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What drives European sovereign bonds spreads? A comparative benchmark analysis

RESUMEN

El objetivo del presente trabajo se basa en determinar los principales determinantes de los spreads de bonos soberanos europeos considerando como referentes un Índice de Bono soberano alemán y otro de Estados Unidos. El período de estudio abarca desde 2004 a 2011 y considera a 17 países de la Unión Europea y de la Unión Monetaria Europea. Aplicamos la metodología de datos de panel con efectos fijos.

Nuestros modelos presentan un buen ajuste y nos permiten identificar las principales variables que afectan los spreads soberanos. Se destaca la incidencia del efecto contagio en los mercados europeos al considerar el índice de bono de referencia norteamericano. Por otro lado, el efecto contagio es más profundo para países de la eurozona.

Palabras clave: Spreads de bonos soberanos, Eurozona, crisis financiera, datos de panel.
Códigos JEL: G01, G15, E43, H6

ABSTRACT

The aim of this work is based to identify the main determinants of European sovereign bonds spread considering as benchmarks a German Sovereign bond index and another one of United States. The period under scrutiny is 2004 to 2011 and considers 17 European countries, some of them belonging to the European Monetary Union. We apply a panel data framework with fixed effects. The models are representative and allow us to identify the main variables that affect sovereign bonds spreads. We find that the contagion effect is stronger in the European financial markets when the US benchmark is considered. Furthermore, contagion effect is deeper for euro zone countries.

Keywords: Sovereign bond spreads, euro area, financial crisis, panel data.
JEL CODES: G01, G15, E43, H63

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INTRODUCTION

Financial crises have long been studied according with their main determinants, consequences and contagion effects. However, since the global financial crisis, the interest in sovereign bond spreads in European countries has increased. The reason for such interest is due to the potential effect of public debt on government bond yields. Previous studies, mainly on government bond spreads of the euro area members, find that not only fundamentals, but also external factors, are relevant in determining sovereign spreads. This kind of studies is relevant to the European Monetary Union (EMU) countries because they can issue debt but have not fully control of the monetary policy of the area.

The EMU is one of the most important policies aimed to fully integrate the financial markets of several countries that belong to the European Union (EU). In the first two years after the introduction of the euro there was a convergence in bond yields across countries of the euro area, increasing their correlations. It should be noted that the EU countries that do not belong to the euro area, such as United Kingdom, also increased their bond yield correlation with the countries of the euro area. The same phenomenon happened relative to the US bond yields (Martinez and Terceño, 2012). Sovereign bond yield spreads across EMU countries converged to the German benchmark and were generally less than fifty basis points (Bernoth and Erdogan, 2012). The decrease of bond spreads were mainly reflected by the introduction of the euro, removing in this way the exchange rate risk.

However, the global financial crisis modifies investors' perception of risk and the diversification of investment portfolios propagates market risks. European countries are now more unstable and the single currency becomes more vulnerable. The extent of the crisis obliges European policy makers to undertake rigorous fiscal measures, to inject large amounts of money into financial institutions (Grammatikos and Vermeulen, 2012) and to set rescue packages for economies such as Greece, Ireland, Portugal and to some extent to Spain.

The main purpose of this work is to analyze the sovereign bond spreads evolution of several EU countries and distinguish three issues with respect to its progression: the incidence of the common currency, the effect of the financial crisis and the importance of the government bond considered as a benchmark.

We apply a panel data econometric methodology to our database of sixteen European countries between Q_1 2004 to Q_3 2011 in order to analyze the impact of the selected explanatory variables on bond spreads. The group of explanatory variables included was chosen considering the literature related to the determinants of sovereign bond spreads. It is important for policy makers to obtain knowledge on the determinants of sovereign bond spreads, because it allows adjust fiscal policies in order to avoid deterioration of bond spreads drivers.

Our analysis makes two important contributions. First, it identifies the determinants that affect sovereign bond spreads when we consider the whole sample of countries. Second, it examines if these determinants have the same effect on sovereign bond spreads of EMU countries. At first sight, we may expect that the determinants explaining the bond spreads for EMU countries should be different from those explaining bond spreads for EU countries. The main reason for such expected behavior is that EMU countries seem to be more homogenous. However, the current crisis sheds light on the divergence process among EMU countries.

Another point of interest is the financial crisis impact over sovereign bonds spreads. Given the existence of different works, which consider dissimilar dates to represent the start of the financial turmoil, we include two dummy variables that indicate the start of the turmoil, one in July 2007 and the other in September 2008.

Regarding the benchmark, we analyze spreads with respect to two benchmarks: the German and the US 10-year government bond. Previous literature commonly uses the German benchmark. However, we consider also the US benchmark because it is the country where the

crisis began. Furthermore, we may expect that the determinants of sovereign bond spreads may show different sensitivity according to the benchmark. Therefore, our analysis considers both benchmarks in order to compare the results.

Our main results shed light on the different dimensions of bond spreads determinants. First, we find that EU and EMU sovereign bond spreads are generally explained by the same economic variables such as public debt to GDP ratio, inflation and the stock market price index. Second, the influence of the common currency is demonstrated by the best explanation of the model for euro area countries. Third, we obtain a good explanatory model of sovereign bond spreads in Europe, which is able to capture the differences in the evolution of bond spreads with respect to the German and US benchmarks.

The remainder of the paper is organized as follows. Section 2 gives an overview of the related literature. Section 3 presents the data and the hypotheses about the expected behavior of the variables. Section 4 describes the model and the econometric methodology. Section 5 presents the evolution of both benchmarks. Section 6 presents the empirical analysis, and section 7 concludes.

LITERATURE REVIEW

A wide and interesting literature about the analysis of sovereign bond spreads has emerged since the last financial crisis. Numerous articles deal with three main determinants of sovereign bond spreads in the euro area.

