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Interest rate spreads in the Euro area: fundamentals or sentiments?

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Abstract

We analyze the determinants of interest rates on long-term government bonds within the Eurozone to assess whether the recent divergence in interest rates is attributable to changes in common economic fundamentals. First, we show that the panel approach, mostly employed by existing literature on this issue, has conceptual as well as empirical problems. Therefore we harness an event study approach using high-frequency (daily) data to investigate the impact of three categories of events on EMU government bond yields. Our results indicate that yields react to forecasts on key economic indicators such as growth and future budget deficits. In contrast, we do not find evidence that investors react to announcement of fiscal "bailouts" or austerity measures.

Keywords and Phrases: Product differentiation, Gravity Equation, Cross-border bank lending

JEL Classification Numbers: L14, F34, G21

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1 Introduction

The borrowing cost of governments has become one of the main economic indicators in the countries that form the European Economic and Monetary Union (EMU). In the aftermath of the global financial crisis of 2008 and the ensuing recession, interest rates on government bonds began to diverge dramatically within the EMU after they had been converging in the years before. While some governments (like the German government) are now able to borrow at record low interest rates, governments from other countries (Greece, Ireland, Italy, Portugal, and Spain) experienced a sharp and sudden increase in their borrowing costs bringing them to (and, in the case of Greece, beyond) the brink of default. Eurozone governments and the International Monetary Fund (IMF) had to take drastic steps to avoid a default of these governments. The ECB has also intervened massively to keep interest rates from rising further. Yet, while the importance of the long-term interest rate is widely recognized, it is not obvious what policy action is appropriate to bring interest rates down and to prevent them from rising again.

The policy response on the part of the EMU governments and the IMF consisted of extensive emergency loans to troubled governments conditional on a set of fiscal and structural reforms. The aim of these reforms is to reduce the public sector debt relative to GDP and enhance the competitiveness of the economy in order to rebuild the confidence of private creditors in the solvency of the governments. Thus, the official response to the crisis rests on the proposition that the crisis was caused by a deterioration in the fundamental determinants of public sector solvency and that the remedy is to improve these fundamentals.

However, this proposition is cast into doubt by two observations: (i) Some of the crisis countries did not feature "bad fundamentals" until the crisis started. Ireland and Spain, in particular, had debt-to-GDP ratios below the EMU average and were even running primary budget surpluses before 2009. (ii) Some countries outside the monetary union that had equally bad fundamentals did not experience a debt crisis. The United Kingdom as well as the United States both have debt levels comparable to the EMU crisis countries and yet continue to borrow at much lower interest rates.

This latter point has been made most forcefully by DeGrauwe (2011), who suggests that the Eurozone debt crisis was caused by a self-fulfilling shift in investor sentiments resulting in a run on EMU government debt. Such a run is more likely to occur in a monetary union, where national governments cannot resort to their own central banks as lenders of last resort. Recent work by DeGrauwe and Yi (2012) has sought to underpin this alternative explanation of the Eurozone debt crisis empirically. More generally, the above observations raise the question whether and to what extent government bond yields are driven by fundamentals as opposed to sentiments.

To analyze this question, we start from the government's intertemporal budget constraint to single out the fundamental determinants of government solvency that should guide investors in their lending decisions. Using the insights from this theoretical discussion we study the determinants of (long-term) government bond yields of European countries. The existing literature on the issue has relied mainly

on panel frameworks with low frequency (mostly quarterly) data. However, this approach has a number of econometric problems which we adress in the paper. Most importantly, we doubt that the effects of the explanatory variables of the countries analyzed are homogenous enough to be studied in a panel framework. We therefore employ Seemingly Unrelated Regression (SUR) using quarterly data for 18 European countries. The SUR approach allows us to assess whether the poolability assumption underlying the panel approach is warranted for our sample.

In a second step we look at high-frequency (daily) data to shed more light on the determinants of government borrowing costs. However, the use of daily interest rate data prevents us from estimating the intertemporal budget constraint, because the required explanatory variables are not available at this frequency. Hence we rely on event study techniques to investigate what kind of economic and financial market news have had an impact on government interest rates. We focus on three categories of news: economic forecasts, the announcement of official fiscal assistance and the announcements of fiscal reforms ("austerity packages"). In so far as these news contain novel information on fundamentals for investors, we expect them to change interest rates significantly. A lack of reaction to news can thus be interpreted as evidence that interest rates are indeed unrelated to fundamentals.

The remainder of the paper is in four sections. The next section looks at the intertemporal budget constraint of the government to derive the fundamentals of government bond yields which we use in our empirical investigation. Section 3 reports and discusses the results of our SUR exercise. In Section 4, we turn to daily data and use event study techniques. The last section summarizes the results of the paper.

2 The fundamental determinants of government borrowing costs

Differences in interest rates on government bonds in the Euro zone results from the difference in the perceived risk of these bonds. In general, this risk contains a default risk element as well as a liquidity risk and an exchange rate risk element. For interest spreads within the EMU, the exchange rate risk element is, of course, absent. Thus one can expect the default risk to dominate as a determining factor of within-EMU spreads. Default risk is in turn determined by the government's future ability (and willingness) to service its debt. The central tool to evaluate the government's future solvency is the intertemporal budget constraint which states that the discounted sum of future primary budget surpluses should not be smaller than the value of debt currently outstanding.

$$E_t\left[\sum_{k=0}^{\infty}\frac{Primary\ surplus_{t+k}}{\prod_{l=0}^{k}(1+r_{t+l})}\right]\leq Debt_t$$

Here E_t denotes the expectation operator, indicating that there is uncertainty over the future primary surpluses as well as future interest rates. A violation of the intertemporal budget constraint implies an exploding debt level. Introducing economic growth alters the constraints in that it yields a stable

debt-to-GDP ratio even if the debt level grows continuously. A stable debt-to-GDP ratio for a government with tax revenues and expenditures growing proportionally to the GDP with rate g is given by $(Primary\ surplus)/(r-g)$. Thus, the (nominal) interest rate r_t^{stable} which is consistent with a stable debt-to-GDP ratio is a function of expected future primary surpluses and the expected (average) nominal growth rates g of the economy.

