EUROPEAN CENTRAL BANK
EUROSYSTEM

Working Paper Series

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Indebtedness in the EU: a drag or a catalyst for growth?

No 2118 / December 2017

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Abstract

We study the relationship between debt and growth in EU countries in the years 1995-2015. We investigate the debt-growth nexus in two alternative empirical set-ups: the traditional cross-county panel regressions and mean group estimations. We find evidence of a positive long-run relationship between private sector indebtedness and economic growth, and a negative relationship between public debt and long-run growth across EU countries. However, the more immediate impact of private sector debt on growth is found to be negative, and positive for the public sector debt. We find no conclusive evidence for a common debt threshold within EU countries, neither for the private nor for the public sector, but some indication of a non-linear effect of household debt.

JEL codes: O47, N14, H60

Keywords: debt, threshold, panel, European Union countries, cross-sectional dependence

Non-technical summary

The issue of excessive indebtedness has attracted much public attention in the aftermath of the financial crisis. An important distinction when it comes to analysing indebtedness is whether the debt belongs to the private sector or the public sector. In this paper, we focus on the indebtedness of households, non-financial corporations, and central governments. Overall, accumulating more debt is a way of financing spending as well as a way of obtaining funds to finance investments.

In the past 20 years, countries in the European Union (EU) have been accumulating more and more private debt, above all in the period before the start of the crisis. At the same time, public indebtedness has also been increasing, especially around the time of the financial crisis. This has raised many questions in the public debate about whether increasing debt is good or bad for economic growth. Few people will argue that indebtedness as a whole has negative consequences, yet many questions have been raised whether countries past a certain threshold of indebtedness are endangering the economy.

The purpose of this paper is to understand what are the effects of accumulation of private and public sector on the economic growth of the EU countries. In order to do so, we empirically estimate such impact, using annual data over 1995-2015 period, for 25 EU countries. We follow two distinct methodologies. Firstly, econometric analysis is used to understand whether higher levels of debt imply lower or higher rates of economic growth in the near future in the panel of 25 EU countries. This analysis holds other characteristics of the economy constant, and hence assumes that all countries share the same properties, like the level of economic development, how open an economy is to trade, what the inflation rate is, etc. Secondly, the econometric analysis is performed to understand how indebtedness levels move with income levels over a longer period of time, country-by-country, hence allowing the effects of indebtedness to vary across the member states of the European Union, from which an average effect is extracted.

Importantly, there are various measures of indebtedness. Most commonly, debt is represented as a percentage of Gross Domestic Product, so the level of economic activity in a given economy. In this paper, we are able to improve this measure by using a measure of income (Gross Disposable Income - GDI) of the different sectors of the economy under consideration – households, non-financial corporations, and the government.

Our results indicate that over the long run, rising private sector indebtedness is associ-

ated with rising income levels as debt allows for consumption and investment smoothing. Households and non-financial corporations are expecting to be richer in the future, hence they are not afraid of borrowing more in the present. This borrowing is used efficiently and it stimulates the economy. The story is different for the public sector, though, where we find rising indebtedness being associated with lower income levels in the long term as higher public debt could be related with higher yields and costs of borrowing in the future, and hence less investment.

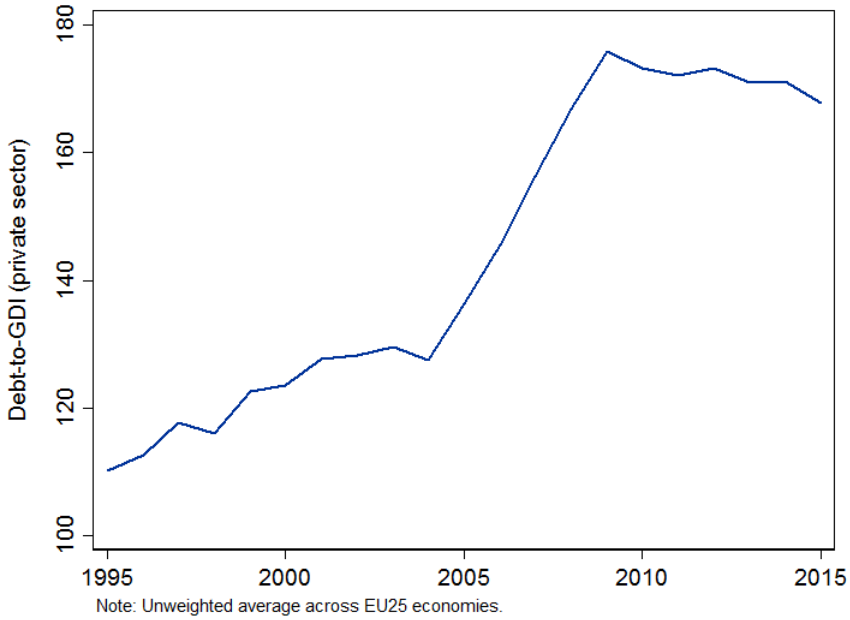
At the same time, we find increasing indebtedness of the private sector has a negative effect on growth rates in the near future. This could be explained, for example, by the fact that households and non-financial corporations are perceived to be over-borrowing. Rising debt-to-GDI of the public sector, on the other hand, can improve the short-run growth prospects of an economy, by stimulating investment and/or consumption.

Overall, the results suggest that there is no one-size-fits-all answer to the question whether rising debt is universally good or bad for economic growth. While we do not find support of the claim that there is a threshold beyond which the effects of debt on growth become negative, it is likely that there are country-specific thresholds, which depend on the country's indebtedness level, as well as other characteristics of that country.

Introduction

Private sector debt in the European Union (EU) has increased markedly over the past two decades. The aftermath of the financial crisis triggered some deleveraging across EU economies, though the decline was neither bold nor broad-based. This paper considers whether debt accumulation constituted a drag on the growth of EU economies, or - on the contrary - served as a catalyst for further development.

Figure 1: Debt-to-gross disposable income (GDI) of the private sector



Most of the literature on the effects of debt on growth is primarily focused on indebtedness of the public sector; private sector debt gained more interest only relatively recently. The seminal paper by Reinhart and Rogoff (2010) brought the study of the effects of public sector debt on growth to the frontline of policy debates. Using a dataset of advanced economies between 1946 and 2009 the study argued that the effects of debt become detrimental to the economy once debts exceeds 90% of GDP. The paper has since been widely discredited due to a number of coding errors, data points exclusion, and averaging issues (Herndon et al, 2014). Nevertheless, it revived the debate on whether and how the accumulation of debt impacts the macroeconomy.

Despite the various problems with the Reinhart and Rogoff (2010) study, economists have

since found similar thresholds effects of public debt. Kumar and Woo (2010) find a threshold of 90% in a panel of advanced and emerging economies, while Checherita-Westphal and Rother (2012) find a threshold of 70-80% when focusing exclusively on the euro area. When the threshold is estimated using the likelihood ratio, instead of standard dummy variables, it was measured at 85% Cecchetti et al. (2011) in selected OECD countries.

