A Sovereign Bond Spreads Analysis in the European Union and European Monetary Union: a Panel Data Framework

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Our study aims to identify the main determinants of the sovereign bond spreads considering the German and US benchmark in the European Union and EMU countries between January 2004 and September 2011. Hence, this period includes the period previous and after to the last financial crisis. We apply a panel data framework with time fixed effects and consider different groups of variables. The results show a good explanatory model and we identify a group of key variables that affect bond spreads. Furthermore, we are able to distinguish when the contagion starts in the European financial markets according to the benchmark.

Keywords: Sovereign bond spreads, Euro area, financial crisis, Panel Data.

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1. Introduction

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

The EMU is one of the most important policies to have been applied to improve the international financial system. It has created a new fully integrated financial market. In the first two years after the introduction of the euro there was a general harmonization in the euro area bond market. Sovereign bond yield spreads across EMU member states relative to the German benchmark converged and were generally smaller than fifty basis points (Bernoth and Erdogan, 2012, p. 640). The decrease of the bond spreads mainly reflected the introduction of the euro and the removal of the exchange rate risk. It should be noted that the European countries that did not belong to the single currency, like the United Kingdom, also increased their bond yield correlation with the countries that had adopted the euro. The same phenomenon occurred relative to the US benchmark.

However, the global financial crisis has modified investors' perception of risk and the diversification of investment portfolios has propagated market risks to the rest of the world. European countries are more unstable and the single currency has become more vulnerable. The extent of the crisis has obliged European policy makers to undertake rigorous fiscal measures, and to inject large amounts of money into financial institutions

(Grammatikos and Vermeulen, 2011) and rescue packages for economies such as Greece and Ireland.

According to Barrios et al. (2009), Arghyrou and Kontonikas (2011), and Sgherri and Zoli (2009), since the global financial crisis, between 2007 and 2010, bond spreads have increased the yield spreads relative to the German benchmark of some euro area members.

This paper aims to identify the main determinants of sovereign bond spreads in the EU and EMU and analyze how vulnerable they are to financial crisis. To cope with these purposes, we apply the following strategy: first, we study the effects of the determinants of the sovereign bond spread using Germany as a benchmark for EU and EMU countries, and, second, we perform the same study with respect to the US benchmark.

Our database is made up of sixteen European countries observed between 2004 and 2011. We shall also measure the change in the financial system by considering two different periods of time. We consider, on the one hand, the start of the turmoil in July 2007 and, on the other, the period after the Lehman Brother's fall in September 2008. We apply a panel data econometric methodology. Following the previous empirical evidence, we consider three groups of variables as key determinants of sovereign bond spreads: liquidity and solvency variables, real variables and variables related with the external shocks. Furthermore, we include two dummy variables that indicate the start of the turmoil in order to measure the effect of financial crisis on the bond spreads.

Our main results are wide ranging and have several points of interest. First, we find that EU and EMU sovereign bond spreads are generally explained by the same economic variables as public deficit, public debt, terms of trade and growth of exports and imports. Second, our results show that bond spreads in EU and EMU countries

reacted differently in the two periods of observation (crisis in 2007 and crisis in 2008) regardless the benchmark. Third, we observe that the crisis in 2007 had a significant impact on bond yield spread when considering the US benchmark, which confirms that first consequences of the current financial crisis took place in that country. Finally, we obtain a good explanatory model of sovereign bond spreads in Europe which is able to capture the differences of the evolution of the bond spreads respect to German and US benchmark.

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 hypothesis about the expected behaviour of the variables. Section 4 describes the model and the econometric methodology. Section 5 presents our empirical analysis and section 6 concludes.

2. Literature review

A wide and interesting literature about the analysis of sovereign bond spreads has emerged since the last financial crisis. However, some important studies date back to the period prior to the onset of financial turmoil. The setting up of the EMU has diverted market attention to debt service payments as the key measure of indebtedness and eliminated liquidity premiums in the euro area. Bond yields have converged noticeably in the transition to EMU. However, the persistence of yield differentials for sovereign debt indicates that the euro area bonds are still not perfect substitutes (Pagano and Von Thadden, 2004; Favero et al., 2010). This phenomenon is commonly known since the financial turmoil when EMU countries had important economic and financial problems as a consequence of risks related to the financial markets.

Numerous articles (Codongo et al., 2003; Geyer et al., 2004; Bernoth et al., 2004; Barrios et al., 2009; Bernoth and Erdogan, 2012; Manganelli and Wolswijk, 2009; Klepsch and Wollmershäuser, 2011; among others) deal with the three main

determinants of the sovereign bond spreads in the euro area. The first of these determinants is Credit Risk, which includes default risk, downgrade risk and credit spread risk. During the crisis, debt and deficit indicators have increased. Governments have had greater difficulties in coping with higher debt and deficit. As a consequence, some markets´ perception of default has been affected, which has led to a decrease in the rating qualification of these economies and an increase in the credit spread risk.