The first of these determinants is the credit risk, which includes default risk, downgrade risk and credit spread risk. During the crisis, debt and deficit indicators increased. Governments had greater difficulties in coping with larger debt and deficit. As a consequence, the market's perception of default changed. This situation led to a decrease in rating qualifications of these economies and an increase in the credit risk spread.

The second determinant is the liquidity risk. Liquid markets allow investors to make decisions at any time. Consequently, the number of financial operations should be considered to determine the size and depth of the market, which in turn determines the liquidity premium level. Liquidity risk and credit risk are interconnected (Barrios et al., 2009; Arghyrou and Kontonikas, 2011).

Finally, the third determinant of sovereign bond spreads is the risk aversion. Bond spreads are affected by the amount of risk that investors are willing to bear when they invest in financial markets. Hence, an increase in the risk perception of the economy will increase bonds spread. Furthermore, according to Barrios et al. (2009), the combination of high risk aversion and large current account deficits tend to magnify the incidence of deteriorated public finances on government bond yield spreads.

Moreover, a common and prevailing view of the literature on euro area government bond indices is that spreads are driven by a common global factor (Codogno et al., 2003; Geyer et al., 2004; Barrios et al., 2009; Manganelli and Wolswijk, 2009; Sgherri and Zoli, 2009) represented by international factors, such as risk perception.

Due to the last financial crisis, bond yields are subject to a considerable attention, with particular focus on the heterogeneous effects on EMU financial markets and its main determinants and differences with respect to previous results analyzed in the literature. Codogno et al. (2003) analyze yield spreads between 1990 and 2002, and prove that changes in default risk influence positively the gap between safe and liquid markets. They point out that movement in yield differentials is mostly explained by changes in global risk factors, while liquidity factors play a minor role. Similarly, Geyer et al. (2004) do not find that macroeconomic variables and liquidity have a significant influence on sovereign spreads. Their main conclusion is that the credit risk is a major indicator of systematic risk in EMU countries. Balli (2008) analyzes the financial integration and gov-

ernment bond yields and finds that, for euro bond markets, international factors play more important role than domestic factors, default or liquidity risks. This author concludes that the euro bond market is still not fully financially integrated.

Schuknecht et al. (2010) find that bond yield spreads before and during the crisis can be explained on the basis of the economic principles that consider proxies reflecting the liquidity premium, partial default and risk aversion. They also point out the existence of fiscal imbalances and the shift in general risk aversion after the collapse of Lehman Brothers and the successive increase in the EMU bond spreads.

Another important contribution to the literature of spreads is Manganelli and Wolswijk (2009). They argue that developments in risk aversion are related to the level of short-term interest rates which, in turn, are related to market liquidity and the incentives investors have to bear risk. However, they show that during financial crisis, it is difficult to distinguish whether liquidity or default risks have the largest impact and they suggest that liquidity risk is still a factor that is prized by investors.

Bernoth and Erdogan (2012) state that not only must the variation in fundamentals be considered, but also the variation in credit risk over time. They estimate time-varying coefficients in an additive nonparametric fixed-effects panel model framework and conclude that bond yield differentials are significantly affected by international and country-specific risk factors such as liquidity and the default risk premium.

The impact of the financial crisis has deeply affected bond markets. During periods of instability investors increase their risk aversion, and change their portfolio to more liquid and better quality assets. These two effects are known as "flight-to-liquidity" and "flight-to-quality" (Vayanos, 2004; Beber et al., 2009).

Therefore, the study of the main determinants of spreads is relevant to policy makers, because it could unveil fiscal vulnerabilities. Additionally, the price of risk represents the cost of the debt. Consequently, identifying the main factors that determine spread changes allow governments to devise policies to strengthen the financial markets through liquidity channel or diminishing the fiscal deficits. If countries are able to control the liquidity and default risks they will be less vulnerable to global risks, being these last ones key determinants of sovereign spreads.

DATA

Our database comprises 16 European countries: Austria, Belgium, Czech Republic, Denmark, Finland, France, Greece, Hungary, Ireland, Italy, Netherlands, Poland, Portugal, Spain, Sweden and United Kingdom. Additionally, we consider two benchmark indices: Germany and the US. The countries were selected on the basis of the data available.

We use the Government Bond Index (GBI) calculated by JPMorgan. The GBI is made up of fixed-rate bonds and domestic bonds of countries that give international institutional investors an opportunity to invest in liquid debt markets. This means that bonds are stable, active and regularly issued. We use quarterly data for government bonds that mature between seven and ten years, and compare them with the benchmark of the same maturity term. All the GBI considered are expressed for the government bond issue denominated in euro.

The data is obtained from DataStream, which presents quarterly time series for the period Q_1 2004 to Q_3 2011 measured at the end of each quarter. There are some exceptions with respect to the frequency used with the variable terms of trade for France, given that there is no data available since Q_2 2009. Hence, we assumed that this last value remains constant until the end of 2011. Another irregularity is that Austria, Greece and Portugal which offer this information yearly. Hence, with the aim to homogenize the time dimension we distribute the change of the value between two years linearly between the intermediate quarters.

The selection of the variables is sensitive to the empirical results of the literature related to the determinants of sovereign bond spreads. It certainly always could be found some missing variables; however, an increase of the number of variables may not increase the explanatory capacity of the model. Furthermore, we also take into account the possible correlation between variables.

Previous empirical evidence shows a large list of variables as important determinants of sovereign bonds, which are expected to be significant and contribute to the explanatory capacity of the model. Rowland and Torres (2004) report an interesting discussion on the importance of using significant explanatory variables.

Our study tested the model using several variables; however, some of them were discarded given their null significance or heterogeneity effect between the different groups analyzed. Within this group, we may mention: the net foreign assets to GDP ratio (Min, 1998; Faïth et al., 2009), the current account to GDP ratio (Eichengreen and Mody, 1998; Rowland and Torres, 2004), exports and imports coefficients (Min, 1998), the international reserves to GDP ratio (Dailamini et al., 2008), the exchange rate (Ades et al., 2000) and the public deficit to GDP ratio (Bernoth et al., 2004; Schuknecht et al., 2010). As mentioned by Kilponen et al. (2012) the empirical evidence on the relevance of the fiscal imbalances is mixed.

