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On Creditor Seniority and Sovereign Bond Prices in Europe

Sven Steinkamp and Frank Westermann

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INSTITUTE OF EMPIRICAL ECONOMIC RESEARCH
Osnabrueck University
Rolandstrasse 8
49069 Osnabrück
Germany

ON CREDITOR SENIORITY AND SOVEREIGN BOND PRICES IN EUROPE

Sven Steinkamp and Frank Westermann[1]
University of Osnabrück
Institute of Empirical Economic Research
Rolandstraße 8, 49069 Osnabrück, Germany

Abstract: The recent increase of interest rate spreads in Europe and their apparent detachment from underlying fundamental variables has generated a debate on multiple equilibria in the sovereign bond market (see Grauwe and Ji (2012)). We critically evaluate this hypothesis, by pointing towards an alternative explanation: the increasing share of senior lenders (IMF, ECB, EFSF, etc.) in the total outstanding government debt of countries in crisis. We illustrate the close relationship between senior tranche lending – including Target2 balances – and recent developments in the sovereign bond market, both graphically and in a formal regression analysis.

JEL: F34, G12, H81; Keywords: Government bond spreads, Eurozone, senior tranche lending, multiple equilibria, sovereign debt crisis, Target

[1] Contact: sven.steinkamp@uos.de and frank.westermann@uos.de.

1 Introduction

Interest rate spreads in Europe have evolved in a way that most researchers find hard to reconcile with the underlying economic fundamentals. While some authors take it as evidence of multiple equilibria in government bond markets (see De Grauwe and Ji (2012), Favero and Missale (2012)), others just point out the large forecast errors that standard empirical specifications of interest rates would generate (see Aizenman et al. (2012), Beirne and Fratzscher (2012)). In this paper, we suggest an alternative explanation by pointing out the increasing share of total debt that is held by public creditors (i.e. the ECB, the EFSF/ESM and IMF) due to the ongoing rescue operations. As most of these public creditors are likely to have senior status in case of insolvency, the remaining public debt in the market has become a junior tranche that requires a higher marginal interest rate.

The theoretical motivation of the senior tranche explanation has its roots in several academic and policy papers. The closest recent theoretical model that would explain high marginal interest rates in the presence of senior official lending is by Corsetti et al. (2006).[2] The puzzling fact that official lending can drive up interest rates, rather than lowering them, has been pointed out by Gros (2011) who calls this phenomenon the "seniority conundrum". More generally, the link between bond prices and the seniority of the lenders is modeled for government bonds in Bartolini and Dixit (1991) and for corporate bonds in Black and Cox (1976).

Empirical evidence for the role of creditor seniority in explaining debt values exists from the Latin American debt crisis in the 1980s. For example, Dooley and Stone (1993) document that the share of loans from domestic banks – also viewed as senior lenders – was an important determinant of secondary market prices of debt in emerging markets.[3]

Related ideas also appear in other papers. Aizenman, Kletzer and Pinto (2002) point out that ultimately, the scarcity of fiscal revenues relative to the demand of fiscal outlays determines assets prices including government bond prices. In a theoretical analysis, they illustrate the ineffectiveness of debt-equity swaps and bond buy-backs.[4] As Gros points out for the Eurozone, such buy-backs could make matters worse for the countries in crisis and might even trigger a speculative attack.

The contribution of the present paper to this literature is empirical. We document graphically, and using various econometric techniques, the close relationship between the senior tranche share of public debt and the interest rate spread (as well as bond prices) in the recent sovereign debt crisis in Europe.

The senior tranche variable in our empirical analysis is defined as the sum of official lending through rescue packages from the IMF and the EU, plus the Target2 liabilities of the respective national central

[2] See also Bolton and Jeanne (2009) as well as Saravia (2010).
[3] See also Bulow et al. (1992), Sturzenegger and Zettelmeyer (2008).
[4] See also Admati et al. (2010), who analyze the cost of equity vs. external financing. The authors point out that bank debt is only expansive when banks hold little equity. The analogy to the public debt arises from the fact that a large share of debt in the balance sheet of central banks means that the remaining debt in the private market must generate a very high return.

bank. The latter is likely to be considered senior lending by the markets because it is collateralized to a large extent by the country government bonds (see Garber (1999), Sinn and Wollmershäuser (2012)). The Target2 balances in fact constitute the largest share of senior tranche lending, roughly 80% in the end of the sample. We also test other measures including the Securities Markets Program of the ECB under which the ECB buys government bonds on the secondary market and domestic bank lending to governments.

In our benchmark regression, we illustrate the robustness of the correlation between the senior tranche and bond price changes to the inclusion of several variables in a multivariate model, such as fiscal space, the current account, the real exchange rate, real GDP growth and the debt ratio. In a set of robustness tests, we then investigate the impact of additional controls, different subsamples and estimation models. Furthermore, we compare regressions explaining bond prices and interest rate spreads, as well as different definitions and subcomponents of our senior tranche variable. In all specifications, the correlation between the senior tranche variable and bond prices is remarkably robust. The large post-2007 residuals in the regressions of De Grauwe and other authors can be significantly reduced in a regression with a full set of control variables including our proxy variable for senior tranche lending.

In the final part of the paper, we investigate the timing in a panel-VAR framework. The impulse response functions show that there is a significant response of government bond prices to an unexpected shock in the share of senior tranche lending. This reaction is statistically significant for two quarters after the initial shock. Thus the partial correlation in the previous panel regression might indeed be interpreted as a causal relationship – in the sense of Granger causality.

This paper is structured as follows. In Section 2, we describe our dataset and give a first graphical illustration between the share of senior tranche lending and the interest rate spreads. In Section 3, we conduct a preliminary analysis of contemporaneous correlations and the unit root and cointegration properties of our data. Section 4 then includes the formal econometric analysis, and Section 5 concludes the paper with a policy discussion and ideas for further research.

2 Data

Our analysis focuses on the member countries of the euro zone which joined the common currency before the onset of the global financial crisis and for which data are available.[5] The panel dataset consists of quarterly observations from 2000 until the end of 2011. The main data sources are Eurostat of the European Commission, International Financial Statistics of the IMF, Thomson Reuters' Datastream and the Target2 database of the Institute of Empirical Economic Research at Osnabrück University. Appendix A1 presents a complete description of the sources and the construction of the variables used in our regression analysis.

[5] The only exception is Luxembourg, for which bond prices are not available as a time series.

Our proxy variable for senior tranche lending consists of two parts: Official loans and Target-liabilities. Official loans comprise all loans received by the IMF, the EU (through ESM/EFSF) and individual countries. TARGET is the payment system which processes transfers between commercial banks in the euro area; the acronym stands for *Trans-European Automated Real-Time Gross Settlement Express Transfer*.[6] Through regular open market operations, a part of government bonds ends up as collateral on the national central banks' balance sheets. This collateral is likely to be considered senior lending by the markets, once the new money created is transferred abroad, and the collateral given to the NCB is then used as collateral of the Target claims of another country. For instance, Germany has about 730 bn. € Target claims in May 2012, while GIIPS have around 880 bn. € in Target liabilities. Government bonds (albeit not only government bonds) are a large part of collateral for these target liabilities.[7]

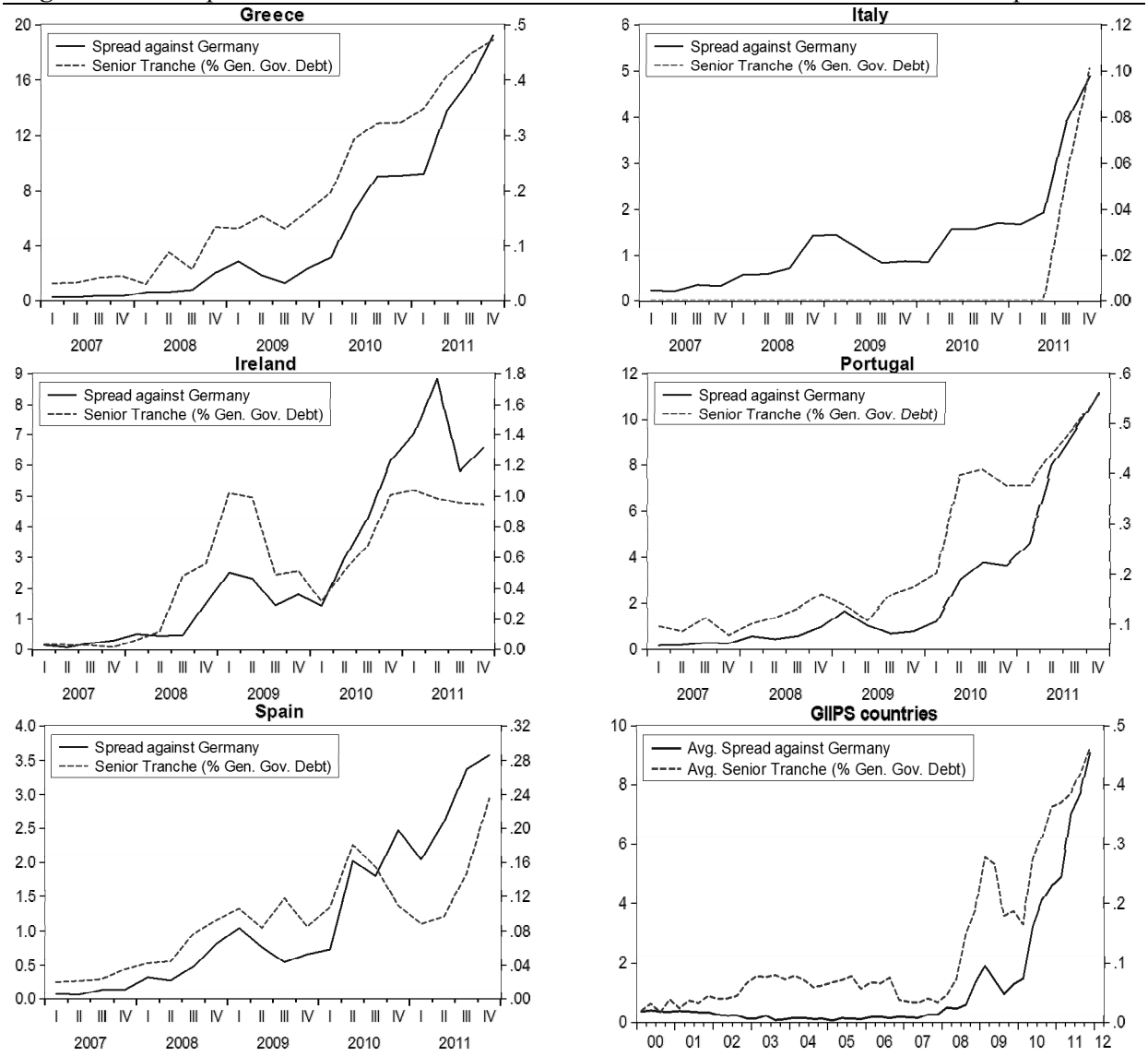
Figure 1 provides an initial visual impression of the data. It compares the senior tranche share with spreads on the sovereign bonds of the crisis countries. One can clearly see a high contemporaneous correlation for the individual GIIPS countries as well as in their aggregate. This impression is confirmed in a first correlation analysis in Table 2 of the appendix. In levels, the correlation is 0.62.

