$L(1/2).debt^{(n)s}$	$L(1/2).debt^{(n)s}$	$L(1/2).debt^{(n)s}$	$L(1/2).debt^{(n)s}$	$L(1/2).debt^{(n)s}$	$L(1/2).debt^{(n)s}$	$L(1/2).debt^{(n)s}$	$L(1/2).debt^{(n)s}$
Estimator	IV/2SLS	IV/GMM	IV/2SLS	IV/GMM	IV/2SLS	IV/GMM	IV/2SLS	IV/GMM
$debt^{nsa90\%}$	-0.1991***	-0.2387**	-0.2084**	-0.1817***				
	(0.0753)	(0.0970)	(0.0819)	(0.0668)				
$debt^{sa90\%}$	-0.2739**	-0.4401***	-0.2635**	-0.2599***				
	(0.1064)	(0.1115)	(0.1074)	(0.0886)				
$debt^{nsb90\%}$	-0.3945***	-0.4424**	-0.3792***	-0.3325***				
	(0.1156)	(0.1830)	(0.1190)	(0.0994)				
$debt^{sb90\%}$	-0.1284	-0.1693	-0.1162	-0.1116				
	(0.0989)	(0.1360)	(0.1052)	(0.0929)				
$debt^{nsa60\%}$					-0.1233*	-0.1483***	-0.1768**	-0.1729***
					(0.0704)	(0.0545)	(0.0740)	(0.0486)
$debt^{sa60\%}$					-0.1075	-0.1024	-0.1720*	-0.1487**
					(0.0860)	(0.0666)	(0.0881)	(0.0592)
$debt^{nsb60\%}$					-0.1988*	-0.2389**	-0.2446**	-0.2817***
					(0.1036)	(0.1067)	(0.1183)	(0.0923)
$debt^{sb60\%}$					-0.0929	-0.1289	-0.1053	-0.0688
					(0.0990)	(0.0889)	(0.1157)	(0.0881)
gov_rev_ca	1.2632***	1.6348**	1.1128**	0.9665**	0.0410	-0.1420	0.3127	0.1108
	(0.4621)	(0.6918)	(0.5007)	(0.4551)	(0.2887)	(0.2193)	(0.2709)	(0.1985)
gov_cab	0.9530**	1.6023***	1.0240*	0.6453	0.2987	0.0186	0.8696**	0.6410**
	(0.4516)	(0.4664)	(0.6130)	(0.5028)	(0.2495)	(0.2366)	(0.3910)	(0.3117)
$ln(GDP/cap)$	-56.0185***	-70.9148***	-53.0514***	-50.8361***	-34.0975***	-27.6782**	-32.9936***	-26.1958***
	(14.8687)	(12.3801)	(15.0449)	(14.0135)	(11.2125)	(11.0298)	(11.0316)	(9.0325)
$pop.growth$	2.8793	5.4948	2.7560	2.1916	-2.7545	-2.2265	-3.2991*	-3.1522*
	(3.7180)	(4.1842)	(3.3820)	(2.9323)	(2.0419)	(1.9543)	(1.9248)	(1.7533)
$gfcf\_pub$	0.1113	0.1615			-0.0400	-0.0145		
	(0.1501)	(0.1833)			(0.0985)	(0.1019)		
$gfcf\_priv$	-0.3664	-0.4355			-0.6301	-0.8927***		
	(0.4723)	(0.4469)			(0.4118)	(0.2477)		
$saving\_pub$			-0.6055	-0.1749			-1.0490**	-1.1492***
			(0.7561)	(0.6949)			(0.5253)	(0.4094)
$saving\_priv$			-0.3650	-0.2033			-0.0758	-0.1854
			(0.5514)	(0.4800)			(0.3802)	(0.2425)
$openness$	0.1504**	0.2380***	0.1541**	0.1259**	0.0722	0.0736*	0.0831	0.0668
	(0.0718)	(0.0704)	(0.0691)	(0.0592)	(0.0577)	(0.0416)	(0.0561)	(0.0416)
LT_real_i	-0.9659	-0.4967	-0.8591	-0.6150	-0.3743	-0.2925	-0.1635	-0.2814
	(0.6933)	(0.9744)	(0.6527)	(0.5654)	(0.3096)	(0.2731)	(0.3159)	(0.2756)
$CountryFE$	YES	YES	YES	YES	YES	YES	YES	YES
$TimeFE$	YES	YES	YES	YES	YES	YES	YES	YES
Obs.	66	66	66	66	61	65	65	65
R^2	0.697	0.589	0.697	0.743	0.824	0.801	0.828	0.791
R^2-adj	0.444	0.247	0.444	0.529	0.665	0.630	0.681	0.612

Note: In specifications under columns (1)-(4) and (5)-(8), the threshold is set to 90% and 60%, respectively. The (non-)sustainable debt-ratios above and below the 60%/90% threshold are instrumented by their time lags (up to the 2th lag). All explanatory variables are lagged by 5 year relative to the dependent variable so as to avoid further endogeneity issues. Robust standard errors in parenthesis. *, ** and *** indicate significance at 10%, 5% and 1% level, respectively.

