Sovereign debt crisis and economic growth: new evidence for the euro area

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Abstract: The recent euro area financial crisis has revived the debates on the macroeconomic impact of sovereign debts. Concerns of a sharp increase of fiscal deficit and government debt across Europe began to surface in early 2009 after that Greece have announced untenable budget deficits. As a result, market interest rates on sovereign debt started to rise in several EU member states requiring constant interventions and bailouts by the IMF, ECB and the European Commission. Although the conventional wisdom tells us that debt crisis produces harmful effects on economic growth, and that huge increases in public debt have frequently led to sovereign defaults, there is no consensus regarding both the magnitude of the output losses and the timing of the recovery after debt episodes. The current paper investigates – from an empirical perspective - the short and the long-run impact of debt crisis on GDP in the case of 18 euro area countries over the yearly period 1995-2014. We employ recent dynamic panel heterogeneity models introduced by Pesaran, Shin and Smith (1999) where the autodistributed lag (ARDL) specifications disentangle both the long and the short-term effects of debt crisis on growth. To checks for the robustness of results, an additional panel smooth transition model by Hansen (1999) is applied. The baseline results suggest that the sovereign debt crisis produces significant long-lasting output losses particularly in the case of peripheral euro area countries.

Key-words: sovereign debt crisis, economic growth-public debt nexus, euro area, dynamic panel models

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1. Introduction

The recent euro area sovereign debt crisis has considerably renewed the debates on the impact of debt crisis on economic growth. Market concerns of sharp increases of fiscal deficit and government debt across Europe begin to surface in early 2009 after the Greek government announcement of untenable budget deficits. Although public debts increased strongly in some peripheral European countries, this became quickly a problem for the entire region sharing the Euro currency because of beliefs that high public debts harm economic growth. Furthermore, the euro area crisis, basically generated by unsustainable budget deficits and government debt in several euro area economies, provides a unique opportunity to investigate the detrimental effects of a debt crisis on the economic growth in a currency union context.

Although the conventional wisdom tells us that debt crisis produces harmful effects on growth and that huge increases in public debt have frequently led to sovereign defaults, only few studies have tested the effect of debt crisis on the output and on the timing of the recovery after debt episodes (see Cerra and Saxena, 2008; Panizza and Presbitero, 2012; Checherita and Rother, 2010; Baum et al., 2013; Egert, 2015). With cross-section and panel data, Sturzenegger (2004) highlights that debt defaults are associated with a reduction in output growth of about 0.6-2.2 percentage points. In the same vein, Borensztein and Panizza (2009) find that defaults involved a decrease in growth of 1.2 percentage points per year. Using an unbalanced panel of 154 countries from 1970 to 2008, Furceri and Zdzienicka (2012) show that debt crisis generates output losses by about 10 percent after 8 years and that debt crisis is more harmful than banking and currency crisis. Conversely, Levy-Yeyati and Panizza (2011) find that growth recovers in the quarters immediately after the occurrence of a debt crisis.

A second strand of the literature aimed to focus on the relationship between the debt and economic growth. Testing the Reinhart and Rogoff (2012) hypothesis (pointing out a strong negative correlation between high public debt and economic growth), Herndon et al. (2013) observed that economic growth did not decline sharply above the 90%. Egert (2015) employs historical data from 1946 to 2009, and by using nonlinear threshold models, finds evidence for a negative nonlinear relationship between the public debt-to-GDP ratio and economic growth. Results are extremely sensitive to modeling choices and data coverage.

From all these existing studies, the use of different countries, time periods, modeling techniques and different proxy variables during the financial crisis produces mixed results and does not reach a consensus regarding the negative relationship between the public debt and economic growth during the crisis periods. Mixed results generated by these studies also suggest that the subject proposed in this paper is still new and stimulating.