In the subsequent regression analysis, we analyze whether this bivariate correlation is statistically significant and robust in a multivariate analysis.

[6] Technically, this description is incomplete: Some countries which are not members of the Eurozone are nonetheless participating in the Target-system (e.g. Denmark). However, these countries are not full members in the sense that they are not allowed to have a negative net balance with the Eurosystem.

[7] According to the investment bank J.P. Morgan, around 77% of the collateral that Greek banks posted with the ECB is government or government-guaranteed (see Panigirtzoiglou et al. (2011)).

Figure 1: Development of the Senior Tranche and the Crisis Countries Government Bond Spreads



Notes: The figure shows the spread between the interest rate of countries' government bonds and the German Bund, both with a maturity of 10 years (left scale). The senior tranche proxy is calculated as described in Section 2 (right scale). The last graph in the figure compares GIIPS countries' geometric means of both variables since the year 2000.

Another potential element of the senior tranche is the Securities Markets Programme (SMP). Under the SMP, the European Central Bank buys government bonds on the secondary market. We did not include the SMP in our measure, although we did perform some robustness checks including the SMP as a control variable. The ECB only publishes the absolute value of the bonds bought under the program. The problems with this are twofold: Firstly, we cannot disaggregate the published number to the country level. Secondly, the ECB buys at an unknown price. As it has announced that it does not intend to make a profit from selling the assets, they can be viewed as lenders at par with private lenders.

Our senior tranche proxy is constructed as follows: The sum of the official loans and Target liabilities, imposing a lower limit of zero since Target claims offer no information on who holds government bonds. The senior tranche is expressed relative to the countries' general government debt. Other

control variables are described in the appendix. We use standard variables also chosen in other articles, for instance De Grauwe and Ji (2012).

3 Preliminary Analysis

We start our analysis with an overview of the descriptive statistics and the stationarity and cointegration properties of the variables that later enter the regression analysis. Table A2 of the appendix to the paper reports the means and standard deviations of our key variable for different time intervals. The most striking differences can be observed in the interest rate spreads and the share of the senior tranche in the periphery countries Greece, Ireland and Portugal. The means of the fiscal space variable, however, are not remarkably different for other countries, an observation that gave rise to the argument for multiple equilibria by De Grauwe and others.[8]

In order to correctly specify the regressions in the subsequent analysis, we conduct tests for stationarity and cointegration (see Breitung and Pesaran (2008) for details on the applicated tests). Table 1 reports the panel unit root tests according to several definitions. We find that the variables have a unit root in levels and are stationary in (logged) first differences.[9] Thus, we treat our data as stationary in first differences in our regression analysis. Table 2 furthermore reports the results of the test for cointegration, following Westerlund (2007) and Pedroni (1999, 2004). In nearly all cases, we cannot reject the null of no cointegration.

Table 1: Panel Unit Root Properties

		Test Statistics					
Test	H_0	Price	Δ Price	Spread	Δ Spread	Senior Tranche	Δ Senior Tranche
Levin-Lin-Chu (2002)	Panels contain (common) unit root	2.05 (0.980)	-9.61 (0.000)	13.10 (1.000)	-3.92 (0.000)	10.24 (1.000)	6.980 (0.000)
Breitung (2000)	Panels contain (common) unit root	1.05 (0.852)	-5.476 (0.000)	3.85 (0.999)	-4.20 (0.000)	-0.20 (0.422)	-5.850 (0.000)
Fisher type ADF	All panels contain (individual) unit roots	12.87 (0.936)	443.55 (0.000)	3.82 (1.000)	227.17 (0.000)	1.69 (1.000)	109.11 (0.000)
Fisher type Phillips-Perron	All panels contain (individual) unit roots	15.99 (0.816)	277.64 (0.000)	5.36 (1.000)	194.01 (0.000)	1.69 (1.000)	109.11 (0.000)
Hadri LM (2000)	All panels are stationary	52.40 (0.000)	1.57 (0.057)	41.403 (0.000)	7.87 (0.000)	13.30 (0.000)	-0.44 (0.670)

Notes: Probability values in parentheses. Statistics of the Breitung and Hadri LM tests have been calculated allowing for cross-sectional correlation of the error term. In a panel context the rejection of the unit root hypothesis should be interpreted as evidence that a statistically significant proportion of the units are stationary.

[8] Interestingly, as shown in Table A4, there is a significant correlation between the senior tranche share and both, the prices and interest rate spreads of the respective countries.

[9] The only exception is the differenced spread variable for which a statistically significant proportion of the panel is stationary, but also a significant proportion has a unit root. In other words, some of the differenced series of the spreads in the panel are likely to be integrated of order one. Table 4 in the subsequent analysis should therefore be interpreted with caution.

Table 2: Panel Cointegration Properties

	Test Statistics for H_0: no cointegration							
	Error correction model based tests by Westerlund (2007)				Residual based tests by Pedroni (1999, 2004)			
	Statistics based on weighted average of individual estimates		Statistics based on pooled information		Panel Statistics		Group Statistics	
Variables	G_τ	G_α	P_τ	P_α	Z_ρ	Z_t^*	$\tilde{Z}_\rho$	$\tilde{Z}_t^*$
Price, Senior Tranche								
Constant	-1.30 (0.961)	-2.49 (0.998)	-3.54 (0.898)	-2.42 (0.912)	-0.58 (0.282)	-1.06 (0.145)	3.02 (0.999)	0.59 (0.724)
Constant and Trend	-1.64 (0.999)	-4.96 (1.000)	-4.91 (0.992)	-5.37 (0.973)	-1.16 (0.123)	-3.09 (0.001)	0.28 (0.612)	-0.95 (0.170)
Price, Fiscal Space								
Constant	-0.76 (1.000)	-1.58 (1.000)	-1.84 (0.999)	-1.87 (0.963)	2.01 (0.978)	1.28 (0.901)	2.50 (0.994)	2.29 (0.989)
Constant and Trend	-1.56 (1.000)	-4.78 (1.000)	-2.03 (1.000)	-3.06 (0.999)	1.51 (0.935)	0.89 (0.812)	1.11 (0.867)	0.58 (0.720)
Price, Senior Tranche and Fiscal Space								
Constant	-0.60 (1.000)	-0.68 (1.000)	-1.63 (1.000)	-0.99 (0.999)	-0.42 (0.337)	-1.09 (0.138)	0.21 (0.582)	-0.860 (0.195)
Constant and Trend	-1.53 (1.000)	-2.78 (1.000)	-4.63 (1.000)	-3.60 (1.000)	-0.66 (0.254)	-1.28) (0.101)	-0.09 (0.466)	-1.04 (0.149)
Price, Senior Tranche and full set of controls								
Constant	-0.64 (1.000)	-0.16 (1.000)	-0.91 (1.000)	-0.16 (1.000)	0.00 (0.501)	-0.89 (0.188)	0.73 (0.767)	-0.54 (0.293)
Constant and Trend	-0.29 (1.000)	-0.03 (1.000)	-0.81 (1.000)	-0.06 (1.000)	0.59 (0.721)	-0.61 (0.272)	1.20 (0.884)	-0.38 (0.352)

Notes: The table shows the results of Westerlund (2007) and Pedroni (1999, 2004) cointegration tests. Lags (and leads) have been selected using the Akaike Information Criterion (restricted to a maximum of four). Probability values in parentheses. In contrast to the widely used Kao (1999) test, the Pedroni approach allows for heterogeneous short-run effects. However, it may result in largely oversized test statistics in the case of cross-sectional dependence (Banerjee (2004)). Therefore we also applied Westerlund's test which allows for heterogeneous short-run effects, unit-specific trend as well as slope parameters and cross-sectional dependencies. Since the time dimension is considerably larger than the panel dimension G_α and G_τ should have higher power than P_τ, P_α, as pointed out by Westerlund. In addition to the reported statistics, we did not find any evidence of cointegration between the government bond spreads, the debt to GDP ratios and the set of control variables used in our benchmark regression.