The significant variables incorporated in the analysis are: VIX index (when the Germany benchmark is considered), VSTOXX index (when the US benchmark is applied), Stock Market Price Index (StockMkt), Inflation rate (Inflation), Public debt to GDP ratio (PublicDebt), Unemployment growth (GrowthUmp), GDP growth, (GrowthGDP), Terms of Trade (TOT), M2 to GDP ratio (M2), Crisis07 (dummy variable), Crisis08 (dummy variable) .

DESCRIPTIVE STATISTICS

	(EU)					(EMU)				
Variable	**Obs**	**Mean**	**Std.Dev.**	**Min**	**Max**	**Obs**	**Mean**	**Std.Dev.**	**Min**	**Max**
VSTOXX	494	22.24	8.55	11.94	43.87	308	22.24	8.57	11.94	43.87
VIX	494	19.83	8.61	11.40	42.28	308	19.84	8.63	11.40	42.28
StockMkt	494	8.11	1.32	5.15	10.67	308	8.24	1.25	5.15	10.67
Inflation	494	106.16	6.61	94.80	135.60	308	105.30	5.14	94.80	119.40
PublicDebt	494	62.11	26.67	23.65	169.26	308	71.43	27.87	23.81	169.26
GrowthUmp	494	0.05	0.69	-2.60	3.45	308	0.10	0.70	-2.60	3.45
GrowthGDP	494	0.00	0.03	-0.19	0.13	308	0.00	0.02	-0.07	0.05
TOT	494	98.28	4.83	76.90	107.40	308	97.08	5.55	76.90	106.60
M2	494	2.35	1.34	0.02	5.19	308	2.68	1.50	0.02	5.19
Crisis07	494	0.55	0.50	0.00	1.00	308	0.55	0.50	0.00	1.00
Crisis08	494	0.38	0.49	0.00	1.00	308	0.38	0.49	0.00	1.00

TABLE 1

Source: Own elaboration

The statistical description shows reasonable parameters and the matrix correlations demonstrate that there are not econometric problems between the selected variables (Tables 1 and 2).

Following, the definition of each variable and its expected impact will be presented.

PEARSON MATRIX CORRELATION

	VSTOXX	VIX	StockMkt	Inflation	PublicDebt	GrowthUmp	GrowthGDP	TOT	M2	Crisis07	Crisis08
VSTOXX	1										
VIX	0.973*	1									
StockMkt	-0.092	-0.087	1								
Inflation	0.465*	0.442*	0.134*	1							
PublicDebt	0.118*	0.099	0.219*	0.183*	1						
GrowthUmp	0.338*	0.335*	-0.006	0.157*	0.089	1					
GrowthGDP	-0.182*	-0.193*	0.017	-0.119	-0.069	0.091	1				
TOT	-0.051	-0.050	-0.064	-0.135*	-0.046	-0.039	0.022	1			
M2	0.132*	0.131*	-0.296*	0.069	0.150*	0.074	-0.039	-0.343*	1		
Crisis07	0.645*	0.660*	-0.037	0.757*	0.153*	0.207*	-0.111	-0.188*	0.163*	1	
Crisis08	0.697*	0.653*	-0.096	0.691*	0.247*	0.259*	-0.132*	-0.093	0.158*	0.720*	1

TABLE 2

*Source: Own elaboration. Note: * significant at 1%.*

A general indicator of common international risk is the VIX index (Arghyrou and Kontonikas, 2011). This variable represents the overall global risk and it is proxied by the Chicago Board Options Exchange (CBOE) volatility index, a measure of US equity market volatility, which is constructed using both call and put implied volatilities from S&P 500 index options. Although movements in this variable do not show significant results respect to the German benchmark, it has only been applied when the US benchmark is considered. Instead, the VSTOXX (Beber et al., 2009) index is included when we consider the German benchmark. The VSTOXX is a similar volatility index for European equity markets that is constructed using implied option prices based on Euro STOXX 50 index. For the period of financial turmoil, these indices increased sharply, while the German and US benchmarks moved in the opposite direction. Hence, the expected influence on the bond spreads is positive.

Another variable considered is the price index of each stock market (StockMkt) included in the study (Baek et al., 2005; Kaminsky and Schmukler, 2002). This variable is expressed in logarithmic terms to analyze the elasticity of this variable on the bond spread. During financial crisis, investors change the composition of their investment portfolios looking for more liquid and/or lower risk assets, describing a flight out of equities and into fixed income markets when the perceived risk in equity markets rises. As a consequence, the expected impact on sovereign bond spreads is negative.

The external variable terms of trade (TOT) (Ades et. al., 2000; Baldacci et al., 2008; Maltritz, 2012) represents the price of a country's exports relative to its imports. A decrease in the terms of trade means that the average export price decreases relative to the average import price. The expected impact is that a decrease in TOT will increase the sovereign bond spreads.

Public debt to GDP ratio (PublicDebt) plays an important role as a determinant of yield spreads. The explanatory capacity of this term is considerable (Schuknecht et al., 2010; Maltritz, 2012). A high ratio indicates an economy that does not make enough internal production to pay back debts. One of the main criteria of the Treaty on European Union, which EMU members should comply with, is to avoid excessive lev-

els of public debt with respect to the GDP. The expected sign of this variable is positive.

The inflation rate (Inflation) is a representative indicator of macroeconomic stability. As Baldacci et al. (2011) mention, high inflation could be a consequence of the monetization of the fiscal deficit and represents the need of higher interest rates, which increases the cost of capital. Hence, higher inflation will increase bond spreads (Min, 1998).