The paper seeks to contribute to this burgeoning dynamic area of research – from an empirical perspective - by analyzing the short and the medium-term impact of debt crisis on GDP in the case of euro area countries in the following ways. First, the paper employs the recent dynamic panel heterogeneity analysis introduced by Pesaran, Shin and Smith (1999). More precisely, I use the autodistributed lag (ARDL) model that disentangles both the long and the short-term effects of debt crisis on growth. By employing this model, the paper takes also into account country-specific heterogeneity. The majority of previous studies employed the generalized method of moments (GMM) estimator, most frequently under the form

proposed by Arellano and Bond (1991) to avoid the endogeneity and omitted variable biases. The GMM estimator takes into account the dynamic dimension of the data, and uses the lags of the dependent and explanatory variables to instrument the contemporaneous crisis effects on growth. But, the GMM estimator disregards the non-stationarity of the growth drivers. This aspect is explicitly exploited by the ARDL approach. Second, by focusing on eighteen euro area countries over the period 1995 to 2014, the paper contributes to the debates on the sustainability of debt dynamics in the euro area particularly in time of crisis. The large number of periods justifies the use of Pesaran, Shin and Smith (1999) approach, while the full set of euro area countries enables us to study the detrimental effect of the sovereign debt crisis on the output growth in the particular context of a currency union. Thirdly, we distinguish between the whole euro area countries and the countries that received institutional bailouts from the Troika institutions (the ECB, IMF and the European Commission) when analyzing the harmful effects of debt and banking crisis on growth. Finally, for robustness checks, we conduct additional panel models, e.g., the panel threshold model by Hansen (2000). The baseline results suggest the debt crisis produces significant long-lasting GDP losses particularly in the case of peripheral euro area countries.

The rest of the paper is organized as follows. Section 2 describes the employed methodology and presents the data. The estimation results are displayed and discussed in section 3. Section 4 provides some robustness checks for our results. Section 5 concludes.

2. Methodology and data

Methodology

(i) Pooled mean group (PMG) model

We propose to estimate the harmful effects of debt crisis on economic growth by using the pooled mean group model (PMG) for dynamic heterogeneous panels by Pesaran, Shin and Smith (1999). Most studies have focused on the generalized methods of moments (GMM - developed by Arellano and Bond, 1991 – e.g. Furceri and Zdzienicka, 2012) to analyze the long-run relationship between the debt, banking and currency crisis on GDP growth or on the panel threshold models to better capture the short-run dynamics (e.g. Baum et al. 2013). Even if the GMM method allows estimating country-specific intercepts, the PMG method imposes also the long-run homogeneity without making the hypothesis of identical short-run dynamics in each country. Furthermore, it is widely accepted that when the time dimension is larger than the number of cross-sectional units, the PMG model offers better estimation results (e.g., Samargandi et al., 2014). By using the autoregressive distributed lag (ARDL) model for time periods $t = 1, 2,\ldots,T$ and groups $i = 1, 2, \ldots, N$, the first model can be written as follows:

$$gdp_{it} = \mu_i + \sum_{j=1}^{p} \lambda_{ij} gdp_{i,t-j} + \beta D_{i,t}^{D} + \sum_{j=0}^{q} \gamma_{ij} Z_{i,t-j} + \varepsilon_{it} \qquad (1)$$

where gdp_{it} is the dependent variable (the logarithm of real GDP per capita), $D_{i,t}^{D}$ is a dummy variable that takes the value 1 if a debt crisis happened in country *i* at time *t* and zero

otherwise, μ_i denotes country-specific effects accounting for different growth trends among countries, Z_{it} is the k × 1 vector of explanatory variables for country *i* that are able to affect economic growth, , λ_{ij}'s are scalar coefficients of the lagged dependent variables, γ_{ij}'s are k × 1 coefficient vectors. The choice of explanatory variables is inspired by the recent empirical literature on the determinants of growth (e.g., Sala-i-Martin, 1997, Sala-i-Martin et al., 2004). The control variable's vector will include the log of trade openness (defined as the sum of exports and imports in terms of GDP), the population growth, the (private) credit growth, the real exchange rate growth, the initial lagged level of GDP and the logarithm of public debt (measured as percentage of GDP). By re-parameterizing the equation (1), we obtain the following panel vector error correction form:

$$\Delta gdp_{it} = \varphi_i \left[gdp_{i,t-1} + \mu'_i + \theta_i Z_{i,t-1}\right] + \sum_{j=1}^{p-1} \lambda_{ij} \Delta gdp_{i,t-j} + \sum_{j=0}^{q-1} \gamma_{ij} Z_{i,t-j} + u_{it} \qquad (2)$$

where u_{it} are independently distributed across *i* and *t*, with zero means and variances $\sigma_i^2 > 0$. The PMG estimator allows assessing two types of impacts: a short-run impact by testing the significance of the coefficients related to the lagged differences of economic variables (λ_{ij} and respectively, γ_{ij}) and a long-run impact by using the speed of adjustment term (φ_i) that needs to be negative for telling that variables exhibit a long-run equilibrium. A larger value of φ_i implies a stronger response of the variable to the deviation from long-run equilibrium; a low value indicates that any deviation from long-run equilibrium of the GDP growth needs much longer time to force the variables back to the long-run equilibrium.