4 Panel regressions and sensitivity analysis

In this section, we establish our main empirical finding: a robust partial correlation of the senior tranche share to total public debt and the prices of 10-year government bonds. Table 3 contains a first set of results that we use as our benchmark regression for the latter robustness tests.

Table 3: Benchmark Regression

Dependent Variable: Government Bond (10y) Secondary Market Prices						
Variables	(1)	(2)	(3)	(4)	(5)	(6)
Senior Tranche	-0.221**		-0.232**		-0.209***	-0.200***
	(2.62)		(2.52)		(3.82)	(3.82)
Fiscal Space		-0.128	-0.155	-0.051***	-0.078***	
		(1.49)	(1.70)	(5.07)	(4.94)	
Current Account				-0.126	-0.134	-0.152
				(0.81)	(0.89)	(0.88)
REER				-0.055	-0.124	-0.111
				(0.53)	(1.27)	(0.96)
Real GDP Growth				0.080	-0.055	-0.057
				(0.36)	(0.28)	(0.26)
Debt to GDP Ratio						-0.017
						(0.40)
Country fixed effects	yes	yes	yes	yes	yes	yes
R-Squared (overall)	0.05	0.01	0.07	0.01	0.08	0.07
Observations	523	517	517	505	505	502

*Notes: All non-stationary variables in (logged) first differences (see data appendix for details). Robust clustered t-statistics are reported in parentheses (see e.g. Williams (2000)); *, **, *** indicate variables significant at a 10%, 5%, and 1% level respectively.*

All regressions are estimated using fixed effects panel regression with robust standard errors. Column (1) reports the coefficient of a simple bivariate regression. The correlation between government bond prices and the senior tranche share in public debt is statistically significant at the conventional 5% level, confirming the results of Table A3 in the descriptive statistics section. Columns (2) and (3) show that this correlation is robust when controlling for fiscal space, using the measure following Aizenman et al. (2011). Regressions (4) to (6) repeat the same exercise including further control variables. Here we follow De Grauwe and Ji (2012), who control for the current account balance, the real effective exchange rate, real GDP growth and either the debt ratio or a fiscal space measure. We confirm the De-Grauwe-puzzle, who points out that the Debt-to-GDP ratio is statistically insignificant. The effect of our senior tranche variable remains statistically significant in all specifications and does not change considerably in size.[10] A one percentage point increase in the senior tranche share is associated with a lower bond price of about 0.2%.

[10] In our benchmark regression, we include all crisis countries. Table A4 in the appendix repeats the exercise, excluding each country from the sample. The table shows that none of the crisis countries drives the results by itself. The point estimate is quite similar in all regressions, except for the last regression where Ireland is excluded. Here, the coefficient is considerably larger.

As a first set of robustness tests, we add further control variables. As Table 4 shows, some controls such as the oil price and trade openness are significant at the 5% and the 10% level. Other reasonable control variables, such as inflation and the financial account, are not statistically significant. Bond purchasing by the ECB in the Securities Markets Program is also statistically insignificant. As the bonds are purchased at market values, and the ECB explicitly announced that it will not retain profits from these bond holdings, this component of bonds on the ECB balance sheet is not likely to be considered senior by the markets. In Table 4, our senior tranche variable is statistically significant in all regressions.

Table 4: Additional Controls

Dependent Variable: Government Bond (10y) Secondary Market Prices						
Variables	(1)	(2)	(3)	(4)	(5)	(6)
Senior Tranche	-0.194***	-0.214***	-0.214***	-0.212***	-0.205***	-0.208***
	(7.05)	(4.02)	(3.98)	(4.19)	(3.71)	(7.30)
Fiscal Space	-0.069**	-0.059***	-0.075***	-0.076***	-0.071***	-0.048*
	(2.49)	(5.19)	(3.75)	(4.74)	(4.44)	(1.92)
Current Account	-0.101	-0.204	-0.184	-0.178	-0.131	-0.227
	(0.82)	(1.32)	(0.98)	(0.91)	(0.83)	(1.31)
REER	-0.185**	-0.223**	-0.115	-0.095	-0.153	-0.233**
	(2.89)	(2.68)	(1.02)	(0.63)	(1.56)	(2.74)
Real GDP Growth	-0.092	0.241	-0.092	-0.084	-0.004	0.164
	(0.51)	(1.44)	(0.43)	(0.39)	(0.02)	(1.00)
SMP	-0.000					-0.000
	(0.84)					(0.69)
Oil Price		-0.077***				-0.079***
		(16.56)				(11.64)
Financial Account			0.033			0.030
			(0.65)			(0.76)
Inflation				-0.024		-0.054
				(0.09)		(0.24)
Trade Openness					-0.082*	0.055
					(1.86)	(0.98)
Fixed effects	yes	yes	yes	yes	yes	yes
R-Squared (overall)	0.09	0.15	0.09	0.08	0.08	0.17
Observations	505	505	472	475	505	472

*Notes: All non-stationary variables in (logged) first differences (see data appendix for details). Robust clustered t-statistics are reported in parentheses (see e.g. Williams (2000)); *, **, *** indicate variables significant at a 10%, 5%, and 1% level respectively.*

Secondly, we compare the result of the regression on bond prices to a regression on interest rate spreads against Germany. In principle, both should lead to the same (inverse) qualitative findings. We prefer to use bond prices in our benchmark regression, however, as the spreads have a number of disadvantages. Notably, they display a stronger increase of the variance over time, an effect that can only be partially controlled for by using robust standard errors. Large parts of the literature including our key reference, De Grauwe and Ji (2012), use interest rate spreads as a dependent variable. As Table 5 shows, our main finding of a significant senior tranche share does not depend on this choice.

Table 5: Spreads Instead of Prices

Dependent Variable: Government Bond (10y) Spread against Germany						
Variables	(1)	(2)	(3)	(4)	(5)	(6)
Senior Tranche	3.477**		3.523**		3.068***	3.003***
	(2.54)		(2.52)		(3.15)	(3.16)
Fiscal Space		0.246	0.603*	-0.033	0.334	
		(1.09)	(2.13)	(0.17)	(1.44)	
Current Account				0.906	0.897	0.922
				(1.01)	(0.97)	(0.95)
REER				-2.650**	-1.676	-1.689
				(2.28)	(1.71)	(1.42)
Real GDP Growth				-5.863**	-4.170*	-3.615
				(2.59)	(1.97)	(1.56)
Debt to GDP Ratio						0.481*
						(1.97)
Country fixed effects	yes	yes	yes	yes	yes	yes
R-Squared (overall)	0.12	0.00	0.13	0.03	0.16	0.17
Observations	571	564	564	552	552	549

*Notes: All non-stationary variables in (logged) first differences (see data appendix for details). Robust clustered t-statistics are reported in parentheses (see e.g. Williams (2000)); *, **, *** indicate variables significant at a 10%, 5%, and 1% level respectively.*

The regression in De Grauwe and Ji (2012), which has been a motivation for our research project estimates in levels rather than first differences. As shown in the preliminary analysis, we find the specification in first differences more plausible due to the unit root and cointegration properties in the data. Nevertheless, for greater rigor, we also ran the regressions in levels. Table A5 of the appendix shows that this regression – although likely to be somewhat spurious – also yields similar results to those reported in the main body of the paper.

Table 6: Varying Subsamples (Pre-crisis and Crisis period)

Dependent Variable: Government Bond (10y) Secondary Market Prices				
Variables	- 2007/Q2	2007/Q3 -	- 2008/Q2	2008/Q3 -
Senior Tranche	0.049	-0.256***	0.011	-0.251***
	(0.80)	(4.62)	(0.15)	(4.97)
Fiscal Space	-0.057*	-0.021	-0.056	-0.003
	(2.12)	(0.31)	(1.76)	(0.04)
Current Account	0.105	-0.392	0.109	-0.415
	(1.43)	(1.23)	(1.76)	(1.08)
REER	0.634***	-1.199***	0.488***	-1.380***
	(8.31)	(7.77)	(8.58)	(5.95)
Real GDP Growth	-0.215	-0.413*	0.103	-0.736**
	(1.15)	(1.89)	(0.73)	(2.53)
Country fixed effects	yes	yes	yes	yes
R-Squared (overall)	0.11	0.22	0.06	0.24
Observations	311	194	355	150

*Notes: All non-stationary variables in (logged) first differences (see data appendix for details). Robust clustered t-statistics are reported in parentheses (see e.g. Williams (2000)); *, **, *** indicate variables significant at a 10%, 5%, and 1% level respectively.*

As a next step, we partition the sample into pre- and post-crisis subsamples. The results, reported in Table 6, indicate that the empirical link between bond prices and senior tranche lending is a recent, post crisis phenomenon. In the subsamples after 2007/Q2 (Introduction of Target2) and 2008/Q2 (Lehman brothers), the partial correlation between the senior tranche share and bond prices is statistically significant, while in the pre-crisis period it is not.