That does not define the maximal interest rate that is consistent with a non-defaulting government, but the one which stabilizes the debt-to-GDP ratio. That is, at this interest rate the primary surpluses finances the difference of nominal interest rate and nominal growth rate $r-g$ of the new debts D, holding the debt-to-GDP ratio constant. The debt-to-GDP ratio, however, is usually not stable but changes (increases) over time making the intertemporal budget constraint more likely to imply an increasing burden on the future. Higher debt-to-GDP ratios require ceteris paribus a lower interest rate which is consistent with a stable debt-to-GDP ratio or higher primary surpluses. Since lower interest rates can only seldom be accomplished and higher primary surpluses are rare, investment include increasing risk which must usually be compensated by a higher risk premium. This risk premium however increases the risk of default even further. This gives rise to multiple equilibria as discussed in DeGrauwe (2012). The compensation for risk for investors is a source of risk itself.

Thus, a risk premium depends on the debt-to-GDP ratio, the expected growth rate, the expected tax revenues and the expected government spending. We use the spread of the interest rate on government bonds of a particular country over the interest rate of German bunds as risk premium. We can do this because the German bund is surely seen as risk-less and (almost) perfectly integrated financial markets in the EMU do not allow for other reasons of interest rate differentials than risk. In the empirical analysis, we therefore explain the government bond yield spread of a country by the fundamentals from the intertemporal budget constraints: the debt-to-GDP ratio, the expected future growth rate, and the expected future primary surplus.

These are also the most often used variables when assessing the effects of changes in the fundamentals on bond yields or CDS spreads (Attinasi et al. (2009)), Gerlach et al. (2010), Aizenman et al. (2011), DeGrauwe and Ji (2012), Steinkamp and Westermann (2012)). These papers differ in (i) the endogenous variable which is bond yield spreads over German yields (Attinasi et al. (2009), Gerlach et al. (2010), DeGrauwe and Ji (2012), Steinkamp and Westermann (2012)) or CDS (Aizenman et al. (2011)), (ii) the main explanatory variable which is fiscal space (Aizenman et al. (2011)), the debt-GDP ratio (DeGrauwe and Ji (2012)), the size of the banking sector (Gerlach et al. (2010)), announcements of bank rescue packages (Attinasi et al. (2009)), or the share of liabilities hold by senior creditors (Steinkamp and Westermann (2012)), and (iii) the econometric method employed which is fixed effect panel estimation (DeGrauwe and Ji (2012), Steinkamp and Westermann (2012)), dynamic panel estimation (Attinasi et al. (2009), Aizenman et al. (2011)) or a random coefficients model (Gerlach et al. (2010)).

In addition to the fundamental fiscal variables, liquidity measures are proposed in the literature. While liquidity measures have been found important in determining government bond yield spreads in Beber

et al. (2009), we refrain from using liquidity measure because they are either (endogenous) price measures or just another variable expressing total government debt. Global risk factors are also excluded because they cancel out when bond yields of a country are measured relative to the German bund yield.

Thus, we estimate an econometric model of government bond yield spreads over German bunds including the debt-to-GDP level, the primary surplus, and the growth expectations as explanatory variables.[1] In contrast to the literature, we estimate time-series models for the 20 countries in our sample but allow for contemporaneous correlations in the residuals. Changes in the world market can therefore have an effect on all government bonds although not necessarily with the same strength. This set-up enables us to assess which countries are homogenous enough to be grouped to a panel analysis. We find the coefficients so heterogeneous that we estimate the two panel regressions presented in the appendix only to make our results comparable to the results found in the literature. We do not discuss them in the paper. I stead, in order to strengthen the study of the effects of changes in the fundamentals on the interest rates, we use daily data and harness singular events like agreements on financial assistance, political uncertainty after general elections, and the voluntary debt forgiveness by private investors.

3 Evidence from quarterly data

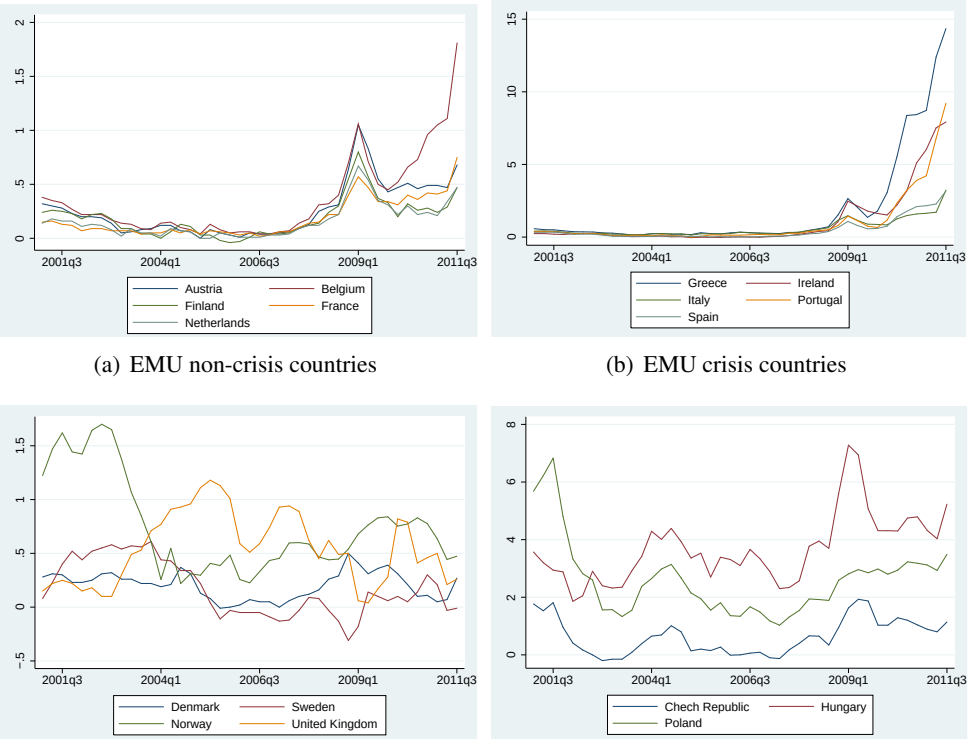
Our sample comprises 18 European countries, of which 11 (Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal, Spain) are members of the Euro zone and seven are not (Czech Republic, Denmark, Hungary, Norway, Poland, Sweden, United Kingdom). We excluded all European countries which have changed their currency regime after 2001. For included countries we obtained interest rates on 10-year benchmark bonds reported by the European Central Bank on a quarterly basis.[2] Data on gross public debt, fiscal space, real GDP growth, real exchange rates and current account balances are from Eurostat and observed quarterly from the 1st quarter 2001 up to the 3rd quarter 2011. For non-EMU countries we also rely on national sources.

