DETERMINANTS OF SOVEREIGN BOND YIELD SPREADS IN THE EURO AREA IN THE CONTEXT OF THE ECONOMIC AND FINANCIAL CRISIS*

*Luciana Barbosa***

*Sónia Costa***

1. Introduction

The economic and financial crisis that started in mid-2007 has had an unprecedented impact on the euro area government bond market. Although differing from country to country, sovereign yield spreads to German bonds have been much higher than in the period preceding the start of the third stage of Economic and Monetary Union.

The widening of sovereign bond yield spreads took place against a background of deteriorating public finances in several countries, as well as an increase in risk aversion and a deterioration in liquidity conditions in international financial markets. This suggests the evolution of spreads to Germany reflected both an increase in country credit risk and liquidity premiums and, that the increase in such premiums is a result of the interaction between common factors and idiosyncratic factors. The purpose of this study is to identify such factors' contribution to the different evolution of government bond yields in euro area countries in the current crisis.

According to the results, euro area sovereign spreads observed during the current crisis may be explained by a common factor, interpreted as the risk premium in international financial markets, as well as by idiosyncratic factors related with sovereign credit risk and the liquidity characteristics of domestic government bond markets. There has been a change in the relative importance of each of these factors in explaining the spreads since the beginning of 2007. This situation resulted both from the evolution of spread determining factors and changes in spreads' sensitivity to them. In the period prior to the collapse of Lehman Brothers, euro area sovereign spreads were mainly driven by the international risk premium. With the deepening of the economic and financial crisis, factors specific to each economy increased in relevance. Initially, the increase in spreads was largely due to liquidity premiums. However, as the financial crisis spilled over into a strongly deteriorating macroeconomic environment, there was an increase in the importance of country credit risk factors. In the first five months of 2010, the heterogeneity of sovereign credit risk premiums and a further increase in global risk aversion were major determining factors behind the evolution of spreads.

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** Banco de Portugal, Economics and Research Department.

This paper is organized as follows: Section 2 describes the euro area sovereign determinants and briefly reviews the literature; Section 3 provides a descriptive analysis of the data used; the econometric results are presented in Section 4; and, finally, Section 5 includes the main conclusions.

2. EURO AREA SOVEREIGN BOND YIELD SPREAD DETERMINANTS

In the euro area, given the single monetary policy and the relative integration of national bond markets, long term sovereign yield spreads mainly reflect differences related to issuers' credit risk and the liquidity of securities. The economic literature has, accordingly, attached particular importance to the breakdown of spreads between credit risk and liquidity premiums.

The credit risk premium of a security corresponds to the compensation demanded by investors to cover the risk of future cash flows being different from those agreed, due to default. This premium depends on each issuer's idiosyncratic factors, which determine the level of risk, as well as on the risk premium in the financial markets. This risk premium, in turn, is determined by the degree of investors' risk aversion and by the global uncertainty prevailing in international financial markets. Therefore, in terms of credit risk, sovereign bond yield spreads should be related with each country's public finances sustainability indicators and with risk indicators in international financial markets. In times of lower risk appetite, as in the current economic and financial crisis, the global risk premium tends to increase. This fact, *per se*, contributes to an increase in the yield spreads of countries which the market assesses as having a higher default risk in comparison to lower risk countries. In situations of the deterioration of a country's default risk, the increase in the global risk premium also amplifies the impact of this deterioration on spreads.

Regarding liquidity, the return demanded by investors is expected to be lower for bonds that can be traded quickly, at low cost and without major price changes. Differences in liquidity among national securities may reflect several factors, such as the value of outstanding amounts, the time elapsed since their issue, whether they are eligible for delivery in the futures market, as well as the degree of efficiency in primary and secondary markets in which they are traded. The liquidity premium included in the price of each bond should contain a component associated with the security's expected level of liquidity, and a compensation for unanticipated changes in liquidity (liquidity risk). This last component depend both on factors that specifically affect the future liquidity of the security, as well as on the global liquidity demand conditions prevailing in international markets. In times of increased macroeconomic uncertainty and greater volatility in financial markets, there is a higher likelihood of the need to unwind an investment position quickly. This should increase the demand for assets that can be traded at low cost. In these periods, higher liquidity risk contributes to an increase in liquidity premiums, suggesting the existence of a positive correlation between liquidity and credit risk premiums.

A breakdown of sovereign yield spreads into components determined by credit quality and related to liquidity is not easy to perform empirically, as these characteristics are not directly observable and are not completely independent. Additionally, the relative importance of credit and liquidity risks tends to change over time in line with structural changes in economies, as well as their cyclical position and, consequently, the risk premium in international financial markets.

A robust finding in the literature, regardless of the sample period, is that euro area sovereign yield spreads are largely determined by a common factor. This factor, which is interpreted as the global risk appetite, is usually measured by credit risk premium indicators on corporate bonds and uncertainty in international financial markets. Empirical results also support the relevance of governments' creditworthiness in determining the spreads. This conclusion is relatively independent from the variables used to measure country credit risk, namely variables related with public finances, credit ratings or information from financial markets, such as Credit Default Swaps (CDS).[1] In the case of liquidity, the evidence is mixed. Bernoth *et al.* (2006) and Schuknecht *et al.* (2010) conclude that liquidity is not a significant determinant of sovereign yield spreads in euro area countries. Codogno *et al.* (2003) and Sgherri and Zoli (2009) also indicate a very limited effect of liquidity. In turn, Gómez-Puig (2006), Beber *et al.* (2009), Schwartz (2009), Ejsing and Sihvonen (2009), Attinasi *et al.* (2009), Barrios *et al.* (2009), Haugh *et al.* (2009) and Gerlach *et al.* (2010) find liquidity effects, which in some cases are quantitatively limited and only relevant for some countries. In most of these papers, liquidity is measured by indicators based on transaction costs (bid/ask spreads), trading volumes or bonds' outstanding amounts. Schwartz (2009) uses a different liquidity measure, which consists of the yield spread between bonds issued by KFW and German government bonds, and obtains a higher liquidity impact on euro area sovereign spreads than usually found in the literature.[2] According to Schwartz (2009), this indicator captures the pricing of liquidity risk, *i.e.* the compensation that investors demand for the possibility that market liquidity will worsen in the future.

The literature on euro area sovereign spreads has also focused on the identification of changes in the relative importance of the determining factors over time. For the current economic and financial crisis, most of the empirical evidence suggests an increase in the importance of domestic factors, namely country credit risk and, to a lesser extent, liquidity factors (e.g. Barrios *et al.* (2009), Ejsing and Sihvonen (2009) and Mody (2009)). The results found by Mody (2009) suggest that, at the beginning of financial market turmoil, *i.e.* in the second half of 2007 and early 2008, spreads were largely determined by common factors. During this period, the increases in international risk aversion lead to flight-to-quality movements to German bonds. After the problems experienced by Bear Stearns in mid March 2008, the different degrees of vulnerability of national financial sectors contributed to a differentiation in yield spreads in euro area countries. The impact of financial sector risk on sovereign risk increased in the period following the collapse of Lehman Brothers. The results of Ejsing and Lemke (2009), Attinasi *et al.* (2009) and Gerlach *et al.* (2010) suggest that the vulnerabilities of national banking sectors and governments' rescue packages contributed to a risk transfer from the financial to the public sector. After September 2008, country credit risk, in particular when evaluated by public finance indicators, appears to have been a major underlying factor behind changes in the yield spreads of euro area countries (Mody (2009), Sgherri and Zoli (2009), Barrios *et al.* (2009) and Schuknecht *et al.* (2010)). According to Caceres *et al.* (2010), in this period the risk of contagion among euro area countries was also a relevant factor in determining the spreads.

