The impact of distressed economies in the EU sovereign market

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Abstract

Financially distressed economies inside the European Union (EU) are blamed for producing a general increase in borrowing costs. This article analyzes the channels of default risk transmission within EU countries using the information content in the sovereign CDS market. We proceed in two directions: first, we test the existence of cross-border volatility effects between central and peripheral EU countries. Second, we explore the effect of distressed economies on default and risk premium constituents of sovereign default swaps. We show a significant volatility spillover from distressed to central European Economic and Monetary Union (EMU) economies. This causality pattern leads to a significant impact on default swap risk premia. On average, risk premium accounts for around 25% of central EMU spreads, doubling for those countries outside the EMU. Peripheral risk also affects the default component of central economies, although its impact is lower.

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1. Introduction

Credit default swaps (CDS, hereafter) are financial instruments that allow debt holders to hedge against default risk. After arising in the US in the late 1990s, the CDS market exploded over the past decade to more than 45 trillion US dollars in mid-2007 as reported by the International Swaps and Derivatives Association (ISDA, 2007). Although the notional outstanding of CDS decreased during the financial crisis, it reached around 26 trillion at mid-year 2010 (ISDA, 2010). Default swaps focused primarily on municipal bonds and corporate debt during the 1990s, but after year 2000 the CDS market expanded internationally into sovereign bonds and structured finance products, such as asset-backed securities. The increasing trading volume of the CDS market could be attributable to several aspects such as the lack of regulation (CDS are traded at over-the-counter markets) or the possibility to speculative investors and hedge funds managers to deal with these insurance contracts without going long on the underlying asset.

After the collapse of Lehman Brothers in fall 2008, the mortgage subprime crisis spread out from US to other developed and emerging economies. The effects on the European Union (EU) resulted in one of the biggest economic crisis after World War II. In particular, sovereign debt market experienced an unprecedented financial distress, leading to a significant increase in the borrowing costs for EU countries, especially Greece, Portugal, Ireland, Spain and Italy[1]. For instance, the 10-year Spanish bond yield reached 550 basis points in April 2011, soaring the spread with the German bund up to 200 basis points. Contemporaneously, similar spreads were observed for the rest of peripheral Euro countries, with a maximum around 1,110 basis points in the case of Greece. European public authorities announced the European Financial Stability Facility (EFSF) in May 2010, and the European Central Bank (ECB) started to play a key role in the crisis through massive interventions in secondary bond markets. At the end of October 2010, the European Council designed a permanent crisis mechanism to safeguard the financial stability of the Euro area as a whole, conditioning the potential assistance to country members to stringent programs of fiscal adjustments and a rigorous debt sustainability agenda.

The Eurozone has experienced an increasing financial instability period since 2008. Some concerns have been raised about the role of CDS contracts as a liquid secondary market for trading credit risk. While CDS contracts have the ability to

[1] Those countries are referred to as the acronym of PIIGS. Otherwise they are also called peripheral countries, in contrast with central EU countries like Germany or France.

anticipate rating announcements and negative credit events (Hull et al., 2004; Ismailescu and Kazemi, 2010), it is also argued that they could adversely affect the creditworthiness of the issuer (Subrahmanyam et al., 2011). Year 2008 appears to be a regime change in the risk perception of default. Before March 2008, the time evolution of European sovereign CDS exhibited a flat pattern with very low volatility, basically reflecting that market participants perceived credit events as rare outcomes. However, the new scenario after March 2008 has been characterized by higher spreads and volatility. This fact might be attributable not only to updated market expectations about interest rate movements in the short-run but also to a higher uncertainty about the credit itself. This is especially true for peripheral countries, whose debt sustainability turned up to be a major concern. In other words, default events within the Eurozone are currently perceived with non-negligible probabilities (Dötz and Fisher, 2011)[2]. Under such scenario, where government bonds have lost their previous role of domestic safe asset, to understand the linkages between changes and volatility of sovereign CDS becomes a crucial issue.

This article explores the nature of default risk transmission in the Eurozone using the information content in sovereign CDS spreads. We stress the crossing effects of time-varying fluctuations of CDS, instead of focusing on the potential destabilizing effects of default swaps on security markets. In this way, we differ from the existing literature on the connections between the CDS market and bond and/or stock markets (see for example, Blanco et al. (2005), Forte and Peña (2009), Norden and Weber (2009) or Belke and Gokus (2011), among others). We document a market segmentation between central and peripheral countries. Factorial analysis reveals two orthogonal components that clearly distinguish the information content of peripheral and non-peripheral CDS spreads. These results extend to CDS levels and their conditional volatilities. A preliminary analysis based on the use of GARCH methodology for CDS factors driving distressed and non-distressed economies suggests a bidirectional volatility transmission pattern between distressed and non-distressed economies inside the European Economic and Monetary Union (EMU). A similar analysis for distressed and non-EMU economies does not reveal a significant volatility impact from inside to outside the euro, suggesting that retaining local currency acts as a firewall.

[2]The recent work of Dötz and Fisher (2011) provides empirical evidence supporting that market perceptions of sovereign risk changed after the rescue of Bear Stearns in March 2008. They show that while in the period prior to the Bear Stearns rescue implied probabilities of default were negligible, after March 2008 the probability of default rose significantly in most EU countries.

The worsening in credit environment since March 2008 resulted in higher levels and volatilities of sovereign default swaps. An interesting question consists on assessing the impact of the peripheral countries on the rest of EU economies. Are the sovereign CDS increments attributable to changes in default probabilities or compensation to investors by means of risk premiums? To appraise these two different credit risk channels, we use the decomposition technique in Pan and Singleton (2008) that allows us to break down CDS into two drivers: i) the risk premium and ii) the default components embedded in CDS spreads. Risk premium stands for the compensation to investors due to changes in the default environment, commonly referred as *distress* risk premium[3] (see Pan and Singleton, 2008; Longstaff et al., 2011). With regard to our modeling choice, we impose a lognormal, mean-reversion structure for the instantaneous risk-neutral arrival rate of a credit event (λ^Q). The maximum likelihood (ML) model estimates show strong differences in the parameters governing the dynamics of λ^Q under risk neutral (Q) and physical (P) measures. More in detail, a persistent departure between risk-neutral and actual long-run means is documented. Additionally, mean-reversion rates are higher in the risk-neutral environment; at the light of our model, these results are consistent with the idea that default environment deteriorates as time goes by. According to our estimations, risk premium accounts for around 25% (on average) of central EMU spreads, and it rises to around 50% for those countries outside the EMU. A regression analysis of the components of sovereigns CDS spreads onto a risk factor representative of the behavior of peripheral countries supports that default contagion channels are not only through risk premium but also through default probabilities. Empirical evidence also indicates that the former channel is relatively more important than the latter. Our empirical findings are robust after controlling for both local and global macroeconomic and financial variables.