Table 4: Dynamic analysis: The role of (non-)sustainable debt-ratio thresholds on annual economic growth, EA12 (1970-2013)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Dependent variable	Annual growth rate	Annual growth rate	Annual growth rate	Annual growth rate	Annual growth rate	Annual growth rate	Annual growth rate	Annual growth rate	Annual growth rate	Annual growth rate	Annual growth rate	Annual growth rate
Instruments			$L(1/5).debt^{(n)s}$			$L(1/5).debt^{(n)s}$			$L(1/5).debt^{(n)s}$			$L(1/5).debt^{(n)s}$
Estimator	Pooled-OLS	FE-OLS	Sys-GMM	Pooled-OLS	FE-OLS	Sys-GMM	Pooled-OLS	FE-OLS	Sys-GMM	Pooled-OLS	FE-OLS	Sys-GMM
LDV	0.4157***	0.2829***	0.3502***	0.4127***	0.2835***	0.3497***	0.4140***	0.2737***	0.3435***	0.4132***	0.2732***	0.3455***
	(0.0660)	(0.0878)	(0.0760)	(0.0670)	(0.0880)	(0.0783)	(0.0670)	(0.0828)	(0.0798)	(0.0683)	(0.0822)	(0.0815)
$debt^{nsa90\%}$	-0.0274***	-0.0274	-0.0078	-0.0239***	-0.0267	-0.0056						
	(0.0052)	(0.0171)	(0.0056)	(0.0055)	(0.0179)	(0.0063)						
$debt^{sa90\%}$	-0.0108**	-0.0168	0.0030	-0.0068	-0.0162	0.0053						
	(0.0046)	(0.0154)	(0.0062)	(0.0048)	(0.0164)	(0.0066)						
$debt^{nsb90\%}$	-0.0345***	-0.0244	-0.0033	-0.0290***	-0.0236	-0.0006						
	(0.0079)	(0.0194)	(0.0078)	(0.0085)	(0.0203)	(0.0090)						
$debt^{sb90\%}$	-0.0044	-0.0118	0.0091	0.0008	-0.0110	0.0119						
	(0.0066)	(0.0165)	(0.0079)	(0.0070)	(0.0175)	(0.0093)						
$debt^{nsa60\%}$							-0.0326***	-0.0332*	-0.0144***	-0.0292***	-0.0333*	-0.0127**
							(0.0053)	(0.0158)	(0.0046)	(0.0055)	(0.0163)	(0.0054)
$debt^{sa60\%}$							-0.0127***	-0.0233	-0.0037	-0.0088*	-0.0235	-0.0020
							(0.0045)	(0.0138)	(0.0056)	(0.0046)	(0.0145)	(0.0059)
$debt^{nsb60\%}$							-0.0514***	-0.0444**	-0.0263***	-0.0469***	-0.0460**	-0.0253***
							(0.0095)	(0.0159)	(0.0063)	(0.0099)	(0.0165)	(0.0070)
$debt^{sb60\%}$							-0.0148*	-0.0205	-0.0036	-0.0119	-0.0217	-0.0022
							(0.0089)	(0.0175)	(0.0103)	(0.0091)	(0.0183)	(0.0112)
gov_rev_ca	0.0117	0.0396	-0.0295	0.0012	0.0380	-0.0314	0.0145	0.0513	-0.0146	0.0060	0.0509	-0.0132
	(0.0246)	(0.0685)	(0.0255)	(0.0245)	(0.0712)	(0.0279)	(0.0235)	(0.0648)	(0.0247)	(0.0232)	(0.0663)	(0.0265)
gov_cab	-0.0215	0.0086	0.0635*	-0.0107	0.0182	0.0747*	-0.0157	0.0004	0.0426	-0.0062	0.0132	0.0529*
	(0.0364)	(0.0364)	(0.0331)	(0.0379)	(0.0395)	(0.0356)	(0.0348)	(0.0306)	(0.0270)	(0.0357)	(0.0343)	(0.0288)
$ln(GDP/cap)$	-2.4357***	-5.1126**	-1.2976*	-1.6690**	-4.9790**	-1.1494	-2.6265***	-5.3560***	-1.5140**	-1.8986***	-5.0874**	-1.5400**
	(0.5625)	(1.8100)	(0.6544)	(0.6767)	(1.8334)	(0.7635)	(0.5784)	(1.6462)	(0.5782)	(0.6901)	(1.7005)	(0.7017)