(ii) Robustness check through Panel Threshold Model

To make sure that the results are robust in the PMG model, I estimate an additional dynamic panel model which divides the observations into two or more regimes depending on whether each observation is above or below a threshold level. Suggested by Hansen (1999, 2000), the general form of the dynamic panel threshold model is given by the following equation:

$$y_{it} = \mu_{it} + \sum_{k=0}^{K-1} \beta_{k+1} x_{it} I(\gamma_k < q_{it} \leq \gamma_{k+1}) + \beta_{K+1} x_{it} I(\gamma_K < q_{it} \leq \gamma_{K+1}) + \varepsilon_{it} \qquad (3)$$

where subscript *i* stands for the cross-sections with ($1 \leq i \leq N$) and *t* is the time ($1 \leq t \leq T$), μ_{it} is the country-specific fixed effect and the error term ε_{it} is assumed to be independently and identically distributed with mean zero and finite variance σ_ε^2. *I(.)* is a function indicating the regimes defined by the threshold variable, q_{it} , and the threshold parameter γ. y_{it} is the dependent variable and x_{it} is the vector of explanatory variables. Equation (3) stands for K thresholds values and therefore, (K+1) regimes. In each regime, the marginal effect of x_{it} ($e.g., \beta_k$) on y_{it} may be different. The benchmark model is presented in the Eq. (4) :

$$\begin{aligned} gdpgrowth_{it} = {} & \mu_{it} + \beta_1 debt_{it} I(debt_K \leq \gamma_k) + \beta_2 D_{it} I(debt_K \geq \gamma_k) + \alpha_1 openess_{it} + \\ & + \alpha_2 pop\ growth_{it} + \alpha_3 SHC_{it} + \alpha_4 REER_{it} + \alpha_5 inflation\ sq_{it} + \alpha_6 EMU_{it} \\ & + \alpha_7 debt/banking\ crisis_{it} + \varepsilon_{it} \end{aligned} \qquad (4)$$

where subscript $i = 1, \ldots, N$ corresponds to the country, $t = 1, \ldots, T$ represents the time, μ_i captures the fixed effects, I(.) is a function indicating the regimes defined by the threshold variable γ_k, β_k are regression slopes for the threshold variables, α_i (with $i = 1,.,7$) are the regression slopes for the explanatory variables included in the model and ε_{ij}'s is the error term independently distributed across *i* and *t*, with zero means and variances $\sigma_i^2 > 0$.

Variables and data

To study the relationship between output growth, public debt and debt crisis, we consider both time and cross-country variation in the data. Our data sample covers 18 euro area countries and the period from 1995 until 2014. This time period also accounts quite accurately for the recent global financial crisis that strongly affected the economic growth in euro area.

We employ yearly data on real per capita GDP, trade openness, real effective exchange rate with 42 partners, stock of human capital (measured by the number of years of school of population between 25 and 64 years), population growth and central government debt and deficit. Data are provided by World Bank database and Eurostat (for the last two variables). Due to data availability, the period of estimation is from 1995 to 2014. We use data on eighteen euro area countries: Austria, Belgium, Cyprus, Estonia, Finland, France, Greece, Germany, Ireland, Italy, Latvia, Luxembourg, Malta, Netherlands, Portugal, Slovakia, Slovenia and Spain. We also estimate our models using variables transformed in natural logarithms. Accordingly, each estimated coefficient should be interpreted as a constant elasticity of the dependent variable with respect to the independent variable.

Properties of the series

Before applying the PMG model, we check for the cross-section dependence hypothesis and different other properties of our series by using panel unit root, and panel cointegration tests.