Summarizing, this article analyzes the default risk channels between peripheral and central EU members using the information content of sovereign CDS spreads. The remainder of the paper is as follows: Section 2 introduces the data and its main features. Section 3 directly analyzes the volatility transmission in CDS spreads. Section 4 explores the determinants of sovereign CDS spreads and Section 5 presents the decomposition of CDS spreads in default and risk premium

[3]Distress risk premium differs from the *default event* premium, i.e., the compensation required for the bond price changes at the event of default. Default event premium has been a subject of analysis in previous studies as Driessen (2005) or Berndt et al. (2005). A theoretical discussion about the default event premium can be found in Jarrow et al. (2005) or Yu (2002).

constituents. Finally, Section 6 provides some conclusions.

2. Data Analysis

This section presents the stylized facts of our dataset. We also analyze the heteroskedastic behavior of default swaps. To finalize, we explore the existence of commonalities in our data.

2.1. Descriptive statistics

Our sample comprises weekly CDS spreads with maturities 1, 3 and 5-years of Senior Unsecured Sovereign debt denominated in USD under the Old Restructuring clause[4]. Data are collected from Markit Ltd. company, a leading group on providing default swap data save of staleness. Our dataset spans from 2008-2010, a period characterized by a significant increase in CDS levels, high volatility and uncertainty in the Eurosystem. We select the countries member of the EU since 1995 with available CDS spreads. More precisely, we collect the most important economies in terms of GDP which belong to the EMU –Austria, Belgium, Germany, Finland, France, Greece, Ireland, Italy, Netherlands, Portugal and Spain– as well as some control countries –Denmark, Sweden and the United Kingdom– outside of the EMU area. Table A.1 reports some averaged country statistics –gross domestic product (GDP), deficit and debt– for the period under study. From Table A.1, our sample accounts for the 93% of the 27 EU gross domestic product, where EMU (non-EMU) countries selected produce around a 73% (20%) of the total GDP. Peripheral countries represent the 26% of the total EU wealth.

[INSERT TABLE A.1 ABOUT HERE]

To perform the analysis of cross-countries effects we use the most liquid contract, which systematically corresponds to the 5-year maturity. Table A.2 reports the descriptive statistics of CDS spreads in levels and first differences for the 5-year contracts[5]. Panel A (Panel B) depicts the descriptive statistics for EMU (Non-EMU) members. Panel C resumes the overall info. In contrast to previous works

[4]ISDA identifies six credit events: bankruptcy, failure to pay, debt restructuring, obligation default, obligation acceleration, and repudiation/moratorium. The Old Restructuring clause qualifies as a credit event any restructuring event, and any bond of maturity up to 30 years is deliverable.

[5]For the sake of brevity, summary statistics concerning such maturities are not reported in the paper, but they are available upon request.

(Pan and Singleton (2008), Longstaff et al., 2011), our study mainly focus on investment grade countries, where AAA and AA countries represent around 57% and 28% of the sample, respectively. Only Portugal and Greece are rated below AA. On average, Finland and Germany exhibit the lower spreads, while the highest one corresponds to Greece. A clear difference between peripheral and central countries is observed in terms of their median spreads and volatilities, suggesting market segmentation between these two blocks of countries. Finally, although a slightly positive asymmetry and excess kurtosis is a common pattern in our sample, the highest outliers are observed for peripheral countries.

With regard to the CDS first differences, similar conclusions can be extracted in general. We also report the percentage of zero increments in the sample. The number of weeks with no change in CDS spreads is a rough indicator of data liquidity. This percentage is zero in almost every case, reflecting high liquidity.

[INSERT TABLE A.2 ABOUT HERE]

We also explore the nature of cross-sectional differences attending to several criteria: membership to the EMU, rating and GDP, deficit and debt amounts. We also take into account the date of the first Greek bailout[6]. More in detail, non-EMU countries are Denmark, Sweden and United Kingdom. The average rating is created by Markit using the credit ratings that Moody's, S&P and Fitch have on the underlying debt. Countries are clustered in AAA versus the remainder ratings. Low GDP countries are considered as those with a nominal GDP lower than 1 trillion euros per year during period 2008-2010. Taking as benchmark the 27 EU countries during the period 2008-2010, we consider high deficit countries those countries with, on average, higher deficits than 5.30% of GDP. In a similiar way, we consider high debt countries as the economies with higher debt than 72.47% of GDP. Finally, the date 11/Apr/2010 refers to the date that EMU leaders agreed a bailout plan for Greece.

Table A.3 compares the variance and median statistics regarding to above mentioned criteria using non-parametric tests. In particular, we report the two-sided Ansari-Bradley (AB) test for the null hypothesis of equal variances and the Wilcoxon-Mann-Whitney (WMW) test for the null hypothesis of equal medians.

[6]Certainly, those categories are subjectively chosen and they are not mutually exclusive; for example, the high deficit group contains almost the same countries as the high indebted countries. However, this preliminary analysis allows us to provide some basic insights about the countries under study.

Given that such interpretation for the null requires identically shaped distributions, the WMW test is only reported if the AB test does not reject the null hypothesis of equal variances.

According to the AB test, the EMU countries with low credit rating, high deficits or debt have more volatile spread increments than those countries outside the EMU with high credit ratings, low deficit or debt ratios, respectively. These results suggest that the source of volatility in CDS spreads especially arises from the EMU distressed economies. This pattern is stressed towards the latest part of the sample, particularly after the EMU agreement for Greek bailout on April 2010.

[INSERT TABLE A.3 ABOUT HERE]

The small countries (those with a GDP lower than 1 trillion euros) do not exhibit more volatile spread increments than bigger countries. Since the null hypothesis of equal variance cannot be rejected at conventional significant levels, we look at the statistical differences in median. The WMW test suggests no statistical discrepancies between large and small economies for CDS increments.

In short, empirical findings reported in Table A.3 suggest a fragmentation of CDS market fluctuations towards the European distressed economies, remarkably during the final part of our sample.