At the same time, other studies put into question the very existence of a threshold, or even of detrimental effects of government debt on growth. Panizza and Presbitero (2014) found no effect of public debt on growth when their debt measure was instrumented with a variable capturing valuation effects. Eberhardt and Presbitero (2015) and Chudik et al. (2017) found no evidence of any universal thresholds beyond which debt derails growth. In fact, threshold levels were found to be highly sensitive to the averaging of the dependent variable (growth rate), with the threshold disappearing when growth was averaged over longer periods of time (Pescatori et al., 2014). Balazs (2015) also found the threshold to be highly sensitive to modelling choices.

While all the studies above focus on the effects of government debt, Cecchetti et al. (2011) is one of the few studies which incorporates measures of both public and private debt. They found that when corporate debt goes beyond 90% of GDP, it becomes a drag on growth, while for household debt, the "best guess" estimate of a threshold is at roughly 85% of GDP. Similarly, Arcand et al. (2012) indicate that financial depth derails growth once credit to the private sector exceeds 100%. A negative relationship is also reported in the study by Mian et al. (2015) who find the negative effects of household debt on income to be particularly pronounced for countries faced with monetary policy constraints. When considering the effects of deleveraging, Chen et al. (2015) found that the quicker the private sector deleveraging, the greater the positive effects on growth in the medium term.

It is worth pointing out that sample composition varies markedly across the different studies considered. It is plausible that the effects are dependent on the group of countries studied. This paper is an extension of the existing literature on the effects of debt on the economy. It focuses exclusively on a sample of European Union countries, not studied in detailed before in a harmonised dataset, including both public and private indebtedness.

We take advantage of the detailed sectoral accounts data available through Eurostat. It allows us to construct sector-specific debt indicators for the private and public sector, as well as households and non-financial corporations separately.[1] This is because both debt

[1] When constructing the sectoral debt indicators, we build upon work by Iossifov and Zumer (forthcoming).

and income are available on the sectoral level, not just the economy-wide level. In fact, considering private and public debt in isolation has been recognised as a drawback of some earlier studies (Eberhardt and Presbitero, 2015). The use of sectoral debt-to-gross disposable income (GDI) is also an improvement over the existing methodology, which - up until now - focused almost exclusively on debt-to-GDP indices. The added benefit is that we can more accurately account for within-sector income dynamics in a given country.

When studying the relationship between debt and economic growth we follow two methodologies recently applied to the study the debt-growth nexus. Firstly, we follow studies seeking to understand determinants of growth in a standard OLS framework, modelling our empirical strategy after the widely-cited study by Cecchetti et al. (2011). We find that private sector debt is negatively associated with the future growth rate, while public sector debt boosts growth. The negative association for private sector debt holds for both non-financial corporations, and households beyond a relatively low level of indebtedness. Secondly, we explore the long run relationship between debt and growth, employing mean group and common correlated effects mean group estimators to account for cross-sectional correlation and parameter heterogeneity, similarly to analysis conducted by Eberhardt and Presbitero (2015). There we find that private sector debt comoves positively with the level of GDP per capita, and that public sector debt comoves negatively with GDP per capita.

Bridging the two worlds, we suggest that while private sector debt constitutes a drag on the short-to-medium run growth of the economy, the effect is rather small, and hence unlikely to make the economies contract. When a longer time frame is considered, debt and GDP per capita actually co-move together in a positive relationship. On the contrary, public debt is found to act as a catalyser to growth in the short-to medium term, while in the long run there is a robust negative relationship between public debt and output. The negative relationship suggests a growth-reducing effect of higher yields.

Ideally, this analysis would be supplemented by a model, which combines the short and long run specifications from an error correction model (ECM), as in the analysis by Eberhardt and Presbitero (2015). This would allow us to directly read off the long and short term impact of indebtedness on output growth, as well as deduce the speed of adjustment of the economy to the long-run equilibrium. Nevertheless, when performing this exercise we did not obtain robust results, likely due to the fact that the time dimension of our sample - crucial in a panel time series analysis like this - is just too short. While we consistently found a statistically significant error correction term (hence hinting at a long-run cointegrating relationship), the

other coefficients were too volatile to be considered robust, and this approach was therefore excluded from this analysis.

Moving on to potential non-linearities in the relationship, we do find any common universal threshold neither for the private nor for the public sector. However, there are likely to be country-specific thresholds, which have been stipulated by earlier studies, and their traces are noticable in graphical exercises.

More generally, while we cannot argue that higher indebtedness is universally *good* or *bad*, its effect on the macroeconomy is likely to be dependent on a number of factors, including the country and time-specific framework, but also possibly on the maturity and contractual form (Dias et al., 2014), or institutional framework (Kraay and Nehru, 2006). Our results should be interpreted as broad EU-wide developments, not country-specific developments. Before making any country-specific policy conclusions, it would be desirable to explore the debt-growth relationship in more detail for an individual country.

Data and stylised facts

This analysis uses data on EU countries between 1995 and 2015,[2] the full data and time coverage available as part of Eurostat's sectoral accounts data. Due to poor data availability for Cyprus, Luxembourg, and Malta, the countries were dropped from the analysis, leaving 25 EU countries in the sample.

Real GDP, population, trade openness, savings, and gross fixed capital formation data were sourced from Eurostat. Schooling and the dependency ratio data came from the World Bank's World Development Indicators. Inflation data came from the IMF's International Financial Statistics.

The main debt indicators used in this analysis are shares of debt in gross disposable income of the different sectors of the economy: private sector (and households and non-financial corporations separately), and public sector.[3] Debt is defined as outstanding loans and securities, in line with the EU Commission's Macroeconomic Imbalance Procedure.[4] Data is unconsolidated within each sector, except for general government, as the denominators of

[2] 2015 data was not yet available for Bulgaria, France, Greece and Portugal when the analysis was conducted. Similarly, data for a few years at the beginning of the sample are unavailable for Bulgaria, Croatia, Latvia, Lithuania, Poland, Romania and Slovenia. The panel is hence unbalanced, yet we consider the coverage to be satisfactory, considering how demanding the data requirements are.