Our senior tranche variable used in the regressions thus far is a combination of target liabilities and the loans of official rescue packages from the EU, IMF and ECB. In Table 7, we include these elements both individually and jointly in the same regression. We find that both elements are significant, but there is a difference in the magnitude of the effect. In comparison to the combined senior tranche variable, the official loans have a larger coefficient, while the target variable has a somewhat smaller coefficient. This finding seems plausible, as the target liabilities are not only collateralized with government bonds, but partly also with other assets. It is, therefore, a noisier proxy-variable for senior tranche lending.

Table 7: Different Definitions of the Senior Tranche

Dependent Variable: Government Bond (10y) Secondary Market Prices					
Variables	(1)	(2)	(3)	(4)	(5)
Fiscal Space	-0.052**	-0.058***	-0.078***	-0.039***	-0.047***
	(2.88)	(8.10)	(4.94)	(4.84)	(5.10)
Current Account	-0.156	-0.158	-0.134	-0.110	-0.175
	(1.08)	(0.88)	(0.89)	(0.68)	(0.99)
REER	-0.066	-0.148	-0.124	-0.072	-0.187
	(0.65)	(1.12)	(1.27)	(0.67)	(1.35)
Real GDP Growth	0.057	-0.083	-0.055	0.091	-0.095
	(0.29)	(0.38)	(0.28)	(0.42)	(0.55)
Official Loans	-0.958***				-1.158***
	(3.34)				(4.81)
Target Liabilities		-0.173***			-0.188***
		(6.72)			(5.09)
Senior Tranche			-0.209***		
			(3.82)		
Domestic MFI Loans				-0.275***	-0.338***
				(8.04)	(9.34)
Country fixed effects	yes	yes	yes	yes	yes
R-Squared (overall)	0.08	0.05	0.08	0.03	0.17
Observations	505	490	505	505	490

*Notes: All non-stationary variables in (logged) first differences (see data appendix for details). Robust clustered t-statistics are reported in parentheses (see e.g. Williams (2000)); *, **, *** indicate variables significant at a 10%, 5%, and 1% level respectively.*

In a last exercise, we test the robustness of our result with respect to the choice of the estimation methods. In our benchmark fixed-effects regression we used clustered t-statistics, which are robust to within- and between-heteroscedasticity. After 'eyeballing' the graphs of government bond prices, we suspected an increasing variance. The higher standard deviations in the post-crisis sample reported in

the descriptive statistic in appendix A2 added to this suspicion.[11] In the first column of Table 8, as an alternative approach, we report the same regression, albeit with Driscoll and Kraay (1998) standard errors. These are robust to more general forms of cross-sectional correlation as well as serial dependence. However, a Wooldridge-test for serial correlation (see Wooldridge (2002)) with a test statistic of $F(1,10) = 1.73$ did not reject the null of no first-order autocorrelation at the 10% level.

Table 8: Estimation Methods

Dependent Variable: Government Bond (10y) Secondary Market Prices							
Variables	DK	RE	FGLS	2SLS	Lewbel	ArBo	Sys. GMM
Senior Tranche	-0.209***	-0.216***	-0.159***	-0.428***	-0.267***	-0.209***	-0.216***
	(2.98)	(3.60)	(8.75)	(3.71)	(5.74)	(4.18)	(4.26)
Fiscal Space	-0.078**	-0.083***	-0.023	-0.105**	-0.0857***	-0.079***	-0.104***
	(2.32)	(5.56)	(1.61)	(2.43)	(5.02)	(4.36)	(4.33)
Current Account	-0.134	-0.137	-0.192***	-0.187	-0.137***	-0.135	-0.166
	(0.79)	(0.93)	(6.01)	(1.12)	(0.97)	(0.92)	(0.93)
REER	-0.124	-0.153*	-0.236**	-0.172	-0.143	-0.132	-0.115
	(0.32)	(1.68)	(2.40)	(1.35)	(1.45)	(1.38)	(1.07)
Real GDP Growth	-0.055	-0.043	-0.170***	-0.225	-0.094	-0.049	-0.090
	(0.20)	(0.22)	(2.93)	(0.79)	(0.47)	(0.24)	(0.45)
$Price_{t-1}$						-0.001	-0.003
						(0.01)	(0.06)
R-Squared	0.07	0.08	-	0.005	0.06	-	-
Observations	505	505	352	475	505	484	495

*Notes: All non-stationary variables in (logged) first differences (see data appendix for details). Again, *, **, *** indicate variables significant at a 10%, 5%, and 1% level respectively. The first column shows the results of a fixed effects regression with Driscoll and Kraay (1998) standard errors, whereas the second shows the results of a random effects model with the same robust t-statistics used in the benchmark regression. Column (3) reports a feasible generalized least squares estimation assuming an heteroskedastic error structure with cross-sectional correlation and panel-specific AR(1) coefficient. Column (4) presents an IV estimation using lagged values as instruments. Column five presents the results of a Lewbel (2012) 2SLS estimation. The last two columns estimate a dynamic model using the Arellano-Bond (1991) GMM estimator and the System-GMM (see e.g. Wooldridge (2002)). Both regressions allow for endogeneity of all covariates using Lags up to fourth order as Instruments. Robust Windmejijer errors are reported.*

In column (2) of Table 8, we use a random effects model instead of country specific constants. When the country specific error is not correlated with the regressors, this method should yield a more efficient estimation. This assumption, however, does not hold. Because of the clustered, robust standard errors it is not possible to conduct a simple Hausman test for Fixed vs. Random Effects. Instead, we follow an artificial regression approach to test the overidentifying restriction of the additional orthogonality condition imposed in random effects models that the country-specific error is not correlated with the regressors (see Wooldridge (2002)). The Sargan-Hansen statistic of $\chi_5^2 = 13.70$ rejects the assumption of random effects in favor of the used fixed effects model at the 5% level of significance.

The reported feasible generalized least square estimation in column (3) allows for an heteroskedastic error structure with cross-sectional correlation and a panel-specific AR(1) coefficient. In this regression, the marginal effect of our senior tranche variable is slightly lower and the significance of the control variables changes. All of the control variables are statistically significant in this specification except for the fiscal space variable. Such a result is not surprising since FGLS tends to underestimate the true underlying variance considerably (See Beck and Katz (1995)).

[11] Additionally, we performed a modified Wald-test (see Greene (2000)). A $\chi_{11}^2 = 61.68$ rejected the null hypothesis of homoscedasticity at the 1% level.

The last four columns all constitute attempts to deal with possible endogeneity of our senior tranche proxy: Column (6) presents an Instrumental variable (IV) estimation of the benchmark specification in which the senior tranche has been instrumented by its lagged values. If we would assume i.i.d. errors for the 2SLS regression, there does not seem to be identification problems (as indicated by Anderson and Sargan statistics) and the senior tranche proxy is significant. If however, we allow for a heteroscedastic error term, the null hypothesis that the equation is underidentified cannot be rejected at the 10% level, as indicated by the LM version of the Kleibergen-Paap rk statistic with $\chi_3^2 = 1.440$.

In the fifth regression, we use the identification approach suggested by Lewbel (2012) that exploits the heteroscedasticity in the first stage of the regression. This IV technique yields consistent estimates by imposing higher moment restrictions even when valid external instruments are unavailable or weak.[12] A modified Wald test (see Greene (2000)) rejects homoscedasticity of the first stage regression at the 1% level, indicating that this approach is indeed valid for our data set.

The last two columns add the lagged value of the price variable and estimate this dynamic model using the Arellano-Bond GMM estimator and, alternatively, the System-GMM which imposes additional moment conditions (see e.g. Wooldridge (2002)). Both regressions allow for endogeneity of all covariates using lags up to the fourth order as instruments. The GMM estimators are both more suited for large N small T datasets and while Arellano–Bond AR(2) tests did not find autocorrelation, Sargan tests reject the assumption that the overidentifying restrictions are valid at the 10% and the 1% level, respectively.

The partial correlation of the senior tranche share and the bond prices remains statistically significant, and does not change considerably in effect size in any of our methodological robustness regressions.