The countries in the sample differ greatly with respect to the spread of the interest rate paid on their 10-years government bond over the German government bond benchmark. Figure 1 depicts the spreads for the countries that have been grouped into four sub-samples: EMU non-crisis countries seen in (a), EMU crisis countries seen in (b), and non-EMU old-EU countries seen in (c), and non-EMU new accession countries in (d). While we also conducted a panel estimation which replicates the results found in the literature (see Table 6 and 7 in the appendix), we want to start with a SUR regression because a SUR-estimation does not require as much homogeneity in the explanation as a panel approach (Hayashi

[1] We use contemporaneous variables because at the particular time expected future values are not available at quarterly basis. We checked with forecast from the World Economic Outlook which reduced the number of observations by half because there are only two WEO forecast per year. the results are less robust but in line with the results presented in the paper.

[2] Not all governments actually issue bonds with 10-year maturity. Therefore, the ECB calculates reference yields using government bonds with maturities close to 10 years.

(2000)).



(a) EMU non-crisis countries

(b) EMU crisis countries

(c) Non-EMU old-EU countries

(d) Non-EMU accession countries

Figure 1: Government bonds' interest rate spreads over Germany

Our basic econometric model uses a set of 'fundamentals' to explain the *spread* of national interest rates over the German benchmark rate. For each country i, we run a regression of the form

$$spread_{it} = \beta_{i0} + \beta_{i1} Debt_{it} + \beta_{i2} Growth_{it} + \beta_{i3} PS_{it} + \varepsilon_{it}, \tag{1}$$

where *Debt* is the government debt-to-GDP ratio, *Growth* is the growth rate of real GDP, and *PS* is the primary surplus measured in percent of GDP. The choice of fundamentals is guided by the theoretical considerations from the last section. We depart from the panel framework used in the literature by allowing the parameters to differ across countries.

Using a set-up as this, we assume that the errors in (1) are uncorrelated with the fundamentals, i.e. $E(\mathbf{x}_{it} \cdot \varepsilon_{it}) = 0$. Moreover, there should be no correlation between country i's fundamentals and country j's errors, i.e. $E(\mathbf{x}_{it} \cdot \varepsilon_{jt}) = 0$. Hence, we could estimate (1) for each country separately by means of equation-by-equation OLS. However, if there is cross-country correlation in the errors ($E(\varepsilon_{it}\varepsilon_{jt}) \neq 0$) OLS will produce inefficient estimates. Since we cannot preclude cross-country correlation in the errors in our context, we use Seemingly Unrelated Regression which provides efficient estimates in that case.

Table (1) provides the results from the SUR estimation for all countries in the sample. The general

	Debt	*Growth*	*PS*	*Constant*	"R^2"
Austria	-0.002	-0.064***	-0.825***	0.463**	0.59
	(0.003)	(0.006)	(0.295)	(0.193)	
Belgium	-0.002	-0.051***	-0.621***	0.602***	0.31
	(0.002)	(0.011)	(0.194)	(0.213)	
Finland	-0.001	-0.026***	0.068	0.273***	0.57
	(0.002)	(0.003)	(0.147)	(0.071)	
France	0.011***	-0.041***	0.104	-0.508***	0.79
	(0.001)	(0.003)	(0.126)	(0.051)	
Netherlands	0.009***	-0.032***	0.476	-0.307**	0.57
	(0.002)	(0.006)	(0.309)	(0.121)	
Greece	0.1289***	-0.137***	17.846***	-12.229***	0.84
	(0.013)	(0.049)	(2.879)	(1.528)	
Ireland	0.062***	0.022	3.440***	-1.673***	0.86
	(0.004)	(0.015)	(0.681)	(0.182)	
Italy	0.040***	-0.049***	0.005	-3.905***	0.55
	(0.004)	(0.011)	(0.600)	(0.540)	
Portugal	0.052***	-0.003	-0.534	-2.977***	0.58
	(0.005)	(0.025)	(1.001)	(0.335)	
Spain	0.021***	-0.042**	-1.078	-0.604***	0.49
	(0.003)	(0.020)	(0.795)	(0.178)	
Denmark	0.003***	-0.016***	-0.878**	0.112	0.50
	(0.001)	(0.004)	(0.361)	(0.054)	
Norway	-0.035***	0.002	-2.828***	2.572***	0.63
	(0.004)	(0.017)	(0.634)	(0.157)	
Sweden	0.032***	-0.017**	-0.672***	-1.265***	0.61
	(0.003)	(0.007)	(0.578)	(0.158)	
United	0.002	0.067***	-0.134	0.356**	0.17
Kingdom	(0.003)	(0.015)	(1.316)	(0.156)	
Czech	0.024**	-0.121***	0.803	0.284	0.50
Republic	(0.012)	(0.013)	(0.950)	(0.390)	
Hungary	0.023*	-0.170***	-0.913	2.374**	0.45
	(0.014)	(0.032)	(1.100)	(0.969)	
Poland	0.005	-0.288***	-0.539	3.377***	0.35
	(0.021)	(0.052)	(3.365)	(0.928)	

Robust standard errors in parentheses. *, **,*** denote significance at the level of 10, 5 and 1%, respectively.