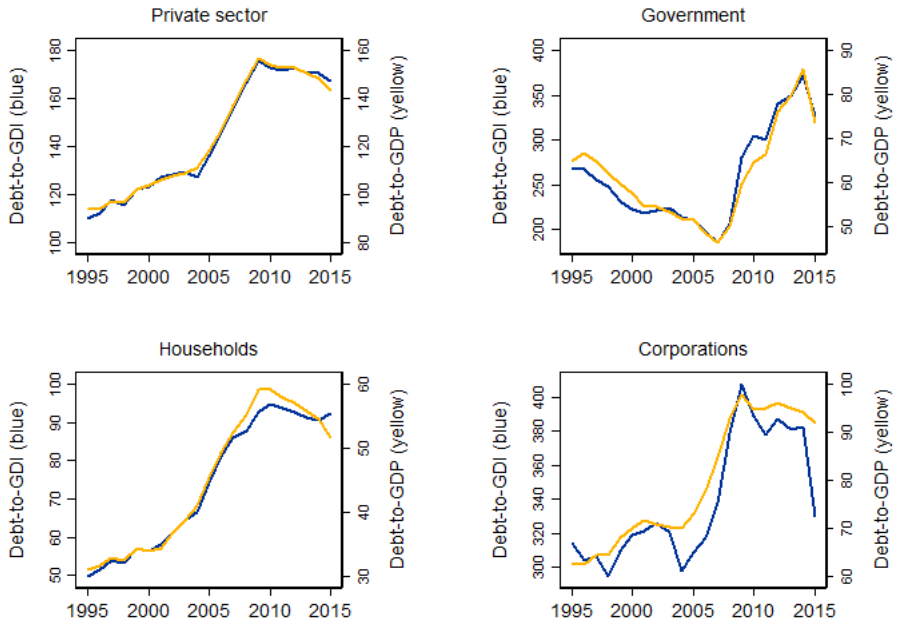
[3] Indebtedness of the financial sector is beyond the scope of this study.

[4] Financial derivatives, trade credit and other accounts payable are not included.

the metrics for the private sector are denoted only in unconsolidated terms.

We proxy the debt serivicing capacity of each sector of the economy by its gross disposable income (GDI). In national accounts gross domestic income (GDI) is defined as the sum of final consumption and savings. It is therefore calculated net of interest payments, and - for non-financial corporations - before payments to shareholders.[5] As both interest payments and payments to shareholders contribute to a given sector's debt servicing capacity, they were added to the GDI measures for the purposes of this paper. For the general government, gross disposable income is equal to total revenues minus social benefits other than social transfers in kind.

Figure 2: Comparison of the debt-to-GDI and debt-to-GDP indicators



Note: Unweighted averages across EU25 economies.

The constructed indicators are strongly correlated with measures of sectoral debt to Gross Domestic Product (GDP), as evident in Figure 2, where debt-to-GDI measures are marked in blue, and debt-to-GDP measures are marked in yellow.

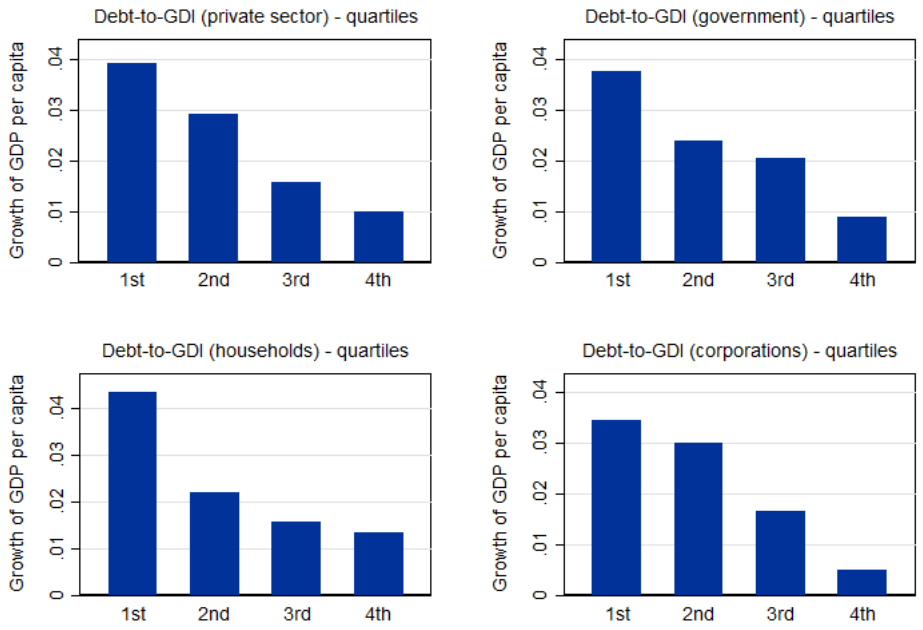
Figure 3 was created in order to better understand the data in relation to the task at hand. The figure presents charts, a la Reinhart and Rogoff (2010), demonstrating growth

[5]For example reinvested earnings on FDI and distributed income of corporations.

rates of GDP per capita at different levels of sectoral indebtedness. What stands out is the inverse relationship between GDP per capita growth and indebtedness across all sectors examined. It appears that more indebted economies tended to grow slower. This does not however mean, that because these economies were more indebted, they grew slower.

Another observation which stands out in Figure 3 is that the relationship appears to be broadly linear. Crossing the different quartiles of the distribution is not linked to marked declines in growth rates. If anything, there appear to be some thresholds to the left of the median for households and non-financial corporations. This graphical exercise is however far from providing conclusive evidence on the impact of debt on the economy. The debt-growth relationships and the possibility of thresholds will be examined more formally in the next sections of this study.

Figure 3: Growth of GDP per capita at different quartiles of the debt indicators



Note: The first quartile corresponds to the lowest 25% of values in the distribution of the indicator in the sample.

The impact of debt on growth: the "traditional" approach

Methodology

The empirical strategy employed in this section was based on the "standard" empirical literature on growth, augmented by sectoral debt indicators, similarly to an influential paper by Cecchetti et al. (2011). Baseline regressions estimated in this paper using the Least Squares Dummy Variable (LSDV) approach took the following form:

$$y_{i,t+1,t+3} = \delta\, Y_{i,t} + \beta\, debt_{i,t} + \mu\, savings_{i,t} + \rho\, popgrowth_{i,t} + \eta\, controls_{i,t} + \tau_t + \gamma_i + \varepsilon_{i,t}, \quad (1)$$

where:

- $y_{i,t+1,t+3} = \frac{1}{3}\sum_{x=t+1}^{t+3} y_x$is the three-year forward looking average growth rate of GDP per capita;
- $Y_{i,t}$ is the level of GDP per capita;
- $savings_{i,t}$ is the level of gross savings as a share of GDP;
- $popgrowth_{i,t}$ is the growth rate of population;
- $controls_{i,t}$ refer to trade openness, inflation, schooling, and the dependency ratio;
- τ_t are year fixed effects;
- γ_i are country fixed effects.

The use of forward looking averages in equation (1), common in the empirical growth literature, aims to mitigate the endogeneity bias. As current growth rates influence debt, just like debt influences growth rates, the use of averaged future values can prevent a degree of reverse causality. However, the use of average growth rates as the dependent variable imposes a moving average structure on the error term. Following Panizza and Presbitero (2014) we use the Huber-White Sandwich correction, found to yield "basically identical" results to the Newey and West (1987) estimator which allow one to explicitly model the autocorrelation in the error term.

