Sovereign bond spreads: the role of debt accumulation

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Very preliminary version

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Abstract

Public debt can positively contribute to economic growth. Excessive debt however can damage the economy notably because of high debt service payments. The sharp increase of sovereign bond spreads in the Eurozone periphery during the financial crisis raises the question about what factors actually underlie bond spreads. It has also revamped the attention of policymakers, academics and the general public on the consequences of large public debts. Debt accumulation is key to explain bond spreads, but contrary to traditional econometric specifications designed to model spreads, we conjecture that debt influences yields in a non-linear way, along the lines of the literature on "debt overhang" that focus on the relationship between debt and economic growth. This paper proposes a straightforward way to examine the potential non-linear pattern of the debt-bond spreads relationship. From a technical perspective, one major difficulty faced by empirical works on sovereign bond spreads is that several of their determinants (but not all) are non-stationary. We cope with this issue using the ARDL bounds testing approach developed by Pesaran et al. (1999). Results show that public debt indeed has a negative impact on sovereign spreads until a certain level of debt is reached - that varies across countries - after which spreads tend to increase.

1. Introduction

The sharp increase of public debt in the aftermath of the 2008 financial crisis raised concerns regarding the long-term sustainability of most indebted European countries' public finances. These fears materialized in a strong increase of sovereign bond spreads in countries such as Greece, Ireland or Portugal.

Because of its magnitude, the rise of sovereign bond yields in these countries – that were paying in the early 2000's only a few basis points more for their debt than Germany – seems to be only partially consistent with the deterioration of macroeconomic fundamentals and of international market conditions, which form the core of traditional determinants of sovereign bond spreads discussed in the literature. It is therefore legitimate to wonder (i) if the impact on spreads of these determinants has been assessed correctly so far and (ii) if other factors

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than these traditional determinants of spreads did play a role in the surge of bond yields in Europe.

Concerning the first question, the literature on debt overhang (see Krugman, 1988) provides interesting insights regarding the relationship between public debt and bond yields. For instance, Cohen (1993) points that debt accumulation impacts investment – and therefore GDP growth – in a non-linear way, i.e. debt contributes positively to investment only up to a certain threshold after which the contribution becomes negative on concerns regarding the government's ability to repay its debt. Since investors' fears regarding a given country's solvency can translate into higher bond yields, one can conclude that the contribution of public debt on bond spreads might also be non-linear.

As for the second question, several authors such as Attinasi et al. (2009) claim that extraordinary fiscal factors and particularly government announcements of bank rescue packages might be important determinants of bond spreads. In fact, it is the size of the banking sector relatively to the size of the economy that will be seen by investors as a potential additional source of risk during banking crises. Gerlach et al. (2010) do indeed claim that in these circumstances the government might be bound to take extra debt to recapitalize or even nationalize banks and that the burden will be proportional to the size of the banking sector itself.

The main objective of this paper is precisely to examine the non-linear pattern of the public debt-bond spreads relationship and the role of the size of the financial sector as an additional source of risk alongside more traditional determinants of spreads. To this end, we design a model for bond spreads that is quadratic on debt and that includes a specific measure for the banking sector leverage.

From an econometric point of view, specifying such a model is not trivial: bond spreads tend to be non-stationary while the set of traditional determinants of spreads is made of both stationary and non-stationary variables, which prevents the use of usual cointegration techniques. We propose an efficient way to cope with this issue, which consists in applying the ARDL bounds testing approach developed by Pesaran et al. (1999).

To sum up, the contribution of this paper is centered (i) on the specific treatment of the non-linear nature of the public debt-spreads relationship suggested in the literature on debt overhang, (ii) on the incorporation of the size of the banking sector as an additional source of risk during financial crises and (iii) on the adoption of appropriate econometric techniques calibrated to deal with the fact that our dataset is made of variables displaying different orders of integration. Overall, our aim is to contribute to the debate concerning the actual role of public debt accumulation on the perceived level of risk associated to the public sector.

The paper is organized as follows. Section 2 presents the background and the literature. Section 3 introduces the data and our econometric approach. Results are discussed in Section 4 and Section 5 concludes.

2. Background and review of the literature

Determinants of bond spreads identified in the literature can be classified in two broad categories (see among many others Edwards, 1984; Codogno et al., 2003; Alexopoulou et al., 2009; Manganelli and Wolswijk, 2009). The first relates to credit default risk and the second to international and liquidity risk.