Table 1: SUR for EMU member countries

picture emerging from this regression is quite clear: the estimated slope parameters differ substantially between countries. While the signs of the coefficients are widely in line, their sizes and statistical significance differ greatly. The results indicate that the impact of debt ratios on government bond yields is very inhomogeneous and that there is no clear relationship between debt ratios and spreads except for those countries that actually experienced a crisis. For Greece, Ireland, Italy, Spain and Portugal, debt has a fairly strong and highly significant positive effect on the spread. For the other Eurozone countries as well as for the non-EMU countries, the estimated debt parameters are much smaller and mostly insignificant.

The effect of real GDP growth is more homogeneous across countries. With the exception of Ireland, Portugal and Norway, higher growth rates are associated with significantly lower spreads. In the case of Ireland and Portugal, this finding can be explained by the fact that the rise in the spreads occurred after the recession of 2009/10 reached its through and the economy was already starting to recover. The estimated parameters on primary surpluses are rather puzzling at first sight. For some countries, including the crisis-countries Greece and Ireland, primary surpluses seem to have a positive impact on borrowing costs. The explanation for this seemingly perverse result is that by the time the Greek and Irish spreads started to rise in 2010, the government's primary balance was actually improving, whereas during the years before the crisis, the spreads where very low and the primary balance was modestly negative in the case of Greece and modestly positive in the case of Ireland. For most of the other countries, the estimated primary surplus parameters have the expected (negative) sign. It is also interesting to note that the explanatory power (judged by the R^2) is consistently larger for the crisis countries than for the non-crisis countries. Finally, note the sizeable differences in the constant terms which raise some doubts on the specification given that the yields of the EMU countries did not differ much until 2010.

There is however one crucial drawback in both the fixed-effects and the SUR estimations: the methods as applied here assume stationarity of the time series whereas the time-series of the spreads and the debt-to-GDP ratios are non-stationary. In particular, standard tests (ADF and KPSS) provide ample evidence that the interest rate *spreads* are non stationary for all countries in our sample. The results of the ADF and KPSS tests can be found in the appendix (Table 8). Therefore, even if we find a significant relationship between debt ratios and interest spreads for some countries, the relationship may be entirely spurious, stemming only from the time-trends found in the variables involved. The significant parameters that we obtain in the above regressions should therefore be interpreted with extreme care.

The bottom line from the SUR-approach is that the evidence drawn from regression analysis using quarterly data is rather inconclusive and plagued with conceptual as well as empirical difficulties. In any case, it does not produce robust evidence for a stable relationship between "fundamentals" and interest spreads. Furthermore, including debt-ratios among the regressors leads to an endogeneity problem: Is the spread high because debt is high or is it the other way round? Moreover, from an empirical perspective it is questionable whether using quarterly data is appropriate in explaining interest rates or their spreads. A graph of the bond yields as given in Figure 2 for Greece is instructing in why lower frequency data

might be unsuited to explain the changes in the bond yields. Up to early 2010, the yields have barely changed. After 2010, however, they have changed drastically at certain dates. To show that these changes are not just driven by sentiments, we relate them to news events that affect investors' decisions: austerity programs, assistance agreements, banking regulation and support acts, economic forecasts of growths and debts and changes in financial regulations.

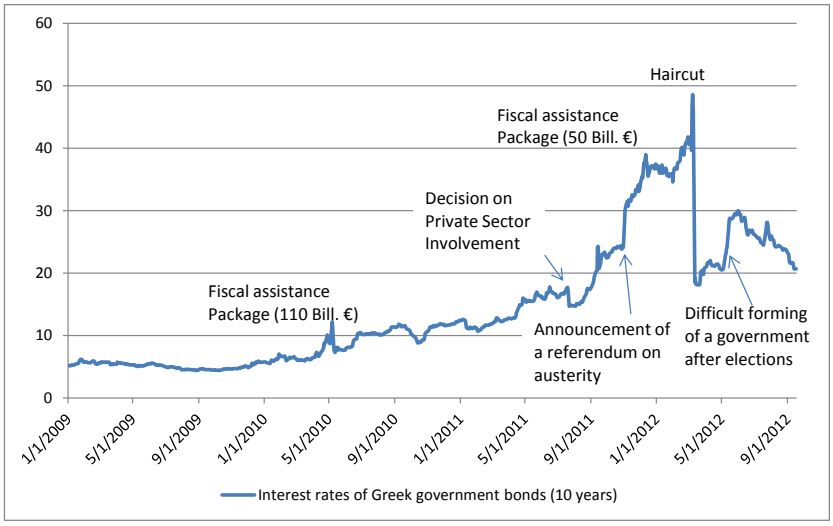


Figure 2: Greek government bond interest rates, 2009-2012

4 Evidence from an event study with daily data

The econometric analysis of the previous section reveals that there is no common pattern in the determinants of bond yields in the EMU. There is, however, a crisis risk premium when investors have doubt that their investment will be paid back. So far there is no reason to claim that sentiments which are unrelated to fundamentals are driving these risk premia. To study the determinants of the yield spread further, we use higher frequency data of government bond yields in the crisis countries.

The data on government bond yields in this section are taken from the Thomson-Reuters Datastream and consist of daily observations of the effective annual yield of government bonds with a residual maturity of 10 years. The information on events comes from two officially assembled, publicly available time-lines: one from the European Commission and another one from the European Central Bank. The critical task in our event study is the identification and selection of events. We differentiate between three categories of events: "economic forecasts", "fiscal assistance" and "austerity measures".