Results

Table 1 reports the results of the baseline cross-country panel regression. All coefficients have the expected sign and are statistically significant. Their magnitude is similar to those typically found in the literature. For example, we find support for β-convergence, with the point estimate -0.127, broadly in line with what has been found in other studies, such as Cecchetti et al. (2011). In addition, trade openness, savings, and education have a positive impact on growth, while inflation, population growth, and the dependency ratio have a negative impact on subsequent growth.

Table 2 displays the result of the baseline regressions supplemented with the debt indicators.[6] Column (1) and (2) demonstrate the results when private and public sector debt are considered separately. Column (3) tests wheher the variables have a joint impact, while column (4) disaggregates the private sector indebtedness indicator into that of non-financial corporations and that of households. These specifications use the debt-to-GDI indicators, as described above. As an alternative indebtedness measure, we consider the leverage ratios (i.e. debt-to-assets), the results are reported in the Appendix (A4).

These regressions indicate that private sector debt has a negative impact on future growth, while public sector debt has a positive impact on future growth. The coefficients on public and private sector debt decline somewhat when both variables are included at the same time, while their significance remains, which suggests that the inclusion of both sectors is important when seeking to understand the effects of indebtedness on growth.

We find the impact to be fairly small, yet significant. An increase in the ratio of private sector debt to GDI by 10% is associated with a decline in the average future three-year growth rate by 0.17-0.21 pp, while an increase in the ratio of public sector debt to GDP by 10% is associated with an increase in the average future three year growth rate by 0.12-0.14 pp. Considering at the private sector breakdown, we find as strong negative relationship between indebtedness of non-financial corporations and future growth, but no significant relationship for households.

[6] Table A1 in the Appendix presents the full regressions.

Table 1

Dependent variable: Three-year forward looking growth rate	
GDP per capita (in 2010 prices)	-0.127***
	(0.015)
Trade openness	0.038***
	(0.011)
Gross savings as % of GDP	0.031***
	(0.006)
Inflation rate	-0.030***
	(0.008)
Education	0.060**
	(0.028)
Population growth	-0.819***
	(0.271)
Dependency ratio	-0.193***
	(0.026)
Constant	0.890***
	(0.145)
Observations	425
R-squared	0.779

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Country and time fixed effects were used in the OLS regression

Table 2

Dependent variable: Three-year forward looking growth rate	(1)	(2)	(3)	(4)	(5)
Debt-to-GDI (private sector)	-0.021***		-0.017***		
	(0.005)		(0.006)		
Debt-to-GDI (government)		0.0142***	0.012***		0.012**
		(0.00406)	(0.004)		(0.005)
Debt-to-GDI (households)				0.001	-0.001
				(0.005)	(0.005)
Debt-to-GDI (corporations)				-0.018***	-0.013**
				(0.005)	(0.005)
Constant	0.951***	1.121***	0.751***	1.049***	0.834***
	(0.166)	(0.200)	(0.183)	(0.173)	(0.204)
Observations	377	382	377	377	377
R-squared	0.818	0.822	0.826	0.819	0.826

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Country and time fixed effects were used in the OLS regression

We performed several robustness checks, including i.) using a different depended variable (five-year and one-year forward growth rates,[7] ii.) using debt to-GDP instead of debt-to GDI, iii.) adding credit to the private sector and government borrowing as additional explanatory variables, iv) dropping countries one-by-one to make sure the results are not driven by outliers. The results described above withstand this scrutiny, and are available upon request.

Nonlinearities

In the literature on the debt-growth nexus it is often suggested that indebtedness can become detrimental to an economy's standing after surpassing a certain threshold. In order to investigate potential non-lineraties and threshold effects of private and public sector debt on growth in our sample, we first visually inspect the data by plotting the relationship between various debt indicators and the forward looking growth rate of GDP per capita, using fractional polynomial regressions, modelled after Eberhardt and Presbitero (2015). The blue dots represent data points in a scatterplot.

Figure 4 shows no obvious nonlinearities in the simple bivariate relationships in any of the sectors.

Next, we formally test for the presence of nonlineraties in the debt-growth relationship by adding the quadratic terms of our indebtedness indicators to the baseline specification. Following Table 3, we do not find evidence of a significant threshold for government debt, reported in earlier studies, such as Cecchetti et al. (2011) or Checherita-Westphal and Rother (2012). However, we do find some evidence that the relationship between household indebtedness and future growth has an inverted U-shape. This means that in our sample increasing indebtedness positively contributed to growth up until a certain point, beyond which further contributions constituted a drag on growth. However, this does not necessarily mean that this would be the case for every country in the sample, as this analysis was conducted on a pooled dataset.

[7] The most notable difference in the specification we follow and the specification by Cecchetti et al. (2011) is the use of a three-year forward-looking average of GDP per capita as the dependent variable, instead of a five-year forward looking average. Given that the sectoral accounts data required for this analysis is only available from 1995, losing five observations per country due to forward-looking averaging would have led to losses in efficiency.

Table 3

Dependent variable: Three-year forward looking growth rate	(1)	(2)	(3)
Debt-to-GDI (households)	0.022**		0.019*
	(0.011)		(0.010)
Debt-to-GDI (households)^2	-0.004**		-0.003**
	(0.002)		(0.002)
Debt-to-GDI (corporations)	-0.079		-0.012**
	(0.062)		(0.005)
Debt-to-GDI (corporations)^2	0.006		
	(0.005)		
Debt-to-GDI (private sector)		-0.022	
		(0.058)	
Debt-to-GDI (private sector)^2		0.001	
		(0.006)	
Debt-to-GDI (government)	0.055*	0.046	0.011**
	(0.031)	(0.031)	(0.005)
Debt-to-GDI (government)^2	-0.004	-0.003	
	(0.003)	(0.003)	
Constant	1.106***	0.830***	1.097***
	(0.278)	(0.181)	(0.230)
Observations	393	393	393
R-squared	0.831	0.826	0.828