The second determinant is Liquidity Risk. A liquid market allows investors to make decisions at any time, so the number of financial operations should be considerable to determine the size and depth of the market and the liquidity premium level. Therefore, if transaction costs are high, investors will demand a higher yield. Liquidity Risk and Credit Risk are interconnected (Barrios et al., 2009; Arghyrou and Kontonikas, 2011). On the one hand, if a government increases its supply of bonds, the pressure on the liquidity premium decreases. On the other hand, a high supply is associated with an increase in public debt and deficit, which increases the credit risk premium.

And finally, the third determinant of sovereign bond spreads is Risk Aversion. Bond spreads are affected by the amount of risk that investors are willing to take when they invest in financial markets. Hence, an increase in the perception of risk in an economy will increase its bond 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.

Furthermore, a common and prevailing view of the literature on euro area government bond indices is that spreads are driven by a common global factor (Codongo et al., 2003; Geyer, 2004; Barrios et al., 2009; Manganelli and Wolswijk, 2009; Sgherri and Zoli, 2009) represented by international factors such as risk perception. This important determinant has a greater impact during the adjustment of international financial

conditions, measured by the spread between US corporate bonds and the government bond yield (Eichengreen and Mody, 1998; Kamin and von Kelist, 1999).

During the last financial crisis, bond yield was subject to a considerable amount of attention, with particular focus on the heterogeneous effects on EMU financial markets, its main determinants and the differences with respect to previous results analyzed in the literature.

Several studies have been made of EMU countries. Codongo et al. (2003) analyze yield spreads between 1990 and 2002, and prove that changes in default risk positively influence the gap between safe and liquid markets. They point out that movements in yield differentials are mostly explained by changes in global risk factors while liquidity factors play a minor role. Similarly, Geyer at el. (2004) do not find that macroeconomic variables and liquidity have a significant influence on sovereign spreads. Their main conclusion is that credit risk is a major indicator of systematic risk in EMU countries. Balli (2008) analyzes financial integration and the government bond yield and finds that for euro bond markets international factors play a more important role than domestic factors, default and liquidity risk. This author concludes that the euro bond market is still not fully financially integrated.

Along the same lines Bernoth et al. (2004) emphasize that the effects on European risk premium pay after the start of the EMU are ambiguous. On the one hand, since EMU governments ceased to have monetary and exchange policies, they lost instruments to cope with a financial crisis. In addition, as is established in the Maastricht Treaty, other governments and the central bank may not be compelled to rescue economies in financial crisis. On the other hand, the Monetary Union has decreased the perceived default risk; if markets prove to have financial problems, they will be bailed out by other countries or the central bank. However, those authors also

conclude that the debt service variable explains a great deal of the spread variation and that the liquidity risk premium has reduced between EMU members since the increase in financial integration.

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 the Lehman Brothers and the successive increase in the EMU bond spreads.

Sgherri and Zoli (2009) suggest that the euro area sovereign risk premium tends to commove over time in relation to the global risk and that sovereign spreads in the euro area have been increasing in the same direction as the influence of debt sensitivity. They point out that the liquidity of sovereign bond markets plays a significant although limited role in explaining spreads. On the other hand, Aβmann and Boysen-Hogrefe (2009) conclude that default and liquidity risks can explain the existence of larger sovereign bond spread. Those authors point out that both risks have increased during the crisis, but the liquidity risks has a larger importance than the default risk. Thus, in line with Beber et al. (2009) their model confirms that investors pursue liquidity and not credit quality in times of market stress.

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 take risk. However, they show that during a financial crisis it is difficult to distinguish whether liquidity or default risks have the highest impact and they suggest that liquidity risk is still a factor that is prized by investors.

Bernoth et al. (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 higher quality assets. These two effects are known as "flight-to-liquidity" and "flight-to-quality" (Vayanos, 2004; Beber et al., 2009) such as the German and US sovereign bonds considerate the safest haven and default free. Beber et al. (2009) analyze if bond investors demand credit quality or liquidity, and they highlight a negative correlation between the two characteristics especially in the euro area. They conclude that investors worry about both of them but at different times and for different reasons.

Therefore, the study of the main determinants of spreads is relevant to policy makers given that they are important indicators of fiscal vulnerabilities and the price of risk represents the cost of the service debt. Consequently, identifying the main factors which determine spread variations allows 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 risk they will be less vulnerable to global risks, being these last ones the main determinants of sovereign spreads. Therefore, particularly in times of crisis the euro area could be considerably less heterogeneous.