A particular problem in event studies is to define the time period over which the impact of an event is measured. For instance, in event studies investigating the impact of earnings announcements on a firm's value, it is usual to define an event time window including the day of the announcement as well as the

day immediately before and the day immediately after the announcement. Here, we extend our event window to ten days before and ten days after the event day to hedge against the possibility of assigning the wrong date to an event.

In order to study the impact of an event on the bond yield, it is necessary to create a benchmark that resembles the performance of a bond in absence of the event under investigation. In stock market event studies one typically resorts to a market portfolio of stocks similar to the stock under investigation (MacKinley (1997)). The bond market analogue of a market portfolio would be a euro-area average of bond yields, or even a world-wide average. However this approach is problematic because there is very little correlation between euro area bond yield average and yields of crisis countries, so that the euro-area average is a very poor predictor for an individual bond yield of a crisis country.

Theory suggests that the yield of any bond should be equal to the riskless interest rate plus a risk premium reflecting investor's expectations of the future solvency of the bond issuer. Assuming that risk aversion does not vary (very much) with time, the yield should remain the same as long as there is no event that changes investor's expectations. We provide two different benchmarks that are based on that proposition. Our first benchmark (BM1) is the yield of day before the event window starts. This means, we implicitly assume that the bond yields follow a simple random walk. If we denote the country i's government bond yield observed at day t with $R_{i,t}$, the assumption can be formalized as follows: $R_{i,t} = R_{i,s-1} + \varepsilon_{i,t}$, where $R_s = R_{t-10}$ is the first day of the event window and ε_{it} is a zero-mean error term. The second benchmark (BM2) is a moving average of the last 20 observations of yields before the event window starts.

The benchmarks are used to calculate the abnormal returns associated with a given event. For our first two benchmarks the abnormal return on day t is the difference between the actual yield on that day and the benchmark yield, i.e. $AR_{i,t} = R_{i,t} - R_{i,s-1}$ in the case of benchmark 1 and $AR_{i,t} = R_{i,t} - \frac{1}{20}\sum_{v=s-21}^{s-1} R_{i,v}$. In addition, we calculate one more measure of abnormal returns (BM3), which is based on the assumption that the bond yields follow a first-order autoregressive process

$$R_{i,v} = \alpha_i + \beta_i R_{i,s-1} + \varepsilon_{i,v}, \tag{2}$$

We run this regression for each country in our sample excluding those days which belong to an event time window. The abnormal return (AR) on day t is then simply calculated as the difference between the actual yield and the predicted yield:

$$AR_{i,t} = R_{i,t} - \hat{\alpha}_i - \hat{\beta}_i R_{i,s-1}, \tag{3}$$

where $\hat{\alpha}_i, \hat{\beta}_i$ denote the estimated parameters of the AR(1) process.

Using the abnormal returns, one can draw inferences on the impact of a given event on the bond yield. Our main interest in this event study is to see which categories of events have an impact on the behavior

of government bond yields. For that purpose we calculate the cumulated abnormal return associated with events. For an event occurring on day t, the cumulated abnormal return is

$$CAR_{it} = \sum_{s=t-10}^{t+10} AR_{is}. \tag{4}$$

We want to test wether any particular category of event has a positive or negative impact on a country's government bond yield. In order to test that, we perform a sign test. Under the null hypothesis that an event category (e.g. "economic forecast") has no impact on the yield, the expected value of the cumulated abnormal returns associated with the events in that category is zero. Assuming further that the *CAR*s are normally distributed, it is equally probable that the *CAR* associated with any event in the category is positive or negative.

Now let N be the total number of events in a given event category and let N^+ be the number of events for which the cumulated abnormal return is positive. Then the sign test is given by

$$\theta = \left[\frac{N^+}{N} - 0.5\right] \frac{\sqrt{N}}{0.5}. \tag{5}$$

Under our assumptions, θ follows asymptotically a standard normal distribution. Hence, the calculated θs can be compared to the critical values of the standard normal distribution.

4.1 Economic forecasts

The European Commission publishes twice a year forecasts of key economic indicators for all EU member countries, including forecasts of GDP growth and public deficits. These forecasts are important to investors for assessing the future solvency of governments. We want to test whether the forecast publications have a significant impact on government bond yields.

We looked at seven forecasts released in the period between 2009 and 2012. All of these forecasts predicted either negative growth or a budget deficit above 3% of GDP or both for all countries. Since these numbers imply exploding debt in the long run, all forecast publications can be consider "bad news" for investors, so that they can be expected to increase the interest rate of government bonds.

Table (2) gives the results of the sign test for economic forecasts, using the three different benchmarks described above. For all benchmarks, the sign test is positive and highly significant. This can be read as evidence that the government borrowing costs indeed react to economic forecasts.

	N	N^+	θ	*p-value*
BM1	35	25	2.536***	0.006
BM2	35	26	2.874***	0.002
BM3	35	21	1.183**	0.034

Table 2: Sign test for economic forecasts

4.2 Fiscal assistance packages

The most severely hit EMU countries received fiscal assistance from other EMU governments as well as from the IMF. The first country to ask for help was Greece in May 2010, followed by Ireland in November 2010 and Portugal in May 2011. Assistance funds were only paid out after the "troika", consisting of the European Commission, ECB and IMF, had assessed the reform programmes on which the assistance was conditioned. The announcements of new disbursements of assistance funds can therefore be seen as "good news" to the bond market and should be associated with a reduction in the borrowing costs of the receiving governments.

As shown in table 3, the fiscal assistance packages do not seem to have a significant impact on the governments borrowing costs. This could suggest either that investors do not believe that the assistance packages improve the future solvency of the targeted government sufficiently, or that the market has already priced in the effect of those packages at an earlier date. However, one should be careful to draw general conclusions from these results, since the number of events in this category is rather small.

