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The paper empirically explores the factor of public debt which considerably changes the transmission mechanism of fiscal policy effects to economic activity in the short term. We examined and evaluate the direct effect of higher indebtedness in the public sector on economic growth for a panel dataset of overall 36 countries (25 EU member states and 11 OECD countries). Our examination will shed light on the current debt problem by identifying a possible non-linear relationship between the level of public debt and economic growth, with an explicit focus to determine the threshold values for our sample of countries. Our sample is divided into subgroups distinguishing between so-called developed, covering the period 1980–2010, and emerging economies, covering the period 1995–2010. Extending our previous research we are particularly interested in the existence of a non-linear impact of government debt on the behaviour of GDP growth. In order to account for the impact of the level of the debt-to-GDP ratio on the real growth rate of GDP, we employ a panel estimation on a generalized economic growth model augmented with a debt variable, while also considering some methodological issues like the problems of heterogeneity and endogeneity. The results confirm the general theoretical assumption that at low levels of public debt the impact on growth is positive, whereas beyond a certain debt turning point a negative effect on growth prevails. Further, we calculated that the debt-to-GDP turning point, where the positive effect of accumulated public debt inverts into a negative effect, is roughly between 90% and 94% for developed economies. Yet for emerging countries the debt-to-GDP turning point is lower, namely between 44% and 45%. Therefore, we can confirm our hypothesis that the threshold value for emerging is lower than for the developed in our sample.

Keywords: *fiscal policy, public debt, economic growth, panel analysis, turning points, EU*

Introduction

The debate about the connection between economic growth and fiscal policy is still unsettled in academic literature and economic research due its complexity and critical importance. Fiscal policy holds crucial implications for economic growth in both the short and long run. During the recent global financial and economic crisis (also known as the 'Great Recession') starting in 2008 we observe in many countries adoption of fiscal measures in order to spur aggregate demand through recapitalization of banks and implementation of sizeable fiscal stimulus packages. The fiscal measures taken in response to the crisis and drop of tax revenues among countries due to the reduced economic activity have resulted in a substantial deterioration of government structural balances, and the sharp accumulation of government debt. Such an accumulation of public debt can be associated with a possible negative impact on subsequent economic growth and economic stability (see Cameron, 2010; Cecchetti *et al.*, 2011; Van Riet, 2010).

Thus, the current debt crisis has triggered a debate among academics and policymakers whether the accumulation of public debt has adverse effects on economic growth. In the literature we found various possible factors that influence the transmission mechanism of high public debt levels on

economic activity. In particular, Kumar and Woo (2010) conclude that detrimental effects of high persistent indebtedness levels in public sector on economic growth are mainly associated with a reduction in growth rates of labor productivity due to a decline in investment and a slowdown in capital stock accumulation. Cecchetti et al. (2011) suggest that higher debt levels may hamper the process of credit flow availability in the future, whereby having through transmission channels a detrimental effects on growth. For instance, high public debt levels can drive up risk premiums which lead to increased financing costs that may, in turn, weaken the sustainability of public finances (Kirchner et al., 2006). Thus, consequently lead to the situation known as debt trap, where the countries are facing the simultaneous occurrence of adverse effects due high and growing fiscal deficits and debt levels, sharp rise in risk premia on sovereign bonds tending to lower economic activity (Padoan et. al, 2012).

In the research we will take into account the factor of public debt which considerably changes the transmission mechanism of fiscal policy effects to economic activity in the short term. We will examine and evaluate the direct effect of higher indebtedness in the public sector on economic growth for countries in the EU which are in the epicentre of today's sovereign debt crisis. In addition, our sample also includes some OECD countries used to obtain robustness in estimated values. Our examination will shed light on the current debt problem by identifying a possible non-linear relationship between the level of public debt and economic growth, with an explicit focus to determine the threshold values for our sample of countries. In comparison to similar empirical studies, our research will add to the existing literature by extending the sample of countries and providing the latest empirical evidence of a non-linear and concave (i.e. inverted U-shape) relationship. The empirical evidence of the transmission mechanisms regarding the effects of debt on economic activity is still inconclusive (Clements et al., 2003; Cecchetti et al., 2011; Herndon et al., 2013; Kumar and Woo, 2010; Reinhart and Rogoff, 2010a, 2010b; Partillo et al., 2002, 2004 etc.)