Unemployment growth (GrowthUmp) has a significant impact on sovereign bond spreads. After the financial crisis, some European countries have experienced higher unemployment rates due to a decrease in economic activity and investment. Consequently, this reduction has increased both public deficit and sovereign bond spreads. According to Sgherri and Zoli (2009), the unemployment rate is a leading determinant and an important consequence of the global financial problems. The expected impact of this variable over sovereign bonds spreads is positive.

GDP growth rate (GrowthGDP) is another interesting variable under consideration. It usually has a significant effect on the financial market. We introduce this variable lagged one period in order to take into account for the impact of the economic trend. The expected relation with the sovereign bond spreads is negative.

M2 to GDP ratio (M2) is a key economic indicator used to forecast inflation (Reinhart et al., 1998). The expected sign with respect to the spreads is negative.

We have also considered two dummy variables relative to the influence of the start of the financial crisis and its effect over government debts. There are two key dates considered in the literature as starting points of the crisis. One of them is 15 July 2007 (Crisis07), when some financial companies such as Bear Stearns, Countrywide, and America Home Mortgage began to have financial problems. The other one is 15 September 2008 (Crisis08), the day on which Lehman Brothers filed bankruptcy. Both variables are significant in explaining government bond spreads. However, in the literature there is no unanimous consensus about the starting date.

Sovereign bond spreads remained relatively stable at a low level and only started to grow in July 2007, but the large increase was in September 2008. According to Aβmann and Boysen-Hogrefe (2009), in mid-2007 the financial crisis took off and had a climax in September 2008 with the collapse of Lehman Brothers. At the end of that year, bond spreads increased abruptly relative to German bonds. Grammatikos and Vermeulen (2012) studied how the financial and sovereign debt crisis was transmitted to fifteen EMU countries in various stages during 2003–2010. They confirm that the collapse of Lehman Brothers marks a point of inflection in the crisis. Similar results were obtained by Bariviera et al. (2012) studying the informational efficiency of European bond markets.

We will perform two analyses. One is considering all the European countries of our sample. The other analysis is considering only the European countries of our sample that belong to the EMU: Austria, Belgium, Finland, France, Greece, Ireland, Italy, Netherlands, Portugal and Spain.

The aim of this classification is to detect which variables are common determinants of bond spreads.

Other interesting country classifications could be EMU and non-EMU countries. However, our evidence shows uneven results for the small group of non-EMU countries (Czech Republic, Denmark, Hungary, Poland, Sweden and the United Kingdom). In part this result could be due to the great heterogeneity of the economies of these countries. We should remark that three out of six countries (Denmark, Sweden and UK) are strong and solid economies, while the other three countries (Czech Republic, Hungary and Poland) are small transition economies. Consequently, the empirical results for the non-EMU group do not contribute to the study.

Finally, we omit Germany because it is our reference to estimate bond differences within Europe. Neither will be taken into account in the estimation of the bond spreads relative to US in order to maintain a homogeneous the set of countries.

MODEL AND METHODOLOGY

We estimate the determinants of yield spreads in European countries by applying panel data with fixed effects. Panel data involves pooling observations on a cross-section of a country over several time periods and it has several advantages that make it of considerable interest. First, it makes possible to control for individual heterogeneity. Our study assumes that countries are heterogeneous, so panel data can allows us to control it. Second, panel data may reveal dynamics that are difficult to detect with cross-sectional data. Panels are important for determining inter-temporal relations, and they also give more information and degrees of freedom. In spite of all these advantages, the empirical literature related to our research topic using this methodology is still scarce. However, some interesting works apply this methodology (Lemmen and Goodhart, 1999; Rowland and Torres, 2004; Barrios et al., 2009). The models used for the estimation are:

$$SPREAD_{it}= \beta_0 + \beta_1 VSTOXX_{it} + \beta_2 StockMkt_{it} + \beta_3 Inflation + \beta_4 PublicDebt_{it} + \beta_5 GrowthUmp_{it} + \beta_6 GrowthGDP_{it} + \beta_7 TOT_{it} + \beta_8 M2 + \mu_i + \gamma_t + \varepsilon_{it} \quad (1)$$

$$SPREAD_{it}= \beta_0 + \beta_1 VSTOXX_{it} + \beta_2 StockMkt_{it} + \beta_3 Inflation + \beta_4 PublicDebt_{it} + \beta_5 GrowthUmp_{it} + \beta_6 GrowthGDP_{it} + \beta_7 TOT_{it} + \beta_8 M2 + \beta_9 Crisis07_{it} + \mu_i + \gamma_t + \varepsilon_{it} \quad (2)$$

$$SPREAD_{it}= \beta_0 + \beta_1 VSTOXX_{it} + \beta_2 StockMkt_{it} + \beta_3 Inflation + \beta_4 PublicDebt_{it} + \beta_5 GrowthUmp_{it} + \beta_6 GrowthGDP_{it} + \beta_7 TOT_{it} + \beta_8 M2 + \beta_9 Crisis08_{it} + \mu_i + \gamma_t + \varepsilon_{it} \quad (3)$$

$$SPREAD_{it}= \beta_0 + \beta_1 VIX_{it} + \beta_2 StockMkt_{it} + \beta_3 Inflation + \beta_4 PublicDebt_{it} + \beta_5 GrowthUmp_{it} + \beta_6 GrowthGDP_{it} + \beta_7 TOT_{it} + \beta_8 M2 + \mu_i + g_t + e_{it} \quad (4)$$

$$SPREAD_{it}= \beta_0 + \beta_1 VIX_{it} + \beta_2 StockMkt_{it} + \beta_3 Inflation + \beta_4 PublicDebt_{it} + \beta_5 GrowthUmp_{it} + \beta_6 GrowthGDP_{it} + \beta_7 TOT_{it} + \beta_8 M2 + \beta_9 Crisis07_{it} + \mu_i + \gamma_t + \varepsilon_{it} \quad (5)$$

$$SPREAD_{it}= \beta_0 + \beta_1 VIX_{it} + \beta_2 StockMkt_{it} + \beta_3 Inflation + \beta_4 PublicDebt_{it} + \beta_5 GrowthUmp_{it} + \beta_6 GrowthGDP_{it} + \beta_7 TOT_{it} + \beta_8 M2 + \beta_9 Crisis08_{it} + \mu_i + \gamma_t + \varepsilon_{it} \quad (6)$$

Where i =1, 2…, 16 identifies the country "i" and t= 1, …31 refers to the observations.