	N	N^+	θ	*p-value*
BM1	13	7	0.277	0.609
BM2	13	7	0.277	0.609
BM3	13	7	0.277	0.609

Table 3: Sign test for fiscal assistance

4.3 Austerity measures

As already mentioned above, the fiscal assistance from Euro zone governments and the IMF was conditioned on fiscal and structural reforms on the part of the receiving governments. These reforms aimed

at cutting the public deficit by reducing (current and future) government spending and increasing taxes. Hence one would expect to improve the long-run solvency prospect and thus to bring down the borrowing costs of the affected governments. Therefore, we selected 36 announcements of "austerity measures"', most of which affected Greece, Ireland and Portugal.

In table 4 we again report the sign tests of these "austerity events". For two of our three benchmarks, we do not find a significant effect of the austerity measures. Taken together with the results from the fiscal assistance packages, one can conclude that the "bailout-cum-austerity" approach failed to have a measurable effect on the government borrowing costs.

	N	N^+	θ	*p-value*
BM1	36	15	-1.000	0.159
BM2	36	19	0.333	0.345
BM3	36	13	-1.667**	0.049

Table 4: Sign test for austerity

5 Event-dummy regressions

The event study demonstrates that news events have a statistically significant and predictable effect on the interest rates of crisis-countries' government bonds. However, in the sign tests we could use only those events that occur in sufficiently large number which requires that they occur in all crisis countries. Yet, we have argued above that the sources and triggers of the crises have been quite different between countries. We therefore present in this section an approach that allows us to include singular country-specific events.

We start with the Greek example that is visualized in Figure 2 above. We explain the *change* in the Greek interest rate only by the events used in the event study above and some additional singular Greece-specific events. Using the difference of the interest rate solves two problems: (i) it gives us a stationary series which allows us to use the OLS regression technique and (ii) it differentiates out all fundamentals, which do not change from one day to another for other reasons than through the event occurring. Employing a regression approach allows also to assess the economic importance of an event by comparing the coefficients. Explaining interest rate differences by dummy variables, the coefficient of the dummy gives the average effect of the event on a daily change in percentage points. Moreover, it is instructive to analyze how much of the variation in the data is explained by the event. For instance, whereas two of the three event study variables (assistance, austerity, and forecast) in column (1) of Table 5 are statistically significant, their joint contribution to the explanation of the variation in government

bonds' interest rate changes is rather small.

	(1) *Common Events*	(2) *Haircut*	(3) *All, without ratings*	(4) *Ratings only*	(5) *All*
Assistance	-0.025		-0.050		-0.050
	(0.129)		(0.061)		(0.061)
Austerity	-0.185***		-0.016		-0.011
	(0.070)		(0.032)		(0.033)
Forecast	0.128*		-0.000		-0.014
	(0.071)		(0.034)		(0.034)
Haircut		-27.505***	-27.511***		-27.478***
		(0.383)	(0.366)		(0.365)
EDP			0.101		0.107
			(0.365)		(0.364)
Eurostat			0.063		0.069
			(0.211)		(0.210)
ECB eligib.			0.071		0.084
			(0.222)		(0.221)
Political			1.030***		1.048***
Instability			(0.128)		(0.127)
Troika			-0.061		-0.075
			(0.164)		(0.163)
ECB full			-0.012		-0.050
allotment			(0.186)		(0.185)
Rescheduling			-1.068***		-1.175***
			(0.365)		(0.365)
Referendum			1.908***		1.928***
			(0.213)		(0.213)
Rating				0.107	0.113***
change				(0.074)	(0.035)
Constant	0.017	0.170***	0.020*	0.002	0.014
	(0.023)	(0.030)	(0.011)	(0.022)	(0.011)
Adj. R^2	0.005	0.78	0.80	0.002	0.80
Observations	1490	1490	1490	1490	1490
Robust stand. errors in parentheses. *, **,*** denote significance at the level of 10%, 5%, 1%.					

Table 5: Event-dummy regressions: Greece, 1/1/2007-9/13/2012

Assistance and Austerity are 21 day-dummies around the announcement of the measures, respectively, Forecast is a 21 days-dummy around the publishing of the economic forecasts by the European Commission, Haircut is a single-day dummy indicating the March 12th 2012, EDP stand for single-day dummies when the European Commission has announced Excessive Debt Procedures, Eurostat is a three-days time window around the Eurostat report on fraudulent government statistics, ECB eligibility is three-days time window around the ECB announcement to suspend the minimum threshold for collateral eligibility, Political Instability refers to two periods of riots, strikes and demonstrations around the introduction of the austerity measures (3 days) and the difficult time forming the government in May 2012 (8 days), Troika marks the days of a visit by the Troika, ECB full allotment is a three days window around the long-term funding of European banks, Rescheduling is a single-day dummy denoting the announcement of debt rescheduling at June 21st 2011, Referendum is a three days-dummy denoting the announcement of a referendum on the austerity measures, Rating changes denotes a fifteen-days window around a change in Greece's country rating.

By far the most important event dwarfing everything else is the debt rescheduling, also known as "haircut", which brought down the interest rate by 27 percentage points. This single-day event explains 78% of the variation in the bond yield. The strongest increase is due to political instability (Political instability and Referendum) which account jointly for an increase of 17 percentage points. The ECB policy measures in contrast have been not so important for Greece, at least not immediately. Long-run effects, however, are impossible to assess with this methodology. In column (4) and (5) we included Rating changes which we take as our proxy for sentiments. The rating agencies stress that they only sell their opinion based on the news and some analysis of the fundamentals. That is what an investors does as well before investing in government bonds. Credit ratings by moody's are translated into a numerical level scale with 22 levels. Using this proxy, we find no contribution of sentiments in the change of Greek' government bonds' interest rates when not controlling for other events. Together, all nine debasements resulted in an insignificant increase in the interest rate in (4). The improvement was very close after the haircut and is therefore dropped. In regression (5) however, there is a significantly positive and sizable effect of the debasements on the interest rates of jointly 13.5 percentage points. That is a sizable effect but as sentiments ratings are necessarily endogenous.[3]

We applied the same approach to three other countries: Ireland, Portugal, and Spain. For Ireland and Spain, the most drastic movements in the interest rate occurred around events involving the domestic banking sector. In the case of Ireland, the nationalization of Anglo Irish Bank in january 2009 lead to a first jump in the government interest rate, followed by further increases during autumn 2010, when major Irish banks faced severe refinancing problems and the government stepped in by means of large-scale capital injections. In Spain, the government bailout for Bankia in May 2005 had a similar impact. In contrast to Greece, the official assistance packages from the EU and the IMF seem to have had an significant (negative) impact on Irish borrowing costs.