2.2. Univariate volatility analysis

A common feature in financial series is heteroskedasticity. This subsection analyzes the behavior of univariate conditional variances for 5-year CDS spread increments, a matter of interest on a subsequent analysis. From the different families of GARCH models at our disposition, we select the Exponential GARCH or EGARCH introduced by Nelson (1991),

$$\Delta CDS_t = c + \varphi \Delta CDS_{t-1} + \epsilon_t \quad (1)$$

$$\ln(h_t) = \alpha_0 + \sum_{j=1}^{q} g_j(z_{t-j}) + \sum_{i=1}^{p} \beta_i \ln(h_{t-i}) \quad (2)$$

$$g_j(z_{t-j}) = \alpha_j z_{t-j} + \psi_j(|z_{t-j}| - E|z_{t-j}|) \qquad j = 1, \ldots, q \quad (3)$$

$$z_t \sim iid\ N(0,1)$$

where the mean equation follows an AR(1) process, p and q denote the lags for the variance and the innovations, respectively. Several reasons support our modeling choice: first, the EGARCH allows for asymmetric response to shocks; in this way, the model captures whether upward movements in the CDS spread market are followed by higher volatilities than downward movements of the same magnitude. Second, our model does not require parameter restrictions to assure positiveness of the conditional variance.

[INSERT TABLES A.4 and A.5 ABOUT HERE]

Table A.4 reports the point estimates for the sample under study and Table A.5 summarizes the structure of the final model considered with the corresponding diagnosis Lagrange Multiplier tests for the null hypothesis of no ARCH effects from the standardized and squared standardized residuals. Some interesting conclusions arise from these Tables. First, we consistently observe high persistence of volatility. This fact is reflected by the sum of estimated GARCH parameters which is close to one. Second, the parameters ψ_j that capture asymmetries of shocks to the conditional variance are systematically positive (with the exception of Ireland). Within the context of our model, this pattern implies that positive CDS increments tend to be associated with higher fluctuations. In contrast with the extant literature on asset markets, where leverage effect entails that negative shocks (bad news) increases the variance more than a positive shock, the nature of leverage for CDS is just the opposite. Therefore parameter ψ_j is expected to be positive. Finally, we observe from Table A.5 that the parsimonious EGARCH(1,1) specification leads to standardized and squared standardized residuals free of autocorrelation in most of the cases, as previously mentioned.

Figure B.1 depicts the estimated conditional volatility for central EMU (upper graph), peripheral (medium graph) and non-EMU (lower graph) countries, respectively. To better appreciate differences in the time-varying pattern we use a logarithmic scale. From inspection of Figure B.1, we observe higher volatility for peripheral economies. A high degree of comovement between the different groups of countries is also observed. Lastly, a regime switch in volatilities seems to happen around March 2008. This is consistent with the variation on sovereign risk perceptions after the Bear Stearns rescue noticed by Dötz and Fisher (2011).

[INSERT FIGURE B.1 ABOUT HERE]

2.3. Factor analysis of CDS spreads

The existence of comovements between CDS spreads is addressed in several studies as Longstaff et al. (2011) or Berndt and Obreja (2010), among others. However, not much is known about the presence of commonalities in the *volatilities* of CDS spreads. Table A.8 reports the factor analysis results for both CDS levels and volatilities. Factors are denoted by F1 to F3. Uniqueness columns refer to the idiosyncratic variance, that is, exclusively attributable to the variable and not shared with others. The greater the uniqueness, the lower the relevance of the variable in the factor model. For ease of interpretation factors are rotated using the varimax rotation technique.

[INSERT TABLE A.8 ABOUT HERE]

Some interesting results arise from Table A.8. F1 and F2 in levels (volatilities) account for around the 90% (80%) of the total explained variance. A close inspection to the factor loadings allows us to identify the countries that are related to each factor. With regard to the analysis in levels, F1 has relatively large coefficients for the non-peripheral countries and the UK, Denmark and Sweden; in contrast, F2 can be considered as more representative for peripheral countries (Greece, Ireland, Italy, Portugal and Spain). Finally, Greece seems to be the less important country in the factor structure in levels. In terms of volatilities, Ireland exhibits the higher uniqueness. Again, the CDS market information seems to be segmented on two orthogonal components: those non-peripheral countries grouped around F1, and the peripheral countries gathered in F2. In conclusion, two sources of commonality attending to debt sustainability are identified from the European sovereign CDS market .

3. Volatility transmission between peripheral and non-peripheral areas

Motivated by the existence of orthogonal sources of commonality among EU regions, this section analyzes the volatility transmission between these geographical areas. To avoid spurious causal relationships, we gather our sample around three different blocks of countries –peripheral EMU, non-peripheral EMU and certain EU countries (Denmark, Sweden and UK)– whose local currency is not the euro. This clustering is supported by the empirical findings from factor analysis in Subsection 2.3, where a fragmentation of the sovereign default swap market into different groups is observed. Finally, we reduce the dimensionality of the problem by performing a factor analysis on each set of countries, keeping their first factor. In the three cases, just one principal component is observed following the rule of eigenvalues greater than one.

A multivariate heteroskedastic model is employed to capture possible volatility spillovers between common trends in CDS. In particular, we estimate a bivariate GARCH from pairs of first-differenced factors. We employ the popular

BEKK model specification of Engle and Kroner (1995). Many others multivariate GARCH specifications are special cases of the BEKK specification as the factor model of Engle et al. (1990), the orthogonal GARCH model of Alexander (2001) or the GO-GARCH model of Weide (2002), among others. Our posited alternative i) reduces the number of parameters to be estimated compared to other multivariate GARCH specifications as for example, the VECH model and ii) interestingly enough, the conditional covariance matrix is guaranteed to be positive definite by construction.