The paper is organized as follows: first, we provide a brief literature review on the connection between public debt and economic growth focusing solely on empirical studies. Then the applied methodology and used data from different sources for examining the effects of public debt on economic growth is presented. The next section outlines the results of the panel analysis and presents the threshold values of debt-to-GDP for a particular group of countries. The paper concludes with the summary of the main findings and present some limitation of the research.

Literature review

Since the economic/financial crisis started, we have noticed an upsurge of empirical studies on the transmission effects of high and persistent debt on potential economic growth in both the short and long run. Most empirical studies analyse the causal negative relationship between public debt and economic growth by identifying a possible non-linear relationship and estimating the turning point beyond which the debt-to-GDP ratio has deleterious effects on growth. However, the empirical results are not robust to small changes in the time and country coverage as well as the empirical methodology applied to determine the critical threshold turning point.

One of the most influential research studies used to justify the austerity measures adopted by most governments in the EU since 2010 is by Reinhart and Rogoff (2010a, 2010b). It provides empirical evidence that a high debt-to-GDP ratio (90% or above) is on average associated with substantially slower, even negative economic growth. Their empirical findings of the negative effect of high debt levels on economic growth beyond a certain threshold have triggered a debate among academics. A recently published paper by Herdon et al. (2013) examines the findings of Reinhart and Rogoff (2010a, 2010b) and determines that their empirical findings inaccurately represent the relationship between debt and economic growth due to coding errors, the selective exclusion of available data and an unconventional weighting of summary statistics.

The available literature suggests the critical debt-to-GDP ratio value will lie in the interval between 85–100% for advanced countries and between 40–70% for emerging countries in the long run

(Kumar and Woo 2010; Checherita and Rother, 2010; Ceccheti et al., 2011; Reinhart and Rogoff, 2010a, 2010b). Considering the short-term impact of public debt on growth, the interval range of the estimated threshold debt-to-GDP value varies between 50–60% for 'new' member states of EU and roughly between 90–100% for advanced EU countries or 'old' member states (see Baum et al., 2013; Mencinger et al., 2014). Notwithstanding the empirical evidence, Pescatori et al. (2013) show that the threshold effect on growth seems to vanish in the long run, that the accumulation of debt seems to be as important as the level of indebtedness in future growth projections and that excessive debt levels are associated with an increase in output volatility.

Nevertheless, the debate on the impact of excessive public debt remains very unsettled and more research on this topic is called for, especially in terms of accounting for the heterogeneous effects of high and persistent debt on economic growth across countries. The existing literature on this topic shows that the relationship between public debt and economic growth is nonlinear and concave (an inverted U-shape) (Clements et al., 2003; Reinhart & Rogoff, 2010a, 2010b; Kumar & Woo, 2010 etc.). This implies that public debt can either have a positive or negative effect on economic growth. In contrast with previous studies, the focus of our research is to examine the critical threshold for public debt and its impact on economic growth in EU and OECD countries, thereby distinguishing between the developed and emerging countries.

Methodology and Data

In order to account for the impact of the level of the debt-to-GDP ratio on the real growth rate of GDP, we employ a generalized theoretical economic growth model augmented with a debt variable. Extending our previous research (Mencinger et al. 2014) and following the estimation strategy by Checherita & Rother (2010), we are particularly interested in the existence of a non-linear impact of government debt on the behaviour of GDP growth. As noted in earlier studies, the process of estimation encounters the problems of heterogeneity and endogeneity which give inconsistent and biased estimates with the pooled OLS estimator (Kumar and Woo, 2010; Partillo et al., 2002, 2004). Namely, the regression model using pooled OLS does not account for unobserved country-specific effects that vary across countries. Thus, the result may be affected by an omitted variable bias (Partillo et al., 2002, 2004). First, the solution of the heterogeneity problem could be avoided by using a fixed effects (FE) panel regression that allows us to control all time-invariant country-specific factors, whether observable or unobservable. In previous empirical studies, they corrected the problem of heterogeneity by introducing a lagged explanatory variable of the initial level of GDP per capita in a dynamic panel specification. However, the presence of a fixed effects panel estimation is likely to impose a correlation between the lagged endogenous variable and the residuals, which makes the results of the coefficient of the lagged initial level of GDP per capita negatively biased (Partillo et al. 2004).