Credit default risk factors mainly involve fiscal fundamentals. Variables such as public debt and deficit reflect the credibility of the government and impact the perceived quality of sovereign credit (Hauner et al., 2007). Fiscal variables have been found to significantly influence bond spreads. For instance, Goldstein and Woglom (1992) and Poterba and Rueben (1999) among others found a positive impact of US states public debt on their bond yield. On fiscal deficit, Laubach (2009) finds a positive relationship with spreads. Similar results have been found for European countries (Faini, 2006 and Bernoth et al., 2004) although differences across countries regularly appear (Codogno et al., 2003).

Besides fiscal fundamentals, other macroeconomic factors also influence credit default risk. The business cycle, captured by real GDP growth or the output gap, is often incorporated as a control variable (Gerlach et al., 2010). The current account in theory also has an important influence on bond spreads as it signals whether the country is a net lender or borrower on international markets (Strahilov, 2006). Nevertheless, results for this variable are mixed.

International and liquidity risk factors capture international markets conditions, i.e. the level of risk aversion, and the size and depth of the bond market. International risk has been found by several researchers to be one of the most important determinants of bond spreads, especially for most indebted countries (Codogno et al., 2003). The size of a given country bond market also has been found to play an important role, particularly in the framework of the European Monetary Union (Beber et al., 2009). The same holds for short term rates and the monetary policy stance that define money market liquidity conditions and therefore have a strong influence on bond yields (Koukouritakis and Michelis, 2008; Manganelli and Wolswijk, 2009).

At first sight, the evolution of credit default risk variables and international and liquidity risk variables since the financial crisis burst is consistent with the sharp widening of bond spreads in Europe. The increase of public debt in the vast majority of European countries is in this respect quite appealing and concerns on the solvency of most indebted countries materialized in higher bond yields spreads against Germany. This was notably the case in Greece, Ireland and Portugal and, but to a lesser extent, in Spain, Italy and Belgium.

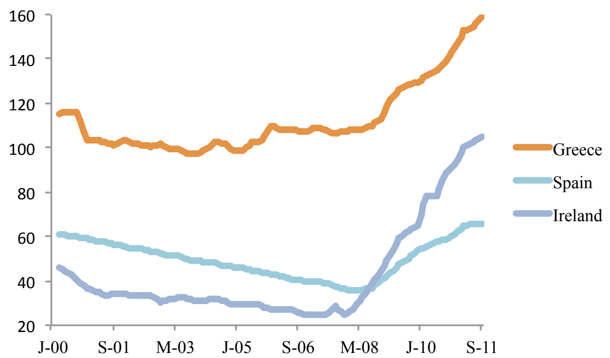

Figure 1: Public debt/GDP (%)

A closer look at the situation in these countries however reveals a more mitigated picture. In this respect, the rise of bond yields spreads appears to be in fact only partially consistent with the evolution of variables measuring credit default risk and international and liquidity risk. This is particularly the case concerning fiscal variables. Figure 1Figure 1 shows that public debt in Greece increased from around 100% to more than 160% of GDP since 2008. In the meantime, public debt almost doubled in Spain and was multiplied by a factor of around five in Ireland without these countries being penalized by investors as strongly as Greece.

One element that may explain this is that the increase of debt affects bond spreads in a non-linear way. That is, beyond the increase of debt, the absolute level of debt might also play a role. In this respect, that Greek bond yields increased faster than Irish or Spanish yields is consistent with the fact that Greece entered the Eurozone with a higher level of debt than Ireland and Spain whose debt-to-GDP ratio was in line with the Stability and Growth Pact.

The non-linear nature of the public debt-bond spreads relationship is hinted in the literature examining the contribution of debt to economic growth (see Elmendorf and Mankiw, 1999 for a literature survey on public debt). The conventional view is that in the short run, debt can have a positive effect on aggregate demand through higher public consumption. Output might also be stimulated when debt finances productive public investment (Modigliani, 1961 and Aschauer, 2000) although Adam and Bevan (2005) found that an increase of productive government expenditure stimulates growth only if the level of public debt is low.

Regarding the negative effect of debt, Modigliani (1961) argued that debt is in fact a burden for next generations, which comes in the form of a reduced flow of income from a lower stock of private capital. Krugman (1988) considers that debt overhang puts investors willingness to lend further capital under pressure. Other authors see debt affecting capital accumulation and growth *via* higher long term interest rates (Gale and Orszag, 2002; Baldacci and Kumar, 2010), higher future distortionary taxation (Barro, 1979; Dotsey, 1994) and inflation (Sargent and Wallace 1981; Barro 1995; Cochrane 2010). Aghion et al. (2011) claim that high debt is also likely to constrain countercyclical fiscal policies, which may result in higher output volatility and further lower growth.