(1) A *Credit Default Swap* is a financial derivative that allows investors to hedge credit risk, *i.e.* protect themselves against the possibility of a debt default.

(2) KFW is a banking group owned by the German State that aims to promote economic, social and ecological development. KFW's bonds are explicitly guaranteed by the German government and have several characteristics similar to German sovereign bonds, particularly in terms of taxes, issuance policy and investors base. In this context, KFW's yield spread against German government bonds should essentially reflect a liquidity premium.

3. DESCRIPTION AND ANALYSIS OF THE DATA

The first part of this section presents the data used in this study and discusses the potential problems related with their interpretation. In the second part a brief analysis of data is carried out as an introduction to the econometric analysis of the following section.

3.1. Data Description

In line with the previous section, the variables included in the model for euro area sovereign spreads aim to capture the price of risk in international financial markets, sovereign credit risk premiums and liquidity premiums.

The countries under analysis are the first twelve countries joining the euro area, with the exception of Luxembourg. The sample period runs from January 2007 to the end of 2009 or mid May 2010, depending on the variables included in the specifications. This period includes a similar number of observations before and after the collapse of Lehman Brothers, which helps the analysis of possible changes in the model determining sovereign spreads given the current economic and financial crisis. The variables for each country are defined in differences against Germany. The option of using Germany as the reference country is justified by the fact that German government bonds have reinforced their safe heaven and benchmark status during the current crisis, as a consequence of their relatively high credit quality and liquidity.[3]

The yields on government bonds were calculated using the data from the MTS electronic trading platforms for securities with a residual maturity of around 5 and 10 years.[4]

Two types of alternative variables were used to measure country risk premiums: sovereign CDS premiums and macroeconomic variables. The interpretation of CDS premiums defined against Germany as measures of country credit risk premiums, which is usual in the literature, should be undertaken with caution in the current context. Changes in liquidity conditions in financial markets may impact on CDS premiums thus leading to possible under/over estimates of sovereign risk premiums.[5] Additionally, movements in sovereign CDS premiums may not only reflect changes in the assessment of the credit quality of the underlying country, but may also reflect changes in global risk perception prevailing in financial markets.[6] Regarding macroeconomic indicators, we computed monthly series for variables related to public finances and the external position of each country, based on forecasts released by the European Commission, IMF and OECD. These series aim to reflect the one-year-ahead forecast at any point of time and correspond to a weighted average of the most recent forecasts, for the current year and the following year, provided by the three institutions. The use of these indicators instead of observed data appears to be more suitable for explaining

(3) One factor often mentioned as a determinant for the higher liquidity of German bonds is the existence of a highly efficient and liquid derivatives market on these securities (EUREX stock exchange), which is not the case for government bonds of other euro area countries. The results found by Ejsing and Sihvonen (2009) confirm the importance of this factor and suggest that its impact on sovereign spreads has increased over the current crisis.

(4) The methodology used for the construction of all indicators obtained from the MTS database is described in Barbosa and Costa (2010).

(5) See Buhler and Trapp (2009) and Alexopoulou *et al.* (2009).

(6) According to the results of Alexopoulou *et al.* (2009), based on data up to October 2008, the common risk factors have greatly increased their contribution to the CDS premiums of European firms during the current crisis.

sovereign yield spreads in the current crisis, a period which has been characterized by frequent reassessments of country credit risk.

Bond liquidity premiums are relatively difficult to evaluate empirically. On the one hand, there is no consensual measure for liquidity in the literature. Empirical applications for gauging liquidity focus on several alternative indicators, related, for instance, with transaction costs, speed of transactions, trading volumes or market depth, which aim to capture its different dimensions. Obtaining representative data on the liquidity of government bonds is also hindered by the fact that these securities are traded in several markets, including non-organized markets for which no data are available. In the particular case of euro area government bonds, many studies construct liquidity measures from the MTS database, given the high weight of these platforms in the secondary market trading of European government bonds. In this study, we have used several alternative measures to assess liquidity premiums.

Based on data from the MTS platforms for the period 2007-2009, we obtained several liquidity indicators, expressed in relation to Germany. These included measures of transaction costs (*bid/ask spread* - *ba*), volumes available for trade (average volume of proposals posted at the best bid and ask prices – *depth*; and maximum volume of proposals for the best three prices - *max*), transactions (trading volume – *vol*; and number of transactions - *trs*), as well as the ratio between transaction costs and the volume available for trade (*adepth*).[7] These variables have the advantage of representing direct measures for the liquidity of the securities under analysis. However, they also have the disadvantage of being highly dependent on the representativeness of MTS platforms in the overall market. This situation is particularly relevant in the crisis period, when unorganized over-the-counter markets have increased their importance *vis-à-vis* electronic platforms.[8] During this period there have also been several regulatory changes which may have contributed to a reduction of the MTS market share in several countries.[9]

In order to overcome the distortions associated with changes in market structure, the liquidity premiums were also assessed using measures not related with a specific market infrastructure (indirect liquidity measures). Given that information and transaction costs may decline with the dimension of the market, the relative size of each country's government bond market was used as a liquidity premium proxy. This indicator was based on the outstanding amounts of long term euro-denominated debt securities issued by euro area central governments, published by the ECB. Additionally, as a proxy for the price of liquidity risk, *i.e.* the risk that liquidity may deteriorate in the future, we calculated the yield spreads between the 5 and 10 years bonds issued by KFW and German bonds with similar maturities, in line with the approach adopted by Schwartz (2009).

Finally, the risk premium in international financial markets was assessed by the first principal component of a set of variables, for the euro area and the United States, usually found in the literature as

(7) Details on the construction of liquidity measures are presented in Barbosa and Costa (2010).

(8) The greater difficulty in performing transactions on large amounts on the electronic platforms without greatly affecting the prices appears to have contributed for this change.