Barrios et al. (2009) consider three determinants of government bond differentials: fiscal vulnerabilities and the risk of default, bond liquidity and changes in investors'

preferences. They find that risk perception plays a major role in explaining the euro area bond spreads and the magnifying effect that the interaction of general risk aversion and macroeconomic fundamentals may have. We have also considered three different groups of variables which represent diverse risks: one of them is related to liquidity and default risk; another includes real variables; and the third controls for external shock variables. We have also constructed several models that contain a wide range of variables although, to present a more precise model, we have only considered the significant ones. The kind of risks mentioned in the literature as the main determinants of spread are represented in our model by a group of key variables.

3. **Data**

We estimate the time-varying determinants of yield spreads in European countries by applying panel data with fixed effects. Our econometric strategy is the following: yield spreads are calculated first relative to the German 10-year benchmark and then relative to the US benchmark with the same characteristics.

Our database comprises 16 European countries which are classified in two groups: members of the European Monetary Union (Austria, Belgium, Finland, France, Greece, Ireland, Italy, Netherlands, Portugal, Spain) and the European Union (EMU countries and Czech Republic, Denmark, Hungary, Poland, Sweden and United Kingdom). We omit Germany because we use it as a reference to estimate bond differences within Europe. Neither will we take it into account when estimating the bond spreads relative to USA so that the set of countries remains homogeneous. The countries were selected on the basis of the availability of data (see Figure A-1 in the annex).

We use data from the Government Bond Index (GBI) calculated by JPMorgan. The GBI is made up of fixed-rate bonds and domestic bonds of countries that give the international institutional investor an opportunity to invest in liquid debt markets. This

means that the 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.

To carry out the analysis we calculate the sovereign debt spread regression against different sets of explanatory variables: liquidity and solvency, real variables, external shocks and two dummy variables. Table 1 shows the explanatory variables.

Table 1

Liquidity and solvency variables	***Real variables***	***External Shocks***	***Dummy Variables***
Public Deficit to GDP (X_1)	Growth of Unemployment rate (X_4)	Terms of trade (X_6)	Crisis (July 2007) (X_9)
Public Debt to GDP (X_2)	Equity Price Index (X_5)	Growth X (X_7)	Crisis (Sep. 2008) (X_{10})
Reserves to GDP (X_3)		Growth M (X_8)	

The empirical evidence above shows that these variables are important so they are expected to be significant and contribute to the explanation of the general model. Rowland and Torres (2004) report an interesting discussion on the importance of using significant explanatory variables. Similarly, the hypotheses and the variables used may be regarded as an overlap of findings in the literature. The statistical description shows reasonable parameters and the matrix correlations demonstrate that there are not econometric problems between the variables selected (Table A.2).

All the data is obtained from DataStream, which presents quarterly time series for the period Q_1 2004 to Q_3 2011. The only exception is the variable "Terms of Trade", which was available every quarter for some countries and annually for others. To homogenize the time dimension we applied an average to transform annual data into quarterly data.

With respect to the variables used to explain the sovereign bond spreads in the European countries (Table 1), we will present the expected impact on the dependent variable according with the previous literature.

The Stock Index variable is an unusual explanatory variable in the empirical literature. However, given the current scenario we consider it is an essential variable that clearly reflects how government bonds vary relative to equity price indices. In particular, during financial turmoil investors change their assets allocations from one market to another one, searching for liquid and qualified assets.

Two other variables are also taken into account. The first is the public deficit to GDP ratio (Eichengreen and Mody, 1998; Rowland and Torres, 2004; Bernoth et al., 2004; Schuknecht et al., 2010), which plays an important role as a determinant of yield spreads. The greater the fiscal deficit is, the more likely it is that external shocks can produce a default. The explanatory capacity of this term is considerable. And the second is the ratio of public debt to GDP (Min, 1998; Kamin and von Kelist, 1999; Arora and Cerisola, 2001; Codongo et al. 2003; Ades et al., 2005; Bernoth et al., 2004; Schuknecht et al., 2010; Maltritz, 2012). A low ratio indicates an economy that produces a large number of goods and services and makes enough profit to pay back debts. A high ratio, however, indicates that the debt burden is higher, and that there is a correspondingly high risk of default and, therefore, of higher spreads. They are both important criteria of the Maastricht Treaty that EMU members should comply with.

The foreign debt has to be serviced out of international reserves, so if the Reserves to GDP ratio is low, the likelihood of a liquidity crisis and risk of default will be higher (Dailamini et al., 2005; Rowland and Torres, 2004; Min, 1998). The importance of this variable could be relative in our analysis; in particular in EMU countries since a considerable percentage of their reserves are in their own currency.