All in all, as stated by Cohen (1993), debt accumulation contributes positively to economic growth only up to a certain threshold after which its contribution becomes negative. Along these lines, the non-linear pattern of the public debt-bond spreads relationship arises from investors concerns on the government's ability to repay its debt translating into higher bond yields. In this paper, we test the non-linear impact of debt on spreads in the same way than Checherita and Rohter (2010) who use a model quadratic on debt (but in the context of the debt-GDP growth relationship). One important advantage of such modeling approach is that it allows estimating the minimum level of debt from which the impact of debt on spreads becomes positive.

Afar the deterioration of the fiscal situation that usually accompanies an economic slowdown, Attinasi et al. (2009) claim that, in the context of the financial crisis, extraordinary fiscal factors and particularly announcements of bank rescue packages may have contributed to the rise of bond spreads in Europe. Gerlach et al. (2010) found that the increase of spreads partly occurred because when governments issued new debt to recapitalize or even nationalize their banks, a transfer of risk from the financial sector to the public sector actually occurred. In this respect, the extra risk for the government was proportional to the size of the banking sector itself.

3. Data and econometric approach

3.1. The data

Our model for bond spreads departs from traditional models proposed in the literature in two ways. First, our specification is quadratic on debt to test for the existence of a non-linear relationship between debt and bond spreads (see Checherita and Rohter, 2010). Second, a measure of the additional risk for sovereign debt arising from the banking sector is incorporated as a control variable.

Along the lines of Alexopoulou et al. (2009), we estimate our model using monthly data. All variables that are available at a lower frequency were interpolated linearly. Variables that are available at a higher frequency were taken in monthly average. We rely on data for the Eurozone largest countries, i.e. Austria, Belgium, Finland, France, Greece, Ireland, Italy, Portugal and Spain.[2] Our dataset covers the period from March 2000 to June 2011.[3]

3.1.1. Dependent variable

The dependent variable is the 10 year bond yield spread against the German 10 year Bund for each country under study. Harmonized yields data are obtained from Eurostat at the daily

[2] Eurozone countries not considered are: Luxembourg, Cyprus, Malta, Slovenia, Slovakia, Estonia. Germany is not included neither as it is the reference country against which bond spreads are computed.

[3] Some differences between countries appear without consequences for our empirical work that consists in country by country estimates.

frequency. Spreads are measured in basis points. Unit root tests (not reported here) indicate that spreads are I(1).

Figure 2 indicates that Eurozone countries bond yields have converged since the euro introduction. Huge disparities became apparent after the financial crisis burst and most indebted European countries were sanctioned with significantly higher risk premiums. This is particularly the case for Greek, Irish and Portuguese yields. On the other hand, countries like France, Finland, Austria and the Netherlands managed to maintain tighter spreads. Belgium, Italy and Spain displayed intermediate performances in this respect.

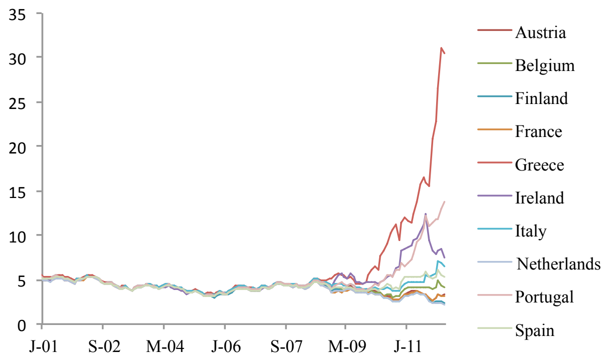

Figure 2: 10 year bond yields (%)

3.1.2. Independent variable

Consistently with the literature consensus, two main sets of variables are considered: credit default risk and international and liquidity risk variables. Credit default risk variables influence a country's ability to repay its debt. International and liquidity factors capture international markets conditions – and especially risk aversion – as well as the size and depth of bond markets. Table 1 summarizes our model specification.

Variable	Definition	Expected sign	Frequency	Source
Y	10 year bond yield spread against Germany (basis points)	-	Daily	Eurostat
	Credit default risk variables			
X_1	Fiscal deficit (% GDP)	>0	Quarterly	ECB
X_2	Public debt (% GDP)	<0	Quarterly	Eurostat
X_3	Squared Public debt (% GDP)	>0	Quarterly	Eurostat
X_4	Real GDP growth (YoY %)	<0	Quarterly	Eurostat
X_5	Current account (% GDP)	<0	Monthly	Eurostat
X_6	MFI Total loans (% GDP)	>0	Monthly	ECB
X_7	CDS (EUR)	>0	Daily	Macrobond
	Liquidity risk variables			
Z_8	US corporate spread (basis points)	>0	Daily	Macrobond
Z_9	Euribor 3m – ECB's Refi spread (basis points)	>0	Daily	ECB
Z_{10}	Debt issuances (% of total Eurozone debt issuances)	<0	Monthly	ECB

Table 1: Summary of variables

Credit default risk

Hauner et al. (2007) argue that the fiscal situation of a country reflects the credibility of the government, which in turn affects the perceived quality of its debt and its bond yield. To account for this effect, we introduce **fiscal deficit and debt-to-GDP ratios** into our model. Square debt is also included to account for the potential non-linear relationship between debt and bond spreads. The expected impact of deficit on spreads is positive. The linear effect of debt is expected to be negative while the non-linear effect is expected to be positive. Public deficit and debt data is available at the quarterly frequency respectively from the ECB and Eurostat.