(9) Since 2008, several euro area countries have been allowing primary dealers to fulfil their quote obligations on electronic platforms other than MTS.

measures of risk premiums in corporate bond markets and uncertainty in financial markets. The input variables were BBB corporate bond spreads, several CDS indices for financial and non-financial sectors and stock and bond markets implied volatilities.[10]

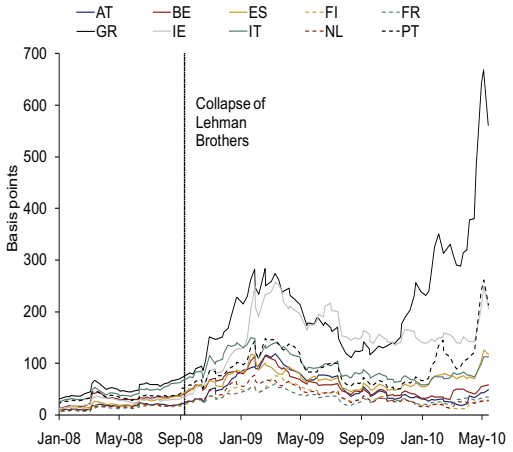
3.2. Analysis of the evolution of spreads and explanatory variables

Throughout the current crisis, there have been substantial changes in the path of sovereign bond spreads in euro area countries. In the months following the collapse of Lehman Brothers, there was a significant widening of sovereign spreads (Chart 1). Between the second quarter of 2009 and early summer, spreads moved generally downwards. Since October 2009, the disclosure of a significant deterioration in Greece's public finances generated substantial concerns over their sustainability, which spilled over to other euro area countries with weaker macroeconomic positions. In Greece, Portugal and, to a lesser extent, Ireland, Spain and Italy, spreads were significantly up in first half 2010. Although there was also an increase in other countries' spreads, they did not exceed the levels recorded in the months following the bankruptcy of Lehman Brothers.

The principal components of spreads and their determinants were calculated for the purpose of evaluating the relevance of common factors to the path of these variables. The first principal components of the yield spreads, of the differences with Germany in CDS premiums and in bid/ask spreads explain, at least, about 75 percent of the respective variances in the period 2007 to 2009.[11] The major importance of the first principal components suggests that the evolution of sovereign risk and liquidity premiums may, to a large extent, be determined by a single common factor. Indeed, in the sample pe-

Chart 1

10 YEAR EURO AREA GOVERNMENT BOND YIELD SPREADS TO GERMANY



Source: Thomson Reuters.

(10) The option to compute the principal components derived from the fact that there is a certain variability in the estimation results obtained from the individual variables. The first principal component explains about 85 percent of the variance of these variables.

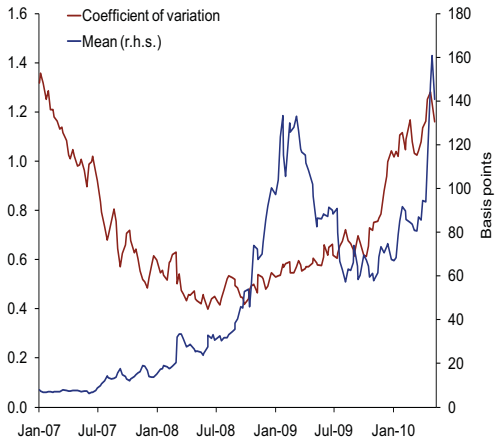
(11) In the case of the MTS liquidity variables referring to quantities, the first principal components explain lower proportions, pointing to the greater importance of idiosyncratic factors. This may be explained by a higher sensitivity of quantities to changes in market structure or to different market making rules in the domestic MTS platforms.

riod, the first principal components of yield spreads, of CDS premiums and of bid/ask spreads defined against Germany are highly correlated either between each other or with the international financial markets global risk indicator or even with the KFW indicator, designed to capture liquidity risk.

In the period under review, there appears to have been a change in the relevance of common factors explaining the spreads. To illustrate the evolution of the dispersion of country spreads, Chart 2 presents the yield spreads coefficient of variation. In the period before the current crisis, this coefficient tended to move downwards, which is in line with the idea that the high liquidity prevailing in international financial markets contributed to a lower level of risk differentiation. The fact that this downward trend continued through the first two months of 2008 suggests that, at the beginning of the crisis, the increase in global risk aversion led to a flight to the government bond markets in general.[12] Between the liquidity problems with the Bear Stearns investment bank, in mid March, and until September 2008, German bonds appear to have benefited from flight-to-quality movements, but there is no evidence of significant differentiation among bonds of other euro area countries. The increase in spreads observed in this period should, accordingly, have mainly been determined by the reduction in risk appetite in financial markets. The coefficient of variation increased, however, from late 2008 and, more markedly so, from late October 2009, which suggests an increase in the importance of idiosyncratic factors. The increased relevance of these factors took place in a context of the deteriorating outlook for public finances, initially due to the support measures for the financial system and economic stimulus plans, and later to the economic recession of 2009. These developments suggest that, at least, part of the idiosyncratic spreads movements were associated with a deterioration in credit quality in several countries. Indeed, the largest increases in spreads since the onset of the

Chart 2

MEAN AND DISPERSION OF 10 YEAR EURO AREA GOVERNMENT BOND YIELD SPREADS TO GERMANY



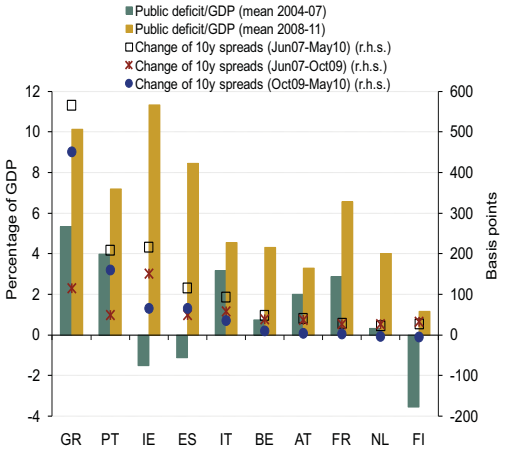
Source: Thomson Reuters.

(12) There was an increase in trading volumers on MTS platforms in this period.

financial crisis, and especially since late 2009, occurred in countries with an adverse macroeconomic situation at the onset of the crisis and/or where it has deteriorated significantly afterwards (Chart 3 and Chart 4).

Chart 3

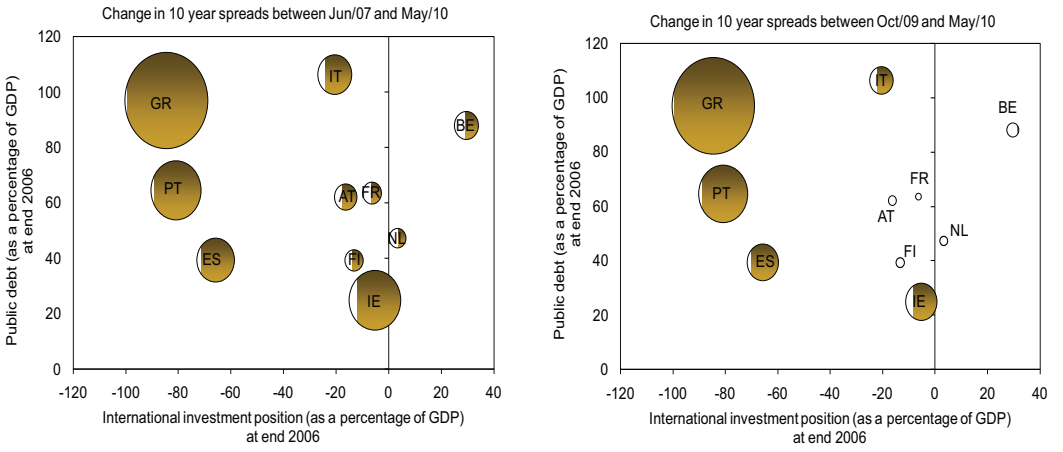
PUBLIC DEFICIT AND EURO AREA GOVERNMENT BOND YIELD SPREADS



Sources: European Commission and Thomson Reuters.