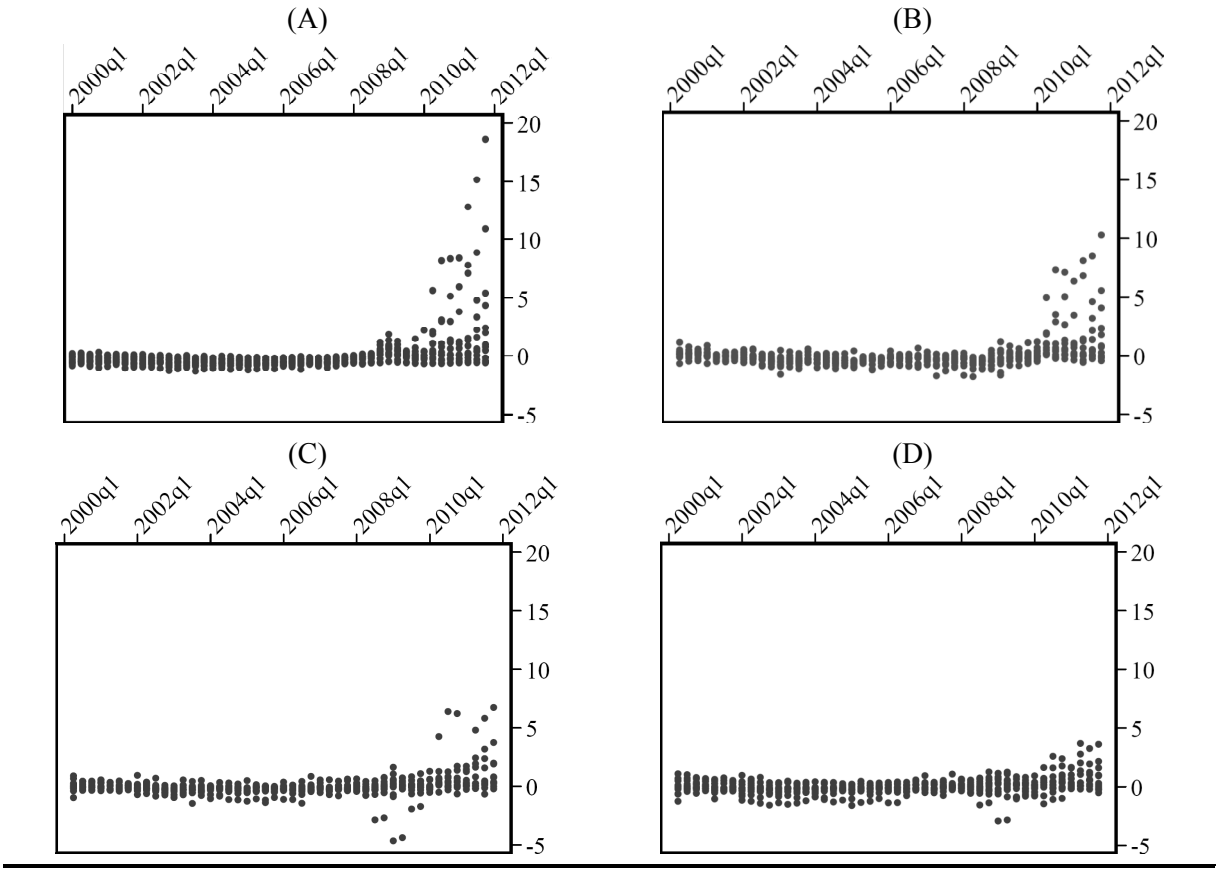
As a last exercise we compare how our benchmark specification relates to the De-Grauwe puzzle. De Grauwe and Ji (2012) argue, that the development of government bond spreads cannot sufficiently be explained by the underlying economic fundamentals. In their regressions, large residuals remain for the countries in crisis in the post-2007 period.

Graph (A) of Figure 2 shows the residual of a univariate regression explaining the spreads by the fiscal space variable. The deviations between the fitted and the actual values are especially high for the crisis countries since the onset of the European debt crisis. The residual has a maximum of about 19 percentage points. This confirms the puzzle established by De Grauwe and Ji (2012), and others.

[12] As identifying instrument $(Z - \bar{Z})\hat{\varepsilon}_1$ is used, where Z is the vector of our exogenous variables, $\bar{Z}$ the vector of means of the Z variables, and $\hat{\varepsilon}_1$ the residual of the first stage regression.

The graph (B) of Table 2 extends the simple univariate regression to the full set of explanatory variables of our benchmark regression, including the senior tranche share that we focus on in our paper. A considerably higher part of the development in spreads can now be explained. When we additionally allow for country specific coefficients of our senior tranche proxy in graph (C) the residuals become even smaller.

Figure 2: De-Grauwe Puzzle



Notes: All four scatter plots show the residual of a regression with different sets of explanatory variables on government bond spreads. The residuals of the graph (A) result from a simple univariate regression explaining the spreads by the fiscal space variable. Graph (B) includes the full set of explanatory variables, except for the senior tranche variable. The residuals in plot (C) and (D) stem from our benchmark specification in Table 2, including the control variables and the senior tranche proxy. In the regression for the residuals in graph (D) we additionally allowed for a country specific influence of our senior tranche proxy.

5 A panel VAR approach

In the previous sections, we have documented the contemporaneous partial correlation between the share of senior tranche lending and bond prices as well as interest rate spreads. In this section, we further address the issue of timing. Are the lead-lag relationships that conclude be interpreted as "causal" in the sense of Granger causality? To address this question, we estimate a panel Vector Autoregression (VAR) model.

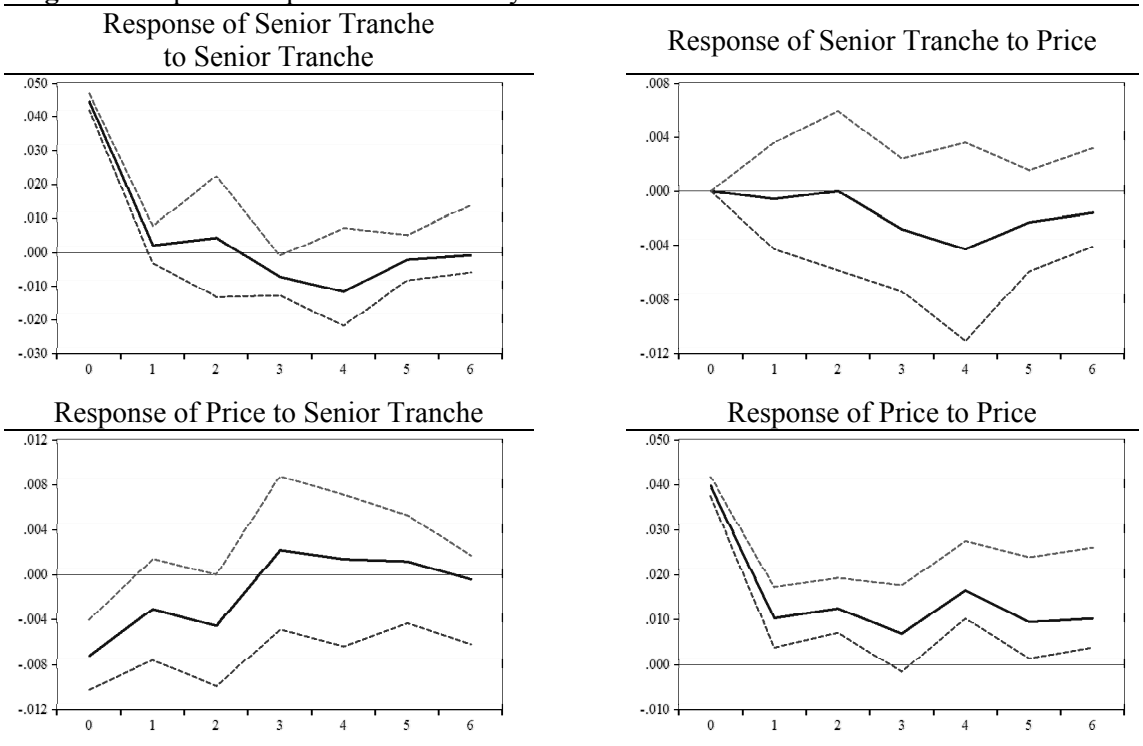
The panel VAR analysis mainly follows Love and Zicchino (2006). Our econometric model is specified as follows

$$x_{it} = \alpha_i + \sum_{l=1}^{k} \varphi x_{it-l} + \varepsilon_{i,t} \quad , \qquad i = 1, \dots, N, \qquad t = 1, \dots, T$$

where x_{it} is a vector of the price and the senior tranche variable, as well as different controls in subsequent analyses, α_i are country fixed effects, φ is the coefficient matrix and $\varepsilon_{i,t}$ a multivariate white-noise error term. To eliminate fixed effects despite their correlation with the regressors (due to lags of the dependent variables), we use forward mean-differencing. This, often called "helmert procedure", preserves orthogonality between the transformed variables and the lagged regressors (See Love and Zicchino (2006)).

In this panel VAR, we make the following identifying assumptions: Within the same period, the senior tranche cannot react to price changes. This assumption rests on the idea that for official lending to react to deterioration in bond prices, there is a decision-making process at the EU- and country levels before any interventions in the markets. The impulse response functions displayed in Figure 2 show that the impact of an unexpected shock in senior tranche lending on government bond prices is not only significant in the same period – a result that is consistent with the previous panel regression –, but also in the two periods following the initial shock. Bond prices are decreasing and are caused by the share of senior tranche lending in total public debt.