As far as domestic and real economic factors are concerned, the unemployment rate 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.

Another external variable considered is terms of trade (TOT) (Ades et. al., 2000; Baldacci et al., 2008; Maltritz, 2012) or 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. A decrease in TOT increases the sovereign spreads bond.

Another important driving force behind spreads is the growth of exports and imports, which reflects the extent to which economies are open to international markets. It should be pointed out that these countries are predominantly importing ones and, furthermore, half of their trade balances are negative. However, exports of goods and services have increased since Q_3 2007 and imports have decreased.

We have also considered two dummy variables relative to the influence of the start of the financial crisis. We believe that there are two key dates. The first one is 15 July 2007 (Crisis 2007) since this is when financial companies first began to have negative consequences on the US markets. And the second one is 15 September 2008 (Crisis 2008), the day on which the Lehman Brothers went bankrupt. Both variables are significant in explaining government bond spreads. However, in the literature there is no unanimous consensus about the start date or the split period.

Sovereign bond spreads remained relatively stable at a low level and only started to grow in July 2007. But the big increase was in September 2008 with the collapse of the Lehman Brothers. 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 the

Lehman Brothers. At the end of that year, bond spreads increased abruptly relative to German bonds. Grammatikos and Vermeulen (2011) studied how the 2003–2010 financial and sovereign debt crises were transmitted to fifteen EMU countries in various stages. They confirm that the collapse of the Lehman Brothers on 15 September 2008 marks a point of inflection in the crisis.

Barrios et al. (2009) and Schuknecht et al. (2010) analyze government bond yields from a historical perspective and use both critical dates to study the spread determinants. They confirm that the sharp rise began in September 2008 with the collapse of the Lehman Brothers. Furthermore, not only there is a considerable increase in spreads for EU countries but also a shift in general risk aversion behavior, which assumed German government bonds to be a safe-haven investment. Similarly, Bernoth and Erdogan (2012), Manganelli and Wolswijk (2009), and Klepsch and Wollmershäuser (2011) consider that the global financial crisis started in the middle of 2007, but that yield spreads first peaked after the collapse of the Lehman´s Brothers. Balli (2008) calls this phase the crisis build-up.

Our results are consistent with those found in the literature and show that the United States´ markets felt the first financial consequences in 2007. Nevertheless, the contagion effect moved to European countries some time later.

4. Model and methodology

We use panel data methodology for the empirical analysis. 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 it 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 sets 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 on this methodology is still scarce. However, some interesting works using this methodology are Lemmen and Goodhart (1999), Rowland and Torres (2004), Barrios et al. (2009), and Bernoth and Erdogan (2012).

The model we use for our estimates is the following:

$$SPREAD_{it} = \beta_0 + \beta_1 X_{1it} + \beta_2 X_{2it} + \beta_3 X_{3it} + \beta_4 X_{4it} + \beta_5 X_{5it} + \beta_6 X_{6it} + \beta_7 X_{7it} + \beta_8 X_{8it} + \beta_9 X_{9it} + \beta_{10} X_{10it} + \mu_{it}$$

where *i=1,2…, 16* identifies the country "*i"* and *t= 1, 2,* … refers to a given time period between the first quartile in 2004 and the third quartile in 2011.

The dependent variable is the sovereign bond spread of each country (SPREAD). The explanatory variables are expressed by X_1 to X_{10}. The β_0, β_1, β_2 … β_{11} are time varying coefficients and μ_{it} is a random disturbance which is assumed to have zero mean and constant variance.

In order to choose between "random" or "fixed" effects panel data, the Hausman test is conducted. The results show that the null hypothesis cannot be rejected (Tables 2 and 3). Hence, the "fixed effects" model seems to be appropriate for estimating our model.

5. **Empirical analysis**

This section presents the empirical results obtained after the variables have been selected. Table 2 shows the estimates of six regressions based on different variable selections relative to the German benchmark. Each regression shows at least the same five significant variables: public deficit, public debt, terms of trade, growth of exports and imports. Given their significant level, these variables appear in all the regressions because they are highly meaningful and almost all are significant at one percent.

All parameters show the expected sign. Estimates (1) and (4) include all liquidity and solvency variables, real macroeconomic variables and international shocks. We have not considered the dummy variables that identify the beginning of the crisis.

For the EU countries, the stock index variable is significant and shows an expected sign. The negative relationship is related to the existence of risks in the financial market. This means that if the equity market is regarded as more risky than the fixed market, prices decrease and the risk premium grows in the same direction as the redemption yield on assets. If investors are risk averse they will change their asset allocation to safer and more liquid financial instruments such as sovereign bonds. So, their demand grows and so does their price. These inverse movements in financial asset prices justify this negative relationship between the two market prices.