Chart 4

MACROECONOMIC IMBALANCES AND SPREADS EVOLUTION[a]



Sources: ECB, European Commission and Thomson Reuters.
Note: (a) Circle area = Change in 10 year government bond spread (unfilled circles correspond to negative values).

4. ECONOMETRIC RESULTS

The first part of this section presents the estimated results for euro area sovereign bond spreads, when credit risk premiums are measured by the sovereign CDS spreads. Although the data are available daily, the volatility of the series in several periods justifies the use of weekly averages. In the second part of the section, we present specifications in which credit risk is measured by macroeconomic variables, using monthly data. In both approaches, the liquidity premium and risk premium in international financial markets are evaluated using the variables outlined in the previous section. The estimates were performed for the period 2007-2009. In the last part of this section, the specification for the monthly spreads has been re-estimated for a longer period, including data up to mid May 2010.

Both equations were estimated using a panel data approach (unbalanced panel). This solution appears to be more appropriate to the small size of the sampling period, particularly in the specifications based on monthly data. The characteristics of the data raise several econometric problems. In addition to heterogeneity across countries (a typical problem in cross section), the temporal dimension of the data and the (spatial) correlation between countries must be taken into account, particularly given the single monetary policy. The econometric method applied is the Pooled OLS, in which the variance and covariance matrix of the residuals is obtained on the basis of the Driscoll and Kraay (1998) approach. This method makes it possible to correct heteroscedasticity and simultaneously to obtain robust residuals for temporal and country correlations.[13,14]

4.1. Credit risk premium measured by CDS

Equation (1) corresponds to the specification for the sovereign bond yield spreads of ten euro area countries against Germany, for the period 2007-09, with data based on weekly averages.

$$spread_{i,t}^{m} = c + \beta_1 cds_{i,t}^{m} + \beta_2 liq_{i,t}^{m} + \beta_3 pr_t + \beta_4 lb + \beta_5 C_i + \beta_6 mat_{i,t}^{m} + \beta_7 Dm + u_{i,t}^{m} \qquad (1)$$

In this equation, i and t represent the country and the time period, respectively, while m corresponds to the bonds' residual maturity (5 and 10 years). The variables $spread$, cds and liq are, respectively, the sovereign bond yield, the CDS premium and the liquidity indicator, all defined relative to Germany. The six MTS liquidity indicators are included alternatively in the specification. The variable pr is a proxy for the risk premium in international financial markets. lb corresponds to a dummy that takes value 1 in the period following the collapse of Lehman Brothers. C represents the country dummies, which make it possible to take into account the differences in the average spread for each country, which are not justified by the remaining variables. mat represents the difference between the aver-

(13) The estimates were made in the STATA econometric programme, applying the command xtcss - Regression with Driscoll-Kraay standard errors.

(14) Given the temporal dimension of data, the impact of persistence in spreads was evaluated with the estimation of regressions that include among the explanatory variables the lag of spreads (applying FGLS estimation methods for panel data, correcting heteroskedasticity and autocorrelation of residuals). In these specifications, although the lagged term is significant, the conclusions concerning the impact of sovereign credit risk, liquidity risk and global risk remained broadly unchanged.

age residual maturity of the bonds of country i and German bonds.[15] Finally, the dummy *Dm* has the value 1 for bonds with a residual maturity of 10 years.

The first six columns of Table 1 present the estimated results of equation (1). The fact that the coefficients of CDS spreads and financial markets risk premium indicator are statistically significant and positive suggests the importance of credit risk and risk aversion in international financial markets in determining sovereign yield spreads. In the case of liquidity indicators, there is no statistical evidence of their relevance in determining the spreads. However, liquidity seems to play a role for bonds with a residual maturity of 5 years.[16]

Given the relevance of the common component in the path of CDS premiums identified in the previous section, it is important to assess to what extent the significance of cds does not stem solely from this component. The previous specifications have therefore been re-estimated replacing the CDS spreads by the residuals obtained in auxiliary regressions performed for each country, in which the endogenous variable is the CDS spread and the explanatory variables are a constant term and the first principal component of the CDS spreads. According to the results, CDS residuals are statistically significant, which confirms the relevance of idiosyncratic factors related with credit risk for the determination of sovereign bond yield spreads.[17] In general terms, there is an increase in liquidity indicator coefficients, which have the expected signs and are in some cases statistically significant. The global risk factor coefficient has also increased and remains significant. These developments are in line with the positive correlations between the common component of CDS spreads, the common component of liquidity indicators and the risk premium in financial markets indicator. The interaction between sovereign credit risk premiums, liquidity premiums and global risk is further corroborated by the results of regressions that include, as an alternative to the MTS variables, the indicator of liquidity risk *kfw*.[18]

To identify possible changes in the relation between the sovereign spreads and the respective determinants arising from the crisis, equation (1) was re-estimated to include the interaction terms between the dummy *lb* and the variables related with global risk, sovereign credit risk and liquidity. The results, which are presented in the last six columns of Table 1, confirm the relevance of global risk aversion for the determination of spreads and suggest its impact has not changed with the deepening of the crisis, after the collapse of the Lehman Brothers. For liquidity premium, the results are not conclusive. With regard to sovereign credit risk, the results suggest an increase in its contribution with the deepening of the crisis. In the regressions with the CDS residuals, the fact that only the interaction term is significant suggests that prior to the collapse of Lehman Brothers spreads were not significantly determined by idiosyncratic credit risk factors.

(15) This variable aims to control the effects arising from the fact that the yields for each maturity were based on bonds with differences in their residual maturity (albeit within a limited range), and from the fact that there are changes in the bonds used throughout the series. The alternative of having estimated yields with constant maturity would not have been a better solution given that, for some periods, there are many days with missing observations and the data is highly volatile.

(16) For simplicity, this article only presents the results obtained for both maturities simultaneously. The results for each maturity are presented in Barbosa and Costa (2010).

(17) The results of these regressions are presented in Barbosa and Costa (2010).

(18) As can be seen in Barbosa and Costa (2010), in these specifications the global risk indicator loses statistical significance, and the t-ratio of *kfw* increases when the CDS are replaced by the CDS residuals.