Equations (1), (2) and (3) are computed against the German benchmark and equations (4), (5) and (6) against the US benchmark. The dependent variable is the sovereign bond spread of each country and β_i are the coefficients of each explanatory variable. Finally, μ_i, γ_t, and ε_{it} are the individual effect at country level, the time effect and a random disturbance, which is assumed to have zero mean and constant variance. Both, the individual and time effects, are introduced in order to control for the idiosyncratic characteristics of countries and the structural changes that may have affected simultaneously to all the countries.

We corroborate the necessity of controlling for those individual and time effects with the analysis of the Hausman test. The Hausman specification test is the conventional test of whether the fixed or random effects model should be used. The research question is whether there is significant correlation between the unobserved country-specific random effects and the estimators. If

there is no such correlation, then the random effects model may be more powerful and parsimonious. Nevertheless, if there is correlation, the random effects model would be inconsistently estimated and the fixed effects model would be the model of choice. Our results show that the null hypothesis of correlation is rejected. Hence, the model with "fixed effects" seems to be appropriate for estimating our model. Finally, we should also mention that our sample is too short to analyze the existence of cointegrated patterns. However, the heterogeneous behavior at country and time dimension is controlled with the estimation of the fixed effects model.

Finally, in order to analyze the existence of multicollinearity, we apply the variance inflation factor (VIF). Our results do not show a value of VIF above 10 (the largest VIF is 1.97), indicating that multicollinearity is not a concern.

US AND GERMAN BENCHMARK: ANALYSIS OF THEIR EVOLUTION

US Treasury securities are generally considered to be free of default risk. Hence, these instruments are free of interest rate risk, large and liquid, and they are used to compare and forecast economic developments and to analyze other governmental securities. Their general characteristics make it a reference benchmark for hedging positions taken in other markets. As a rule, the 10-year maturity government bond is used for hedging positions taken in other sovereign bond markets. For European countries, the 10-year maturity German sovereign bond is usually used.

As could be appreciated in Figure 1, the US and German GBI evolution is homogeneous over the time. Since 2004, after the euro market consolidation and the stabilization of a EUR/USD exchange rate greater than one, the German 10-year bond yield is lower than the US bond yield. During these years until the end of 2007 the US reference bond has higher relative risk with respect to the German government bond of the same maturity. In this period, in particular at the end of 2005 there is the largest difference between both benchmark yields.

The general risk aversion perception since the beginning of the financial crisis led to restructuring assets in investment portfolios. Thus, the US benchmark became a safe haven within a climate of market volatility and uncertainty. This effect could be observed in the third quarter of 2008, since Lehman Brothers fall. At the end of 2009 this situation was reversed jointly with an increase in EUR/USD exchange rate. Since middle 2011, both benchmarks present similar yields.

US AND GERMAN 10-YEAR GOVERNMENT BOND INDEX EVOLUTION (GBI)

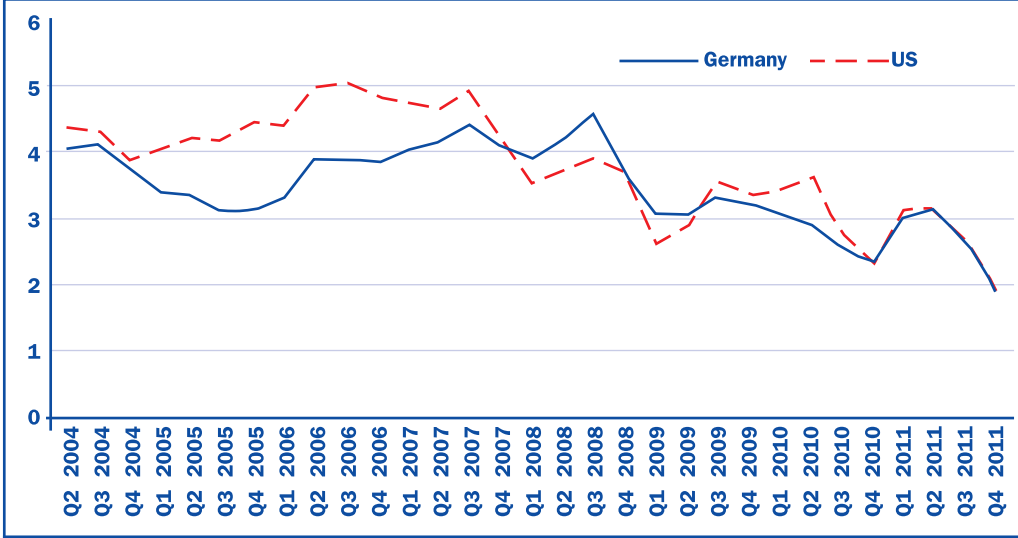


FIGURE 1

Source: JPMorgan GBI. DataStream. Own elaboration.

In general, the Eurozone bond market is very similar in size to the US market. The German government bond is assumed to be a safe haven investment with a similar status to US government bond. However, between the start of the crisis in 2007 and the Lehman Brothers' fall, German bonds suffer from movements related with flight-to-quality and flight-to-liquidity, increasing their yields. For this reason, we may assume that during this short period of time, the German bond suffered from a lack of international recognition as a benchmark status.