We propose the following BEKK specification:

$$\begin{pmatrix} \Delta PC_{r,t} \\ \Delta PC_{s,t} \end{pmatrix} = \begin{pmatrix} \alpha_{11} & 0 \\ 0 & \alpha_{22} \end{pmatrix} \begin{pmatrix} \Delta PC_{r,t-1} \\ \Delta PC_{s,t-1} \end{pmatrix} + \begin{pmatrix} \epsilon_{r,t} \\ \epsilon_{s,t} \end{pmatrix}, \quad \epsilon_t \sim N(0, H_t) \tag{4}$$

$$H_t = CC' + \sum_{j=1}^{p} A_j' \epsilon_{t-j} \epsilon_{t-j}' A_j + \sum_{j=1}^{q} B_j' H_{t-j} B_j \tag{5}$$

where H_t denotes the variance-covariance matrix, A_j, B_j and C are 2×2 parameter matrices and C is lower triangular. The conditional variances depend on the lagged squared conditional variances and the lagged squared errors, whereas the covariances depend on the cross-products of the lagged conditional variances and errors, respectively. The diagonal elements in matrices A_j capture the own ARCH effects, while the diagonal elements in matrices B_j measure the own GARCH effects. The off-diagonal elements capture potential cross-effects between the first differences of factors. The structure $p = q = 2$ appears to be a valid specification to capture the volatility dynamics.

For the ease of interpretation, the elements of the covariance matrix in the case of $p = q = 1$ are expressed below,

$$\begin{aligned} \sigma^2_{r,t} &= c^2_{11} + a^2_{11}\epsilon^2_{r,t-1} + 2a_{11}a_{21}\epsilon_{r,t-1}\epsilon_{s,t-1} + a^2_{21}\epsilon^2_{s,t-1} + b^2_{11}\sigma^2_{r,t-1} \\ &+ b_{11}b_{21}\sigma_{rs,t-1} + b^2_{21}\sigma^2_{s,t-1} \end{aligned} \tag{6}$$

$$\begin{aligned} \sigma_{rs,t} &= c_{11}c_{12} + a_{11}a_{12}\epsilon^2_{r,t-1} + a_{11}a_{22}\epsilon_{r,t-1}\epsilon_{s,t-1} + a_{12}a_{21}\epsilon_{r,t-1}\epsilon_{s,t-1} + a_{22}a_{21}\epsilon^2_{s,t-1} \\ &+ b_{11}b_{12}\sigma^2_{r,t-1} + b_{12}b_{21}\sigma_{rs,t-1} + b_{11}b_{22}\sigma_{rs,t-1} + b_{22}b_{21}\sigma^2_{s,t-1} \end{aligned} \tag{7}$$

$$\begin{aligned} \sigma^2_{s,t} &= c^2_{12} + c^2_{22} + a^2_{12}\epsilon^2_{r,t-1} + 2a_{22}a_{12}\epsilon_{r,t-1}\epsilon_{s,t-1} + a^2_{22}\epsilon^2_{s,t-1} + b^2_{12}\sigma^2_{r,t-1} \\ &+ b_{22}b_{12}\sigma_{rs,t-1} + b^2_{22}\sigma^2_{s,t-1} \end{aligned} \tag{8}$$

where a_{ij} and b_{ij} denotes the i-th row and j-th element of matrix A_1 and B_1, respectively.

The BEKK-GARCH specification presents some inference difficulties, because spillover effects are obtained via the multiplication/addition of various parameter estimates. Therefore, it is not possible to identify the source of volatility spillovers by directly checking the significance of the parameters involved in matrices A and B. We test the directional source of volatility transmission by regarding the significance of b_{21}^2 and b_{22}^2 in equations (6) and (8), respectively. We use the delta method to estimate standard errors of the squared parameters.

Table A.6 shows the Quasi-Maximum Likelihood (QML) estimation of the bivariate BEKK-GARCH models for each pair of factors (non-peripheral / peripheral and non-EMU / peripheral) considered, while Table A.7 reports the model diagnostics based on the standardized residuals. From Table A.7, our bivariate GARCH specification is a statistically valid representation of the cross-interactions for each pair of heteroskedastic factors under analysis.

[INSERT TABLES A.6 and A.7 ABOUT HERE]

Back to Table A.6, we explore the directional causality between peer factors. Inside the EMU, we detect a bidirectional causal relationship between peripheral and non-peripheral countries for volatilities. The squared parameters involved are statistically different from zero at the conventional significant levels. However, empirical evidence suggests an unidirectional transmission channel from non-EMU to EMU-peripheral area. Past volatility in peripheral countries does not anticipate an increase of volatility in non-EMU countries.

Figure B.2 displays the estimated conditional correlations for each bivariate GARCH-model. The correlation coefficients between peripheral and non-peripheral countries suggest a strong comovement inside the Eurozone. Moreover, its magnitude tends to be higher than those corresponding to peripheral and EU, especially until January 2010.

[INSERT FIGURE B.2 ABOUT HERE]

4. The determinants of credit spreads

Since peripheral countries spill over non-peripheral economies inside the EMU, this section analyzes the impact of the peripheral risk factor into the remainder sovereign CDS spreads.

4.1. Control variables

We run OLS regressions of CDS increments for non-EU and central EMU countries on the peripheral risk factor, but controlling for a set of local and global variables following the research design in Longstaff et al. (2011). Table A.9 provides a detailed description of the control variables as well as some recent papers that support the choice of these variables.

Local variables include a CDS liquidity proxy, the local stock market return and its realized volatility, the relevant exchange rate and its 1-month option implied volatility and the corresponding interest rate for each monetary region. On the other hand, global variables incorporate a worldwide CDS liquidity score, the EuroStoxx50 index returns, the volatility risk premium, the Chicago Board of Trade S&P 500 Implied Correlation Index, the constant maturity 5-year US Treasury yield and the spread between AA and BBB rated European corporates.

[INSERT TABLE A.9 ABOUT HERE]

Concerning to the local variables, some early articles have considered the CDS market as liquidity frictionless market (Blanco et al., 2005; Longstaff et al., 2005). However, Tang and Yan (2007) find that liquidity measures are important determinants of default swap spreads. For that reason, we use the Fitch's liquidity scores for individual sovereign CDS. The higher the Fitch score, the lower the CDS liquidity is. This measure takes into account the information content in the bid-ask spread, the staleness of quotes and the dispersion of mid-quotes across brokers. Then, this variable has the advantage of summarizing several liquidity proxies into a single one, allowing for a direct comparison through time and across countries.

Stock markets also contain important information about the state of the local economy (Longstaff et al., 2011; Dieckmann and Plank, 2011). Moreover, Zhang et al. (2009) have also shown that the volatility of the stock market can predict a large variation in corporate CDS spreads. We proxy local volatility using the open-high-low-close volatility estimator of Garman and Klass (1980).

The exchange rate could also provide additional information on the country creditworthiness. Carr and Wu (2007) propose a joint modeling of the exchange rate volatility and the sovereign default risk to capture the co-movements between the volatility of currency options and the sovereign CDS market. For this reason, we also include the option implied volatility of the local currency. Finally, day-to-day money market interest rates on unsecured loans for each monetary region are a proxy for funding risk. This completes the local information set.