Table 1

RESULTS OF SPREADS ESTIMATION IN THE PERIOD 2007-2009
Credit risk measured by CDS

	All bonds						All bonds - regressions with interaction terms					
	(1)	(2)	(3)	(4)	(5)	(6)	(1)	(2)	(3)	(4)	(5)	(6)
cds	0.854***	0.851***	0.848***	0.851***	0.873***	0.872***	0.330**	0.320**	0.316**	0.323**	0.290*	0.314**
	(24.64)	(24.09)	(23.45)	(24.58)	(28.41)	(28.35)	(2.39)	(2.27)	(2.13)	(2.34)	(1.86)	(2.09)
cds_lb							0.511***	0.522***	0.516***	0.514***	0.566***	0.538***
							(3.95)	(4.03)	(3.92)	(3.95)	(3.89)	(3.87)
pr	0.031***	0.031***	0.031***	0.031***	0.031***	0.031***	0.031***	0.037***	0.037***	0.032***	0.038***	0.036***
	(4.21)	(4.18)	(4.21)	(4.15)	(4.13)	(4.12)	(5.20)	(6.11)	(5.70)	(5.68)	(5.64)	(5.65)
pr_lb							0.010	0.005	0.004	0.009	0.008	0.010
							(0.99)	(0.42)	(0.31)	(0.86)	(0.83)	(1.03)
ba	-0.005						0.163					
	(-1.01)						(1.66)					
ba_lb							-0.169*					
							(-1.72)					
depth		-1.612						-2.275***				
		(-1.63)						(-3.23)				
depth_lb								2.667				
								(0.69)				
max			-0.641						-0.459			
			(-1.37)						(-0.96)			
max_lb									-0.187			
									(-0.16)			
adepth				0.0000528						0.002		
				(0.40)						(1.70)		
adepth_lb										-0.002		
										(-1.69)		
trs					-0.001						-0.00003	
					(-1.28)						(-0.06)	
trs_lb											-0.00565**	
											(-2.39)	
vol						-0.176						-0.062
						(-1.56)						(-0.93)
vol_lb												-0.421
												(-1.54)
mat	0.087***	0.088***	0.087***	0.087***	0.074***	0.074***	0.082***	0.084***	0.083***	0.082***	0.067***	0.066***
	(5.41)	(5.49)	(5.42)	(5.35)	(3.82)	(3.83)	(5.77)	(5.87)	(5.72)	(5.70)	(3.95)	(3.90)
Dmat	0.086***	0.084***	0.080***	0.085***	0.094***	0.094***	0.093***	0.091***	0.090***	0.093***	0.107***	0.106***
	(6.43)	(6.06)	(4.99)	(6.35)	(6.97)	(7.01)	(6.83)	(6.99)	(5.71)	(6.83)	(8.00)	(7.99)
lb	0.085**	0.091***	0.090***	0.085**	0.087**	0.088**	0.021	0.008	0.008	0.017	0.006	0.004
	(2.87)	(3.13)	(3.00)	(2.88)	(2.70)	(2.72)	(0.74)	(0.30)	(0.27)	(0.62)	(0.26)	(0.17)
constant	0.032	0.021	0.026	0.031	0.058	0.059	0.082*	0.089**	0.099**	0.086*	0.129***	0.129***
	(1.28)	(0.83)	(1.01)	(1.23)	(2.05)	(2.09)	(2.58)	(2.97)	(3.28)	(2.77)	(4.00)	(4.01)
Country dummy	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
N	3066	3066	3066	3066	2479	2479	3066	3066	3066	3066	2479	2479
R-sq	0.902	0.902	0.902	0.902	0.911	0.911	0.910	0.910	0.909	0.909	0.921	0.920

Sources: European Commission, IMF, MTS, OECD and authors' calculations.

Notes: The table presents the estimated coefficients and the respective significance levels (*** 1%, ** 5% and * 10%). The t-statistics are presented in brackets. *cds* represents the CDS spread; *pr* corresponds to the risk premium in international financial markets; *lb* is a dummy for the period after the collapse of Lehman Brothers; *mat* corresponds to a maturity variable; *Dmat* has the value 1 for bonds with 10 year residual maturity; *ba, depth, max, adepth, trs* and *vol* correspond to liquidity indicators based on MTS data. The interaction terms between *lb* dummy and the other variables are identified by *_lb* at the end of the variable name. The variables for each country are defined in differences against Germany.

In short, the above analysis suggests that an increase in the global risk premium in financial markets has a positive and significant impact on euro area government bond yield spreads, contributing apparently to increases in credit and liquidity risk premiums. These premia also seem to have been conditioned by factors specific to each economy. With the deepening of the financial crisis, after mid-September 2008, the positive impact of CDS on yield spreads increased, which stems apparently from the greater relevance of country credit risk.

4.2. Credit risk premium measured by macroeconomic variables

4.2.1. Data up to end 2009

In this subsection sovereign credit risk is measured by macroeconomic variables instead of CDS spreads. Macroeconomic data are not affected by changes in liquidity conditions or by changes in the risk premium in financial markets. This approach therefore enables us to evaluate the robustness of the importance of country credit risk, as measured by CDS spreads, found in previous specifications.

The path of credit risk premiums in euro area countries is likely to have reflected not only developments in economies over time, but also the baseline position concerning macroeconomic imbalances. Therefore, in addition to macroeconomic forecasts, explanatory variables also include the international investment position and public debt, as a percentage of GDP, at the end of 2006, *i.e.* in the period preceding the beginning of the sample.

In this context, we tested several specifications. We found evidence that the initial macroeconomic situation of each economy is relevant in determining the average level of spreads. We also noted that changes in spreads over time are related to the outlook for the public finances. Table 2 displays the results of the estimation of equation (2).

$$spread_{i,t}^{m} = c + \beta_1 so_{i,t} + \beta_2 iip_i^{06} + \beta_3 div_i^{06} + \beta_4 share_i^{06} + \beta_5 liq_{i,t}^{m} + \beta_6 pr_t + \beta_7 lb + \beta_8 Dm + u_{i,t}^{m} \quad (2)$$

In addition to the previously defined variables, $so_{i,t}$ corresponds to the forecast in t (for the one-year-ahead period) of the fiscal balance, as a percentage of GDP, for country i against Germany. div_i^{06} and iip_i^{06} respectively represent the differentials with Germany in the public debt and international investment position of country i at the end of 2006 (both as a percentage of GDP). Finally, $share_i^{06}$ represents the relative size of the public debt market in country i in late 2006, defined in comparison to Germany.

The fact that the coefficient of fiscal balance is negative and statistically significant indicates that a deterioration in the outlook for the fiscal balance in comparison to Germany leads to an increase in the spread. The public debt and international investment position coefficients are also significant, suggesting that the differences between the average levels of spreads in the various countries are related to macroeconomic imbalances. Countries which, in late 2006, already had higher public debt ratios or poorer international investment positions should have noted, only taking these effects into account, an average level of spreads higher than countries with a more favourable macroeconomic

Table 2

RESULTS OF SPREADS ESTIMATION IN THE PERIOD 2007-2009
Credit risk measured by macroeconomic variables