Empirical studies on sovereign bond spreads in emerging markets apply the US benchmark to analyze and compare risks between countries. For these countries US Treasury securities are the only reference, given that they present dollarized economies (Balli, 2008; Mauro et al., 2002).

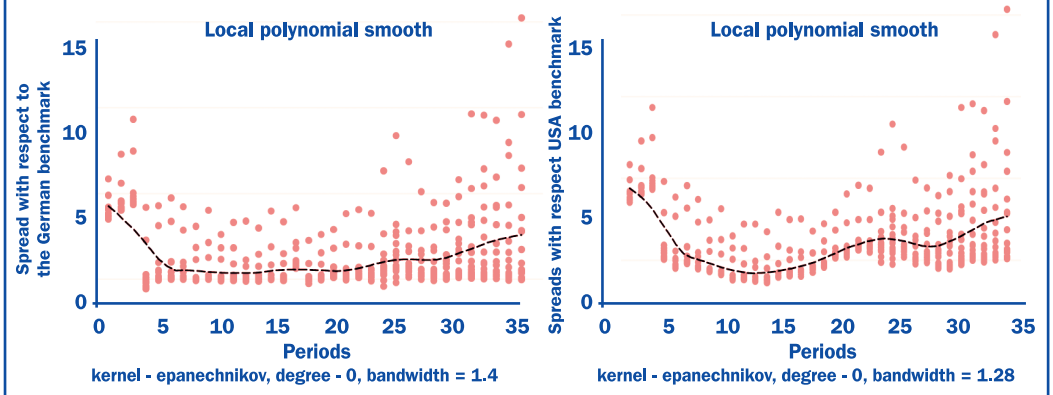
Related to the European countries, there are many papers that analyze government bond risk premiums and its different aspects taking into account diverse concepts. As mentioned in the previous section, the German benchmark is the most cited (Arghyrou and Kontonikas, 2011; Manganelli and Wolswijk; 2009).

Other remarkable works such as Codogno et al. (2003), Bernoth and Erdogan (2012), consider the influence of the US economy on European bond spreads. However, they incorporate the influence of the US market through proxies for the global credit risk. For instance, they use the US corporate yield bond related to sovereign spreads considering the German reference bond. On the other side, Von Hagen et al. (2011) study the government bond spreads relative to the US and German benchmarks. To cope with the different benchmarks, those authors adapt the explanatory variables according to whether the bond is denominated in euro or dollar.

Given the existence of the common currency among some European markets, it is reasonable to compare these markets *vis-à-vis* the safest market of the zone, like the German market. Nonetheless, especially during financial turmoil we consider interesting to compare sovereign bonds spreads with respect to the largest world economy, namely the US. So, for this reason we present a similar analysis of panel data fixed effects considering, separately, both benchmarks.

If we observe (see Figure 2) the evolution of bond spreads between $Q_1$2004 and Q_3 2011, we should highlight the fact that bond yields among EU countries present a co-movement. This co-movements show the presence of a systemic risk. In order to detect the relationship between bonds spreads over the time, we apply kernel-weighted local polynomial smoothing techniques to obtain non-parametric estimates.

SPREADS EVOLUTION



Local polynomial for the evolution of the bond spreads. On the left hand, there is the evolution of the bond spreads with respect to the German benchmark, and on the right hand, with respect to the US benchmark.

FIGURE 2

The non-parametric estimation shows the common trend of the spreads over time, which may uncover the common risk. From Figure 2, we may highlight several characteristics. First, there is a U-shape of the evolution of the bond spreads. Second, this U-shape pattern is much more pronounced for the bond spreads considering the US benchmark. Third, despite the common trend some spreads have been fluctuating over the smoothed trend.

All these characteristics may highlight the presence of a common trend, but where the idiosyncratic characteristics of the countries may play an important role when determining the bond spread.

EMPIRICAL ANALYSIS

6.1 Bond spreads *vis-à-vis* the German benchmark

This section presents the empirical results considering the explicative variables *vis-à-vis* the German benchmark, using equations (1), (2) and (3). We consider two groups,

the whole sample, i.e. EU countries; and the EMU countries. For each country classification we perform the three regressions. The results are shown in Table 3. Each regression shows at least the same three significant variables: stock market price index, inflation and public debt ratio. They are almost all significant at one percent level. A similar result presents the variables unemployment growth and terms of trade, with some specific exceptions.

RESULTS FOR EU AND EMU COUNTRIES PANEL ESTIMATION USING FEASIBLE GENERALIZED LEAST SQUARES (FGLS) WITH RESPECT TO THE GERMAN BENCHMARK

Variables	EU			EMU		
	UE_1	UE_2	UE_3	UME_1	UME_2	UME_3
VSTOXX	-0.0074	-0.0051	0.0015	-0.0132*	-0.0045	0.0089
	(0.00624)	(0.00670)	(0.00684)	(0.00734)	(0.00776)	(0.00787)
StockMkt	-0.726***	-0.720***	-0.847***	-0.431**	-0.422**	-0.786***
	(0.163)	(0.163)	(0.166)	(0.192)	(0.190)	(0.191)
Inflation	0.0356***	0.0420***	0.0533***	0.101***	0.136***	0.152***
	(0.00930)	(0.0115)	(0.0109)	(0.0138)	(0.0177)	(0.0156)
PublicDebt	0.0585***	0.0580***	0.0636***	0.0881***	0.0873***	0.101***
	(0.00460)	(0.00462)	(0.00486)	(0.00507)	(0.00500)	(0.00529)
GrowthUmp	0.140**	0.140**	0.139**	0.115*	0.117*	0.0937
	(0.0607)	(0.0607)	(0.0602)	(0.0693)	(0.0683)	(0.0656)
GrowthGDP	-1.266	-1.212	-1.135	-7.390**	-7.057**	-6.381**
	(1.156)	(1.158)	(1.147)	(3.228)	(3.183)	(3.056)
TOT	-0.0429***	-0.0448***	-0.0326*	-0.0499***	-0.0522***	-0.0257
	(0.0165)	(0.0166)	(0.0167)	(0.0190)	(0.0187)	(0.0184)
M2	-0.252	-0.196	-0.139	-1.534***	-1.405***	-1.541***
	(0.200)	(0.209)	(0.201)	(0.228)	(0.229)	(0.216)
Crisis 07		-0.148			-0.581***	
		(0.157)			(0.188)	
Crisis 08			-0.523***			-1.193***
			(0.171)			(0.200)
Constant	4.391*	3.776	1.901	-3.408	-7.123**	-9.213***
	(2.299)	(2.389)	(2.420)	(3.095)	(3.279)	(3.084)
Observations	494	494	494	308	308	308
R-squared	0.535	0.536	0.544	0.720	0.729	0.751
Number of countries	16	16	16	10	10	10
Mean VIF	1.26	1.67	1.65	1.32	1.90	1.69
Hausman Test	227.74	152.60	140.38	-824.84	-1115.94	272.95
Prob >χ2	0.0000	0.0000	0.0000	-	-	0.0000