With regard to the global variables, the Fitch's Liquidity Score for 5-year sovereign CDS worldwide is the global version of the individual Fitch measure previously mentioned. We also employ the premium for bearing the volatility risk of an option position. This volatility risk premium accounts for the difference between implied and realized volatility and it represents the price of a variance swap contract (Carr and Wu, 2006, 2009; Bollerslev et al., 2009). We build such volatility risk premium as the difference between the 1-month VSTOXX option implied volatility index and the realized volatility estimator of Garman and Klass (1980).

An increase in the stock market correlations can damage the investment opportunities and worsen the diversification benefits (Driessen et al., 2009). Thus, we incorporate the Chicago Board of Trade S&P 500 Implied Correlation Index. Moreover, we consider some standard market variables that capture the state of the economy such as i) the 5-year US Treasury yield, that can be seen as a save haven debt security in comparison to the European debt securities and ii) the spread between AA and BBB rated European investment grade corporates, which summarizes the European corporate bond market situation.

Finally, ΔCDS Peripheral variable comprises the first factor scores in the factor analysis structure involving the five peripheral countries. It captures the commonality among financially distressed economies and it is the main object of our analysis.

4.2. OLS estimates

Table A.10 shows the resulting OLS estimates of projecting the individual default swap increments onto the local and global variables set. We also report the p-values based on the White (1980) heteroskedasticity-consistent estimate of the covariance matrix and the adjusted R^2. To emphasize the contribution of the peripheral component to non-peripheral spreads, we repeat our regressions omitting the related variable (ΔCDS Peripheral). In this way, the term R^2-Adj Before stands for the adjusted coefficient of determination excluding the mentioned variable. Additionally, we also explore differences between EMU and non-EMU membership.

[INSERT TABLE A.10 ABOUT HERE]

Several results come up from Table A.10. As to the local variables (panel A), exchange rates fluctuations appears to be a a key variable in explaining CDS spread increments. Given that CDS contracts are nominated in USD, a significant and positive coefficient for the exchange rates reveals that USD appreciation against the local currency results in increments of default swaps. On the contrary, stock market changes are not significant in order to explain spread changes, in contrast to empirical findings reported in Longstaff et al. (2011) for 12 emerging economies. The effect of realized volatility is only significant in the case of Sweden. With regard to the global variables, no control variable is successful in explaining CDS spread changes with the exception of the peripheral factor. However, the explanatory ability of these local and global variables is not as high as reported in Longstaff et al. (2011) for emerging countries as well as for some developed countries as Japan.

The factor representing financially distressed economies significantly affect increments of CDS spreads. The associated coefficient is systematically positive. This pattern is noticeable for both EMU an non-EMU countries. Interestingly enough, the OLS explaining ability clearly improves after the inclusion of the peripheral component as an additional regressor. While the adjusted R^2s excluding the peripheral CDS component range from 18 to 33 percent, the explanatory power of regressions substantially increases (around 30% on average) after the inclusion of this variable.

In conclusion, the behavior of peripheral economies and exchange rates arise as the main variables that account for CDS variability. However, we cannot appreciate a clear pattern for the effect of global variables.

5. Decomposing CDS spreads

Previous empirical evidence suggests a risk channel transmission from peripheral to non-peripheral countries. How this transference passes on each country posses an intriguing question. This section explores the nature of risk transmission at an individual level. We decompose the default swap spreads in two components, default risk and risk premium. This distinction allows us to disentangle the impact of distress economies in EU countries due to changes in default risk or investors risk appetite. We outline the methodology of Pan and Singleton (2008) for the CDS decomposition, providing an econometric framework for its estimation.

5.1. The model

We adopt the intensity approach of Pan and Singleton (2008) and Longstaff et al. (2008) to decompose the CDS spreads in default risk and risk premium components. Within this framework, the credit event is triggered by the first jump of a Poisson process with stochastic intensity,

$$d \ln \lambda_t^Q \quad = \quad \kappa^Q \left(\theta^Q - \ln \lambda_t^Q \right) dt + \sigma dW_t^Q, \tag{9}$$

where κ^Q, θ^Q and σ stands for the mean-reversion speed, long-run mean and volatility of the process, respectively. The log-intensities in (9) follow an Ornstein-Uhlenbeck process, which ensures the positiveness of the default intensity.

Under this formulation, Longstaff et al. (2005) or Pan and Singleton (2008) provide an expression for computing the CDS spreads,

$$CDS_t^Q(M) = \frac{4\,L^{\mathbb{Q}} \int_t^{t+M} E_t^{\mathbb{Q}}\left[\lambda_u^{\mathbb{Q}} e^{-\int_t^u (r_s+\lambda_s^{\mathbb{Q}})\,ds}\right] du}{\sum_{i=1}^{4M} E_t^{\mathbb{Q}}\left[e^{-\int_t^{t+.25i}(r_s+\lambda_s^{\mathbb{Q}})\,ds}\right]} \quad , \tag{10}$$

with M the maturity of the CDS, r_t the risk-free rate and $L^{\mathbb{Q}}$ the risk-neutral expected losses. We consider a loss given default of 60%, a standard assumption in the literature.

The risk-neutral intensity process (9) admits an equivalent formulation in terms of the actual measure P,

$$d\ln\lambda_t^Q \;=\; \kappa^P(\theta^P - \ln\lambda_t^Q)dt + \sigma dW_t^P, \tag{11}$$

where $\kappa^P = \kappa^Q - \delta_1\sigma$ and $\kappa^P\theta^P = \kappa^Q\theta^Q + \delta_0\sigma$. Parameters δ_0 and δ_1 determine the market price of risk,

$$dW^Q \;=\; (\delta_0 + \delta_1 \ln\lambda^Q)dt + dW^P \tag{12}$$

From previous expressions for the risk-neutral intensity, notice that equation (11) collapses to (9) when parameters δ_0 and δ_1 equals to zero (no compensation for changes in the default environment). Then, if there is no risk premium embedded in CDS spreads, expressions (9) and (11) are equal and the difference between CDS spreads (CDS^Q) computed under risk-neutral Q and actual P measures,

$$CDS_t^P(M) = \frac{4\,L^{\mathbb{Q}} \int_t^{t+M} E_t^{\mathbb{P}}\left[\lambda_u^{\mathbb{Q}} e^{-\int_t^u (r_s+\lambda_s^{\mathbb{Q}})\,ds}\right] du}{\sum_{i=1}^{4M} E_t^{\mathbb{P}}\left[e^{-\int_t^{t+.25i}(r_s+\lambda_s^{\mathbb{Q}})\,ds}\right]} \quad , \tag{13}$$

is zero. Otherwise, divergences between CDS^Q and CDS^P are capturing the risk premium embedded in CDS spreads for compensating changes in the default environment.