Second, we use an instrumental variable (IV) approach to address the problem of endogeneity resulting from the issue of *reverse causality* between the economic growth and level of public debt ratios. Namely, the reserve causality problem derives from the possibility that lower economic growth may lead to higher debt build ups for reasons unrelated to debt (Kumar and Woo, 2010; Partillo et al. 2004). To account for the possibility of the endogeneity issue influencing the debt variable, among a variety of methodologies in the panel context we employ the instrumental variable (IV) estimation technique proposed by Checherita and Rother (2010). In particular, the estimator used in our research is the two-stage GMM estimator with instrumental variables. Following earlier studies, we implemented the lagged debt-to-GDP ratio and the lagged debt-to-GDP ratio squared as instruments (Checherita and Rother, 2010; Partillo et al. 2002, 2004).

Thus, we employ two different models to empirically assess the impact public debt has on potential growth, thereby identifying the debt turning point, where the negative effect of public debt on growth prevails. First, the non-dynamic baseline fixed effects (FE) panel regression specification to control the heterogeneity is as follows:

$$g_{i,t} = \alpha_i + \beta \ln(GDP\ per\ capita)_{\mathrm{t}} + \gamma_1 debt_{i,t} + \gamma_2 debt_{i,t}^2 + \delta X_{i,t} + \eta_i + \varepsilon_{i,t} \quad (1)$$

Second, the instrumental variable (IV) dynamic panel regression specification to control for endogeneity is as follows:

$$g_{i,t} = \alpha_i + \beta \ln(GDP\ per\ capita)_{\mathrm{t-1}} + \gamma_1 debt_{i,t} + \gamma_2 debt_{i,t}^2 + \delta X_{i,t} + \varepsilon_{i,t} \quad (2)$$

where $g_{i,t}$ and $debt_{i,t}$ are the annual change of GDP per capita and initial government debt as a share of GDP (note that subscripts *i* and *t* denote the country and time). Against this background, we assume a non-linear relationship between government debt and growth and thus the model is augmented with the quadratic equation in debt ($debt_{i,t}^2$). Based on the theoretical assumption that the relationship is non-linear, we expect that the coefficient of the debt variable will be positive whereas the coefficient of the debt variable squared will be negative. This would imply that public debt at lower levels has a positive impact on growth, while at higher levels a negative impact prevails (concave functional form). In addition, $X_{i,t}$ represents a vector of explanatory variables to take account of the determinants of economic growth and other economic and financial factors including the initial level of GDP per capita, gross government savings as a percentage of GDP, gross fixed capital formation as a share of GDP to cover the level of investment, the population growth rate, the gross secondary school enrolment rate as a proxy for human capital, trade openness as a percentage of GDP as an indicator of an economy's competiveness, initial inflation measured as a GDP deflator, general government structural balance as a fiscal indicator to examine the impact of fiscal policy on economic growth. In this regard, we will consistently follow the core determinants associated with growth in the related literature to obtain robust results (see Sala-i-Martin et al., 2004; Kumar and Woo, 2010; Checherita and Rother, 2010; Clements et al., 2003). The model (1) also includes country-fixed effects η_i to control the heterogeneity for unobserved country-specific effects and the unobservable error term $\varepsilon_{i,t}$.

The empirical analysis primarily includes a panel dataset of overall 36 countries (25 EU member states and 11 OECD countries). Our sample is divided into subgroups distinguishing between so-called developed and emerging economies[1], respectively. The former subgroup includes a sample of 24 developed economies, namely, Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland Ireland, Italy, Korea, Luxembourg, the Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, the United Kingdom and the United States, covering the period 1980–2010. The latter sample is composed of 12 emerging countries, including Czech Republic, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia, Slovenia, Turkey, Mexico, Bulgaria and Romania[2], covering the period 1995–2010 since data for most of the control variables are not available before then for that subgroup of countries. Thus, the obtained results will provide us with important understanding of differences in the short-term effects of public debt on economic activity in both subgroups.