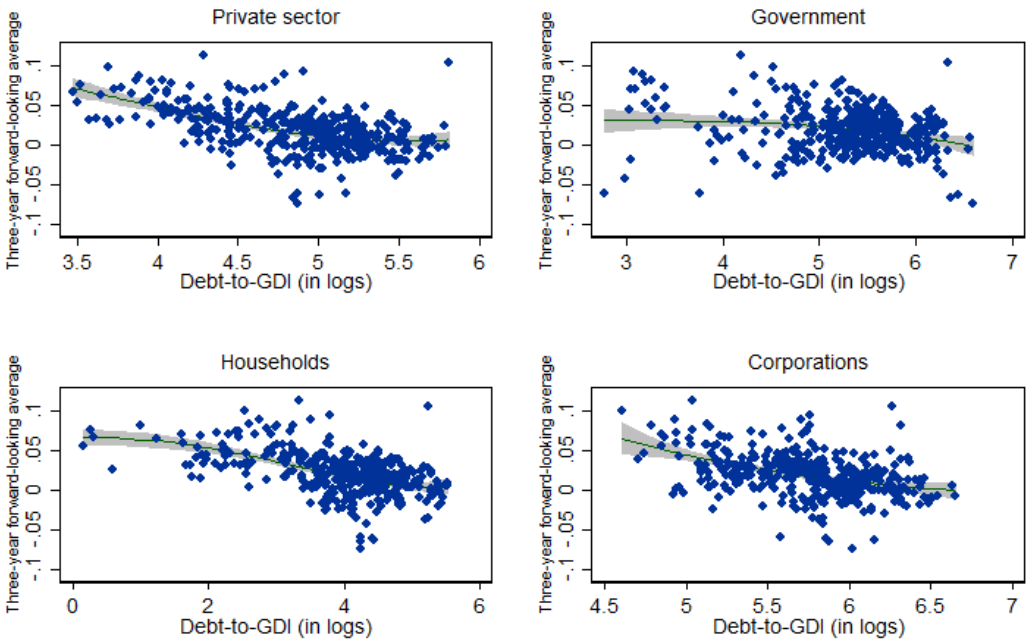
Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Country and time fixed effects were used in the OLS regression

The threshold is estimated at the level of debt-to-GDI of 18%, computed as the maximum of the parabola from the non-linear relationship shown in column (3) of Table 3. This is a relatively low level, although it is worth pointing out that almost 10% of observations fall below the threshold; they mostly belong to Central, Eastern and Southeastern European countries.

This supplements the analysis from above, where indebtedness of non-financial corporations was the main driver of the negative effect of the private sector on indebtedness. It now appears that the negative effect of debt on growth of the private sector is related both to non-financial corporations and - for the most part - households.

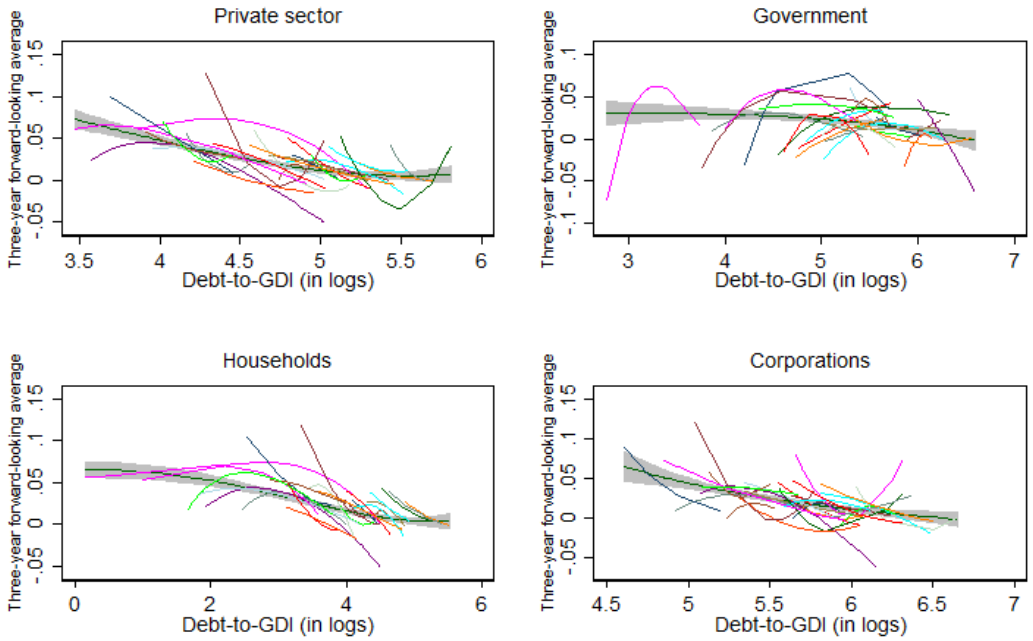
Importantly, none of this precludes the existence of country-specific thresholds, which would be highly relevant for policy recommendations. In fact, country-specific nonlinearities are hinted at in Figure 5, where each line depicts the fractional polynomial regression line for a different country.

Figure 4: The relationship between indebtedness and future growth



Note: The solid line is the unconditional relation between the two variables made using the fractional polynomial regression. The shaded area is the corresponding 95% confidence interval. The blue dots are data points.

Figure 5: The relationship between indebtedness and future growth



Note: The solid line is the unconditional relation between the two variables made using the fractional polynomial regression. The shaded area is the corresponding 95% confidence interval. The colourful lines are fractional polynomial regression lines for each country in the sample.

Long-run debt-income relationship: Linear static model

Methodology

Developments in the analysis of panel time-series datasets allowed one to enrich the standard OLS analysis presented above. These developments take into account the non-stationarity of variables and parameter heterogeneity as well as cross-sectional dependnece, some of the problems limiting the effectiveness of the traditional cross-country regression studies.

Levels of GDP per capita and debt-to-income are highly persistent. When stationarity is breached, standard OLS analysis can lead to inconsistent results, i.e. spurious regressions, as evidenced by the simulation of two random walks famously made by Granger and Newbold (1974). Modelling non-stationary independent and dependent variables becomes appropriate

only if the relationship is cointegrated, or - loosely speaking - when the error term is stationary I(0). If cointegration is present one can pinpoint an equilibrium trajectory, which in the long run is unaffected by sporadic deviations.[8]

Results of the Pesaran (2007) CADF unit root test can be found in the Appendix (Table A2). We find most of the variables to be nonstaionary. Another issue affecting the success of OLS estimates is parameter heterogeneity, and cross-sectional dependence in the regression error terms. As an example, take a simple model of the effect of debt on income, adapted from Eberhardt and Teal (2011):

$$Y_{i,t} = \beta_i debt_{i,t} + u_{i,t}, \tag{2}$$

where Y_{it} is the level of income, an $debt_{i,t}$ is a debt indicator:

$$debt_{i,t} = \theta_i f_t + \varphi_i g_t + v_{i,t}. \tag{3}$$

f_t and g_t are unobserved factors, common for all i; θ_i and φ_i are their factor loadings; v_{it} is white noise. Assume that just like $debt_{i,t}$, $Y_{i,t}$ is influenced by f_t, as

$$u_{i,t} = \alpha_i + \lambda_i f_t + \varepsilon_{i,t}, \tag{4}$$

where α_i is a country-specific factor influencing GDP levels and $\varepsilon_{i,t}$ is white noise.