It is worth to mention that our risk premium stands for compensation due to changes in default conditions (changes in economic fundamentals, etc.) instead of rewarding the default itself. The former is called *distress* premium and it has been previously analyzed by Pan and Singleton (2008) or Longstaff et al. (2011), among others. The latter is called default-event premium; it has been studied by Yu (2002), Pan and Singleton (2006), Driessen (2005) or Berndt et al. (2005) and it is out of the scope of our study. Jarrow et al. (2005) present an unifying framework of both premia within the intensity modeling.

5.2. Estimation procedure

We estimate the parameters of our model by maximum likelihood (ML). We summarize here the main steps involved in. For the sake of notation, we denote λ^Q as λ. First, we assume that 3-year CDS contracts are perfectly priced; given a set of κ^Q, θ^Q and σ parameters, we recover a time series for λ by means of a non-linear optimization technique. Second, differences between sample and theoretical 1 and 5-year CDS contracts are priced with normally distributed errors ϵ_{1y}, ϵ_{5y} with zero mean and standard deviations $\sigma(1)$ and $\sigma(5)$, respectively. Third, we use the bootstrapped USD Libor-Swap curve as risk-free rates to discount future payoffs. More in detail, we employ the 3, 6, 9 and 12-month USD Libor published by the British Bankers' Association. We also use the 2, 3, 4 and 5-year USD interest rate swaps from the Federal Reserve Statistical Release H.15. Fourth, expectations in equations (10) and (13) when λ^Q follows a log-OU process are not in closed form, so they are computed using a Crank-Nicholson discretization scheme for the corresponding partial differential equation. Finally, the joint density function is,

$$
\begin{aligned}
f^P(\Theta,\lambda) &= f^P(\epsilon_{1y}|\sigma(1)) \times f^P(\epsilon_{5y}|\sigma(5)) \times f^P(\ln\lambda|\kappa^P,\kappa^P\theta^P,\sigma) \\
&\times \left|\partial CDS^Q(\lambda|\kappa^Q,\kappa^Q\theta^Q,\sigma)/\partial\lambda\right|^{-1} \qquad (14)
\end{aligned}
$$

with parameter vector $\Theta = (\kappa^Q, \theta^Q\kappa^Q, \sigma^Q, \kappa^P, \theta^P\kappa^P, \sigma(1), \sigma(5))$, $f^P(\cdot)$ the density function of the Normal distribution and Δt equal to 1/52.

5.3. Maximum Likelihood Estimates

Table A.11 displays the ML estimates for the sample under study. We observe that the convergence of different default intensity processes to a certain long-run mean are faster in the actual than risk-neutral environments ($\kappa^P > \kappa^Q$), indicating that the default arrival rates as seen from risk-neutral investors tend to explode as time goes by. Moreover, the average default intensity level is much lower in the actual than risk-neutral measure $\kappa^Q\theta^Q > \kappa^P\theta^P$. Our results are quite similar to those reported in Pan and Singleton (2008) and Longstaff et al. (2011) in the context of emerging economies.

We also address the performance of the model under two different criteria. First, Figure B.3 displays the cross-sectional, averaged pricing errors for our sample of countries. As shown, pricing errors are (in mean) close to zero. Differences between fitted and sample spreads are 15 basis points in the worst case. Second, Table A.12 shows the projections of sample CDS spread increments onto their theoretical counterparts. An intercept and slope coefficients close to zero and one, respectively, indicate a reasonable fit of the model. From Table A.12, we observe that intercepts are zero and slopes close to one when we differentiate maturities. Additionally, the overall R-squared coefficient is 72% and standard deviation of residuals is lower than five basis points.

[INSERT FIGURE B.3 and TABLE A.12 ABOUT HERE]

Table A.13 reports some descriptive statistics for the risk premium and risk premium fractions of 5-year CDS spreads, respectively. Risk premium is computed as the difference between CDS^{Q} and CDS^{P} using expressions (10) and (13). In addition, we look at the contribution of risk premium (in percentage) over the total of spread of the CDS,

$$RPF \equiv (CDS^{Q}(M) - CDS^{P}(M))/CDS^{Q}(M) \tag{15}$$

or risk premium fraction (RPF), similarly to Longstaff et al. (2011). Some interesting conclusions arise from Table A.13. For example, we observe that investors pay around 14.00 (18.00) basis points to Germany (France) default swaps in terms of risk compensation, approximately a 10% of its total value. On the contrary, protection sellers of countries outside the EMU demand higher risk premia. In particular, Finland, Sweden and UK demand 18.00, 30.00, and 37.00 basis points, respectively. Such component represents around the 50% of their total spreads. It should be also highlighted that non-EMU countries exhibit lower variability in the risk premium fractions than EMU ones. Again, last result suggests that membership in a common currency arrangement could act as a contagion enhancer.

[INSERT TABLE A.13 ABOUT HERE]

5.4. Disentangling the impact on risk premia and default components

This subsection retakes the analysis carried out in Section 4 in order to exploit the information content in the risk premium and default risk components of sovereign CDS spreads. In this way, we project the constituents of 5-year sovereign default swaps onto the risk peripheral factor, controlling for both local and global financial variables previously described in Section 4. Tables A.14 and A.15 summarize the OLS estimates. Again, we report the adjusted-R^2 for the regressions with and without including the peripheral risk factor.

[INSERT TABLES A.14 AND A.15 ABOUT HERE]

Is the market translating peripheral risk into higher central sovereign CDS risk premia? Results from Table A.14 suggest an affirmative answer to this question. First, slope coefficients associated with the peripheral factor are statistically different from zero at conventional significant levels. The estimated effect on the risk premium is systematically positive. Second, the adjusted R^2 increases on average from 20% to 42% when peripheral risk factor is included. Third, just exchange rates seem to exhibit a wide effect on CDS risk premiums similar to those of peripheral countries. Exchange rates are positive and significant at the 10% significance level in 6 out of 9 cases. The rest of the local variables that retain some explaining ability are the stock market return (Austria and Denmark) and volatility (Sweden), and exchange rate volatility (Austria, Belgium, Finland, France and UK). Lastly, global variables play a negligible role in explaining CDS risk premia.