$pop.growth$	-0.5401*	-1.1774*	-0.6209**	-0.5764*	-1.1942*	-0.6718**	-0.4853	-1.2220*	-0.6881**	-0.5371*	-1.2517*	-0.7573***
	(0.3094)	(0.6468)	(0.2453)	(0.3126)	(0.6559)	(0.2250)	(0.3082)	(0.6233)	(0.2537)	(0.3104)	(0.6346)	(0.2260)
$gfcf\_total$	-0.1318***	-0.0428	-0.1013				-0.1531***	-0.0453	-0.1033			
	(0.0459)	(0.1032)	(0.0632)				(0.0460)	(0.1022)	(0.0649)			
$gfcf\_pub$				-0.0157	0.0089	-0.0004				-0.0139	0.0151	0.0043
				(0.0115)	(0.0169)	(0.0092)				(0.0114)	(0.0169)	(0.0092)
$gfcf\_priv$				-0.1417***	-0.0555	-0.1024				-0.1601***	-0.0662	-0.0959
				(0.0512)	(0.1074)	(0.0643)				(0.0499)	(0.1053)	(0.0633)
$openness$	0.0086**	0.0170	0.0097**	0.0035	0.0183	0.0091*	0.0077**	0.0180	0.0092**	0.0030	0.0200	0.0100**
	(0.0037)	(0.0131)	(0.0034)	(0.0052)	(0.0138)	(0.0042)	(0.0037)	(0.0123)	(0.0033)	(0.0051)	(0.0130)	(0.0041)
LT_real_i	0.0411	-0.0788**	-0.0704***	0.0331	-0.0796**	-0.0729**	0.0416	-0.0798**	-0.0765**	0.0329	-0.0817**	-0.0746**
	(0.0633)	(0.0340)	(0.0228)	(0.0667)	(0.0340)	(0.0255)	(0.0636)	(0.0349)	(0.0252)	(0.0667)	(0.0349)	(0.0290)
$\_cons$	11.3723***	14.3576**		9.6849***	14.0142*		12.7843***	14.8854**		11.0216***	14.3294*	
	(2.1981)	(6.5109)		(2.0093)	(6.8368)		(2.2797)	(6.2525)		(2.1368)	(6.6326)	
$CountryFE$	NO	YES	YES	NO	YES	YES	NO	YES	YES	NO	YES	YES
$TimeFE$	NO	YES	YES	NO	YES	YES	NO	YES	YES	NO	YES	YES
Obs.	390	390	390	390	390	390	390	390	390	390	390	390
R^2	0.408	0.728		0.410	0.728		0.412	0.731		0.412	0.732	
R^2-adj	0.389	0.684		0.389	0.684		0.393	0.688		0.392	0.688	
AR(1)			-2.527**			-2.534**			-2.484**			-2.488**
			[0.0115]			[0.0113]			[0.0130]			[0.0128]
AR(2)			0.912			0.904			0.776			0.770
			[0.362]			[0.366]			[0.438]			[0.441]

Note: In specifications under columns (1)-(6) and (7)-(12), the threshold is set to 90% and 60%, respectively. The (non-)sustainable debt-ratios above and below the 60%/90% threshold are instrumented by their time lags (up to the 5th lag). All explanatory variables are lagged by 1 year relative to the dependent variable so as to avoid further endogeneity issues. LDV is the lagged dependent variable. First order serial correlation in first-differenced residuals (AR 1 significant) with no second order serial correlation (AR 2 insignificant) supports the claim that instruments for the system-GMM analysis are valid. LDV coefficient of the system-GMM between the pooled-OLS and FE-OLS coefficients suggest a good model fit. Robust standard errors in parenthesis. *, ** and *** indicate significance at 10%, 5% and 1% level, respectively.