	All bonds						All bonds - regressions with interaction terms					
	(1)	(2)	(3)	(4)	(5)	(6)	(1)	(2)	(3)	(4)	(5)	(6)
so	-0.048***	-0.052***	-0.051***	-0.037**	-0.055***	-0.055***	-0.002	-0.004	-0.003	-0.002	-0.003	-0.003
	(-3.36)	(-4.38)	(-4.03)	(-2.84)	(-3.88)	(-3.92)	(-1.17)	(-1.71)	(-1.38)	(-1.20)	(-1.42)	(-1.56)
so_lb							-0.095***	-0.072***	-0.082***	-0.081***	-0.102***	-0.103***
							(-7.70)	(-6.62)	(-7.41)	(-6.36)	(-8.69)	(-8.88)
div_06	0.004***	0.004***	0.005***	0.004***	0.004**	0.004**	0.002***	0.002***	0.002***	0.002***	0.002***	0.002***
	(3.02)	(3.04)	(3.31)	(3.17)	(2.79)	(2.71)	(7.25)	(7.41)	(5.73)	(7.58)	(6.69)	(6.58)
div06_lb							0.008***	0.008***	0.008***	0.008***	0.009***	0.008***
							(6.72)	(6.18)	(6.35)	(6.05)	(6.26)	(5.60)
iip_06	-0.002***	-0.002***	-0.002***	-0.002***	-0.002***	-0.002**	-0.001***	-0.001***	-0.001***	-0.001***	-0.001***	-0.001***
	(-3.82)	(-3.62)	(-4.08)	(-3.67)	(-3.63)	(-3.51)	(-7.66)	(-7.58)	(-7.28)	(-7.53)	(-7.11)	(-7.05)
iip06_lb							-0.002**	-0.002**	-0.001*	-0.002**	-0.002**	-0.002**
							(-2.43)	(-2.38)	(-1.76)	(-2.40)	(-2.39)	(-2.37)
pr	0.058***	0.071***	0.070***	0.052**	0.071***	0.074***	0.045***	0.052***	0.053***	0.045***	0.052***	0.052***
	(3.53)	(4.19)	(4.51)	(3.43)	(4.21)	(4.16)	(6.76)	(8.53)	(8.47)	(6.59)	(8.94)	(8.73)
pr_lb							0.045	0.043	0.031	0.034	0.051	0.059*
							(1.44)	(1.48)	(1.03)	(1.12)	(1.72)	(1.97)
share_06	-0.011**	-0.014**	-0.013**	-0.010**	-0.012***	-0.013***	-0.002***	-0.002***	-0.002***	-0.002***	-0.002***	-0.002***
	(-2.87)	(-3.16)	(-3.14)	(-2.89)	(-3.03)	(-3.18)	(-4.14)	(-4.28)	(-4.40)	(-4.38)	(-4.37)	(-4.81)
share_06_lb							-0.024***	-0.027***	-0.024***	-0.021***	-0.026***	-0.027***
							(-4.76)	(-5.73)	(-4.88)	(-4.74)	(-5.51)	(-4.97)
ba	0.239***						0.235**					
	(6.30)						(2.43)					
ba_lb							-0.073					
							(-0.67)					
depth		-13.300**						-0.815				
		(-2.28)						(-1.06)				
depth_lb								-59.190***				
								(-3.96)				
max			-5.048**						-0.206			
			(-2.84)						(-0.37)			
max_lb									-12.550**			
									(-3.85)			
adepth				0.006***						0.004**		
				(10.12)						(2.81)		
adepth_lb										0.001		
										(0.38)		
vol					-0.598						-0.191	
					(-1.72)						(-1.46)	
vol_lb											-1.371*	
											(-2.02)	
trs						0.001						-0.000341
						(1.10)						(-0.52)
trs_lb												0.005
												(0.89)
Dmat	0.097***	0.104***	0.069**	0.089***	0.129***	0.122***	0.101***	0.136***	0.116***	0.095***	0.131***	0.123***
	(4.04)	(4.02)	(2.63)	(3.48)	(5.34)	(5.48)	(4.37)	(4.23)	(3.93)	(3.81)	(5.42)	(5.70)
lb	0.247***	0.309***	0.289***	0.242***	0.259***	0.254***	-0.232**	-0.228**	-0.104	-0.210*	-0.248**	-0.310**
	(4.40)	(5.63)	(5.83)	(5.01)	(3.73)	(3.51)	(-2.19)	(-2.39)	(-1.12)	(-2.06)	(-2.31)	(-2.45)
constant	-0.029	-0.082	-0.010	-0.032	-0.015	-0.036	0.105***	0.105***	0.119***	0.107***	0.118***	0.117***
	(-0.49)	(-0.89)	(-0.14)	(-0.57)	(-0.23)	(-0.52)	(4.83)	(4.42)	(4.76)	(4.62)	(6.06)	(6.11)
N	710	710	710	710	696	696	710	710	710	710	696	696
R-sq	0.665	0.662	0.665	0.707	0.652	0.650	0.762	0.794	0.775	0.786	0.769	0.767

Sources: ECB, European Commission, IMF, MTS, OECD and authors' calculations.

Notes: The table presents the estimated coefficients and the respective significance levels (*** 1%, ** 5% and * 10%). The t-statistics are presented in brackets. *so* corresponds to the fiscal balance forecast; *div_06* corresponds to the public debt at end 2006; *iip_06* corresponds to the international investment position at end 2006; *pr* represents the monthly average of the risk premium in the international financial markets; *share_06* represents the relative size of the public debt market at end 2006; *ba, depth, max, adepth, vol* and *trs* correspond to the monthly average of the liquidity indicators based on MTS data; *Dmat* has the value 1 for bonds with 10 year residual maturity; *lb* is a dummy for the period after the collapse of Lehman Brothers; The interaction terms between *lb* dummy and the other variables are identified by *_lb* at the end of the variable name. The variables for each country are defined in differences against Germany.

position. In the case of liquidity indicators, the results suggest that the size of the long term government bond market has a favourable impact on the average level of spreads.[19] For the MTS variables, the indicators based on quotes data (*ba, depth, max* and *adepth*) are generally significant and have the expected signals. The fact that the indicators associated with transactions (*vol* and *trs*) are not significant may possibly be due to the fact that, in months with a low level of trading activity, the monthly averages do not correctly reflect market liquidity. The risk premium in financial markets coefficient remains positive and statistically significant.

In line with the approach for weekly data, Table 2 also presents the results of equation (2) when the cross-terms with the dummy *lb* are included. These results confirm the sharper impact of the macroeconomic situation in the period following the bankruptcy of Lehman Brothers. The results even suggest that the outlook for fiscal balances only began to affect yield spreads with the deepening of the crisis. With regard to liquidity, when measured by $share_i^{06}$, there is evidence of an increased effect. The conclusions based on MTS variables are still not clear. The interaction term for the risk premium in financial markets suggests that in the period of deepening of the crisis there were no significant changes in the way in which risk aversion in financial markets affected spreads.

Chart 5 compares the levels of observed spreads with those estimated for the period before and after the bankruptcy of Lehman Brothers. It also provides a breakdown of estimated spreads by their determinants. The estimated figures capture relatively well the levels of spreads, both in the period prior to and after the collapse of Lehman Brothers.[20] With regard to the breakdown of spreads, the results illustrate the reduction of the relative importance of the global risk factor during the economic and financial crisis. Although in absolute terms this variable's contribution to the level of spreads has increased from about 15 bp to about 35 bp, in relative terms it declined, on average, from around 70 per cent to around 50 per cent. The contributions made by credit risk and liquidity premiums increased both in absolute terms in the period following the bankruptcy of Lehman Brothers. In most countries the liquidity premium increased in comparison to credit risk premium.