The cross-section dependence hypothesis is explored by applying the Pesaran (2004) test based on pair-wise correlation coefficients. Interdependencies between euro area countries may occur after certain common shocks with various impacts across countries (e.g., the sovereign debt crisis, oil shocks) and other unobserved components due to the economic and financial integration process faced in the last decade by EU countries. The Pesaran (2004) and Baltagi, Feng, and Kao (2012) bias-corrected scaled LM test's results are reported in the table 1. The results strongly reject the null hypothesis of no cross-sectional dependence at the 1% level of significance for all variables on the entire period. This result means that variables may exhibit the same common dynamics to the countries.

Table 1: Cross section dependence results of Pesaran (CD)

	PANEL: VARIABLES IN LOG			
	CD	p-value	Biais-corrected scaled LM	p-value
Euro area – 18				
Central gov. debt	30.43[a]	0.00	65.99[a]	0.00
GDP real per capita	47.66[a]	0.00	124.68[a]	0.00
Population growth	-1.04[a]	0.00	24.90[a]	0.00
Trade openness	32.83[a]	0.00	92.93[a]	0.00
Human capital	26.64[a]	0.00	99.16[a]	0.00
Real effective exchange rate	24.40[a]	0.00	60.27[a]	0.00

Notes: i) *a* means significant at the 1% level.

We check now for the stationarity of the selected variables[2] (i.e., the order of integration of series) by applying second-generation panel unit root tests (PURT). Because Pesaran (2004) test shows evidence in favor of cross-section correlation, we use the second generation test of Pesaran (2007). These PURT results are upon request from the author.

Panel cointegration analysis

To check for the cointegration properties of the series, we apply Pedroni (1999). It allows for cross-section interdependence with diverse individual effects and establishes whether a long-run equilibrium relationship exists:

$$gdp_{it} = \alpha_{it} + \gamma_i t + \beta_{1i} debt_{it} + \beta_{2i} to_{it} + \beta_{3i} pop_{it} + \beta_{4i} tcr_{it} + \beta_{5i} DC_{it} + \varepsilon_{it} \quad (5)$$

where i = 1,…, N for each country of the panel and t=1,…,T refers to the time period. The parameters α_{it} , and $\gamma_i t$ capture the possibility of country-specific fixed effects and deterministic trends, and deviations from the long-run equilibrium relationship are measured here by the estimated residuals ε_{it} . The equation (5) assumes that central government debt ($debt_{it}$), population $growth$ (pop_{it}), trade openness (TO_{it}), real effective exchange rate with 42 partners (tcr_{it}) and debt/banking crisis (DC_{it}) are the driving forces of economic growth (gdp_{it}). By applying the unit root test on the residuals, e.g., ε_{it} ($\varepsilon_{it} = \gamma_i \varepsilon_{it-1} + u_{it}$), Pedroni (1999, 2004) tests the null hypothesis of no cointegration. The panel tests provide four statistics in the within dimension: the panel v - statistic, panel ρ – statistic, panel PP – statistic and panel ADF – statistic. All these statistics assembly the autoregressive coefficients across different countries for the unit root tests on the estimated residuals, taking into account common time factors and heterogeneity across countries. In the between dimension (i.e., group mean panel cointegration statistics), the test includes only three statistics: group ρ – statistic, group PP – statistic, group ADF – statistic that are based on the averages of the individual autoregressive coefficients related with the unit root tests of the residuals for each country in the panel. All these tests are distributed asymptotically as standard normal, as highlighted by Pedroni (1999). Table 2 displays the results reported by all these seven

statistics for the eq. (5). The results indicate that is some evidence of cointegration between output growth rates and government debt, population growth, trade openness, real effective exchange rate and debt crisis. More precisely, in the equation (5) the test statistics reject the null hypothesis of no cointegration (for the panel-*v*, the panel-*PP*, the panel-*ADF* and the group-*ADF*) at the 1% , 5% , and respectively, 10% significance levels.

Overall, the results shows that most of the variables are integrated of order one and are cointegrated. Therefore, the results enable to test the PMG model to evaluate the relationship between output growth, debt crisis, and the additional explanatory variables (both in the short and in the long-run horizons).