Table 5: Robustness analysis: (Non-)dynamic analysis of the role of (non-)sustainable debt above and below the 90% and 60%, respectively, thresholds, EA12 (1970-2013)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
Dependent variable	Annual gr. rate	Annual gr. rate	Annual gr. rate	Annual gr. rate	Cum. 5-yr overlap. gr. rate	Cum. 5-yr overlap. gr. rate	Cum. 5-yr overlap. gr. rate	Cum. 5-yr overlap. gr. rate	Cum. 5-yr non-overl. gr. rate	Cum. 5-yr non-overl. gr. rate	Cum. 5-yr non-overl. gr. rate	Cum. 5-yr non-overl. gr. rate	Annual gr. rate	Annual gr. rate	Annual gr. rate	Annual gr. rate	Annual gr. rate	Annual gr. rate
Instruments	$L(1/5).debt^{(n)s}$	$L(1/5).debt^{(n)s}$	$L(1/5).debt^{(n)s}$	$L(1/5).debt^{(n)s}$	$L(1/5).debt^{(n)s}$	$L(1/5).debt^{(n)s}$	$L(1/5).debt^{(n)s}$	$L(1/5).debt^{(n)s}$	$L(1/2).debt^{(n)s}$	$L(1/2).debt^{(n)s}$	$L(1/2).debt^{(n)s}$	$L(1/2).debt^{(n)s}$			$L(1/5).debt^{(n)s}$			$L(1/5).debt^{(n)s}$
Estimator	IV/2SLS	IV/GMM	IV/2SLS	IV/GMM	IV/2SLS	IV/GMM	IV/2SLS	IV/GMM	IV/2SLS	IV/GMM	IV/2SLS	IV/GMM	Pooled-OLS	FE-OLS	Sys-GMM	Pooled-OLS	FE-OLS	Sys-GMM
LDV													0.4267***	0.2825***	0.3523***	0.4242***	0.2830***	0.3537***
													(0.0699)	(0.0805)	(0.0765)	(0.0709)	(0.0799)	(0.0799)
$debt^{nsa90\%}$	-0.0169***	-0.0092**	-0.0176***	-0.0092**	-0.0458***	-0.0424**	-0.0329*	-0.0331*	-0.0066	0.0072	0.0007	0.0126	-0.0158***	-0.0118**	-0.0100***	-0.0154***	-0.0120**	-0.0095***
	(0.0046)	(0.0038)	(0.0047)	(0.0039)	(0.0172)	(0.0176)	(0.0187)	(0.0192)	(0.0447)	(0.0362)	(0.0356)	(0.0426)	(0.0035)	(0.0046)	(0.0021)	(0.0035)	(0.0046)	(0.0022)
$debt^{sa90\%}$	-0.0000	0.0025	-0.0004	0.0027	0.0040	0.0072	0.0122	0.0159	0.0253	0.0134	-0.0518	0.0345	-0.0011	-0.0009	0.0000	-0.0002	-0.0011	0.0005
	(0.0055)	(0.0045)	(0.0055)	(0.0046)	(0.0199)	(0.0202)	(0.0193)	(0.0197)	(0.0489)	(0.0269)	(0.0576)	(0.0291)	(0.0030)	(0.0049)	(0.0040)	(0.0029)	(0.0050)	(0.0039)
$debt^{nsb60\%}$	-0.0358***	-0.0285***	-0.0380***	-0.0298***	-0.1182***	-0.1252***	-0.0966**	-0.1020***	0.0331	0.0203	-0.0731	0.0105	-0.0207***	-0.0119**	-0.0146***	-0.0215***	-0.0133**	-0.0156***
	(0.0117)	(0.0105)	(0.0123)	(0.0109)	(0.0417)	(0.0443)	(0.0403)	(0.0393)	(0.0958)	(0.0774)	(0.0594)	(0.0878)	(0.0063)	(0.0048)	(0.0042)	(0.0065)	(0.0052)	(0.0046)
$debt^{sb60\%}$	0.0231**	0.0229***	0.0231**	0.0228***	0.0709*	0.0798*	0.0911**	0.1000***	0.1640*	0.0736	0.0860	0.1336*	0.0099	0.0087	0.0042	0.0077	0.0076	0.0035
	(0.0096)	(0.0087)	(0.0098)	(0.0088)	(0.0388)	(0.0417)	(0.0356)	(0.0384)	(0.0863)	(0.0639)	(0.0578)	(0.0797)	(0.0071)	(0.0056)	(0.0065)	(0.0072)	(0.0056)	(0.0066)
gov_rev_ca	0.0284	0.0069	0.0308	0.0053	-0.2018*	-0.1639	0.0916	0.1066	-0.1572	-0.4900*	0.4388	-0.0769	-0.0061	0.0180	-0.0245	-0.0140	0.0168	-0.0214
	(0.0382)	(0.0357)	(0.0389)	(0.0362)	(0.1166)	(0.1205)	(0.1343)	(0.1303)	(0.3825)	(0.2884)	(0.3422)	(0.3409)	(0.0243)	(0.0459)	(0.0218)	(0.0237)	(0.0462)	(0.0226)
gov_cab	0.0707**	0.0637**	0.0820**	0.0723**	0.2474	0.2587	0.4779*	0.5131**	0.2065	0.2060	0.9905**	0.6297	0.0666*	0.0483*	0.0725***	0.0685**	0.0620**	0.0784***