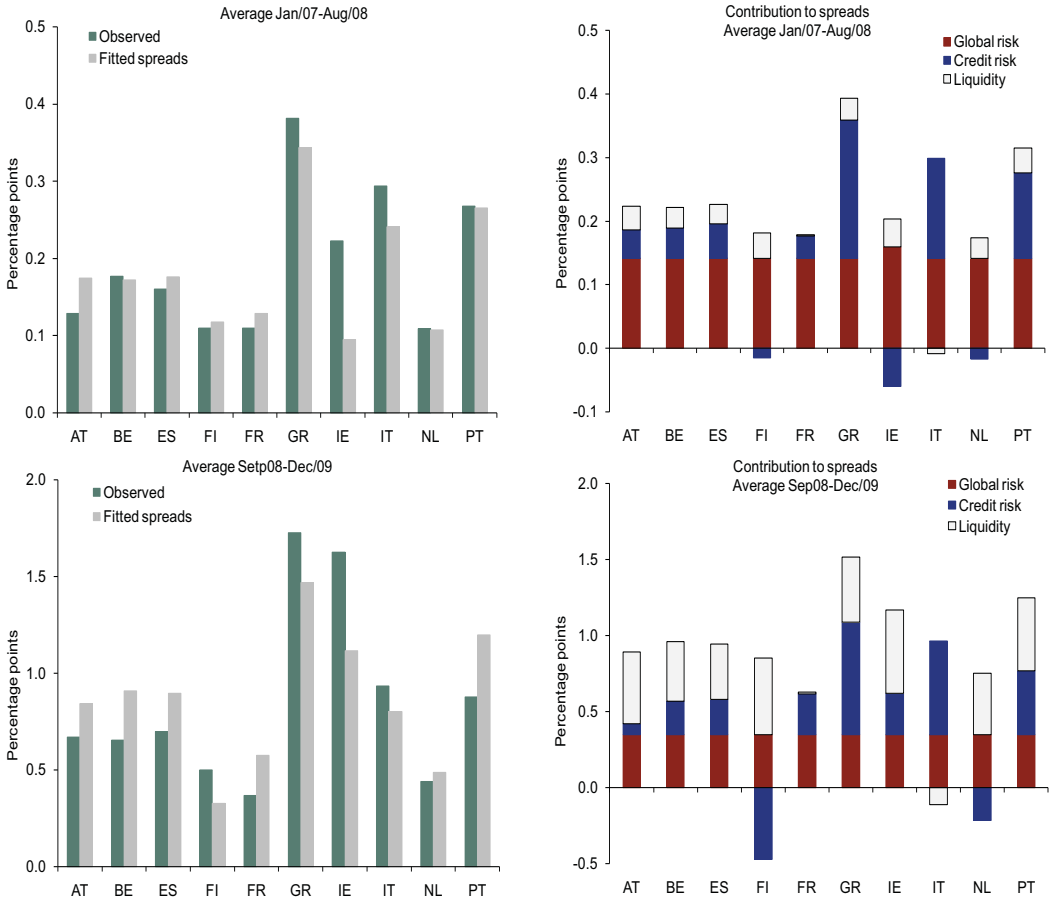
Chart 6 provides a breakdown of changes in spreads for different periods. Between January 2007 and August 2008, the increase in spreads was determined by increased risk aversion in financial markets. In the months following the bankruptcy of Lehman Brothers, the risk premium in financial markets continued to contribute to a widening of spreads, although it was no longer the main factor behind changes in spreads. In that period, most countries witnessed a significant increase in the liquidity premium and, to a lesser extent, in the credit risk premium. The narrowing of spreads recorded between March and September 2008 reflected a reduction in the risk premium in international financial markets, as well as slight reductions in liquidity premiums. These developments were, however, partially offset by an increase in sovereign risk premiums in most countries. In the last quarter of 2009, country credit risk explained the increases in spreads.

(19) The variable corresponding to the evolution over time of each country's share of the euro area long term government bond market (defined relative to Germany) also presents a negative and significant coefficient when included in the equation (2), as an alternative to $share^{06}$. However, the results with this variable are unstable, which may suggest they are also capturing sovereign credit risk effects. In fact, changes in the sovereign debt outstanding amounts in the current crisis were largely determined by increased public sector borrowing requirements.

(20) The chart is based on the results for the specification with *adepth* and *lb* interaction terms estimated for 10 year residual maturity bonds. The use of the alternative specifications does not lead to significant differences in the results. For simplicity, only the results for bonds with residual maturity of 10 years are presented. The conclusions for bonds with residual maturity of 5 years are similar.

Chart 5

FITTED 10 YEAR GOVERNMENT BOND YIELD SPREADS



Sources: ECB, European Commission, IMF, MTS, OECD and authors' calculations.

To sum up, the results based on macroeconomic data up to the end of 2009 confirm that, while in the period before the collapse of Lehman Brothers global risk aversion was the main factor determining the spreads, with the deepening of the crisis there was an increase in the relevance of idiosyncratic factors.