For Portugal and Spain, we find that the extraordinary measures pursued by the ECB, such as the Securities Market Program (SMP) and the Long-term Refinancing Operations (LTRO), had a strong dampening impact on the government bond yields. The SMP reduced the Spanish yield by 0.525 percentage points (0.175 percentage point per day on average), and the Portuguese yield came down by 1.635 percentage points (0.545 percentage points per day on average) during the three-day event period surrounding the start of the SMP. There is also a significant effect of the debt downgradings by the rating agencies on the Spanish and Portuguese bond yields which is absent in the cases of Greece and Ireland.

6 Summary and conclusion

The recent debate on interest rates on government bonds has very much concentrated on irrationality, sentiments, and multiple equilibria. Most of the evidence presented by the existing literature is based on

[3]We have conducted Granger causality tests using monthly data that rejected weak exogeneity. These results are available on request.

panel regressions using low frequency data. We find these regressions problematic for three reasons: first, it is often unclear which explanatory variables to include in the regression and what the functional form should be used. Second, we showed in this paper that the poolability assumption underlying the panel approach is not met in the present case of European countries. Third, the results obtained from these regressions are likely to be spurious due to the non-stationarity of both the dependent and independent variables.

We therefore use daily data to analyze how singular events change the interest rate of government bonds. The event study shows consistently that bad news on debt and growth prospects increase the interest rates as does political instability. Most importantly for the political debate however is investors reaction to austerity measures as well as fiscal assistance packages. For these event categories, we cannot find a significant impact. Hence, while our results indicate that government interest rates in the Euro zone do indeed respond to forecast news on fundamentals such as growth and future budget balances, they also suggest that investors did not show a measurable reaction to the political actions taken by the European governments so far. In contrast, the event dummy regression reveal a measurable effect of the extraordinary interventions by the ECB (e.g. the securities market program) on interest rates, particularly for Ireland, Spain, and Portugal.

The difficulty to find significant effects of policy actions when pooling over countries stems from the heteregeneity of the crisis countries. As becomes clear in the event dummy regressions, each country is different whith regard to the underlying causes as well as the chronological development of the crisis. It seems that the only characteristic all crisis countries have in common is their membership in the EMU. Methodological, there is therefore no good reason to group those countries together at any level of aggregation in order to look for a common determinants of government interest rates. Politically, it is important to account for the differences in the sources of the crisis by designing country-specific policy actions to overcome the crisis.

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7 Appendix

	All Countries	EMU-countries only	EMU non-crisis	EMU-crisis country	Non-EMU-countries
Debt	0.041**	0.066***	0.007*	0.083***	0.004
	(0.015)	(0.016)	(0.004)	(0.014)	(0.013)
Growth	-0.085**	-0.071*	-0.041***	-0.087	-0.104**
	(0.031)	(0.038)	(0.008)	(0.076)	(0.049)
PS	0.001	0.021	-0.008	0.043	0.013
	(0.011)	(0.021)	(0.006)	(0.028)	(0.012)
Constant	-1.400	-3.719***	-0.178	-4.463***	1.262**
	(0.907)	(1.027)	(0.270)	(0.932)	(0.612)
Observations	712	418	210	208	294
Groups	17	10	5	5	7
$R^2 - within$	0.31	0.46	0.33	0.54	0.15

Robust standard errors in parentheses. *, **,*** denote significance at the level of 10, 5 and 1%, respectively.

Table 6: Panel regressions using specification (1)

	All Countries	EMU-countries only	EMU non-crisis	EMU-crisis country	Non-EMU-countries
Debt	-0.032**	-0.022*	0.015**	-0.016*	0.008
	(0.015)	(0.012)	(0.004)	(0.007)	(0.031)
$Debt^2$	0.001***	0.001***	-0.000	0.001***	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Current Account	0.009	0.030	-0.009	0.045	-0.010
	(0.023)	(0.033)	(0.015)	(0.057)	(0.33)
Growth	-0.093***	-0.069***	-0.036**	-0.055*	-0.091*
	(0.022)	(0.020)	(0.011)	(0.026)	(0.042)
Real Exch. Rate	0.010	0.011	0.016	0.007	0.014*
	(0.010)	(0.020)	(0.017)	(0.027)	(0.007)
Constant	-0.950	-2.796	-2.085	-3.365	-0.536
	(1.043)	(2.333)	(1.82)	(3.023)	(1.482)
Observations	691	404	201	203	287
Groups	17	10	5	5	7
$R^2 - within$	0.55	0.73	0.37	0.81	0.19

Robust standard errors in parentheses. *, **,*** denote significance at the level of 10, 5 and 1%, respectively.

Table 7: Panel regressions following DeGrauwe and Yi (2012)

	ADF Unit root test		KPSS Test for stationarity
	Test Statistic	P-value	Test *Statistic*
Austria	-0.989	0.7574	0.201**
Belgium	1.983	0.9987	0.269***
Czech Republic	-2.172	0.2166	0.163**
Denmark	-2.041	0.2690	0.128*
Finland	-1.341	0.6101	0.175**
France	0.812	0.9918	0.253***
Greece	4.942	1	0.237***
Hungary	-1.765	0.3979	0.065
Ireland	4.185	1	0.242***
Italy	2.588	0.9991	0.27***
Netherlands	-0.996	0.7548	0.172**
Norway	-1.304	0.6273	0.226***
Poland	-2.454	0.127	0.212**
Portugal	8.988	1	0.226***
Spain	3.896	1	0.266***
Sweden	-1.330	0.6151	0.164**
United Kingdom	-1.912	0.3264	0.211**

ADF - H0: spread is trend stationary. Critical values: 10% -2.610, 5% -2.952, 1% -3.634. The maximum lag length of three is chosen by Schwert criterion.
KPSS - H0: spread has unit root. Critical values: 10% 0.119, 5% 0.146, 1% 0.216.