	(0.0334)	(0.0277)	(0.0361)	(0.0299)	(0.1615)	(0.1626)	(0.2484)	(0.2343)	(0.3257)	(0.2746)	(0.4439)	(0.4423)	(0.0343)	(0.0243)	(0.0164)	(0.0340)	(0.0249)	(0.0176)
$ln(GDP/cap)$	-3.5152***	-2.8483**	-3.0020**	-2.6964**	-37.4729***	-36.4456***	-37.8442***	-37.1693***	-37.9999**	-34.8063**	-42.8125***	-33.9481**	-2.4460***	-4.2205**	-1.4537**	-1.6754**	-3.9432**	-1.4844**
	(1.3238)	(1.1386)	(1.3205)	(1.1638)	(4.6937)	(5.6452)	(4.6642)	(5.4361)	(17.0590)	(14.8138)	(13.0244)	(14.9779)	(0.6025)	(1.6384)	(0.5078)	(0.7107)	(1.7188)	(0.5747)
$pop.growth$	-1.7517***	-1.5247***	-1.7885***	-1.5475***	-2.3189**	-2.7149**	-2.6127***	-2.8238***	-2.2660	-1.0544	-3.0607	-2.4618	-0.4207	-1.0588*	-0.6401**	-0.4647	-1.0676*	-0.7263***
	(0.4152)	(0.3200)	(0.4126)	(0.3238)	(1.0178)	(1.0763)	(0.9842)	(1.0674)	(3.1467)	(2.5004)	(1.9460)	(2.6737)	(0.3267)	(0.5436)	(0.2224)	(0.3295)	(0.5382)	(0.1919)
$openness$	0.0231**	0.0176*	0.0249**	0.0191*	0.0898***	0.0818**	0.0891***	0.0795**	0.0560	0.0435	0.1385**	0.0301	0.0078**	0.0176	0.0093**	0.0016	0.0192	0.0097**
	(0.0107)	(0.0103)	(0.0108)	(0.0104)	(0.0260)	(0.0367)	(0.0254)	(0.0330)	(0.0647)	(0.0565)	(0.0641)	(0.0643)	(0.0038)	(0.0141)	(0.0033)	(0.0052)	(0.0148)	(0.0038)
LT_real_i	-0.1367***	-0.1721***	-0.1346***	-0.1731***	-0.0391	-0.0881	-0.0265	-0.0623	-0.2995	-0.2700	-0.2413	-0.4060	0.0067	-0.0997**	-0.0835**	-0.0110	-0.1027**	-0.0839**
	(0.0510)	(0.0482)	(0.0511)	(0.0479)	(0.1762)	(0.2061)	(0.1699)	(0.1904)	(0.4683)	(0.3479)	(0.4135)	(0.3751)	(0.0638)	(0.0369)	(0.0274)	(0.0661)	(0.0374)	(0.0309)
$gfcf\_pub$			0.0213	0.0095	-0.0522	-0.0508			-0.0399	-0.0706						-0.0179	0.0138	0.0029
			(0.0145)	(0.0138)	(0.0601)	(0.0469)			(0.1252)	(0.1104)						(0.0119)	(0.0137)	(0.0099)
$gfcf\_priv$			-0.0141	-0.0432	-0.2667	-0.2498			-0.3625	-0.8352**						-0.1966***	-0.0690	-0.1137*
			(0.0780)	(0.0655)	(0.1848)	(0.2041)			(0.4753)	(0.3609)						(0.0502)	(0.0965)	(0.0615)
$gfcf\_total$	0.0104	-0.0305											-0.1599***	-0.0416	-0.1162*			
	(0.0740)	(0.0634)											(0.0465)	(0.0945)	(0.0645)			
$saving\_pub$							-0.0633	-0.1172			-0.1143	-0.6580						
							(0.3281)	(0.3043)			(0.6245)	(0.6452)						
$saving\_priv$							0.4878***	0.4907***			0.3125	0.3323						
							(0.1521)	(0.1709)			(0.4694)	(0.3797)						
$\_cons$													12.2650***	12.2017*		11.3035***	11.8233*	
													(2.4027)	(6.0937)		(2.2444)	(6.4533)	
$CountryFE$	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES		YES	YES		YES	YES
$TimeFE$	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES		YES	YES		YES	YES
Obs	374	374	374	374	344	344	344	344	66	66	69	66	390	390	390	390	390	390
R^2	0.677	0.676	0.675	0.676	0.738	0.729	0.751	0.741	0.732	0.774	0.771	0.739	0.370	0.727		0.377	0.728	
R^2-adj	0.614	0.613	0.610	0.611	0.681	0.670	0.696	0.684	0.509	0.586	0.585	0.522	0.350	0.683		0.355	0.683	
AR(1)															-2.470			-2.475
															0.0135			0.0133
AR(2)															0.923			0.905
															0.356			0.366