However, EMU countries do not show this phenomenon. As can be observed, in this group the relationship between the stock index and the sovereign spreads is positive and non significant. One reason for this may be the higher volatility of financial markets during the period of crisis (in our database this period covers a great deal of the whole sample). In this scenario, investors are risk averse and do not rely on any particular market, except on US and German bonds or value in gold. As a consequence, the fixed bond market and the equity market move in the same direction.

Public debt and public deficit are also key determinants of sovereign bond spreads. They always move together and present a positive and significant relationship. This confirms the importance that liquidity problems can have for a country. A higher debt burden means a higher risk of default aggravated by bigger public deficits. This scenario has been common in EU countries in the last four years, and particularly in EMU countries. Our results show that coefficients are slightly larger for the EMU countries. Given an increase of 1% in the public debt, the sovereign bond spreads increase 9.1%

and 10.6% in the euro zone. Similarly, an increase of 1% in the public deficit increases yield spreads by 11.5% in the European countries and by 14.3% in the euro area.

Table 2: Regressions respect Germany benchmark

	European Union (EU)			European Monetary Union (EMU)		
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Stock Index	-3.79e-05***	-3.78e-05***	-3.23e-05**	2.56e-06	1.60e-06	2.54e-06
	(1.30e-05)	(1.30e-05)	(1.31e-05)	(1.59e-05)	(1.62e-05)	(1.70e-05)
Pub.Deficit/GDP	0.0912***	0.0908***	0.0874***	0.106***	0.106***	0.106***
	(0.00484)	(0.00496)	(0.00513)	(0.00586)	(0.00593)	(0.00626)
Pub. Debt/GDP	0.115***	0.116***	0.121***	0.143***	0.143***	0.143***
	(0.0127)	(0.0127)	(0.0128)	(0.0149)	(0.0150)	(0.0150)
UnemplGrow	0.128**	0.125**	0.112**	0.0901	0.0928	0.0901
	(0.0549)	(0.0553)	(0.0551)	(0.0676)	(0.0682)	(0.0678)
I.Res/GDP	-0.173***	-0.174***	-0.179***	0.532	0.725	0.537
	(0.0235)	(0.0236)	(0.0236)	(4.575)	(4.614)	(4.882)
TOT	-0.0346**	-0.0324**	-0.0329**	-0.0341*	-0.0371*	-0.0341*
	(0.0150)	(0.0157)	(0.0149)	(0.0176)	(0.0194)	(0.0180)
Growth X	0.173***	0.175***	0.177***	0.185***	0.184***	0.185***
	(0.0279)	(0.0281)	(0.0278)	(0.0320)	(0.0321)	(0.0321)
Growth M	-0.182***	-0.182***	-0.177***	-0.189***	-0.189***	-0.189***
	(0.0268)	(0.0268)	(0.0267)	(0.0302)	(0.0304)	(0.0312)
Crisis 07		0.0399			-0.0422	
		(0.0869)			(0.117)	
Crisis 08			0.234**			-0.0004
			(0.106)			(0.159)
Constant	-0.539	-0.741	-0.572	-3.135*	-2.847	-3.134
	(1.579)	(1.641)	(1.571)	(1.897)	(2.061)	(1.922)
Hausman test	118.81	120.64	195.61	104.64	274.32	212.13
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Observations	424	424	424	262	262	262
R-squared	0.639	0.639	0.643	0.751	0.751	0.751
Number of countries	16	16	16	10	10	10

Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

These results are consistent with the serious problems of financial integration that are endangering the stability and unity of the European markets. In particular, some EMU countries have violated the Maastricht Treaty criteria, which jeopardizes the future of the euro. We must bear in mind that the annual government deficit- and debt-to-GDP ratio must not exceed 3% and 60% per year, respectively.

Another significant variable for European countries is the growth in the unemployment rate. Hence, an increase in the unemployment rate of 1% increases the

yield spreads of fixed income securities by 12.8%. This result should be no surprise if we bear in mind the real variables and economic problems of some European countries where this variable is one of the main obstacles to coping with the financial crisis.

However, we observe that the effect of this variable is not significant in EMU countries. This result should be interpreted with caution, because these countries have different unemployment ratios. For instance, Spain and Ireland have the highest unemployment ratio, while countries such as Netherlands, Austria and Belgium have the lowest of all the European Union. The large dispersion between such a small group of countries may lead to the unemployment growth becoming a non-significant parameter. For more details, see the descriptive statistics in Table A.1.