The data used for estimating both models come from various sources. Data on the levels of public debt are primarily drawn from the OECD's Economic Outlook database. For the purpose of the empirical research we used gross central government debt[3] as a percentage of GDP (henceforth

[1] We divided our sample according to IMF's classification with expectation including Czech Republic, Slovenia and Slovakia in the group of 'emerging economies'.

[2] We excluded Estonia and Cyprus because comparable data was unavailable.

[3] The narrow concept of government debt at the central level based on the European System of Integrated Economic Accounts (ESA-95) covers the entire stock of direct government fixed-term contractual obligations to others outstanding on a particular date, excluding state and local government debt and social security funds. It includes marketable and non-

"public debt"). Openness as a ratio of GDP is obtained from the Penn World Table (PWT) version 7.1 of Heston et al. (2012). Data on government structural balances (referring to the general government cyclically adjusted balance as a share of potential GDP) is drawn from the IMF's Wold Economic Outlook database, while the real exchange rate is obtained from the European Commission's AMECO database. All other data were taken and calculated from the Word Bank's World Development Indicator (WDI) database.

In particular, our aim is to identify the turning point beyond which the debt-to-GDP ratio has deleterious effects on growth. The available literature suggests that the critical debt-to-GDP ratio value will lie in the interval between 85–100% for developed economies and between 40–60% for emerging economies, respectively. Accordingly, these hypotheses will be applied to and tested on both sub-groups. The results will give us an important understanding of differences in the short-term effects of public debt on economic activity in both subgroups.

7 **Empirical results**

Before presenting the empirical results, we provide some stylized facts that higher levels of public debt clearly have negative effects on potential economic growth in our sample of countries. Figure 1 provides a preliminary summary of average GDP growth rates across varying levels of public debt for a particular subgroup of countries. It follows that the annual observations are classified in four categories according to the debt-to-GDP ratio during that particular year. Referring to the interpretation in the literature, the groups distinguish the years when the debt-to-GDP ratio was at low levels (below 30%), middle-low levels (between 30 and 60%), middle-high levels (between 60% and 90%) and high levels (more than 90%) (see Reinhart and Rogoff, 2010a, 2010b). The bars show the average GDP growth per capita rates for each of the four debt categories, thereby distinguishing between developed and emerging economies. Note that all calculations for developed economies cover the period 1980–2010, whereas for emerging economies we took the period 1995–2010. Figure 1 shows a possible negative link between public debt and growth already at a lower level of debt-to-GDP ratios, especially for the subgroup comprising emerging economies[4]. Figure 1 implies that the threshold value for emerging economies is lower than for the advanced as a group of countries. As shown below, this pattern is consistent with the results obtained using an econometric analysis.

marketable central government debt instruments, including domestic and foreign liabilities such as currency and money deposits, securities other than shares, and loans (OECD, 2010; Eurostat, 2011; IMF, 2011).

[4] However, note that the negative effect of public debt on growth exceeding a 90% threshold presents just one observation at a particular point in time (Bulgaria), which enables us to draw a significant inference of the pattern.