The business cycle is another element that likely influences the ability of a given country to repay its debt and therefore the level of bond spreads (Gerlach et al., 2010). We incorporate **year-on-year real GDP growth** into our model to account for this. The impact of GDP growth on bond spreads is expected to be negative. Quarterly data for real GDP is obtained from Eurostat.

The **current account** may also have an important influence on bond spreads (Strahilov, 2006). The current account balance is in fact a measure of the country's external position. A positive current account balance signals that the country is a net exporter of capitals and that it relies less on international financial markets for its funding. Conversely, a negative balance indicates that the country is a net borrower and that it depends on incoming capital flows and in turn that it is more dependent upon international markets conditions. In this respect, we can expect an improvement of the current account balance to have a negative contribution on bond spreads. In this paper, the current account balance is introduced as a percentage of GDP. Monthly data is obtained from Eurostat.

A transfer of risk from the financial sector to the public sector may occur when governments are bound to issue new debt to recapitalize or even nationalize their banking sector (Attinasi et al., 2009). Along these lines, the additional risk represented by the banking sector is proportional to the relative **size of the banking sector**. Gerlach et al. (2010) measure this risk relying on the banks total assets-to-GDP ratio. We adopt a slightly more restrictive view by using the total banks loans-to-GDP ratio, which in our view is a more accurate measure of the actual leverage of the banking sector. Data on monetary and financial institutions balance sheet is obtained at the monthly frequency from the ECB.

Finally, as a control variable, we introduce the **level of CDS**. CDS are the cost of guaranteeing positions on bonds issued by a country or a corporate. The higher the CDS, the higher is the risk perceived by the market associated to the bond issuer. In this respect, we can anticipate that the impact of CDS on bond spreads will be positive. In this paper, we consider CDS at five years maturity, which is considered to be the most liquid segment of the CDS market.

International and liquidity risk

One usual measure of international risk is the **US corporate spread**, i.e. spread between BBB corporate bonds against the US 10 year bond yield. Corporate spread is considered to be an accurate measure of the level of risk aversion (Codogno et al., 2003 and Geyer et al., 2004). This arises from the fact that in periods of uncertainty, investors fly to quality, i.e. they tend to opt for less risky assets like government bonds and particularly US bonds. An increase of US corporate spread signals a deterioration of market conditions that may impact positively bond spreads in countries seen by investors as representing a higher level of sovereign risk. Daily data on US corporate spread is obtained from Macrobond Financial.

The **size of the bond market** of a given country is captured by the amount of debt issuances of the country as a share of total debt in the EU (Bernoth et al., 2004). Better liquidity conditions are expected to lead to lower spreads. Monthly data is provided by the ECB.

Liquidity conditions are also determined by short term rates and the monetary policy stance (Koukouritakis and Michelis, 2008; Manganelli and Wolswijk, 2009). Within the European monetary Union, money market conditions can be assessed using the **Euribor 3 months – ECB's main refinancing rate spread**. An increase of money market rates vis-à-vis the ECB's policy rate signals higher tensions on the money market that in turn may lead to a rise of bond spreads. Daily data is obtained from the ECB.

3.2. Econometric approach

An important issue regarding our specification is that some of the independent variables are stationary while others are not. As a consequence, traditional error correction models cannot be used. In this paper we address this problem using the autoregressive distributed lag bounds testing approach of cointegration (ARDL) introduced by Pesaran (1997), Pesaran and Shin (1999) and Pesaran et al. (2001).

Contrary to other cointegration methods such as the ones developed by Engle and Granger (1987) and Johansen (1988), the ARDL approach does not require all regressors to be of equal order of integration, i.e. the ARDL method can be applied to models in which some variables are stationary and others are not. Another advantage of the ARDL procedure is that it remains valid with small samples while Johansen cointegration techniques require large data samples. The ARDL approach is made of two steps that are described below.