In this case, the unobserved common factor f_t[9] introduces cross-sectional dependence to the model. As suggested by Eberhardt and Teal (2011), there are three ways of controlling for cross-sectional dependence in this scenario. Firstly, this dependence can be modelled explicitly, if the drivers of the cross-sectional correlation are known. This is not the case for the relationship between debt and growth, unless very strong assumptions are made. Secondly, fixed effects α_i and f_t can be introduced into OLS regressions, as was done in the analysis in the previous section of this paper. This however imposes the restriction that the coefficient λ_i is the same for all cross-sectional units, meaning that the unobserved common factor influences y_{it} in the same way for all countries. This is likely to be problematic in as heterogenous a sample as the EU. Thirdly, a multi-factor error correction methodology can be employed. The Pesaran and Smith (1995) mean group estimation (MGE) with varying

[8] For this reason we analysed the time-series dimension of our dataset. The Pesaran (2007) panel unit root test was conducted on the variables employed in the regressions discussed previously. Results of the unit root test can be found in the Appendix A2.

[9] In this context f_t can be loosely thought of as a reflection of the general world economic climate at time t, which influences both a country's income and debt accummulation, and impact all countries, yet in different ways.

intercepts for the different cross-sectional units is a good contender, if we know that the cross-sectional average $\bar{\lambda}$ is equal to zero. To see why this must be the case, consider the following substitution of equations (4) and (3) into equation (2):

$$Y_{i,t} = \alpha_i + \beta_i debt_{i,t} + \lambda_i f_t + \varepsilon_{i,t}, \tag{5}$$

$$Y_{i,t} = \alpha_i + \beta_i debt_{i,t} + \lambda_i \frac{debt_{i,t} - \varphi_i g_t - v_{i,t}}{\theta_i} + \varepsilon_{i,t}, \tag{6}$$

$$Y_{i,t} = \alpha_i + (\beta_i + \frac{\lambda_i}{\theta_i}) debt_{i,t} - \lambda_i \frac{\varphi_i g_t + v_{i,t}}{\theta_i} + \varepsilon_{i,t}. \tag{7}$$

Hence, we can only get an unbiased estimate$\hat{\beta}_{MG} = \frac{\sum_{i=1}^{N} \beta_i}{N}$ if $\frac{\bar{\lambda}}{\theta} = 0$, therefore when $\bar{\lambda} = 0$.

When the cross-sectional average of $\lambda_i$is likely to be non-zero, the common corelated effects mean group (CCEMG) estimator suggested by Pesaran (2006) is a more reliable way to estimate the relationship. In CCEMG estimations, cross sectional averages of the dependent and independent variables are added to the main equation. Consider cross-sectional average of equation (5):

$$\bar{Y_t} = \bar{\alpha} + \beta \bar{debt_t} + \bar{\lambda} f_t + \bar{\varepsilon}. \tag{8}$$

Solving for the unobserved common factor f_t, and plugging (8) back to equation (5):

$$Y_{i,t} = \alpha_i + \beta_i debt_{i,t} + \frac{\lambda_i}{\bar{\lambda}} (\bar{Y_t} - \bar{\alpha} - \beta \bar{debt_t} - \bar{\varepsilon}) + \varepsilon_{i,t} \tag{9}$$

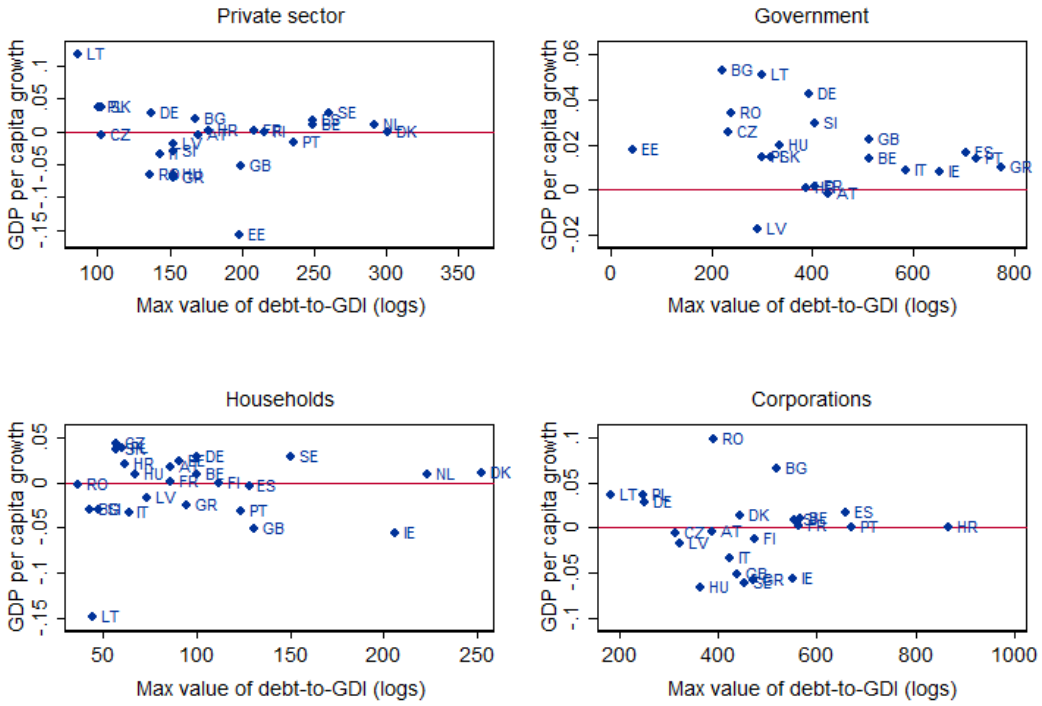
$$Y_{i,t} = \alpha_i^* + \beta_i debt_{i,t} + \lambda^* \bar{Y_t} - \beta^* \bar{debt_{i,t}} + \varepsilon_{i,t}^*, \tag{10}$$

where $\lambda^* = \frac{\lambda_i}{\bar{\lambda}}$, $\alpha_i^* = \alpha_i - \lambda^* \bar{\alpha}$, $\beta^* = \lambda^* \beta$, and $\varepsilon_{it}^* = \varepsilon_{it} - \lambda^* \bar{\varepsilon}$.

Hence, we arrive at equation (2) supplemented with cross sectional averages, where f_t is controlled for. The CCEMG estimator is the unweighted average of the country-specific estimators $\hat{\beta}_{CCEMG} = \frac{\sum_{i=1}^{N} \beta_i}{N}$.[10] Up to date, the CCEMG estimator is most promising in battling cross-sectional dependence of the form described above. In addition, as the estimator is an average of country-specific estimators, it better accounts for parameter heterogeneity than a pooled OLS estimator.

[10] An alternative is using a weighted average, where the weights correspond to the variance of the estimator. Nevertheless, computing the simple average has been the standard approach.