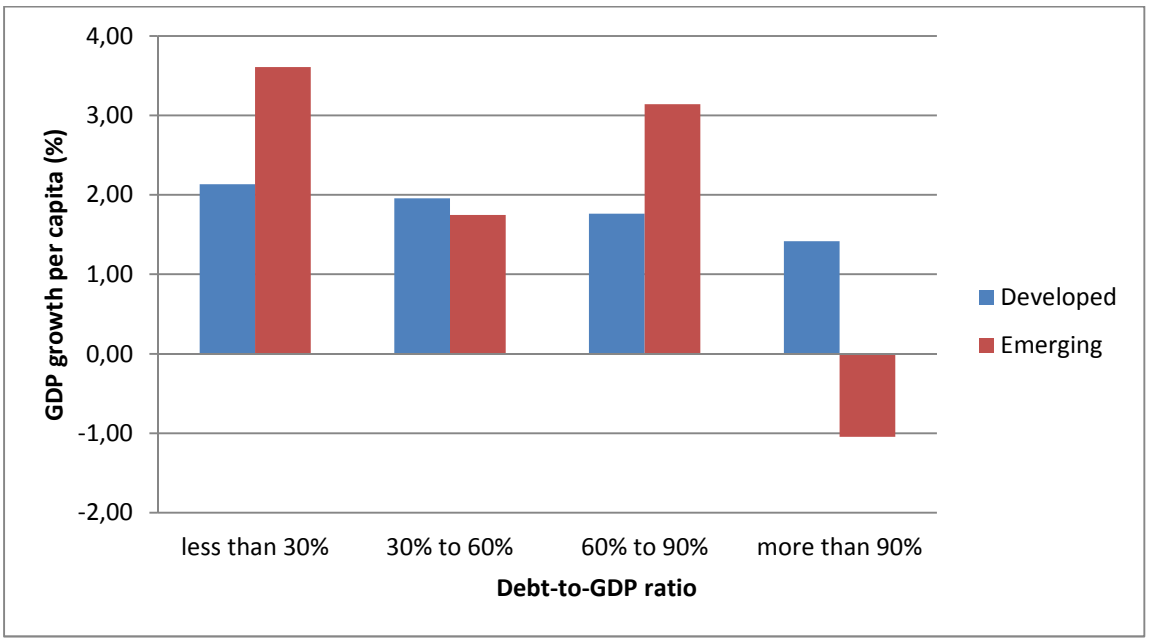

Figure 1: Relationship between GDP growth per capita and different levels of public debt for old and new EU member states

Sources: WDI, 2012; OECD, 2013; own calculations

As noted in the previous section, to evaluate the direct relationship between public debt and economic growth for our subgroup of countries, we estimated both panel growth regression models augmented with a debt variable. Specifically, we considered all potential explanatory variables in order to control the impact on economic growth. This allowed us to obtain statistically significant robust results on the short-term relationship between public debt and economic growth regarding both subgroups of countries. Thus, in addition to the debt and debt squared variable our final set of control variables in economic growth models with statistically significant coefficients is the following: GDP per capital, inflation, population growth, government total expenditures, gross government revenues, gross fixed capital formation, lagged initial GDP per capita, gross government savings, openness and government structural balance. Table 1 shows which control variables are included in panel regressions estimated with respect to the estimation procedure and sample of countries.

The empirical results for both subgroups of countries are displayed in Table 1. Columns 1 and 2 show the estimations for the FE regression model and IV model with the GMM estimators regarding developing countries. In addition, statistically significant results for emerging economies are presented in column 3. As shown in Table 1 by the first-stage Shea partial R-square statistics, both instruments (the lagged levels of debt and debt squared) used in the IV estimation approach in models 2 and 3 may potentially satisfy both required conditions of instrument validity, such as that the endogenous variables are highly correlated with the instrument, and exogeneity so that the instruments are not correlated with the error term (Cameron and Trivieri, 2010; Checherita and Rother, 2010). All the coefficients of explanatory variables are in line with expectations according to economic theory (Kumar and Woo, 2010; Checherita and Rother, 2010, Clements et al. 2003).

Table 1 Panel regression on 'old' and 'new' EU member states

	Developed countries		**Emerging countries**
	(1) FE	(2) GMM IV	(3) GMM IV
Dependent variable	GDP growth per capita	GDP growth per capita	GDP growth per capita
ln(GDP per capita)	-1.2737***		
	(0.1905)		
Debt	0.0935***	0.0715***	0.3471**
	(0.0188)	(0.0143)	(0.1096)
Debt squared	-0.0005***	-0.0004***	-0.0039**
	(0.0001)	(0.0001)	(0.0013)
Government total expenditures	-0.3538***	-0.2780***	-1.6653***
	(0.0299)	(0.0374)	(0.2700)
Inflation	-0.1203***	-0.1154***	0.2415**
	(0.0233)	(0.0165)	(0.0779)
Government revenues	0.1763***	0.2259***	1.4788***
	(0.0461)	(0.0354)	(0.3030)
Population growth	-1.5421***		
	(0.3593)		
Gross fixed capital formation	0.2388***		
	(0.0476)		
Lagged ln(GDP per capita)		-1.5150***	-1.7992***
		(0.1667)	(0.4461)
Government savings		0.0576**	
		(0.0219)	
Government structural balance			-1.2469***
			(0.2532)
Openness			0.0161*
			(0.0063)
Constant	15.8401***	16.3870***	19.6700***
	(2.8373)	(1.8802)	(5.4500)
Number of observations	548	533	114
R-squared	0.342	0.319	0.495
Shea partial R-squared		0.94	0.79
Turning point	**93.5**	**89.5**	**44.5**