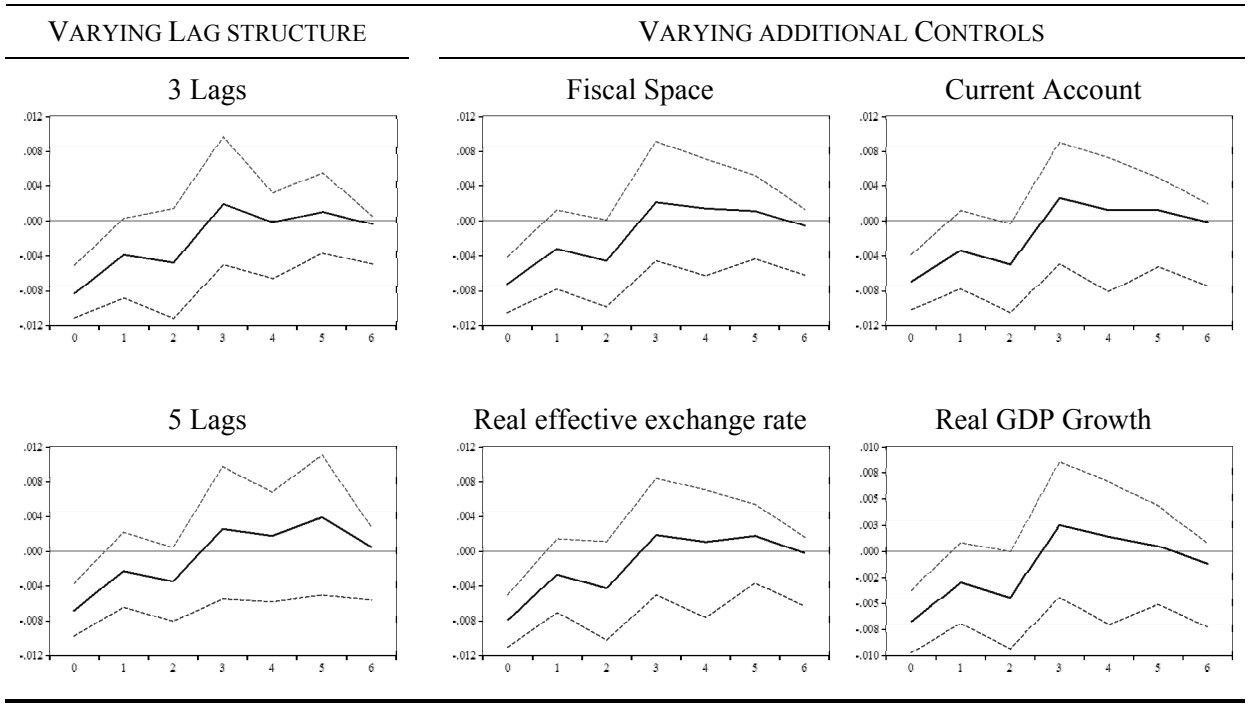
Figure 2: Impulse Response to a Cholesky One Standard Deviation Shock



Notes: 95% confidence bands are generated using a Monte Carlo Simulation with 2000 repetitions.

In a robustness test, we expand the bivariate panel VAR model by including the other control variables from the benchmark regression. While modeling the dynamics more completely, this of course intensifies the problem of the identification of shocks caused by contemporaneous correlation of error terms. We therefore include the control variables only one at a time and compute the impulse response functions from trivariate VARs, where we order the additional control variables in the mid position. Figure 3 shows that the reaction of bond prices to a shock in senior tranche lending is largely unaffected by the inclusion of control variables.

Figure 3*:* Impulse response of price to Senior Tranche in different panel VAR specifications



Notes:95% confidence bands are generated using a Monte Carlo Simulation with 2000 repetitions.

6 Policy implications and further research

The understanding of the determinants of interest rate spreads and sovereign bond prices is very important for the current economic policy debate in Europe. Several researchers have argued that high interest rate spreads in Europe are driven by bounded rationality in financial markets and multiple equilibria. If this is indeed the case, the appropriate policy response would be to flood the markets with liquidity and to expand the tasks of the ECB to assuming the role of a lender of last resort.

Other researchers, for instance from the Bruegel think tank in Brussels, have argued that the introduction of Eurobonds would help to solve the European crisis. The idea here is to explicitly partition the debt into a senior and a junior tranche. As a result, the *average* interest burden would decline due to the joint liability of all European countries for the first 60% of the debt. On the other

hand, incentives for fiscal discipline would remain intact because of the high marginal interest rate of the resulting junior tranche, the debt above the 60% level (See Delpla and Von Weizsäcker (2010)).

Based on the results of our paper, we argue that both proposals should be treated with caution. Although standard variables – such as debt to GDP ratios – do not fully explain interest rates and bond prices, this may not be due to multiple equilibria. Instead, the ongoing process of rescue operations of the public rescue funds and the ECB themselves are likely to be responsible for this missing mean reversion in interest rates. From the perspective of the remaining creditors in the market, their presence creates the impression that they have already become the junior tranche and thus, they require a higher interest rate.

Regarding the proposal from Bruegel, Europe might already be quite close to the sketched out scenario in their paper. Even without explicit joint liabilities for the first 60% of debt, countries in crisis are largely borrowing from official sources at low interest rates, while simultaneously facing a high marginal interest rate in the markets.

Finally, it is important to further analyze the precise causal relationship between the senior tranche share and the interest rate. We have undertaken different attempts, including 2-stage least squares regressions and a panel-VAR approach. In future research, a full structural identification of the effects could be achieved by using higher frequency data and better instruments.

Appendix A1: Data descriptions and sources

Variable	Description	Time Period	Sources	Units in regression analysis	Notes
Government Bonds					
Prices	Government Bond secondary market price (10 year maturity)	2000Q1–2012Q1	Thomson Reuters Datastream (Series: "Benchmark 10 year DS Govt. Index – Clean Price Index")	Index (2000Q1 = 100), Period on period % change.	No data for Luxembourg available
Spreads	Interest rate spread between Government Bond secondary market yield and the German Bund (both with a 10 year maturity)	2000Q1–2012Q1	OECD - Monthly Monetary and Financial Statistics (Series: "Long-term interest rates, Per cent per annum"), For gaps in series of Luxembourg: Thomson Reuters Datastream (Series: "Luxembourg Benchmark Bond 10 Yr (DS) Red. Yield")	Per cent per annum, Period on period change.	
Senior Tranche	Sum of the Target - liabilities and official loans	2000Q1–2011Q4	See below	Relative to General Government Debt, Period on period change.	For further details see Section 2
Intra-Eurosystem Liabilities ("Target")	Liabilities of the individual countries central banks to the Eurosystem	2000Q1–2012Q1	See Table A6 of the appendix	Relative to General Government Debt, Period on period change.	
Official Loans	Sum of cumulated loans from EU, EFSF/ESM, IMF and bilateral loans	2000Q1–2011Q4	See below	Relative to General Government Debt, Period on period change.	
EU, EFSF/ESM, bilateral	Loans and credit granted by official institutions (except IMF)	2000Q1–2011Q4	International Financial Statistics – Balance of Payments Statistics (Series: "Other Investment, Liabilities, General Government (Excludes Exceptional Financing), Total, Net"; Code: 78BTDZF)		
IMF	Loans and credit given by the IMF	2000Q1–2011Q4	International Financial Statistics – Balance of Payments Statistics (Series: "Other Investment, Liabilities, Loans, Monetary Authorities, Use of Fund Credit and Loans, Net"; Code: 4766..1)		
Main Macroeconomic Controls					
Fiscal Space	General Government Debt to General Government Revenue ratio	2000Q1–2011Q4	See below	Relative to General Govt. Revenue, Period on period % change.	
Govt. Debt	General Government Debt	2000Q1–2011Q4	Eurostat (Series: "Gross Government Debt"; Code: gov_q_ggdebt)		
Govt. Revenue	General Government Revenue	2000Q1–2011Q4	Eurostat (Series: "Total general government revenue"; Code: gov_q_ggnfa)		
Debt Ratio	General Government Debt to GDP ratio	2000Q1–2011Q4	Eurostat (Series: "Gross Government Debt"; Code: gov_q_ggdebt)	As % of GDP, Period on period % change.	
Current Account Ratio	Net Current Account to GDP ratio	2000Q1–2011Q4	Eurostat (Series: "Current Account"; Code: bop_q_c)	Relative to GDP, Period on period % change.	For Belgium, time series are only from 2002Q1 onwards
REER	Real effective exchange rate (based on CPI)	2000Q1–2012Q1	International Financial Statistics (Series: "Real Effective Exchange Rate, Consumer Price Index"; Code: ..RECZF)	Index (2005=100), Period on period % change.	
Real GDP Growth	Percentage change of real Gross domestic product	2000Q1–2011Q4	Eurostat (Series: GDP and main components – volumes; Code: namq_gdp_k)	Period on period % change.	
Other Controls					
SMP	ECB Government Bond purchases during its "Securities Markets Programme". See decision ECB/2010/5.	2010Q2–2012Q1	Thomson Reuters Datastream (Series: "Sec. Markets Prog. Amount"; Code: S244FC)	Mio. €, Period on period change.	First purchase on 14. May 2010. The ECB does not publish which government bonds it bought. Therefore, the time series is assumed to be the same for all crisis countries.
Domestic MFI Loans	Loans of the respective countries MFI's to Government	2010Q2–2012Q1	ECB – Statistical Data Warehouse (Series: "Balance Sheet Items; reference sector breakdown: MFIs excluding ESCB; Loans; Total; Counterpart area: Euro area; Counterpart sector: General Government", Code: BSI.M….N.A.A20.A.1.U2.2100.Z01.E)	Relative to General Government Debt, Period on period change.	
Oil Price	Price for one barrel of crude oil	2000Q1–2012Q1	ECB – Statistical Data Warehouse (Series: "Oil price, brent crude -1 month forward – Euro"; Code: RTD.M.S0.N.P_OILBR.E)	€/Barrel, Period on period % change.	
Financial Account Ratio	Net Financial Account to GDP ratio	2000Q1–2011Q4	Eurostat (Series: "Financial Account"; Code: bop_q_c)	As % of GDP, Period on period % change.	For Belgium, time series are only from 2002Q1 onwards
Inflation	Change in Harmonized Consumer Price Index	2000Q1–2012Q1	International Financial Statistics (Series: "Consumer Prices, Harmonized", Code: 64H..ZF)	Period on period % change.	
Trade Openness	Sum of Imports and Exports relative to GDP	2000Q1–2011Q4	Eurostat (Series: "Imports/Exports of goods and services"; Code: namq_exi_k)	Relative to GDP, Period on period % change.	No data for Greece 2011Q2 to 2012Q1
Others used for calculations					
Nom. GDP	Gross domestic product at current prices	2000Q1–2011Q4	Eurostat (Series: „Gross domestic product at market prices" ; Code: namq_gdp_c)		
Exchange rate	National Currency per U.S. Dollar	2000Q1–2012Q1	International Financial Statistics (Series: "National Currency per U.S. Dollar, period average"; Code: ..RF.ZF)		