TABLE 3

*Note: Standard errors in parentheses. *** significant at 1%, ** at 5%, and * at 10%.*

If we analyze the results taking into account all the time series data since 2004 to 2011, the present econometric model is a stable model that explains a large percentage of spread movements.

All parameters show the expected sign. We do not consider the dummy variables in estimations (EU_1) and (EMU_1), in order to demonstrate the relevance of the selected variables.

According to our results, VSTOXX is not a representative variable in this model, as determinant of sovereign bond spreads. Only in estimation (EMU_1) it is significant at 1%, although it does not present the expected sign.

The stock market index variable is significant for both groups of countries and shows the expected sign. The negative relationship is related to the existence of risks in the bond market. This means that if the equity market is regarded as riskier than fixed asset market, stock prices decrease. Moreover, if investors are risk averse, they will change their asset allocation to safer and more liquid financial instruments such as sovereign bonds. These inverse movements in financial asset prices justify the negative relationship between both market prices.

Another important and significant explicative variable is the inflation rate, which presents the expected positive sign. If the inflation rate increases by 1% the effect on bond spreads is an increase equal to 1.03% for EU countries (EU_1) and equal to 1.10% for EMU members (EMU_1).

Public debt to GDP ratio is also a key determinant of sovereign bond spreads and presents a positive and significant relationship. A higher debt burden means a higher risk of default aggravated by larger public deficits. This scenario has been common in EU countries during the last four years, particularly in EMU countries. Given an increase of 1% in the public debt ratio, the sovereign bond spreads increase by 1.058% in EU countries (EU_1) and by 1.088% in EMU countries (EMU_1).

Another significant variable for EU countries is the change in unemployment rate. Hence, an increase in the unemployment rate of 1% increases the bonds spreads by 1.40% and 1.15% for EMU countries. As could be appreciated in Table 3, this variable and GDP growth are the most explicative for both groups of countries, once we have considered the three previous main variables.

GDP growth presents the expected negative sign, but it is not significant for EU countries. Estimation (EMU_1), indicates that if the economy grows during a period, the sovereign bond spreads should decrease as an indicator of economic strength. Terms of trade is significant for both group of countries and presents the expected negative sign. Therefore, an improvement in this variable implies an increase in export revenues. Thus, better debt repayment capacity reduces bonds spreads. M2 to GDP ratio shows an interesting result regarding the existence of a common currency. The expected sign of this variable is negative. This ratio is not significant for EU countries and highly significant for EMU countries.

These estimations provide good levels of adjustments. Consequently, these estimations show that we have included correct explanatory variables. For the European countries we obtain a R^2 equal to 53.5% while for the EMU countries we obtain a R^2 equal to 72%.

On the basis of these initial estimations, we try to capture the effect of the financial crisis on the bond spreads by introducing dummies on the start of the financial crisis. As previously commented, we use two different data as landmark of the financial crisis. First, estimations (EU_2) and (EMU_2) include the dummy variable Crisis07, which recognizes the start of the crisis in July 2007 in both sets of countries. Second, estimates (EU_3) and (EMU_3) include the dummy variable Crisis08, which recognizes the climax of the crisis in September

2008. The aim of including these variables is to probe the existence of the contagion effect of the US-originated financial crisis to European countries.

Regarding to the first analysis (estimations (EU_2) and (EU_3)), there seems that the crisis starts more intensively in 2008 given that the dummy variable Crisis08 is significant, but not Crisis07. On contrary in estimations (EMU_2) and (EMU_3) both dummies are significant. This difference could be due to different reasons and not only directly related to the financial crisis. In this sense, Gómez-Puig (2009) shows that risk of sovereign bond spreads of EMU countries is due, in part, to the incidence of idiosyncratic risks.

As could be observed, the statistical coefficient is larger for EMU countries than for EU countries. For instance, this difference could be interpreted as EMU countries have been more affected by the financial crisis than the rest of the European countries. There are many reasons for this situation. However, the common factor is the impossibility of EMU members to apply local monetary policies and to adapt some European economics rules. The existence of a single currency means that economic decisions must be taken to comply with some established rules, to revise others and to ensure that the Monetary Union can continue over time. It should be pointed out that these modeling are important given that Germany is a traditional benchmark for European countries.

The main conclusion of this subsection is that sovereign bond spreads are partly explained by the influence of the stock market price index, inflation and public debt ratio and affected by the financial crisis.

6.2 Bonds spreads vis-à-vis the US benchmark

In order to compare some of the specific effects of the impact of the financial crisis, we make a similar analysis to the previous section, but with respect to the US benchmark (Table 4). In general, our results are similar to those using the German benchmark, although we should point out some differences.