Note: Standard errors are in parentheses.
Levels of significance: * p<0.05, ** p<0.01, *** p<0.001
Sources: OECD, 2011; IMF, 2012; WDI, 2012, own calculations

To summarize, the results across all models indicate a statistically significant non-linear impact of public debt ratios on the annual GDP per capita growth rate for developed and emerging included in our sample. Namely, the coefficient of the quadratic debt-to-GDP variable is negative, indicating a concave (i.e. inverted U-shaped) relationship between economic growth and public debt. These results confirm the general theoretical assumption that at low levels of public debt the impact on growth is positive, whereas beyond a certain debt turning point a negative effect on growth prevails (Elmendorf and Mankiw, 1998). Further, the calculated debt-to-GDP turning point[5], where the positive effect of accumulated public debt inverts into a negative effect, is roughly between 90% and 94% for developed countries when we consider both models. The results are comparable with the estimated threshold values for developed countries in previous empirical studies (Kumar and Woo, 2010; Checherita and Rother, 2010; Reinhart and Rogoff, 2010a, 2010b etc.). For emerging countries the debt-to-GDP turning point is substantially lower, namely between 44% and 45%. Therefore, we can confirm our previously stated hypothesis that the threshold value for emerging is lower than for advanced countries. Beyond estimated turning point the possibility arises that the countries will be trapped in so-called vicious circle of high debt accompanied with low growth and unsustainable debt dynamic projections.

However, we should note that the estimated threshold values do not provide the level to be targeted to support the growth projections. In fact, those results represent an additional argument for implementing fiscal consolidation strategies to reduce public debt. In this context, it is reasonable to assume that our research provides direct evidence of nonlinearity between public debt and economic growth. The obtained results thus imply that unstable debt dynamics may increase the risk of a detrimental effect on capital accumulation and productivity growth, which would potentially trigger an adverse effect on economic growth (Cecchetti et al. 2010). Hence, the research may contribute to a better understanding of the problem of high public debt and its effect on economic activity. As a result, the knowledge gained could be used to tackle the problem in a timely fashion so as to preserve a stable macroeconomic environment in the future.

Conclusion

The paper empirically explores the factor of public debt which considerably changes the transmission mechanism of fiscal policy effects to economic activity in the short term. We examined and evaluate the direct effect of higher indebtedness in the public sector on economic growth for countries in the EU which are in the epicentre of today's sovereign debt crisis. In addition, our sample also includes some OECD countries used to obtain robustness in estimated values. Our examination will shed light on the current debt problem by identifying a possible non-linear relationship between the level of public debt and economic growth, with an explicit focus to determine the threshold values for our sample of countries.

Our results across all models indicate a statistically significant non-linear impact of public debt ratios on the annual GDP per capita growth rate for developed and emerging countries included in our sample. Namely, the coefficient of the quadratic debt-to-GDP variable is negative, indicating a concave (i.e. inverted U-shaped) relationship between economic growth and public debt. The results confirm the general theoretical assumption that at low levels of public debt the impact on growth is positive, whereas beyond a certain debt turning point a negative effect on growth prevails. Further, we calculated that the debt-to-GDP turning point, where the positive effect of accumulated public debt inverts into a negative effect, is roughly between 90% and 94% for developed economies. Yet for emerging countries the debt-to-GDP turning point is lower, namely between 44% and 45%. Therefore,

[5] Note that we obtained it as a maximum of quadratic function.

we can confirm our hypothesis that the threshold value for emerging is lower than for the developed in our sample.

Nevertheless, we must point out some limitations and further avenues for research. First, our model specification was not subject to robustness tests which could confirm the validity of our results. It would also be desirable to calculate the confidence intervals for the critical threshold values and control for other potential variables. Second, we did not take the possibility of outliers in the data into account, which may bias the results. Finally, our research could be extended to determine the channels through which the impact of public debt is indirectly transmitted to growth.

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