As far as the ratio between the International Reserves and GDP is concerned, we found different results in the two groups of countries. As can be seen, this variable has a negative and significant effect. This means that if a country decreases its ratio of international reserves to GDP, it has less economic support to cope with financing and debt problems. As a consequence, the country is more vulnerable to financial turbulences and its premium risk grows. According to our results, an increase in the ratio of international reserves to GDP equal to 1% decreases the sovereign bond spread by 17.3%. However, if we consider only EMU countries this variable is not significant. The main reason for this result is that euro zone economies have as international reserves their own currency. Therefore, the influence of international reserves in other legal currencies is not so explicative for these countries.

Regarding to the external shock variables, the effect of terms of trade (TOT) is similar in all regressions, and both significant and negative. However, the estimated parameter is more significant for European Union than for the EMU countries. Therefore, an

improvement in this variable leads to an increase in export earning and a better repayment capacity, which in turn reduces the yield spreads.

The other variables that capture external shocks are growth of exports and growth of imports. As can be observed, both rates are statistically significant at 1% and their signs are different. Our results are opposite to those of Min (1998). At first glance, they seem a bit confused if they are analyzed separately. However, we focus on how these variables grow and also on their combined effect on the balance of trade.

During stable periods, spreads should be smaller for all countries and the balance of trade is generally worse than during the period of financial turmoil. The main reason for this is that European countries are generally importers: during economic expansion, domestic demand grows and imports increase, while during crises, spreads might rise and the balance of trade improves because imports decrease and exports increase.

According to the results in regressions (1) and (4), if exports increase by 1% spreads increase by 17.3% in European countries and 18.5% in EMU countries. On the other hand, if imports increase by 1%, spreads decrease by 18.2% and 18.9%, respectively.

The analysis for equation (1) and (4), shows that we have included correct explanatory variables which provide good adjustments. For the European countries we obtain a R^2 equal to 63.9% while for the EMU countries we obtain a R^2 equal to 75.1%.

On the basis of these initial equations, we try to capture the effect of the financial crisis on the bond spreads. First, in estimates (2) and (4) we include a dummy variable "Crisis 07", which identifies data from July 2007 to the end of the data sample. Second, in estimates (3) and (6) we include the dummy variable "Crisis 08", which identifies data after September 2008. The main purpose is to analyze how the different periods of current financial crisis affect the European countries.

As can be seen, these dummy variables do not increase the explanatory capacity of the model given that the R^2 remain similar. For European Union countries, the Crisis 07 is not significant and its inclusion does not change the general adjustment. However, the Crisis 08 is statistically significant at 5%, indicating that after September 2008 European countries increased their bond spreads. For the EMU countries, the results show that incorporating both dummy variables does not alter the R^2.

However, 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.

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 regressions are important given that Germany is a traditional benchmark for European countries.

The main conclusion is that sovereign bonds spreads are partly explained by the influence of these groups of variables affected by the financial crisis.

In order to compare some of the specific effects of the impact of the financial crisis, we made a similar analysis of the US benchmark. Table 3 shows the results obtained for the 10-year US benchmark. In general, our results are similar to those of the analysis of the German benchmark, although we should point out several differences.

First, one interesting result is that the significance of some variables is quite different from those of EU and EMU countries. As can be seen, the EMU countries do not show a significant impact of the Stock index, International Reserves/GDP and the growth of unemployment rate, regardless the benchmark.

The growth of the unemployment rate presents large variations between countries, so it is unlikely to be significant in our estimates. Nevertheless, when this variable is

significant the R^2 does not increase. So, there are two models that can explain the determinants of bond spreads depending on whether we consider EU or EMU countries.

Second, the impact of the Crisis 07 is noteworthy in both groups of countries analyzed. In regressions (2) and (5) it is significant at 1% and its coefficients are considerably high to explain the spread movements. The parameters are correctly signed and give a reasonably good explanation of the US benchmark. As we have mentioned above, the financial turmoil started in the US in the summer of 2007, affecting negatively the US financial markets. This may be the reason, then, why this variable is significant for the US spreads and not for the German spreads. This impact increases the explanatory power of the model for the EU and EMU countries. In fact, the R^2 in estimates (2) and (5) are the highest of all the models performed. Therefore, we can conclude that the time period between July 2007 and September 2008 increased the bond spreads with respect to the US benchmark.

Third, the Crisis 08 is not significant in EMU countries. Between Q_3 2007 and Q_4 2008 the spread movements changed in nearly all countries. Not only did the spreads increase in all countries but also the risk level, as a consequence of the start of the financial crisis in the US.