RESULTS FOR EU AND EMU COUNTRIES PANEL ESTIMATION USING FEASIBLE GENERALIZED LEAST SQUARES (FGLS) WITH RESPECT TO THE US BENCHMARK						
Variables	**EU**			**EMU**		
	UE_4	**UE_5**	**UE_6**	**UME_4**	**UME_5**	**UME_6**
VIX	0.0239***	0.00756	0.0389***	0.0217***	0.0134	0.0521***
	(0.00676)	(0.00732)	(0.00706)	(0.00796)	(0.00884)	(0.00785)
StockMkt	-1.032***	-1.077***	-1.297***	-0.661***	-0.673***	-1.246***
	(0.179)	(0.174)	(0.179)	(0.210)	(0.208)	(0.197)
Inflation	0.0643***	0.0263**	0.101***	0.129***	0.101***	0.210***
	(0.0102)	(0.0124)	(0.0117)	(0.0150)	(0.0198)	(0.0162)
PublicDebt	0.0529***	0.0546***	0.0631***	0.0857***	0.0858***	0.107***
	(0.00514)	(0.00502)	(0.00529)	(0.00565)	(0.00562)	(0.00554)
GrowthUmp	0.127*	0.131**	0.129**	0.130*	0.131*	0.105
	(0.0671)	(0.0654)	(0.0650)	(0.0761)	(0.0757)	(0.0676)
GrowthGDP	-0.777	-1.242	-0.524	-4.884	-5.420	-3.281
	(1.281)	(1.251)	(1.241)	(3.576)	(3.564)	(3.179)
TOT	-0.0721***	-0.0594***	-0.0510***	-0.0787***	-0.0760***	-0.0410**
	(0.0182)	(0.0180)	(0.0181)	(0.0209)	(0.0208)	(0.0190)
M2	-0.592***	-0.888***	-0.368*	-1.910***	-1.985***	-1.948***
	(0.223)	(0.225)	(0.220)	(0.255)	(0.256)	(0.226)
Crisis 07		0.891***			0.462**	
		(0.175)			(0.217)	
Crisis 08			-1.019***			-1.802***
			(0.180)			(0.203)
Constant	6.825***	10.42***	1.987	-1.620	1.234	-10.30***
	(2.540)	(2.574)	(2.605)	(3.410)	(3.645)	(3.180)
Observations	494	494	494	308	308	308
R-squared	0.586	0.607	0.612	0.736	0.740	0.793
Number of countries	16	16	16	10	10	10
Mean VIF	1.25	1.72	1.60	1.31	1.97	1.64
Hausman Test	200977.04	57.34	83.94	455.36	467.96	339.34
Prob >χ2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

TABLE 4

*Note: Standard errors in parentheses. *** significant at 1%, ** at 5%, and * at 10%.*

First, an interesting result is that some variables show greater significance regardless we consider EU or EMU countries. In addition to the three significant explicative variables detected using the German benchmark (stock market price index, inflation and public debt to GDP ratio), M2 to GDP ratio and terms of trade are also significant determinants of bond spreads (EU_4 and EMU_4).

Unemployment growth is significant in all regression, except for EMU countries, when Crisis08 is taken into

account. A similar result was obtained against the German benchmark.

In this analysis we include VIX as a proxy for global risk. This variable is significant for the general model in both groups of countries (EU_4 and EMU_4) and also when considering the dummy variable Crisis08 (EU_6 and EMU_6). In all estimations this variable presents the expected positive sign as an indicator of higher international volatility in financial markets. Hence, this effect increases sovereign bond spreads. With respect to the GDP growth, this variable does not show a significant impact considering the US benchmark.

Respect to the dummy variables, they present an interesting influence on the models. Both dummy variables are significant for EU and EMU countries. Additionally, they have opposite signs. One possible explanation for this pattern is that the effect of the variable Crisis07 is due to the origin of the financial crisis was in the US. Consequently, it first affected the US bonds yields, and later European bonds yields. On the other side, in 2008 the financial crisis was already present in Europe, so it affected more deeply the European bonds of EU and EMU countries.

The financial crisis increased the perception of risk, by increasing the spreads in all European countries. This is reflected in a better adjustment of the model when including the dummy variables and their significance.

CONCLUSIONS

The goal of this paper is twofold. First, identify the main determinants of bond spreads by applying a panel data approach with time fixed effects for EU and EMU countries. Second, study the influence of the financial crisis on bond spreads for both sets of countries. The period under study goes from 2004 until 2011.

The empirical analysis compares the results using German and US sovereign bond indices as benchmarks. After a selection process, our results present clear evidence that public debt ratio, inflation and stock market price index have a considerable and stable effect regardless the different estimation procedures. Hence, the results show that domestic factors are crucial to explain the different evolution of bond spreads with respect to either German or US benchmarks.

Considering the US benchmark, R^2 is greater for all the estimations. This result is interesting as long as the US economy has been the epicenter of the financial crisis and bearing in mind that the general benchmark for European countries has been the German bond.

Estimations for EMU countries show better adjustment than estimations for EU countries. This effect may highlight, in some aspects, the influence of the euro over country members. Despite the financial crisis effect over these economies, and the different economic situations of EMU members during recent years, the presence of a common currency makes the explicative variables of this group more significant. A possible explanation for such increase in the significance levels is that the single currency makes countries more homogeneous (for financial markets participants), and favors stronger contagion among them than among EU countries.

As it is commonly known, the incidence of the financial crisis is a crucial aspect over sovereign bond spreads increase. According with the results obtained, we detect that the financial crisis has a stronger impact over spreads since 2008, independently of the benchmark.

Our paper sheds light on two important issues regarding bond spreads. Firstly, that the crisis uncovered the importance of country specific variables in the determination of bond spreads, which were latent in the pre-crisis period. In some way, the crisis magnified the heterogeneity of EMU countries, which before the crisis seemed to be very homogeneous. Secondly, that the selection of the benchmark is very important and could make the models more explicative.

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