Figure 6: Growth rates of GDP per capita in the years when indebtedness indicators for the different sectors were at their peak



There is evidence to believe that in our analysis we should expect parameter heterogeneity. Even though the sample includes only EU countries, parameter heterogeneity is still likely, given the varying levels of development of countries in the sample. Figure 6 is adapted from Eberhardt and Presbitero (2015); it depicts GDP per capita growth rates in the years in which a given indebtedness indicator was at its peak. It is evident that the growth performance of countries is heterogeneous when at the peak of their indebtedness; it is also clear that the maximum level of intra-country indebtedness varies considerably for each of the sectors considered. While fixed effects estimations described in the previous section allowed our regressions to carry different intercepts for each country in regression (1), the mean-group estimations also allow the slopes to vary across our cross-sectional units.

Cross-sectional dependence must also be considered in this framework, given the tight levels of integration between EU economies. A good example of a common shock, with different consequences for different countries is the global financial crisis. It undoubtedly had an impact on both GDP per capita levels, and on debt levels. Further, there is strong

evidence of cross-sectional dependence amongst all of the variables considered, as evidenced by the results of the Pesaran (2004) test for cross-sectional dependence.[11] Hence, we will also augment the mean group regressions with cross-sectional averages. Another argument in favour of using the CCEMG framework is the robustness of the estimator to the integration (of order (1)) of variables used in the regression Eberhardt and Teal (2011). As results of the Pesaran (2007) CADF test indicate (Figure A2 in the Appendix), this can also be another issue affecting simple OLS estimation, making an vene stronger argument in favour of the CCEMG approach.

It is worth adding that one of the recent developments in the CCEMG estimations is introducing a dynamic structure (lagged values of the dependent and independent variables) to regression (2) (Chudik and Pesaran, 2015). Nevertheless, they remain more suited to cases in which T is relatively large, which - given limited data availability of sectoral debt and incomavailable upon requeste indicators - would be difficult to pursue with our framework at this point in time.

Note that in order to explore the long run relationship, we adopt variables in levels. Extending equation (2), we estimate the following relationship for each country (i) separately:

$$Y_t = \beta debt_t + \eta investment_t + t + u_t, \tag{11}$$

where:

- Y_t is the level of GDP per capita;
- $investment_t$ is gross fixed capital formation;
- t is a country-specific time trend.

Results

Table 4 presents the coefficients on debt-to-GDI of different sectors, first for the private and public sector and jointly thereafter.[12] We report both results obtained by the standard

[11] The table can be found in Figure A3 in the Appendix.

[12] We also consider the leverage ratios (i.e. debt-to-assets) as an alternative indebtedness measure, but the results (Appendix A5) become less conclusive, which we attribute to the fact that exploring a long-run relationship between the leverage and income is less sensible.

MGE and the MGE corrected for cross-sectional dependence, CCEMG.

The presence of cross-sectional dependence in the data would suggest focusing on CCEMG results,[13] yet the relatively small sample size makes us believe that the standard MGE results should also be considered. The CCEMG approach is equivalent to more than doubling the amount of regressors[14] whern compared with an MG regression. This could lead to losses in efficiency in studies with T as small as ours, since the regressions are ran separately for each country. In any case, we find that both approaches - MG and CCEMG - lead us to the same main conclusions.

Our main finding is that there is a positive long-run relationship between private sector indebtedness and GDP per capita, while there is a negative long-run relationship between public sector debt and per capita output. This is consistent across the different estimation methods. Additionally, as robustness, we i.) used debt to-GDP instead of debt-to GDI, ii) used savings instead of investment as the control variable, iii.) dropped countries one-by-one to make sure the results are not driven by outliers.[15] We found that our results mainly hold across the different specifications.

Columns 5 and 6 include the private sector breakdown (non-financial corporations and households), yet they point to more inconclusive results. The effect of household indebtedness on per capita income is found to be significant on the 10% level in the MG specification, yet the significance is lost when cross-sectional averages are added in column (8). The relationship between GDP per capita and indebtedness of non-financial corporations is inconclusive.

It is also worth to point out that the CD statistics for the residuals of the CCEMG specifications are still high, suggesting that cross-sectional dependence was not eliminated with the use of CCEMG. [16] Yet in the absence of other methods to tackle this problem, we are not left with other options. Reassuringly, the CD statistic does not tend to be significantly higher in regressions where the cross-sectional averages were used.

[13] We indeed find the cross-sectional correlation in the raw data by conducting cross-section dependence (CD) tests following Pesaran (2004). We also conducted the test on the residuals of our regressions, reported in Table 4.

[14] It means including the cross-sectional average of all the regressors, and of the dependent variable.

[15] Results are available upon request.

[16] This is consistent with Eberhardt and Presbitero (2015), who also report high CD statistics in residuals from the CCEMG regressions, when focusing on the static model.

Table 4

Dependent variable:	(1)	(2)	(3)	(4)	(5)	(6)
Real GDP per capita	MG	CCEMG	MG	CCEMG	MG	CCEMG
Gross fixed capital formation	0.391***	0.390***	0.333***	0.298***	0.350***	0.339***
	(0.026)	(0.030)	(0.027)	(0.021)	(0.026)	(0.028)
Debt-to-GDI (private sector)	0.042**	0.097***				
	(0.020)	(0.030)				
Debt-to-GDI (government)			-0.041**	-0.028*		
			(0.019)	(0.015)		
Debt-to-GDI (households)					0.069**	0.035
					(0.032)	(0.040)
Debt-to-GDI (corporations)					-0.013	0.017
					(0.011)	(0.015)
Constant	-1.660***	-1.396***	-0.665*	0.674	-1.223***	-0.969**
	(0.244)	(0.363)	(0.379)	(0.521)	(0.282)	(0.439)
CD statistic	10.01	6.64	10.93	11.29	4.99	4.20
Observations	463	463	469	469	463	463
Number of countries	25	25	25	25	25	25

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

All specifications include a country-specific trend

Conclusions

This paper investigates the relationship between debt and growth, using two alternative empirical methods, focusing on: i.) the short-to medium term impact of debt on growth in the context of standard growth literature and ii.) the long-run equilibrium relationship between indebtedness and GDP per capita using panel econometrics robust to non-stationarity. With the new findings and with the focus on the EU countries, it relevantly contributes to the empirical literature on debt-growth nexus.

Our main result is that there is a positive long-run relationship between private sector indebtedness and GDP per capita, while we find a negative relationship between public sector debt and per capita output. However, in the short-to medium-run we find the impact of increasing private sector indebtedness on future growth to be negative, while increasing government debt is found to have a positive impact on future growth.

Our findings suggest that in the long-run, rising private sector indebtedness is associated with rising income levels. This is consistent with the credit demand theory and the standard permanent income hypothesis as more debt allows for consumption and investment smoothing. Households and firms expand their debt today in view of higher income tomorrow. More debt may increase productive technologies in the future, while a technological shock may increase output tomorrow and the capacity to borrow today. However, the more immediate impact of rising private debt on future growth is found to be negative, which could reflect, for example, over-borrowing, in line with the credit supply hypothesis. This negative relationship holds for both, non-financial firms' indebtedness and households' indebtedness, although the later only after a certain, albeit low threshold.