Table 2: The Pedroni (1999) panel cointegration tests

Panel test statistics	Weighted Value
panel v – statistic	7.733*** (0.00)
panel ρ – statistic	4.257 (1.000)
panel PP – statistic	-1.783** (0.037)
panel ADF – statistic	-1.535* (0.062)
Group mean panel test statistic	Value
group ρ – statistic	5.878 (1.000)
group PP – statistic	-4.252 (0.000)
group ADF – statistic	-1.559*(0.0595)

Note: (i) the second column shows the statistic values for the period 1995-2014; ii) the null hypothesis is no cointegration; all reported values are distributed N(0,1) under the null of unit root or no cointegration; iii) ***p<0.01, **p<0.05; *p<0.10; iv) the estimations based on AIC criterion with of max lag of 1.

3. Estimation results and discussion

(i) PMG model: linear relationship

This section studies the short-and long-run effects of debt crisis episodes on economic growth for eighteen euro area countries from 1995-2014. The results of the eq. (2) suggest that the debt crisis significantly reduces the output growth by around of 0.25 to 0.57 percentage points in the long-run. The significance of the results is robust across the two specifications. The magnitude of the debt defaults is in line with the outcomes obtained, e.g., by Sturzenegger (2004) and Borensztein and Panizza (2009).

Furthermore, among the selected explanatory variables the trade openness, the population growth, the human capital stock and the real effective exchange rate (as a measure of the country's competitiveness) have significant and positive effects on GDP growth, particularly in the long-run horizon. Conversely, central government debt and deficit in the euro area countries have a negative and significant effect on economic growth. The last two variables produce significant long-lasting output losses particularly in the case of peripheral euro area countries, in the long run. In the short-run, debt crisis effects on GDP growth are unclear. The trade openness has a positive and significant effect on output growth in the selected models.

Table 3: PMG model: long-run & short-run estimates with the dep. var., GDP growth for the whole euro area (column 2) and the PIIGS countries (column 3)

Sample	Whole euro area	PIIGS countries
Long-run coefficients		
Openness	0.631*** (0.06)	0. 504 (0.46)
REER	0.752*** (0.06)	-0.279 (0.70)
Population growth	0.124*** (0.02)	-0.326** (0.16)
Gov. debt	- 0.075*** (0.03)	-0.33*** (0.09)
SHC	0.100*** (0.01)	0.334*** (0.10)
Debt crisis	- 0.254*** (0.04)	-0.573*** (0.16)
Deficit*EMU	- 0.063*** (0.01)	-0.066*** (0.03)
Error correction term (ECT)	- 0.102*** (0.04)	-0.10** (0.09)
Short-run coefficients		
Δ lagged GDP growth $_{i,t-1}$	0.079 (0.08)	-
Δ Openness	0.089* (0.05)	0.065** (0.05)
Δ $REER_{i,t}$	- 0.067 (0.08)	0.077** (0.03)
Δ population growth $_{i,t}$	0.057 (0.03)	0.143 (0.10)
Δ gov. $debt_{i,t}$	- 0.129*** (0.03)	- 0.067 (0.06)
$\Delta SHC_{i,t}$	- 0.017 (0.02)	-0.052 (0.04)
Δ debt crisis	0.03** (0.01)	0.034 (0.03)
Δ deficit*EMU	0.010** (0.004)	0.006* (0.003)
Constant	0.360* (0.14)	1.071** (0.45)
No. obs.	324	114
No. groups	18	6
Criterion Akaike	-5.17	-5.66

Note: ECT – the speed of adjustment coefficient, * p<0.10, ** p<0.05, *** p<0.01; for the whole euro area - ARDL (2,1,1,1,1,1,1,1); for the PIIGSC countries, estimates reflect an ARDL (1,1,1,1,1,1,1,1) model; PIIGSC means Portugal, Italy, Ireland, Greece, Spain and Cyprus; REER – is the real effective exchange rate, SHC - is the stock of human capital (measured in the number of years as scholar for the population between 25-64 years).

(ii) Panel Threshold Model: non-linear relationship

According to Reinhart and Rogoff (2010), public debt is found to reduce economic growth above the 90% threshold by 1% while this relation seems to be less evident below the 90% level. Because it is difficult to assume a clear-cut shape of the public debt economic growth link, and particularly regarding the presence or the absence of nonlinearities, I start by applying the F-tests of the null of no threshold.