First step

The first step tests for the existence of a cointegrating relationship between bond spreads and our set of independent variables. For this, we perform a joint test on the conditional error correction model (ECM) in Equation (1):

$$\Delta y_t = c_0 + \pi_1 y_{t-1} + \pi_2 x_{t-1} + \sum_{i=1}^{p-1} \psi_i \Delta z_{t-i} + \varepsilon_t \ (1)$$

y_t is the dependent variable, x_t is a set of dependent variables (see Table 1 for further details on the set of explanatory variables), $z_t=(y_t, x_t)$ and ε_t is a disturbance term.

The null hypothesis of no cointegration, $H_{0:}\, \pi_i = 0, i = 1,2$ is tested against the alternative of $H_{1:}\, \pi_i \neq 0, i = 1,2$ using the bounds testing procedure, which is based on the joint F-statistic. Critical values for the test are reported in Pesaran et al. (2001).

The test procedure involves critical values bounds for all classifications of the regressors into purely I(1), purely I(0) or mutually cointegrated. If the F-statistic lies above the upper level of the band, the null hypothesis is rejected, denoting cointegration. On the other hand, if the F-statistic is below the lower critical value, the null hypothesis of no cointegration cannot be rejected. Finally, if the F-statistic lies between the bounds, no conclusion regarding the existence of a cointegration relationship between the variables can be drawn.

Importantly, for the procedure above to be valid, ε_t must be serially uncorrelated. This supposes estimating Equation (1) using an optimal structure of lag, i.e. a structure that makes rid of the residual autocorrelation problem. Therefore, a preliminary step required before testing for the cointegration relationship itself consists in determining the optimal lag for each variable of the model.

This is achieved by estimating $(p + 1)^k$ models, where p is the maximum number of lags authorized and k is the number of variables in the model. The selection of the lag structure is based on an information criterion: the lag structure must be sufficiently large to mitigate the residual autocorrelation problem and sufficiently small for the model not to be over-parameterized. According to Pesaran and Shin (1999), the Schwart's Bayesian Information criteria will generally be preferred to other criteria because it tends to define more parsimonious specifications. An LM test is conducted to make sure that there is no serial correlation left.

Step 2

When there is evidence of a cointegrating relationship, the second step of the procedure consists in estimating the following long run (Equation 2) and short run (Equation 3) models, where $\widehat{\omega}_t$ is the equilibrium correction term whose coefficient is expected to be negative and measures the adjustment speed to the long term equilibrium:

$$y_t = c_1 + \delta x_t + \omega_t \quad (2)$$

$$\Delta y_t = c_2 + \sum_{i=1}^{p-1} \psi_i \Delta z_{t-i} + \lambda\widehat{\omega} + \mu_t \quad (3)$$

4. Results

4.1. Optimal structure of lags and existence of a cointegrating relationship

Results concerning the ARDL structure are reported in Table 2. In the vast majority of cases, only a few lags were sufficient to capture the dynamic of spreads. Moreover, the LM statistics confirm the absence of any remaining serial correlation, meaning that the lag structure is optimal and that the cointegrating procedure is valid.

Regarding the cointegrating relationship, the bounds F-test shows evidence of a cointegrating relationship at 1% significance for France, Greece, Ireland, Italy and Portugal, at 5% for Belgium, Spain and The Netherlands and at 10% for Austria. No cointegrating relationship is found for Finland.

Country	ARDL structure	LM-stat	F-stat
Austria	(0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0)	0.99***	3.29*
Belgium	(1, 0, 0, 0, 0, 1, 0, 3, 2, 3, 0)	0.50***	3.34**
Finland	(1, 0, 0, 0, 0, 0, 0, 2, 0, 0, 0)	0.02***	2.04
France	(0, 0, 0, 0, 0, 0, 0, 0, 0, 2, 0)	0.15***	6.92***
Greece	(3, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0)	0.60***	10.40***
Ireland	(1, 0, 0, 0, 1, 0, 1, 3, 3, 0, 0)	0.81***	6.71***
Italy	(2, 1, 0, 0, 3, 1, 0, 3, 2, 0, 3)	1.72***	7.70***
Spain	(3, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0)	2.20***	3.44**
Netherlands	(0, 0, 2, 0, 0, 0, 0, -, 0, 0, 0)	0.55***	3.88**
Portugal	(3, 0, 2, 0, 0, 0, 0, 3, 0, 2, 0)	0.13***	8.43***
Critical value at 1%: I(0) 2,65 - I(1) 3,97			
Critical value at 5%: I(0) 2,14 - I(1) 3,30			
Critical value at 10%: I(0) 1,88 - I(1) 2,99			

Table 2: Results on the test for the existence of a cointegrating relationship

The ARDL procedure to obtain the optimal lag structure length for each variable is based on the Schwart's Bayesian Information criteria such as $\mathrm{SBC} = n * \ln(\hat{\sigma}_\varepsilon^2) + k * \ln(n)$ where $\hat{\sigma}_\varepsilon^2$ is the variance of the error term, k is the number of freely estimated coefficients and n is the sample size. LM-stat is the Lagrange multiplier test for serial correlation with a Khi-2 distribution with only one degree of freedom. Critical value = 2.71. F-stat is the ARDL cointegration test. The critical values for the lower I(0) and upper I(1) bounds are taken from Pesaran et al. (2001), page 300: Case III. ***, ** and * respectively holds for significance at the 1%, 5% and 10% level.