Note: Columns (1)-(12) report the non-dynamic results, while columns (13)-(18) the dynamic results. The (non-)sustainable debt-ratios above the 90% and below the 60% threshold are instrumented by their time lags (up to the 5th lag). All explanatory variables are lagged by 1 and 5 years relative to the dependent variable so as to avoid further endogeneity issues. *LDV* is the lagged dependent variable. First order serial correlation in first-differenced residuals (AR 1 significant) with no second order serial correlation (AR 2 insignificant) supports the claim that instruments for the system-GMM analysis are valid. *LDV* coefficient of the system-GMM between the pooled-OLS and FE-OLS coefficients suggest a good model fit in the dynamic specifications. Robust standard errors in parenthesis. *, ** and *** indicate significance at 10%, 5% and 1% level, respectively.

Table A.1: Data definition and sources

Variable	Definition	Source
debt	Gross government debt (% GDP)	AMECO
gov_bal	Government budget balance (% of GDP)	AMECO
gov_primary_bal	Government budget primary balance (excl. interest payments; % of GDP)	AMECO
gov_cab	Cyclically adjusted gov. balance (% of GDP at market prices)	AMECO
gov_rev_ca	Cyclically adjusted gov. revenue (% of GDP at market prices)	AMECO
GDP_cap	GDP at 2000 market prices per head of population (1000 euro)	AMECO
potentialGDP	Potential gross domestic product at 2000 market prices (bill. EUR)	AMECO
trendGDP	Trend gross domestic product at 2000 market prices (bill. EUR)	AMECO
pop.growth	Total populationgrowth rate	AMECO
openness	Calculated as sum of exports and imports (% of GDP)	AMECO
CA_bal	Current account balance (% GDP)	AMECO
gfcf_total	Gross fixed capital formation: total economy (% GDP)	AMECO
gfcf_gov	Gross fixed capital formation: general government (% GDP)	AMECO
gfcf_priv	Gross fixed capital formation: private sector (% GDP)	AMECO
saving_total	Gross national saving: total economy (%GDP)	AMECO
saving_pub	Gross saving: general government (% GDP)	AMECO
saving_priv	Gross saving: private sector (% GDP)	AMECO
reer	Real effective exchange rate, based on ULC, relative to rest 23 industrial countries	AMECO
LT_nom_i	Nominal long-term (LT) interest rates, sovereign (mostly central government LT bond yields)	AMECO
LT_real_i	Real long-term interest rates, sovereign; deflator: GDP at market prices	AMECO
ST_nom_i	Nominal short-term (ST) interest rates (3M-EURIBOR after 1999)	AMECO
ST_real_i	Real short-term interest rates; deflator: GDP at market prices	AMECO
inflation (GDPdefl.)	Annual rate of change in GDP deflator at market prices	AMECO
output_gap	Gap between actual and trend GDP at 2000 market prices/trend GDP	AMECO
old_dep_ratio	Age dependency ratio, old (% of population over 65 in working-age population)	WDI
young_dep_ratio	Age dependency ratio, young (% of population under 15 in working-age population)	WDI
credit_priv	Domestic credit to private sector (% of GDP)	WDI
TFP_g	Growth rate of Total Factor Productivity (TFP), calculated based on TFP_index (2000=100)	AMECO

Note: Our database consist of the same variables as those in Checherita-Westphal and Rother (2012).