Table 4 reports the results only for the public debt, but I selected the threshold variable amongst all the possible ones such as: the inflation, the trade openness and the deficit. These results indicated that p-values are less or not significant than those of the public debt (the

results are upon request from the author). The results depicted in the table 4 show us that the number of thresholds has to be blocked to one in this transition function.

Table 4. Identification of the PSTR model (1): nonlinearities in the public debt ratio

	First transition Function	Threshold value (in log)
1 threshold – F test (p-value)	39.10** (0.0367)	4.852**
2 threshold – F test (p-value)	26.22 (0.200)	1.5041

Note: Bootstrap p-values are given in brackets; ***, **, * - the null of no threshold is rejected at 1, 5 and 10%.

The first line shows that the single-threshold model's estimator is 4.852. Because the F-statistic is significant (at 5% level), we reject the linear model and fit a double threshold model. In the second line, the single-threshold model is accepted with a probability of 0.20. As the results suggest the existence of some robust non-linearities in the effect of public debt on economic growth, the next step is to study the effects of public debt (reflected by β_1 and β_2 coefficients) on economic growth. The first coefficient (β_1) captures the effect of debt below the threshold level γ_k while the second one (β_2) measures the effect of public debt exceeding the threshold level γ_k. Table 5 displays the estimation results obtained from the equation (4) for the whole euro area countries (except for Estonia – because of the availability of our data). The upper part of the table shows the estimated debt threshold and the corresponding 95% confidence interval. The middle part indicates the regime dependent coefficients of public debt on economic growth. More precisely, the $\hat{\beta}_1$ and $\hat{\beta}_2$ measure the marginal effect of debt on the output growth in two debt regimes: low and high debt regimes. The coefficients of the other explanatory variables are shown in the lower part of the table 5.

Table 5. Debt threshold and economic growth results (whole sample)

Threshold estimates	**Whole euro area**
γ_k	4.852
95% confidence level	(4.8398, 4.8583)
Impact of public debt	
$\hat{\beta}_1$	-0.0142 (0.0167)
$\hat{\beta}_2$	-0.0436*** (0.0173)
Impact of covariates	
Population growth	0.001 (0.016)
Trade openness	0.377*** (0.038)
REER	0.849*** (0.055)
SHC	0.054*** (0.014)
EMU	0.064*** (0.012)

Debt crisis	-0.0995*** (0.021)
Inflation squared	0.009*** (0.004)
Nb of observations	323
Nb groups	17
R-sq	0.740
F (9, 297) – p -value	93.90 (0.00)
Constante	4.448*** (0.285)

Note: (i) Estonia is not included in this sample; (ii) * p<0.10, ** p<0.05, *** p<0.01;

The estimated threshold parameter of public debt (i.e., 4.852 – that is 127.88%) is inside the 95% confidence interval. The higher debt threshold could be explained by the long history of debt levels in some EMU countries. The coefficients of public debt are negative and plausible, but significant only in the case where the public debt gets above its threshold 4.852 (in log). Our result implies that high public debt levels come along with lower growth rates. The debt/banking crisis coefficient negatively and significantly impacts output growth by about 10%. Our results suggest also that the trade openness, the real effective exchange rate (as a measure of country's competitiveness), the human capital accumulation, the inflation and the quality of the euro area member have a significant stimulus effect on economic growth.

4. Conclusions

The paper investigates the impact of the recent euro area debt crisis on the GDP in eighteen euro area economies. The analysis is performed over the period 1995-2014 and uses dynamic panel estimation models, including the Pooled Mean Group estimator (Pesaran, Shin and Smith, 1999). The findings suggest that debt crisis produces harmful effects on the GDP growth in the euro area countries, particularly in the case of peripheral euro area countries (i.e., the PIIGSC economies). Furthermore, the trade openness, the population growth, the human capital stock and the real effective exchange rate affect significantly and positively the GDP growth, particularly in the long-run horizon. Conversely, the central government debt and the deficit in the euro area countries have a negative and significant impact on the output growth. In the panel smooth transition model, the preliminary outcomes suggest that trade openness, real effective exchange rate (as a measure of country's competitiveness), human capital accumulation, inflation and euro area membership have a significant stimulus effect on economic growth.

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