4.2. Determinants of spreads

Results for the long term model are reported in Table 3. Short term model estimates are in Table 4 (only the first lag of each variable is reported). For each country for which a cointegrating relationship was identified, the ECM term displays a significant and negative coefficient, showing the speed of adjustment to the long term equilibrium. Its magnitude ranges from -0.20 to -0.87 (with an average of -0.48), meaning that each month there is between 20% and 87% adjustment to the long run equilibrium.

Credit default risk variables

Results show that increases of the fiscal deficit influence positively bond spreads in four countries out of the nine for which a cointegrating relationship was found (Greece, Spain, The Netherlands and Portugal). The fact that this variable is significant only for a limited number of countries might be explained by the short term nature of deficits that can slip off for temporary factors without necessary signaling the unsustainability of public finances.

In this respect, results associated to public debt are much more appealing. Both debt and squared debt are significant for the vast majority of countries (seven out of nine) and display the expected sign. Debt influences spreads negatively while the coefficient of squared debt is positive. Overall, this confirms the non-linear pattern of the debt-bond spreads relationship:

public debt accumulation triggers higher spreads only after some critical level of debt is reached.

Our specification allows determining this level of debt. Quite interestingly, our results point to a great variability across countries. The critical level of debt – beyond which the impact of debt on spreads become positive – ranges from 36.34% for Ireland to 105.46% for Italy. Our estimates also show that the financial crisis led to a general increase of the net effect of debt on spreads. Some countries even witnessed a reversal of the net impact of debt on their spread (see Figure 3). Overall our results confirm the key role played by fiscal fundamentals as determinants of bond spreads.

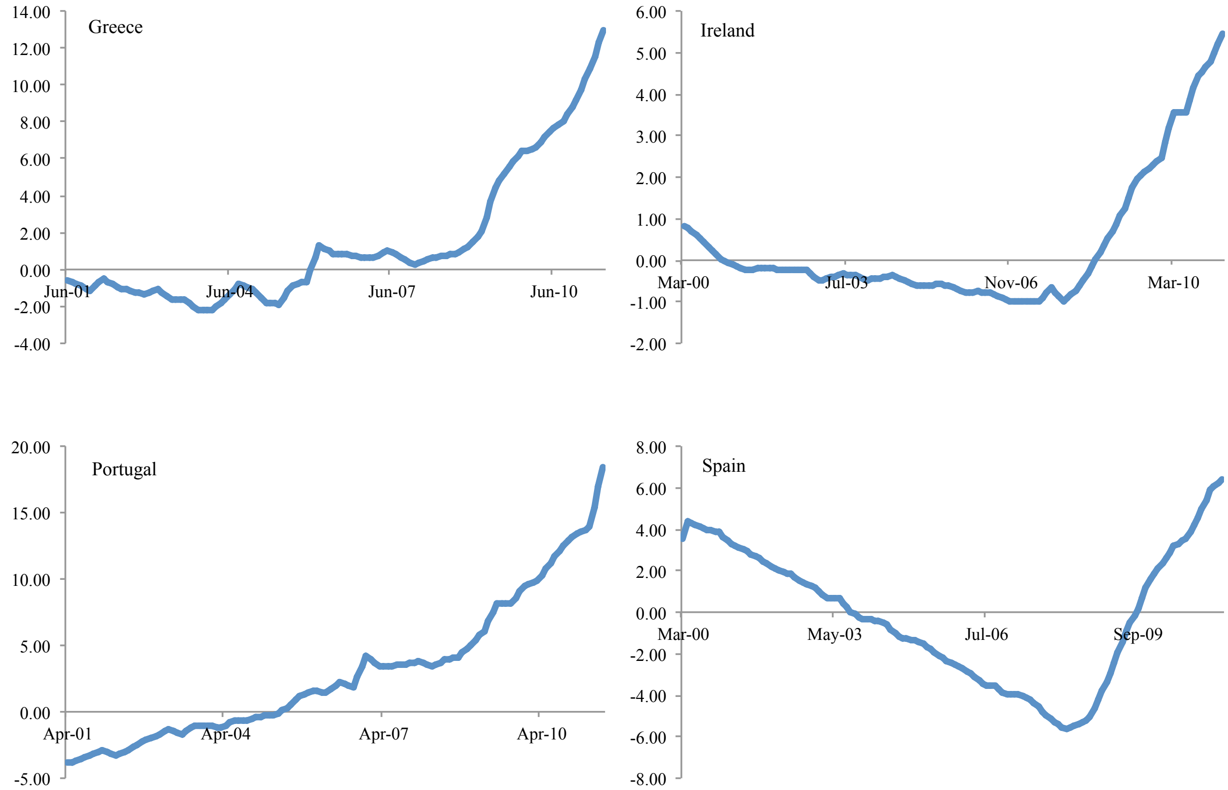

Figure 3: Net effect of debt on bond spreads (selected countries)