Table A.2: Replication of Checherita-Westphal and Rother (2012) results, EA12 (1970-2013)

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable	Annual growth rate	Cumulative 5-yr overlapping growth rate	Cumulative 5-yr non-overlapping growth rate	Annual growth rate	Cumulative 5-yr overlapping growth rate	Cumulative 5-yr non-overlapping growth rate
Instruments/ Estimator	FE-OLS	FE-OLS	FE-OLS	Avg.gov debt(n-i) IV/2SLS	Avg.gov debt(n-i) IV/2SLS	Avg.gov debt(n-i) IV/2SLS
debt	0.1079***	0.3223***	0.4515**	0.0927***	0.2162**	0.4518**
	(0.0261)	(0.0863)	(0.2038)	(0.0322)	(0.0945)	(0.1913)
debt_sq	-0.0006***	-0.0018***	-0.0023**	-0.0005***	-0.0013***	-0.0024***
	(0.0001)	(0.0004)	(0.0010)	(0.0002)	(0.0004)	(0.0009)
gov_rev_ca	-0.0704*	-0.3761***	-0.3501	0.0094	-0.0256	-0.3033
	(0.0422)	(0.1276)	(0.2852)	(0.0588)	(0.1508)	(0.3144)
gov_cab	0.1839***	0.6453***	0.8350***	0.0983	0.5939***	0.8764**
	(0.0425)	(0.1450)	(0.3010)	(0.0684)	(0.2204)	(0.4250)
$ln(GDP/cap)$	-0.9020	-33.2968***	-22.8799*	-1.4862	-35.4071***	-23.2062**
	(1.6003)	(5.2463)	(12.3311)	(1.7505)	(5.8568)	(10.5464)
pop.growth	-1.5339***	-2.0785**	-2.8631	-1.5723***	-3.2371***	-3.8008*
	(0.3254)	(0.9653)	(2.3871)	(0.3576)	(0.9600)	(2.1920)
gfcf_total	0.0565					
	(0.0554)					
gfcf_pub		-0.0949*	-0.0761			
		(0.0560)	(0.1381)			
gfcf_priv		-0.1841	-0.2812			
		(0.1655)	(0.4098)			
saving_pub				0.1965**	0.1600	-0.1266
				(0.0849)	(0.2735)	(0.4898)
saving_priv				0.1553***	0.4844***	-0.0928
				(0.0526)	(0.1621)	(0.3201)
openness	0.0157**	0.1050***	0.1093*	0.0137	0.1146***	0.1330**
	(0.0076)	(0.0241)	(0.0611)	(0.0094)	(0.0313)	(0.0601)
LT_real_i	-0.1158**	0.0567	-0.2217	-0.1224**	0.0609	-0.2148
	(0.0488)	(0.1677)	(0.4027)	(0.0498)	(0.1829)	(0.2922)
_cons	3.9880	107.4681***	78.5714**			
	(4.7983)	(14.8470)	(35.8166)			
Country FEs	YES	YES	YES	YES	YES	YES
Time FEs	YES	YES	YES	YES	YES	YES
Obs.	389	341	69	381	341	69
R^2	0.697	0.793	0.828	0.704	0.797	0.824
R^2-adj	0.639	0.750	0.708	0.649	0.753	0.697
Debt turning point	**87.26**	**90.12**	**97.73**	**87.08**	**83.93**	**95.50**
95% CI nlcom	(71.42; 103.09)	(73.13; 107.12)	(66.79; 128.66)	(67.27; 106.89)	(60.65; 107.21)	(72.62; 118.37)

Note: Results under columns (1), (2) and (3) correspond to models 1, 3 and 5, respectively of Table 1 in Checherita-Westphal and Rother (2012), while results under columns (4), (5) and (6) correspond to models 1, 3 and 6 of Table 3 in Checherita-Westphal and Rother (2012). All explanatory variables are lagged by 1 and 5 years relative to the dependent variable so as to avoid further endogeneity issues. *, ** and *** indicate significance at 10%, 5% and 1% level, respectively.