Table 8: Unit root and stationarity tests

	(1) *Common Events*	(2) *All, without ratings*	(3) *Ratings only*	(4) *All*
Assistance	-0.028**	-0.038***		-0.037***
	(0.009)	(0.010)		(0.010)
Austerity	-0.004	-0.013		-0.013
	(0.009)	(0.009)		(0.009)
Forecast	0.015	-0.008		0.008
	(0.009)	(0.009)		(0.009)
EDP		-0.125		-0.124
		(0.103)		(0.103)
AIB national-		0.200***		0.201***
ization		(0.046)		(0.046)
Banking crisis		0.128***		0.128***
		(0.024)		(0.024)
Banks		0.095**		0.096**
downgrading		(0.033)		(0.033)
ECB full		-0.011		-0.011
allotment		(0.024)		(0.024)
Rating			0.015	0.011
change			(0.013)	(0.012)
Constant	0.009	0.002	0.002	0.014
	(0.012)	(0.003)	(0.003)	(0.011)
Adj. R^2	0.006	0.041	0.001	0.041
Observations	1490	1490	1490	1490

Robust standard errors in parentheses. *, **,*** denote significance at the level of 10, 5 and 1%, respectively.

Table 9: Event-dummy regressions: Ireland, 1/1/2007-9/13/2012

Assistance and Austerity are 21 day-dummies around the announcement of one of these measures, respectively; Forecast is a 21 days-dummy around the publishing of the economic forecasts by the European Commission; EDP stand for single-day dummies when the European Commission has announced Excessive Debt Procedures; AIB nationalization refers to the nationalization of Anglo Irish bank, from first announcement to implementation (7 days); Banking crisis refers to the climax of the refinancing problems of major Irish banks in November 2010 (30 days); Banks downgrading refers to Moody's decision to downgrade Irish bank debt to junk status (3 days); ECB full allotment is a three days window around the long-term funding of European banks; Rating changes denotes a fifteen-days window around a change in Greece's country rating.

	(1) *Common Events*	(2) *All, without ratings*	(3) *Ratings only*	(4) *All*
Austerity	0.002	0.004		0.004
	(0.006)	(0.006)		(0.006)
Forecast	0.017***	0.018***		0.019***
	(0.007)	(0.007)		(0.007)
EDP		0.090		0.091
		(0.077)		(0.078)
Bankia		0.038		0.039
		(0.030)		(0.030)
SMP		-0.175***		-0.175***
		(0.046)		(0.046)
Stresstest		0.006		0.007
		(0.077)		(0.078)
LTRO		-.0166		-0.015
		(0.033)		(0.032)
Protests		0.020		0.021
		(0.023)		(0.024)
Rating			0.017*	0.019**
change			(0.009)	(0.009)
Constant	-0.002	0.001	0.000	-0.002
	(0.009)	(0.003)	(0.002)	(0.002)
Adj. R^2	0.005	0.012	0.002	0.014
Observations	1490	1490	1490	1490

Robust standard errors in parentheses. *, **,*** denote significance at the level of 10, 5 and 1%, respectively.

Table 10: Event-dummy regressions: Spain, 1/1/2007-9/13/2012

Assistance and Austerity are 21 day-dummies around the announcement of one of these measures, respectively; Forecast is a 21 days-dummy around the publishing of the economic forecasts by the European Commission; EDP stand for single-day dummies when the European Commission has announced Excessive Debt Procedures; Rating changes denotes a fifteen-days window around a change in Greece's country rating; Bankia is a 3-days-event surrounding Bankia's request for a government bailout; SMP is a 3-days event surrounding the start of the ECB's securities market program; Stresstest marks the announcement of European Banking Supervision stresstests (single day event); Protests refers to protest activities against proposed austerity measures.

	(1) *Common Events*	(2) *All, without ratings*	(3) *Ratings only*	(4) *All*
Assistance	-0.004	-0.003		-0.001
	(0.028)	(0.027)		(0.027)
Austerity	0.017	0.040		0.035
	(0.033)	(0.033)		(0.033)
Forecast	-0.004	0.009		0.011
	(0.013)	(0.013)		(0.013)
EDP		-0.031		-0.028
		(0.145)		(0.145)
ESM		-0.190**		-0.189**
		(0.076)		(0.076)
Troika		0.029		0.031
		(0.033)		(0.033)
SMP		-0.547***		-0.545***
		(0.089)		(0.089)
LTRO		0.007		-0.022
		(0.059)		(0.060)
Protests		-0.095***		-0.093***
		(0.033)		(0.032)
Rating			0.050***	0.048***
change			(0.017)	(0.017)
Constant	-0.003	0.004	0.000	0.001
	(0.004)	(0.004)	(0.004)	(0.004)
Adj. R^2	0.002	0.037	0.005	0.042
Observations	1490	1490	1490	1490

Robust standard errors in parentheses. *, **,*** denote significance at the level of 10, 5 and 1%, respectively.

Table 11: Event-dummy regressions: Portugal, 1/1/2007-9/13/2012

Assistance and Austerity are 21 day-dummies around the announcement of one of these measures, respectively; Forecast is a 21 days-dummy around the publishing of the economic forecasts by the European Commission; EDP stand for single-day dummies when the European Commission has announced Excessive Debt Procedures; Rating changes denotes a fifteen-days window around a change in Greece's country rating; Bankia is a 3-days-event surrounding Bankia's request for a government bailout; SMP is a 3-days event surrounding the start of the ECB's securities market program; Stresstest marks the announcement of European Banking Supervision stresstests (single day event); Protests refers to protest activities against proposed austerity measures.

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