What about the effect of peripheral countries on default risk for central EU economies? At light of results in Table A.15, it is observed that the peripheral factor is again significant in explaining CDS risk default risk across all the countries. Again, the estimated parameter is systematically positive, revealing that financially distressed economies tend to deteriorate sovereign creditworthiness of central EU economies. With regard to the local and global variables, results remain qualitatively similar to those reported for the risk premium component.

In short, our empirical findings show the risk factor for peripheral economies is a relevant variable that accounts for much of the variability of European CDS components. We also detect that exchange rates is a relevant variable to explain the time evolution of European CDS. However, global variables do not play a key role in driving Euro sovereign credit spreads.

5.5. Is the impact stable over time?

As a robustness check, we examine whether the previous slope coefficients for the peripheral risk factor could be safely interpreted as the representative impact, on average, for the overall sample. To deal with this issue, we compute rolling-window regressions using an one-year window. For the sake of brevity, FigureB.4

only depicts the OLS slope coefficients (left column) and the relative adjusted R-squared ratios (right column) for the three largest economies (Germany, France and United Kingdom)[7].

[INSERT FIGURE B.4 ABOUT HERE]

Several interesting aspects emerge from Figure B.4. First, the impact of distressed economies on both default and risk premium is positive and relatively steady until the beginning of 2010. Second, during this time period, the effect on the default component remains lower than the corresponding to the risk premium. Third, coefficients dramatically decrease after January 2010, becoming clearly negative during the last part of the sample. Fourth, the peripheral risk factor remains as a relevant regressor for the overall sample, but its added explanatory power is clearly higher before January 2010. Hence after, such additional explained ability substantially decreases. These results suggest that the financial stability program implemented in the EU acted as a gradual cushion against peripheral risk. Assuming that contagion between two assets is defined as a significant increase in the degree of comovement between them (see Caporale et al. (2005), Rigobon, 2003), the last fact is consistent with the time evolution of estimated conditional correlation coefficients between factors in Section 3.

6. Conclusions

Volatility of credit default swaps inside the European Economic and Monetary Union has significantly increased after March 2008. The Keynesian treatment of the crisis to encourage economic growth led to fiscal imbalances that resulted in significant updating of default risk expectations. Under a new scenario where a sovereign credit event is not perceived as a *rare* event, to understand the credit risk interactions among EU countries is a major concern. This article provides additional insights on the risk transmission channels from the perspective of the credit derivative market during the period covering 2008-2010.

We analyze the spillover effects from peripheral to central EU economies as a reaction to some common global shocks. A preliminary overview reveals a strong commonality among EU sovereign default swaps. We also find that CDS market signals a market fragmentation between financially distressed economies

[7]Empirical findings for the remainder countries are available from the authors upon request.

and central EU countries. Additionally, a significant risk transmission between peripheral and non-peripheral countries takes place during the period analyzed.

To better understand the impact of distressed economies, we decompose the sovereign CDS spreads into their risk-premium and default risk components in accordance with the affine sovereign credit valuation proposed in Pan and Singleton (2008). A sharp difference for the relative weight of the risk premium component is found. In the case of EMU economies, risk premium accounts for, on average, the 25% of the total CDS spread. However, this percentage rises to one-half for non-EMU countries. We find that both risk premium and default components of CDS spreads are partially explained by global and local macroeconomic factors. Peripheral risk plays a key role in explaining CDS increments for the remainder EU members. The impact of peripheral risk vanishes after the approval of the European Financial Stabilisation Mechanism (EFSM) in May, 2010.

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Appendix A. Tables

Table A.1: Average Government Statistics

Country	EMU member	GDP (mill of €)	DEFICIT (% of GDP)	DEBT (% of GDP)
Austria	Yes	281,253.8	-3.13	68.37
Belgium	Yes	346,968.4	-3.73	93.80
Germany	Yes	2,441,700.0	-2.53	74.77
Denmark	No	229,965.8	-0.70	40.00
Finland	Yes	179,723.7	-0.23	41.83
France	Yes	1,918,409.3	-5.97	76.50
Greece	Yes	230,626.7	-12.07	129.07
Ireland	Yes	165,526.0	-17.60	68.13
Italy	Yes	1,552,654.4	-4.23	113.23
Netherlands	Yes	584,680.0	-3.40	60.73
Portugal	Yes	171,122.8	-7.83	82.63
Spain	Yes	1,062,307.3	-8.33	51.63
Sweden	No	323,819.3	0.57	40.40
UK	No	1,688,443.7	-8.93	68.10
EU(27)		12,154,291.7	-5.30	72.47

This Table reports average annual government statistics from 2008 to 2010. Source: Eurostat