Table A.3: Replication and extension of Dreger and Reimers (2013) results, EA12 (1970-2013)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Dependent variable	Annual growth rate	Annual growth rate	Annual growth rate	Annual growth rate	Annual growth rate	Annual growth rate	Annual growth rate	Annual growth rate	Annual growth rate	Annual growth rate
Instruments			$L(1/2).(n)s\_debt$	$L(1/2).(n)s\_debt$			$L(1/2).(n)s\_debt$			$L(1/2).(n)s\_debt$
Estimator	FE-OLS	FE-OLS	IV/2SLS	IV/2SLS	Pooled-OLS	FE-OLS	Sys-GMM	Pooled-OLS	FE-OLS	Sys-GMM
LDV					0.3815***	0.2085***	0.2767***	0.4167***	0.2868***	0.3556***
					(0.0588)	(0.0534)	(0.0686)	(0.0676)	(0.0865)	(0.0820)
s_debt	-0.0090	-0.0192	0.0013	-0.0044	-0.0007	-0.0071	0.0036	-0.0030	-0.0184	0.0021
	(0.0126)	(0.0156)	(0.0103)	(0.0150)	(0.0038)	(0.0106)	(0.0045)	(0.0041)	(0.0150)	(0.0062)
ns_debt	-0.0226*	-0.0326*	-0.0158*	-0.0187	-0.0242***	-0.0193*	-0.0104***	-0.0252***	-0.0295	-0.0096*
	(0.0119)	(0.0174)	(0.0089)	(0.0129)	(0.0041)	(0.0104)	(0.0031)	(0.0051)	(0.0166)	(0.0049)
gov_rev_ca		0.0268		-0.0011				-0.0047	0.0347	-0.0210
		(0.0788)		(0.0476)				(0.0237)	(0.0688)	(0.0244)
gov_cab		0.0147		0.0302				-0.0005	0.0083	0.0565
		(0.0459)		(0.0391)				(0.0358)	(0.0349)	(0.0317)
ln(GDP/cap)		-5.0370***		-4.4332***				-1.6799**	-5.3698***	-1.3616*
		(1.5942)		(1.5165)				(0.6841)	(1.6628)	(0.7078)
gfcf_total	-0.0047		0.0233		-0.0410	-0.0367	-0.0262			
	(0.0774)		(0.0569)		(0.0419)	(0.0731)	(0.0512)			
gfcf_pub		0.0111		0.0026				-0.0171	0.0079	0.0018
		(0.0234)		(0.0133)				(0.0113)	(0.0189)	(0.0089)
gfcf_priv		-0.0142		0.0034				-0.1578***	-0.0576	-0.0945
		(0.1244)		(0.0704)				(0.0495)	(0.1104)	(0.0667)
pop.growth	-1.4481**	-1.7886**	-1.4858***	-1.6469***	-0.6942**	-1.1103**	-0.5553**	-0.5754*	-1.1924*	-0.7357***
	(0.4944)	(0.5935)	(0.3911)	(0.4361)	(0.3095)	(0.4586)	(0.2311)	(0.3191)	(0.6491)	(0.2402)
openness	0.0166	0.0222	0.0199**	0.0212*	-0.0002	0.0130	0.0057**	0.0033	0.0186	0.0099**
	(0.0118)	(0.0171)	(0.0088)	(0.0110)	(0.0026)	(0.0093)	(0.0024)	(0.0053)	(0.0135)	(0.0042)
LT_real_int	-0.0054	-0.1438***	-0.0266	-0.1613***	0.1095*	0.0103	0.0190	0.0250	-0.0819**	-0.0753**
	(0.0466)	(0.0252)	(0.0590)	(0.0561)	(0.0613)	(0.0416)	(0.0340)	(0.0665)	(0.0341)	(0.0272)
_cons	2.5239	15.5640*			2.7379**	2.1767		10.3520***	15.4251**	
	(2.1130)	(7.2302)			(1.0718)	(1.7815)		(2.0309)	(6.7067)	
CountryFE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
TimeFE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Obs.	476	390	441	374	476	476	476	390	390	390
R^2	0.590	0.701	0.596	0.696	0.293	0.608		0.403	0.727	
R^2-adj	0.543	0.655	0.537	0.638	0.282	0.563		0.385	0.684	
AR(1)							-2.632***			-2.534**
							[0.008]			[0.011]
AR(2)							0.501			0.888
							[0.617]			[0.374]

Note: Results under column (1) correspond to those of column 1 of Table 1 in Dreger and Reimers (2013) , while results under the remaining columns serve for robustness purposes. All explanatory variables are lagged by 1 year relative to the dependent variable so as to avoid further endogeneity issues. *LDV* is the lagged dependent variable. Robust standard errors in parenthesis. *, ** and *** indicate significance at 10%, 5% and 1% level, respectively.