General remarks: If the original data source did not provide the series seasonally adjusted – and we suspected a seasonal pattern in it – we accounted for this using the U.S. Census method (X12-ARIMA). In general we stationarized the level series by calculating the Period-on-Period (PoP) percentage change. In some cases we had to take PoP absolute change because of negative, zero, or close to zero data. Our sample includes the EA-12 countries, namely Belgium, Spain, Ireland, Italy, Luxembourg, Netherlands, Germany, Finland, France, Austria, Portugal and Greece.

Appendix A2: Summary statistics

		Gov. Bond Prices			Gov. Bond Spreads			Fiscal Space			Debt to GDP		
	SAMPLE	00 - 07	07 - 12	full	00 - 07	07 - 12	full	00 - 07	07 - 12	full	00 - 07	07 - 12	full
COUNTRIES	Greece	112.7	91.6	103.1	0.36	5.57	2.59	39.9	39.8	39.9	102.9	129.9	113.7
		(7.2)	(28.8)	(23.9)	(0.20)	(5.91)	(4.81)	(1.8)	1.8)	(1.8)	(3.7)	(19.2)	(18.1)
	Ireland	110.9	100.0	111.6	0.10	3.02	0.63	34.7	35.6	45.0	32.2	65.9	67.9
		(6.7)	(13.8)	(11.8)	(0.13)	(2.71)	(1.87)	(1.8)	(1.1)	(4.8)	(5.2)	(29.1)	(30.7)
	Italy	109.4	113.9	111.1	0.27	1.46	0.68	44.2	45.9	44.1	108.2	113.4	61.9
		(6.7)	(5.5)	(12.3)	(0.08)	(1.18)	(1.97)	(1.2)	(0.6)	(5.6)	(2.2)	(6.6)	(29.0)
	Portugal	109.8	103.3	111.6	0.19	2.89	0.62	39.8	41.3	44.5	59.2	83.5	65.7
		(6.8)	(17.9)	(11.6)	(0.11)	(3.37)	(1.79)	(2.3)	(3.1)	(5.4)	(6.6)	(14.4)	(31.9)
	Spain	113.6	117.6	110.7	0.13	1.31	0.69	38.9	36.5	44.7	49.7	50.9	67.4
		(8.1)	(4.7)	(12.2)	(0.11)	(1.11)	(1.97)	(1.3)	(2.2)	(5.2)	(6.9)	(11.9)	(31.7)
AGGREGATES	Eurozone	110.1	112.8	111.1	0.14	1.43	0.69	44.2	44.2	44.2	62.0	72.4	65.9
		(6.9)	(15.4)	(11.9)	(0.10)	(2.62)	(1.90)	(5.4)	(5.3)	(5.4)	(29.2)	(32.4)	(30.8)
	GIIPS	111.3	105.3	108.5	0.21	2.84	1.33	39.5	39.8	39.6	69.8	88.7	77.0
		(7.2)	(18.8)	(14.4)	(0.16)	(3.61)	(2.81)	(3.5)	(4.2)	(3.7)	(30.4)	(34.3)	(33.2)
	Non GIIPS	109.2	119.0	113.3	0.09	0.43	0.23	47.5	47.3	47.4	56.6	60.7	58.1
		(6.5)	(7.3)	(8.7)	(0.10)	(0.38)	(0.31)	(3.8)	(3.7)	(3.8)	(27.2)	(25.2)	(26.5)

		Senior Tranche Share			Current Account			REER			Real GDP Growth		
	SAMPLE	00 - 07	07 - 12	full	00 - 07	07 - 12	full	00 - 07	07 - 12	full	00 - 07	07 - 12	full
COUNTRIES	Greece	0.057	0.210	0.114	-0.079	-0.117	-0.093	95.7	106.2	99.7	0.9	-0.9	0.2
		(0.03)	(0.14)	(0.11)	(0.02)	(0.02)	(0.03)	(5.3)	(1.5)	(6.6)	(0.9)	(1.2)	(1.4)
	Ireland	0.089	0.593	0.054	-0.016	-0.024	0.000	94.1	105.5	98.9	1.2	-0.5	0.3
		(0.07)	(0.37)	(0.08)	(0.01)	(0.02)	(0.06)	(8.5)	(5.4)	(4.1)	(1.6)	(1.6)	(0.9)
	Italy	0.001	0.008	0.079	-0.012	-0.028	-0.000	96.7	100.9	98.9	0.3	-0.2	0.3
		(0.00)	(0.02)	(0.14)	(0.01)	(0.01)	(0.06)	(4.4)	(1.8)	(4.8)	(0.4)	(1.0)	(1.0)
	Portugal	0.108	0.251	0.065	-0.092	-0.100	0.007	97.0	101.4	98.8	0.3	-0.2	0.3
		(0.03)	(0.15)	(0.13)	(0.01)	(0.02)	(0.05)	(4.0)	(1.1)	(4.8)	(0.8)	(0.7)	(1.0)
	Spain	0.010	0.101	0.076	-0.054	-0.061	0.003	96.0	104.9	98.8	0.8	-0.1	0.3
		(0.01)	(0.05)	(0.14)	(0.02)	(0.02)	(0.06)	(4.9)	(1.4)	(4.6)	(0.2)	(0.6)	(1.0)
AGGREGATES	Eurozone	0.035	0.136	0.073	0.003	-0.009	-0.001	96.9	102.1	98.8	0.6	-0.1	0.3
		(0.05)	(0.20)	(0.10)	(0.06)	(0.06)	(0.10)	(4.5)	(3.1)	(4.7)	(0.8)	(1.1)	(1.0)
	GIIPS	0.053	0.233	0.120	-0.050	-0.066	-0.056	95.9	103.8	98.9	0.7	-0.4	0.3
		(0.05)	(0.27)	(0.19)	(0.03)	(0.04)	(0.04)	(5.7)	(3.5)	(6.2)	(1.0)	(1.1)	(1.2)
	Non GIIPS	.023	0.067	0.039	0.043	0.031	0.038	97.6	100.8	98.8	0.5	0.1	0.3
		(0.03)	(0.08)	(0.06)	(0.04)	(0.03)	(0.04)	(3.3)	(2.2)	(3.3)	(0.5)	(1.1)	(0.8)

Notes: Table shows arithmetic means and standard deviations (in parentheses) of government bond prices, spreads, and the main control variables used in our regression analysis. See data appendix for sources and composition of the variables.

Appendix A3: Contemporaneous correlations

LEVELS	Gov. Bond Price	Gov. Bond Spreads	Fiscal Space	Debt to GDP	Senior Tranche Share	Current Account	REER	Real GDP Growth
Gov. Bond Price	1.00							
Gov. Bond Spreads	-0.71***	1.00						
Fiscal Space	0.08*	-0.16***	1.00					
Debt to GDP	-0.23***	0.40***	0.11**	1.00				
Senior Tranche Share	-0.37***	0.62***	-0.29***	0.24***	1.00			
Current Account	0.12***	-0.24***	0.40***	-0.45***	-0.23***	1.00		
REER	0.15***	0.24***	-0.03	0.04	0.27***	-0.10**	1.00	
Real GDP Growth	0.17***	-0.34***	-0.02	-0.18***	-0.25***	0.11**	-0.31***	1.00

FIRST DIFFERENCES	Gov. Bond Price	Gov. Bond Spreads	Fiscal Space	Debt to GDP	Senior Tranche Share	Current Account	REER	Real GDP Growth
Gov. Bond Price	1.00							
Gov. Bond Spreads	-0.61***	1.00						
Fiscal Space	-0.10**	0.03	1.00					
Debt to GDP	-0.07*	0.13***	-0.03	1.00				
Senior Tranche Share	-0.20***	0.33***	-0.08*	0.06	1.00			
Current Account	-0.06	0.05	-0.02	-0.01	-0.029	1.00		
REER	-0.02	-0.01	-0.03	-0.11***	-0.06	0.05	1.00	
Real GDP Growth	0.13***	-0.22***	-0.07	-0.35***	-0.13***	-0.02	0.041	1.00

*Notes: Table shows pairwise correlations of government bond prices, spreads, and the main control variables in levels and first differences. *, **, *** indicate variables significant at a 10%, 5%, and 1% level respectively.*