Table 3: Regressions respect United States benchmark

	European Union (EU)			European Monetary Union (EMU)		
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Stock Index	-5.43e-05***	-5.34e-05***	-4.22e-05***	-3.06e-05	-1.07e-05	-2.58e-05
	(1.57e-05)	(1.39e-05)	(1.56e-05)	(1.90e-05)	(1.76e-05)	(2.02e-05)
Pub.Deficit/GDP	0.0976***	0.0857***	0.0891***	0.108***	0.102***	0.106***
	(0.00585)	(0.00531)	(0.00610)	(0.00698)	(0.00647)	(0.00745)
Pub. Debt/GDP	0.111***	0.124***	0.123***	0.138***	0.149***	0.139***
	(0.0153)	(0.0136)	(0.0153)	(0.0178)	(0.0164)	(0.0179)
UnemplGrow	0.175***	0.102*	0.140**	0.163**	0.108	0.161**
	(0.0663)	(0.0591)	(0.0656)	(0.0806)	(0.0743)	(0.0807)
I.Res/GDP	-0.167***	-0.187***	-0.178***	0.696	-3.317	-0.665
	(0.0284)	(0.0253)	(0.0281)	(5.450)	(5.030)	(5.811)
TOT	-0.0958***	-0.0433**	-0.0922***	-0.111***	-0.0500**	-0.108***
	(0.0181)	(0.0168)	(0.0178)	(0.0209)	(0.0211)	(0.0215)
Growth X	0.132***	0.162***	0.139***	0.138***	0.158***	0.138***
	(0.0337)	(0.0300)	(0.0331)	(0.0381)	(0.0350)	(0.0382)
Growth M	-0.189***	-0.182***	-0.178***	-0.190***	-0.175***	-0.183***
	(0.0323)	(0.0286)	(0.0318)	(0.0360)	(0.0331)	(0.0372)
Crisis 07		0.977***			0.877***	
		(0.0930)			(0.127)	
Crisis 08			0.514***			0.129
			(0.126)			(0.189)
Constant	4.813**	-0.133	4.740**	4.002*	-1.984	3.773
	(1.907)	(1.755)	(1.871)	(2.260)	(2.247)	(2.288)
Hausman test	8.01	60.63	58.93	-471.90	185.90	170.16
	(0.4324)	(0.0000)	(0.0000)	(-)	(0.0000)	(0.0000)
Observations	424	424	424	262	262	262
R-squared	0.627	0.708	0.642	0.733	0.777	0.734
Number of countries	16	16	16	10	10	10

Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

6. **Conclusions**

This article focuses on an interesting, current issue, which covers the period prior to the financial crisis, starting in 2004, to the latest data available in Q_3 2011. Its main objective is to identify the determinants of bond spreads by applying a panel data approach with time fixed effects. The empirical analysis is performed on EU and EMU countries relative to US and German benchmarks. Our results show that the determinants of the bond spreads depend on the benchmark and the group of countries. Therefore, the influence of the euro can be seen.

In general, our model shows a good adjustment. However, some interesting differences appear between the German and US spreads. On the one hand, the bond spreads relative to Germany are not significantly affected by the crisis, with the

exception of the dummy Crisis 08 in EU countries. Furthermore, the dummies capturing both periods of crisis do not increase the explanatory capacity of the model.

On the other hand, relative to the US benchmark the dummy Crisis 07 has a notable influence in both groups of countries. Furthermore, the R^2 is the highest of all the estimates. Therefore, there was an important contagion effect because of the movements of the premium risk during this period and the risk-averse behaviour of investors. Similarly, the Crisis 08 is only significant in EU countries; its effect increases the overall fit but by less than the other dummy variable. Hence, the relationship between the crisis and bond spreads is stronger for the US benchmark than the German one.

Another important result of this study is that, regardless of the benchmark, the significant determinants of spreads define two quite different models. In this regard, all the explanatory variables are significant for EU countries, but the Stock Index, International Reserves over GDP and the growth of unemployment rate are non-significant for EMU countries. Five of our explanatory variables significantly affect both groups of countries.

Generally speaking, the adjustments of the estimates are rather high. They all explain at least more than 60% of the bond spreads and in some cases are as high as 77%. Several conclusions can be drawn. First, there is a contagion effect on the rest of the economies. Second, the behaviour of the EMU countries is homogeneous relative to the benchmark during the period analyzed.

Finally, we should mention that this study may help to identify those determinants that affect the bond spreads relative to the benchmark and to understand the specific effect that the crisis has had in both periods. Policy makers should bear in mind that if they can control these factors they may be able to decrease the overall risk in their economies.