As for public sector debt, the robust negative long-run relationship with GDP per capita lends support to the Ricardian equivalence, however only in the long run. Namely, the immediate impact of increasing public sector indebtedness is found to be supportive to future growth (although small in size), hence defending the effectiveness of counter-cyclical polices. The negative long-run relationship implies that while rising debt might bring impetus to economic growth, it cannot raise living standards indefinitely; high public debt ultimately increases the risk premia, reduces capital accumulation (due to higher interest rates), increases taxes, and reduces efficiency of public spending. This finding is consistent with many studies that call for public debt reduction being good for sustainable growth.

Finally, we find no *magic* threshold in the debt-to-growth relationship common to all

countries in our sample, neither for the private nor for the public sector debt. However, as these relationships differ across countries, there might be thresholds in the individual countries. This has important policy relevance, as the policy implications and recommendations in this context should be country-specific and cannot be done as "one size fits all".

Overall, we contribute to the empirical literature in the following ways. Firstly, our study is the first one to our knowledge exploring empirically the debt-growth nexus in the EU, using the harmonised sectoral accounts data provided by Eurostat. Secondly, we use novel debt indicators to better capture the underlying indebtedness of the individual sector. Thirdly, we explore the impact of both, public and private indebtedness separately as well as jointly. Finally, we employ two different empirical strategies: the "traditional" cross-country panel regression models that have been widely used in this context so far, and the more recent common correlated effects mean group estimations, which better accounts for the data properties. Therefore, we would primarily emphasise the results obtained by investigating the long-run relationship between debt and growth by means of the common correlated effects mean group estimations. Nevertheless, as most studies on the topic have so far been conducted in the "traditional" panel growth regression framework, our results provide an important contribution also to this end.

Appendix

Table A1 - Full OLS regression output

Dependent variable: Three-year forward looking growth rate	(1)	(2)	(3)	(4)	(5)
GDP per capita (in 2010 prices)	-0.150***	-0.168***	-0.146***	-0.173***	-0.161***
	(0.018)	(0.0162)	(0.018)	(0.025)	(0.024)
Trade openness	0.018	0.0277**	0.016	0.016	0.016
	(0.012)	(0.0118)	(0.012)	(0.012)	(0.012)
Gross savings as % of GDP	0.024***	0.0368***	0.030***	0.026***	0.031***
	(0.007)	(0.00678)	(0.008)	(0.008)	(0.008)
Inflation rate	-0.159***	-0.122***	-0.146***	-0.145***	-0.141***
	(0.027)	(0.0259)	(0.027)	(0.031)	(0.031)
Number of years spent in secondary education	0.078**	0.115***	0.107***	0.070*	0.101**
	(0.037)	(0.0351)	(0.037)	(0.037)	(0.039)
Population growth	-0.359	-0.127	-0.126	-0.331	-0.120
	(0.324)	(0.263)	(0.269)	(0.320)	(0.264)
Dependency ratio	-0.187***	-0.200***	-0.169***	-0.197***	-0.180***
	(0.030)	(0.0300)	(0.030)	(0.029)	(0.030)
Debt-to-GDI (private sector)	-0.021***		-0.017***		
	(0.005)		(0.006)		
Debt-to-GDI (government)		0.0142***	0.012***		0.012**
		(0.00406)	(0.004)		(0.005)
Debt-to-GDI (households)				0.001	-0.001
				(0.005)	(0.005)
Debt-to-GDI (corporations)				-0.018***	-0.013**
				(0.005)	(0.005)
Constant	0.951***	1.121***	0.751***	1.049***	0.834***
	(0.166)	(0.200)	(0.183)	(0.173)	(0.204)
Observations	377	382	377	377	377
R-squared	0.818	0.822	0.826	0.819	0.826

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Country and time fixed effects were used in the OLS regression

Table A2 - The Pesaran (2007) CADF unit root test

Null hypothesis: All series are non-stationary

	p-values	
	1 lag	*2 lags*
Debt-to-GDI (private sector)	0.98	1.00
Debt-to-GDI (public sector)	0.91	0.98
Debt-to-GDI (households)	0.57	0.75
Debt-to-GDI (corporations)	1.00	1.00
Real GDP per capita	0.07	0.00
Real GDP per capita growth	0.00	0.00
Gross fixed capital formation	0.53	0.72
Gross fixed capital formation as % of GDP	0.11	0.52
Gross savings	0.15	0.93
Savings as % of GDP	0.49	1.00
Openness	0.01	0.36
Inflation	0.00	0.00

Table A3 - The Pesaran (2004) test for cross-sectional dependence

Null hypothesis: Cross-sectional independence

	p-values
Debt-to-GDI (private sector)	0.00
Debt-to-GDI (public sector)	0.00
Debt-to-GDI (households)	0.00
Debt-to-GDI (corporations)	0.00
Real GDP per capita	0.00
Real GDP per capita growth	0.00
Gross fixed capital formation	0.00
Gross fixed capital formation as % of GDP	0.00
Gross savings	0.00
Savings as % of GDP	0.00
Openness	0.00
Inflation	0.00

Table A4 - OLS regression results with debt-to-assets, instead of debt-to-GDI indebtedness measures

Dependent variable: Three-year forward looking growth rate	(1)	(2)
Debt-to-net worth (households)	-0.000	-0.004
	(0.003)	(0.003)
Debt-to-capital (corporations)	-0.016***	-0.017***
	(0.004)	(0.004)
Debt-to-GDI (government)		0.013***
		(0.004)
Constant	0.923***	0.996***
	(0.154)	(0.206)
Observations	389	380
R-squared	0.811	0.838

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Country and time fixed effects were used in the OLS regression.

Table A5 - MG regression results with debt-to-assets, instead of debt-to-GDI indebtedness measures

Dependent variable: Real GDP per capita	(1) MG	(2) CCEMG	(3) MG	(4) CCEMG
Debt-to-net worth (households)	0.036**	-0.006	0.030	-0.019
	(0.018)	(0.026)	(0.019)	(0.030)
Debt-to-capital (corporations)	-0.001	0.016	0.004	0.009
	(0.012)	(0.015)	(0.013)	(0.017)
Debt-to-GDI (government)			-0.050***	-0.028
			(0.017)	(0.018)
Constant	-1.439***	-1.153***	-0.339	0.171
	(0.243)	(0.217)	(0.346)	(0.555)
Observations	477	477	466	466
Number of country	25	25	25	25

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
All specifications include a country-specific trend.

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Acknowledgements

We would like to thank Markus Eberhardt for his helpful suggestions and resources provided.

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ISSN	1725-2806 (pdf)	DOI	10.2866/698137 (pdf)
ISBN	978-92-899-3047-5 (pdf)	EU catalogue No	QB-AR-17-130-EN-N (pdf)