For the rest, results for both real GDP growth and the current account balance provide mixed results. Economic growth impacts bond spreads negatively as expected only in Austria, Belgium and Spain. The impact of the current account balance is ambiguous: the expected negative sign is found for a couple of countries (Belgium and The Netherlands) but a positive and significant coefficient is found for Ireland, Spain and Portugal. One possible explanation for this result is that the current account balance improvement in fact results from a worsening of domestic demand, which is consistent with the crisis.

Our results indicate that the banking sector plays the role of an additional source of risk for the public sector only in a very limited number of cases. We find that the variable has the expected positive coefficient only for Austria, France and The Netherlands and is insignificant in the rest of the countries under study. Finally, CDS appear to be strongly linked to bond spreads.

International and liquidity risk variables

Regarding international and liquidity risk, our results confirm that the US corporate spread is an important driver for bond spreads. A positive and significant coefficient is found for all countries except Spain. International risk aversion is therefore an important factor determining bond spreads. Liquidity conditions on the money market only affect spreads in the expected direction in Austria, Ireland, Italy and Portugal. Bond market liquidity also displays mixed results, the variables measuring the size of a given country bond market having a negative and significant coefficient only for Austria, Belgium, Ireland and Spain.

5. Conclusion

The paper proposes a model for bond spreads including two sets of determinants. The first concerns credit default risk and the second holds for international and liquidity risk. Our results confirm that fiscal fundamentals represent the most important determinants of bond spreads. Other variables capturing macroeconomic fundamentals (real GDP growth, current account balance, the size of the banking sector or CDS) play a role too, although results are less robust. Similarly, international markets risk aversion (measured by US corporate spreads) and liquidity conditions (captured by money market rates and the size of bond markets) also matter.

The main contribution of the paper is the way the impact of debt on spreads is assessed. The literature on debt overhang suggests that debt might influence spreads in a non-linear way. We test this effect relying on a model quadratic on debt. Our results strongly support the existence of a non-linear public debt-bond spreads relationship. Along these lines, debt, by stimulating aggregated demand and output, contributes negatively to bond spreads only up to a certain level after which the contribution becomes positive, reflecting investors' fears regarding the government's ability to repay its debt.

In the context of the European debt crisis, our method allows to determine what is the critical level of debt, i.e. the level of debt beyond which the net effect of debt accumulation on bond spreads becomes positive. Our estimates point to quite large differences across countries along with a dramatic increase of the positive contribution of debt to bond spreads in Eurozone most indebted countries.

	Austria	Belgium	Finland	France	Greece	Ireland	Italy	Spain	Netherlands	Portugal
Credit default										
Constant	660.10***	19.39	-	-148.19*	1455.77***	45.29*	2895.14***	512.34***	244.37***	804.26***
	231.69	317.39		82.40	436.25	25.12	760.87	106.73	60.31	96.59
Deficit	-0.17	0.26	-	-0.22	2.71*	0.00	0.49	0.97**	0.42*	1.65*
	0.25	0.22		0.25	1.53	0.34	0.41	0.44	0.24	0.93
Debt	-21.02***	-0.91	-	3.18	-29.03***	-3.09***	-54.85***	-19.58***	-10.73***	-22.51***
	6.80	6.04		2.26	7.94	0.98	13.78	3.52	2.11	2.95
Debt2	0.16***	0.01	-	-0.02	0.14***	0.04***	0.26***	0.20***	0.11***	0.19***
	0.05	0.03		0.02	0.03	0.01	0.06	0.03	0.02	0.02
GDP	-1.04***	-1.67***	-	-0.45	1.19	-0.39	-0.20	-2.97**	-0.56	-1.89
	0.39	0.80		0.65	3.17	0.78	0.67	1.31	0.37	1.53***
CA	0.31	-0.59*	-	0.41	0.97	1.88**	-0.48	4.24***	-0.31*	2.58
	0.31	0.32		1.10	1.12	0.96	0.89	1.04	0.19	1.08
Loans	0.21***	0.13	-	0.15***	1.07	0.03	-0.04	0.05	0.10***	-0.80***
	0.04	0.12		0.08	0.72	0.04	0.08	0.11	0.04	0.31
CDS	0.51***	0.74***	-	0.32***	0.84***	1.02***	0.68***	0.91***	-	0.69***
	0.04	0.03		0.07	0.07	0.07	0.05	0.04		0.08
Liquidity risk										
US corp. spread	0.02***	0.05***	-	0.04***	0.10***	0.05*	0.06***	0.00	0.08***	0.07***
	0.01	0.01		0.01	0.04	0.03	0.01	0.01	0.01	0.02
Euribor3m	0.09***	0.07	-	0.00	0.03	0.17**	0.21***	-0.05	0.02	0.43***
	0.03	0.05		0.03	0.21	0.08	0.04	0.06	0.02	0.09
Debt liquid.	-0.83***	-0.67*	-	0.01	0.92	-2.91***	0.11	-0.84**	-0.09	-0.24
	0.43	0.37		0.10	2.25	1.27	0.13	0.39	0.14	1.80