Appendix A4: Outlier Analysis

Dependent Variable: Government Bond (10y) Secondary Market Prices					
Variables	(GRC)	(ESP)	(ITA)	(PRT)	(IRL)
Senior Tranche	-0.186***	-0.216***	-0.205***	-0.189***	-0.533**
	(5.69)	(3.54)	(3.91)	(4.81)	(3.05)
Fiscal Space	-0.076***	-0.085***	-0.080***	-0.086**	-0.080***
	(5.00)	(5.51)	(4.83)	(2.97)	(3.72)
Current Account	0.024	-0.140	-0.115	-0.145	-0.169
	(0.44)	(0.88)	(0.75)	(0.89)	(1.07)
REER	-0.198**	-0.118	-0.176*	-0.123	-0.142
	(2.84)	(1.09)	(2.09)	(1.18)	(1.22)
Real GDP Growth	-0.261**	-0.050	-0.050	-0.079	-0.076
	(2.36)	(0.23)	(0.23)	(0.37)	(0.29)
Country fixed effects	yes	yes	yes	yes	yes
R-Squared (overall)	0.07	0.09	0.08	0.07	0.10
Observations	462	458	458	458	458

*Notes: In the reported regressions individual countries are dropped from the sample. All non-stationary variables in (logged) first differences (see data appendix for details). Robust clustered t-statistics are reported in parentheses (see e.g. Williams (2000)); *, **, *** indicate variables significant at a 10%, 5%, and 1% level respectively.*

Appendix A5: Level Regressions

Dependent Variable: Government Bond (10y) Secondary Market Prices						
Variables	(1)	(2)	(3)	(4)	(5)	(6)
Senior Tranche	-38.153*		-37.154*		-44.302**	-39.384
	(2.06)		(2.08)		(2.44)	(1.63)
Fiscal Space		-1.380**	-1.212**	-1.351**	-1.082**	
		(2.69)	(2.66)	(3.05)	(2.93)	
Current Account				-47.957	-5.623	7.641
				(0.93)	(0.13)	(0.16)
REER				0.547*	0.842***	0.868***
				(2.13)	(4.26)	(4.06)
Real GDP Growth				2.557	1.328	1.341
				(1.77)	(1.30)	(1.44)
Debt Ratio						-0.087
						(0.34)
Country fixed effects	yes	yes	yes	yes	yes	yes
R-Squared (within)	0.17	0.04	0.21	0.17	0.35	0.33
R-Squared (between)	0.58	0.22	0.02	0.24	0.02	0.49
Observations	534	528	528	520	520	517

*Notes: All variables in levels (see data appendix for details). Robust clustered t-statistics are reported in parentheses (see e.g. Williams (2000)); *, **, *** indicate variables significant at a 10%, 5%, and 1% level respectively.*

Appendix A6: Target2 data sources[13]

The organization of the Target statistics varies widely across the 17 central banks and sometimes over time for individual central banks. Most of the central banks publish them as a part of their annual, quarterly, or in many cases monthly financial statements. The relevant positions are mostly called "Intra-Eurosystem Claims/Liabilities", "Other Liabilites/ claims of euro area residents" or "Deposits/Liabilities of/to other euro area MFI's". In the data set, we try to construct the narrowest definition of Target2 balances available for the individual countries. The following table describes the adjustments made for each country. An alternative, although less precise proxy can be constructed from Central Bank Survey data of the IMF and is discussed in Sinn and Wollmershäuser (2012).

	Central Bank	Source/Publication	Position	Notes
SAMPLE COUNTRIES GIIPS	Bank of Greece	Website of the Bank of Greece (http://www.bankofgreece.gr) 1. Balance sheet of the Bank of Greece 2. Bank of Greece Monthly Financial Statement	1. "Claims on MFIs, Other euro area countries" / "Liabilities to MFIs, Other euro area countries" 2. "9.4 Net claims related to transactions with the ESCB (TARGET2)" / "9.3 Net liabilities related to transactions with the ESCB (TARGET2)"	
	Central Bank and Financial Services Authority of Ireland	Website of Central Bank and Financial Services Authority of Ireland (http://www.centralbank.ie), Money and Banking Statistics, Table A.2 Financial Statement of the Central Bank of Ireland.	"Other liabilities"	We adjust this item for "Liabilities related to the allocation of euro banknotes within the Eurosystem", using the latest data available in the IFS database. After correction, this position still contains some smaller other liabilities which amount to roughly 2.3 bn. € in December 2011 (see note 30 of the annual report 2011).
	Bank of Italy	Bank of Italy Balance Sheet Aggregates and Official Reserves, Bank of Italy Balance Sheet Aggregates	"Other claims within the Eurosystem (net)" / "Other liabilities within the Eurosystem (net)"	
	Bank of Portugal	Statistical Bulletin, Table B.2.4, Assets and liabilities of the Banco de Portugal Vis-à-vis non-residents	Column 8: "Liabilities - Monetary financial institutions - Euro area countries"	
	Bank of Spain	Boletín Estadístico 1. "Table 7.13 Balance sheet" Economic Bulletin 2. 8.1.b Balance sheet of the Banco de Espana. Net Lending to credit institutions and its counterparts (monthly average of daily data)	Boletín Estadístico 1. Column 12 minus Column 17 Economic Bulletin 2. Column 21: "Counterparts, Intra ESCB, Target"	For the period 01/99 to 11/07 only monthly averages of daily data are available.

[13] The regularly updated Target2-dataset for all 17 euro area countries can be found online on the homepage of the Institute of Empirical Economic Research, Osnabrück University, at http://www.iew.uni-osnabrueck.de/en/8959.htm.

CORE	Austrian National Bank	Financial Statement	"10.4 Other liabilities within the Eurosystem (net)" / "9.5 Other claims within the Eurosystem (net)"	Data only published on a yearly basis (see parliamentary question 9004/J, 8932/AB). So this is the only exception for which we estimate quarterly data on the basis of Balance-of-Payments flow data together with yearly financial statement information.
	National Bank of Belgium	Statistical Bulletin / Belgostat online	"Other liabilities within the Eurosystem (net)" / "Other claims within the Eurosystem (net)"	These items comprise also some other, but minor, positions.
	Federal Bank of Germany	Website of the Federal Bank of Germany (http://www.bundesbank.de)	"Time series BBK01.EU8148B: MEMO ITEM: External position of the Bundesbank since the beginning of EMU / Claims within the Eurosystem / TARGET 2 (net)"	Before the Deutsche Bundesbank explicitly published the Target balance, one could find the series EU8148. This one diverges from EU8148B in two aspects: Firstly, the accrual principle is applied. Secondly, target balances with central banks of countries not member of the Eurozone are not included.
	Bank of France	Balance sheet of the Banque de France	Liabilities, other euro area countries – Deposits, MFIs	
	Bank of Finland	Website of the Bank of Finland (http://www.suomenpankki.fi) 1. Balance sheet of the Bank of Finland Bank of Finland Bulletin 2. Balance sheet of the Bank of Finland	1. "9.4 Claims related to Target and correspondent accounts (net)", "9.2 Liabilities related to Target and correspondent accounts (net)" 2. "Other claims within the Eurosystem (net)" / "Other liabilities within the Eurosystem (net)"	Monthly data does not match annual data since the first ones are as of the last Friday of the month while the figures in the annual report are as of the last day of the year.
	Central Bank of Luxembourg	Website of the Central Bank of Luxembourg (http://www.bcl.lu), Tab. 1.2 Financial statement of the Banque centrale du Luxembourg	"Cl. 18 Claim on the Eurosystem" / "Cl. 16 Liabilities to the Euroystem"	
	Netherlands Bank	Website of the Netherlands Bank (http://www.statistics.dnb.nl), T5.1 Balance sheet of the Nederlandsche Bank (monetary presentation)	"Loans to euro area residents, MFI, of which: target2 balance", "Deposits of euro area residents, MFI, of which: target2 balance"	
OTHER EURO AREA COUNTRIES NOT IN THE SAMPLE	Central Bank of Cyprus	Website of the Bank of Cyprus (http://www.centralbank.gov.cy), Monthly Balance Sheets	„Intra-Eurosystem liabilities" / „Intra-Eurosystem claims"	We adjust this item for "Liabilities related to the allocation of euro banknotes within the Eurosystem", using the latest IFS data available.
	Bank of Estonia	Website of the Bank of Estonia (http:// http://www.eestipank.info), Statistical Indicators, Quarterly Balance sheet of the Eesti Pank	"9.4 Other claims within the Eurosystem (net)" / "10.3 Other liabilities within the Eurosystem (net)"	
	Central Bank of Malta	Website of the Central Bank of Malta (http://www.centralbankmalta.org), Balance Sheet of the Central Bank of Malta based on Statistical Principles	"Intra-Eurosystem claims" / "Intra-Eurosystem liabilities"	In the case of net liabilities to the Eurosystem, we adjust this item for "Liabilities related to the allocation of euro banknotes within the Eurosystem", using the latest IFS data available.
	Bank of Slovenia	Website of the Bank of Slovenia (http://www.bsi.si/), Table 1.7., Balance Sheet of the Banke of Slovenia – by Instruments – Liabilities	„Intra-Eurosystem liabilities" / „Intra-Eurosystem claims«	
	National Bank of Slovakia	Annual Report	Note 18 to "Intra-Eurosystem liabilities"	Data only published on a yearly basis

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