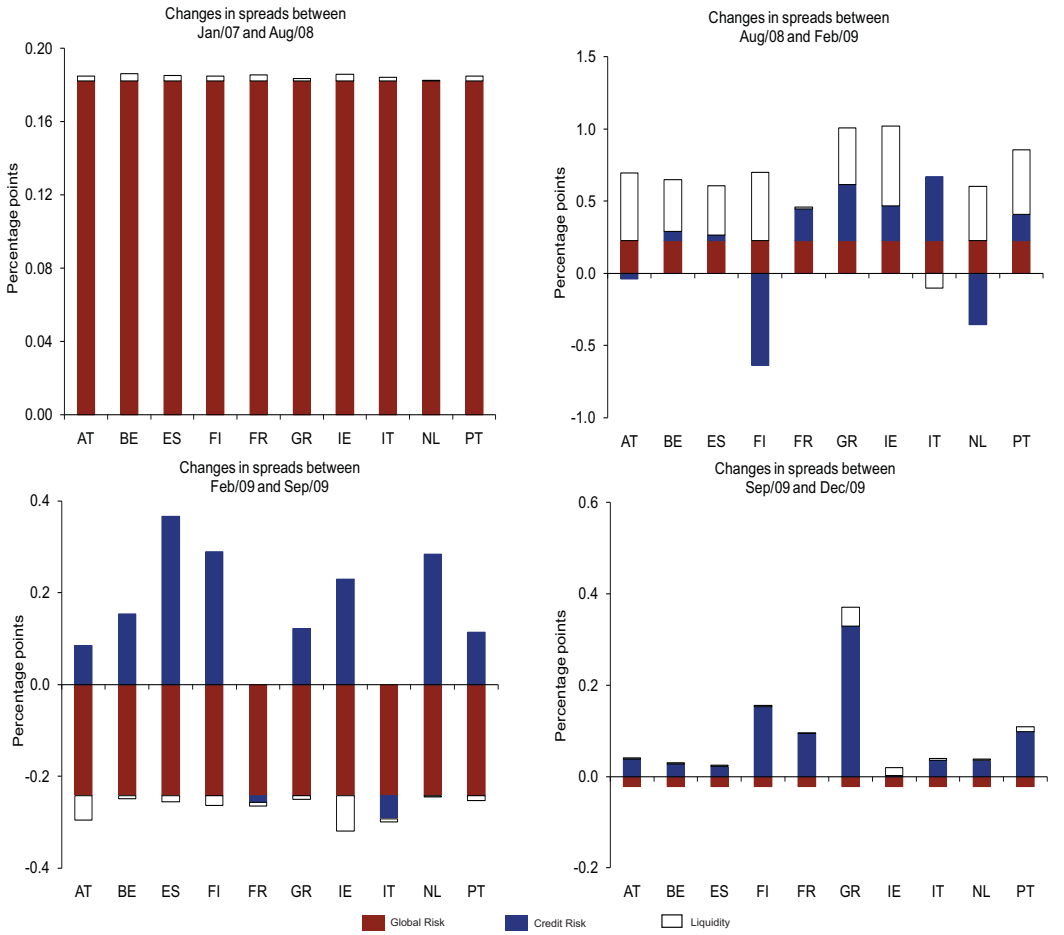
4.2.2. Data up to March 2010

The analysis performed in Section 3 suggests that the widening in euro area sovereign spreads recorded from late 2009 was related with an increase in the importance of country specific factors and, in particular, the increased possibility of default by several countries. This period of renewed turbulence in euro area sovereign bond markets was largely triggered by the perception that Greece's public finances were on an unsustainable path. These concerns spilled over rapidly to other euro area countries such as Portugal, Ireland, Italy and Spain, with a poorer level of economic performance, giving rise to some concerns over the stability of the euro area as a whole.

In this subsection we have re-estimated the previous specifications for a sample period extended to May 2010. The cut-off date was May 9, in order to exclude possible effects arising from the Eurosys-

Chart 6

DETERMINANTS OF CHANGES IN 10 YEAR GOVERNMENT BOND YIELD SPREADS



Sources: ECB, European Commission, IMF, MTS, OECD and authors' calculations.

tem's purchases of euro area government debt securities in the secondary market, under the Securities Market Programme. As we do not have MTS data for 2010, liquidity premiums are measured only by the variable $share^{06}$, while yield spreads are calculated using the yields on benchmark bonds with residual maturities of 5 and 10 years provided by Thomson Reuters (which do not differ significantly from the yields obtained from the MTS database). The exclusion of MTS variables does not change the conclusions for the period 2007-09.

The results based on data up to May 2010 are given in Table 3. In addition to the previously defined variables, *lb** corresponds to a dummy with the value 1 for the period between the collapse of Lehman Brothers and October 2009, while *nov* takes the value 1 for the subsequent period. In line with previous subsections, the table also includes a specification containing the interaction terms with the temporal dummies. In the regression without these cross terms, all variables have the expected signals and are statistically significant. The results of the specification with the cross terms confirm that spreads' sensitivity to country factors has changed in the current crisis. Both in the case of macroeconomic variables, which aim to capture sovereign credit risk, and the liquidity variable the coefficients of cross terms with the dummy *nov* are higher than those of the cross terms with the dummy

Table 3

RESULTS OF SPREADS ESTIMATION IN THE PERIOD 2007- MAY 2010
Credit risk measured by macroeconomic variables

	All bonds	
	(1)	(2)
so	-0.083***	-0.002
	(-3.62)	(-0.80)
so_lb*		-0.107***
		(-7.99)
so_nov		-0.232***
		(-4.92)
div_06	0.008**	0.003***
	(2.64)	(8.79)
div06_lb*		0.010***
		(5.87)
div06_nov		0.028***
		(3.42)
iip_06	-0.003**	-0.001***
	(-2.53)	(-9.42)
iip06_lb*		-0.001**
		(-2.18)
iip06_nov		-0.008**
		(-2.37)
share_06	-0.020***	-0.001
	(-2.93)	(-1.35)
share_06_lb*		-0.029***
		(-4.89)
share_06_nov		-0.052***
		(-3.51)
pr	0.076***	0.052***
	(4.03)	(7.81)
pr_lb*		0.044
		(1.35)
pr_nov		0.457***
		(3.51)
lb*	0.223**	-0.283**
	(2.57)	(-2.30)
nov	0.494**	-0.569**
	(2.73)	(-2.29)
Dmat	0.068***	0.059**
	(2.98)	(2.50)
constant	-0.182	0.161***
	(-1.34)	(6.79)
N	798	798
R-sq	0.454	0.693

Sources: ECB, European Commission, IMF, OECD and authors' calculations.

Notes: The table presents the estimated coefficients and the respective significance levels (*** 1%, ** 5% and * 10%). The t-statistics are presented in brackets. *so* corresponds to the fiscal balance forecast; *div_06* corresponds to the public debt at end 2006; *iip_06* corresponds to the international investment position at end 2006; *pr* represents the monthly average of the risk premium in the international financial markets; *share_06* represents the relative size of the public debt market at end 2006; *Dmat* has the value 1 for bonds with 10 year residual maturity; *lb** is a dummy for the period between the collapse of Lehman Brothers and October 2009; *nov* is a dummy for the period after November 2009. The interaction terms between the time dummies and the other variables are identified by *_lb** and *_nov* at the end of the variable name. The variables for each country are defined in differences against Germany.

*lb**. This result confirms the analysis in Section 3, which suggested that there had been an increase in the impact of each economy's specific factors since the end of 2008, and, more sharply so, since October 2009. In turn, the impact of the risk premium in financial markets remained unchanged until October 2009, increasing thereafter.

5. FINAL REMARKS

Euro area government bond spreads to Germany, recorded since early 2007, can largely be explained by differences between countries regarding the creditworthiness of national governments, liquidity in domestic bond markets, as well as by the risk premium in international financial markets. This latter factor is strongly correlated with the principal components of the sovereign CDS premiums and of the *bid/ask* spreads, defined in comparison to Germany, as well as with an indicator of the liquidity risk in euro area bond markets. This situation suggests that the decline in risk appetite in international financial markets noted during the current crisis has amplified the credit and liquidity risk premiums of euro area bonds against Germany. After the deepening of the crisis in September 2008, idiosyncratic factors have increased their effect on spreads reflecting both the adverse developments in sovereign credit risk and deteriorating liquidity conditions, but also the fact that markets have gone to penalize more the interest rates of countries with major macroeconomic imbalances and/or less liquid sovereign debt markets. The increase in sovereign credit risk premiums has been more marked in countries whose fiscal balance outlook has deteriorated more and/or in countries which, prior to the onset of the crisis, already had higher public debt ratios and poorer international investment positions. In turn, there has been a greater increase in liquidity premiums in countries with smaller public debt markets.

In the period before the collapse of Lehman Brothers, the risk premium in financial markets accounted on average for around 70 percent of euro area sovereign bond yield spreads. Since September 2008, the indicators for country differences in terms of credit quality and liquidity have played a more important role in determining the yield spreads. These indicators, as a whole, accounted for around 50 per cent of the average level of spreads noted between September 2008 and December 2009. Differences between countries in terms of liquidity were particularly important in explaining the increase in yield spreads in the months following the collapse of Lehman Brothers. In turn, idiosyncratic credit risk factors appear, to a large extent, to explain the increase in spreads at the end of 2009. In the first five months of 2010, the evolution of spreads was largely determined by greater heterogeneity in sovereign credit risk premiums, together with a further increase in risk aversion in financial markets.

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