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Annex

Table 1: Statistical descriptive

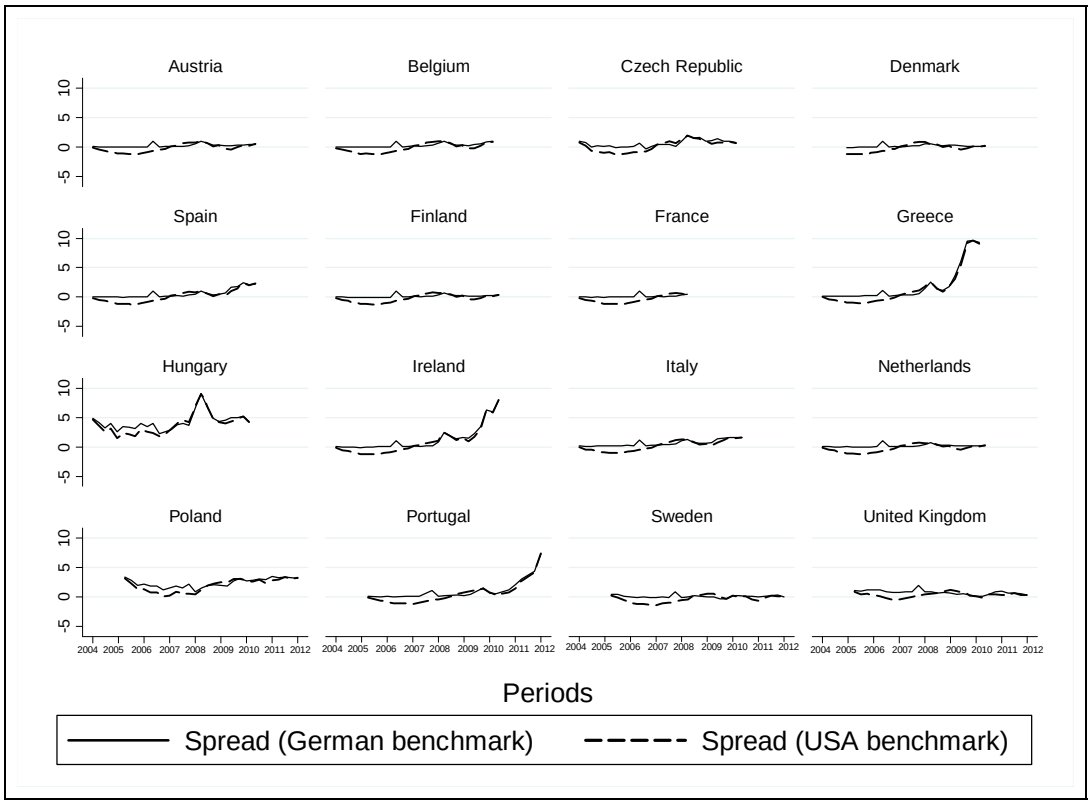
	Mean	Standard deviation	Minimum	Maximum
Spread	0.9444	1.5735	-.3360	9.678
Stock Index	7090.97	8363.31	174.2	43018.82
Pub.Deficit/GDP	62.92	26.64	24.71	165.56
Pub. Debt/GDP	-3.42	4.99	-32.4	5.2
UnemplGrow	0.0635	0.7011	-2.6	3.45
I.Res/GDP	1.1756	4.6090	0.0002	28.9573
TOT	98.14	4.85	77.20	107.40
GrowthX	1.4475	3.4236	-11.257	9.0249
GrowthM	1.4171	3.6825	-10.4122	8.7254

Table A.2: Correlation matrix

	Spread	Stock Index	Pub. Deficit/GDP	Pub. Debt/GDP	UnemplGrow	I.Res/GDP	TOT	GrowthX	GrowthM
Spread	1.0000								
Stock Index	0.2163*	1.0000							
Pub.Deficit/GDP	0.3383*	0.2912*	1.0000						
Pub. Debt/GDP	-0.4333*	-0.0386	-0.4915*	1.0000					
UnemplGrow	0.1958*	-0.0327	0.1017	-0.2493*	1.0000				
I.Res/GDP	-0.0375	-0.0501	-0.0326	-0.1680*	0.0008	1.0000			
TOT	-0.0464	0.0540	-0.0493	0.1399*	-0.0401	0.1313*	1.0000		
GrowthX	0.0646	0.0787	-0.0417	0.1228	-0.2876*	-0.0319	0.0698	1.0000	
GrowthM	-0.1205	0.0843	-0.1208	0.2669*	-0.3813*	-0.0263	0.0385	0.9129 *	1.0000

* Significance level at 1%.

Figure A-1:



Spreads relative to the benchmark (Germany and US). From the first quarter in 2004 until the last quarter in 2011.