Table 3: Results for the long term model

Note : the regression is based on the estimation of the long-run equation given by Eq, 2 and the short-run equation given by Eq, 3, the conditional EC, We use an ARDL specification with the variation of sovereign bond spreads as a dependent variable and the ECM term given by the long run equation, Estimations are done by OLS, See Table 1 for a definition of regressors. ***, ** and * respectively holds for significance at the 1%, 5% and 10% level.

	Austria	Belgium	Finland	France	Greece	Ireland	Italy	Spain	Netherlands	Portugal
Constant	0.02	0.94**	-	-0.24	-0.15	-0.76	0.87**	0.65	0.09	-0.15
	0.36	0.45		0.48	2.23	1.33	0.41	0.60	0.25	1.77
Δ Deficit	-0.32	0.21	-	0.00	1.53	-0.30	0.34	0.46	0.06	1.14
	0.28	0.24		0.35	1.52	0.45	0.37	0.36	0.27	0.94
Δ Debt	7.81	10.18	-	8.30	3.32	-2.24	-51.59***	-22.94***	-11.40*	-30.37***
	8.92	9.13		10.94	14.72	2.82	18.31	7.64	6.34	10.31
Δ Debt2	-0.06	-0.05	-	-0.06	-0.02	0.03	0.24***	0.25***	0.10	0.27***
	0.07	0.05		0.08	0.06	0.03	0.08	0.08	0.06	0.06
Δ GDP	-0.82	-0.53	-	0.60	-2.05	1.15	2.60	-3.08	-0.69	-3.88
	1.07	1.51		1.94	4.23	1.52	2.24	2.84	0.87	3.90
Δ CA	-0.26	0.08	-	-1.95	0.16	1.03	0.09	3.96***	-0.84***	3.43**
	0.39	0.38		1.61	1.10	1.37	1.05	1.33	0.32	1.52
Δ Loans	0.29***	0.00	-	0.61***	1.63**	-0.29	-0.56***	-0.09	0.10**	0.16
	0.10	0.11		0.19	0.83	0.21	0.18	0.26	0.05	0.44
Δ CDS	0.46***	0.37***	-	0.24**	0.66***	0.84***	0.58***	0.56***	-	0.40***
	0.04	0.05		0.09	0.06	0.09	0.05	0.04		0.08
Δ US corp. spread	0.02	0.03	-	0.04**	0.14**	0.06	0.08***	0.05***	0.08***	0.10**
	0.01	0.02		0.02	0.07	0.05	0.02	0.02	0.01	0.05
Δ Euribor3m	0.03	-0.01	-	-0.07*	-0.35*	0.05	0.07*	-0.05	-0.01	0.08
	0.04	0.04		0.04	0.18	0.11	0.04	0.05	0.02	0.13
Δ Debt liquid.	-0.29	-0.14	-	-0.06	1.69**	-1.66**	0.10	-0.51***	-0.05	0.14
	0.28	0.15		0.07	0.82	0.75	0.07	0.20	0.08	0.97
ECM	-0.53***	-0.20***	-	-0.87***	-0.54***	-0.74***	-0.22***	-0.34***	-0.38***	-0.55***
	0.09	0.09		0.10	0.06	0.10	0.06	0.07	0.07	0.11

Table 4: Results for the short term model

Note : the regression is based on the estimation of the long-run equation given by Eq, 2 and the short-run equation given by Eq, 3, the conditional EC, We use an ARDL specification with the variation of sovereign bond spreads as a dependent variable and the ECM term given by the long run equation, Estimations are done by OLS, See Table 1 for a definition of regressors. ***, ** and * respectively holds for significance at the 1%, 5% and 10% level.

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