Table A.2: Descriptive statistics for CDS levels and first differences

Country	Rating	Recovery	5-year CDS spreads							5-year CDS spread changes								
			Mean	Median	Std	Skew	Kurt	Min	Max	Mean	Median	Std	Skew	Kurt	Min	Max	Acorr	Zero inc
	(Average)	(%)	(bps)	(bps)	(bps)			(bps)	(bps)	(bps)	(bps)	(bps)			(bps)	(bps)	(1st lag)	(%)
Panel A.- EMU members																		
Austria	AAA	40.00	73.30	75.23	50.86	1.00	5.07	6.90	264.60	0.54	0.06	13.41	0.87	11.74	-49.31	77.43	0.2510	0.00
Belgium	AA	40.01	66.35	55.72	41.97	0.67	2.36	15.25	191.32	1.13	0.32	9.11	0.67	7.02	-30.73	42.68	0.1942	0.00
Germany	AAA	39.45	30.14	31.36	17.82	0.63	3.81	5.01	90.35	0.28	0.16	4.49	0.39	8.33	-16.64	22.29	0.2849	0.00
Finland	AAA	40.00	28.46	27.48	17.15	1.24	4.89	6.67	92.23	0.19	0.21	4.03	1.00	8.78	-13.19	17.85	0.3395	0.00
France	AAA	40.00	42.46	36.90	26.33	0.30	1.84	6.15	95.36	0.57	0.13	5.40	-0.33	5.57	-20.19	18.72	0.2173	0.00
Greece	BBB	40.84	300.86	170.35	294.06	1.14	2.82	34.37	996.41	6.18	1.53	53.35	-0.48	24.98	-356.27	324.31	-0.0164	0.00
Ireland	AA	40.00	176.55	158.93	131.27	1.05	4.15	18.29	596.92	3.91	0.91	27.03	0.91	6.94	-80.76	114.15	0.0727	0.00
Italy	AA	40.00	109.53	103.13	58.39	0.27	1.86	24.78	237.99	1.25	0.60	15.07	0.46	7.72	-58.40	74.25	0.0985	0.00
Netherlands	AAA	39.50	40.54	36.71	27.65	1.15	4.34	6.45	126.43	0.36	0.12	6.14	0.99	8.92	-18.66	28.68	0.2084	0.00
Portugal	A	40.00	132.99	80.45	120.39	1.35	3.67	24.44	482.49	3.06	0.91	30.52	-2.59	28.41	-234.73	106.52	-0.1613	0.00
Spain	AA	39.96	110.66	93.28	72.18	0.87	2.78	23.60	314.70	1.89	0.85	16.15	-0.47	9.50	-86.88	57.71	-0.0506	0.00
Panel B.- Non-EMU members																		
Denmark	AAA	39.89	42.42	34.67	32.90	1.43	4.43	6.52	143.39	0.21	0.16	6.78	0.72	8.69	-23.44	29.86	0.3058	0.00
Sweden	AAA	40.00	46.72	41.13	34.69	1.18	4.01	6.56	155.96	0.18	-0.01	7.99	0.69	8.95	-26.60	39.35	0.2729	0.66
UK	AAA	39.64	63.11	67.25	35.86	0.32	2.94	7.80	164.02	0.42	0.19	8.16	0.58	7.40	-27.78	35.97	0.1063	0.00
Panel C.- OVERALL																		
Mean		39.95	90.29	72.33	68.68	0.90	3.50	13.77	282.30	1.44	0.44	14.83	0.24	10.93	-74.54	70.70	0.1517	0.05
Std		0.33	74.62	45.97	73.78	0.40	1.07	9.63	254.51	1.78	0.45	13.76	0.97	6.87	99.36	79.40	0.1491	0.18
Min		39.45	28.46	27.48	17.15	0.27	1.84	5.01	90.35	0.18	-0.01	4.03	-2.59	5.57	-356.27	17.85	-0.1613	0.00
Max		40.84	300.86	170.35	294.06	1.43	5.07	34.37	996.41	6.18	1.53	53.35	1.00	28.41	-13.19	324.31	0.3395	0.66

Summary statistics for 5-year CDS spreads in levels and first differences. The sample contains weekly observations from January 2008 to December 2010.

Table A.3: Test statistics for CDS increments under different grouping criteria

	EMU		Rating		GDP		DEFICIT		DEBT		Time (11/Apr/2010)	
	NonEMU	EMU	AAA	AA-BBB	Low	High	High	Low	High	Low	After	Before
Obs.	21.41%	78.59%	57.19%	42.82%	64.22%	35.78%	42.82%	57.19%	42.91%	57.09%	23.27%	76.74%
Mean	0.270	1.758	0.343	2.904	1.751	0.881	2.672	0.517	2.075	0.962	3.817	0.719
Median	0.100	0.309	0.118	0.804	0.261	0.227	0.497	0.156	0.343	0.191	0.624	0.194
WMW					(0.952)							
Std.	7.651	22.072	7.553	29.067	23.434	10.963	28.465	9.153	26.235	13.253	35.417	11.566
AB	(0.000)		(0.000)		(0.413)		(0.000)		(0.000)		(0.000)	

This Table provides the Ansari-Bradley (AB) and Wilcoxon-Mann-Whitney (WMW) test statistics for 5-year CDS increments under different grouping criteria. Main summary statistics (mean, median and standard deviation) are also included. EMU countries include Austria, Belgium, Germany, Finland, France, Greece, Ireland, Italy, Netherlands, Portugal and Spain. Non-EMU countries are Denmark, Sweden and United Kingdom. Low GDP countries are those with a nominal GDP lower than 1 trillion Euros per year during period 2008-2010. High deficit countries refer to those with higher deficits, on average, than the 27 EU members (5.30% of GDP) during 2008-2010. High debt countries are those with a higher debt (on average) than that of the 27 EU members (72.47% of GDP). The date 11/Apr/2010 corresponds to the EMU agreement about the Greek bailout plan. The sample period covers from Jan/2008 to Dec/2010.

Table A.4: QML estimates of EGARCH model for the CDS increments

This table reports the univariate QML estimates of the AR(1)-EGARCH(p,q) model of Nelson (1991),

$$\begin{aligned} \Delta CDS_t &= c + \varphi \Delta CDS_{t-1} + \epsilon_t \\ \ln(h_t) &= \alpha_0 + \sum_{j=1}^{q} g_j(z_{t-j}) + \sum_{i=1}^{p} \beta_i \ln(h_{t-i}) \\ g_j(z_{t-j}) &= \alpha_j z_{t-j} + \psi_j(|z_{t-j}| - E|z_{t-j}|) \qquad j = 1, \ldots, q \\ z_t &\sim iid\ N(0,1) \end{aligned}$$

Data comprises the 5-year CDS spread increments for each country. The sample period spans from January 2008 to December 2010.

	Mean: AR(1)		Volatility: EGARCH(p,q)												
				β_{t-i}		α_{t-j}					ψ_{t-j}				
	c ($\times 10^{-2}$)	φ	α_0	β_{t-1}	β_{t-2}	α_{t-1}	α_{t-2}	α_{t-3}	α_{t-4}	α_{t-5}	ψ_{t-1}	ψ_{t-2}	ψ_{t-3}	ψ_{t-4}	ψ_{t-5}
Austria	0.0052	0.1172	0.8462	0.9381		0.3742					0.2795				
	(0.531)	(0.215)	(0.006)	(0.000)		(0.000)					(0.008)				
Belgium	0.1122	0.1473	-0.2323	0.9828		0.2771					0.0299				
	(0.146)	(0.179)	(0.374)	(0.000)		(0.000)					(0.306)				
Germany	0.0019	0.1437	-0.1120	0.1581	0.8366	0.6902					0.0776				
	(0.585)	(0.072)	(0.802)	(0.012)	(0.000)	(0.000)					(0.193)				
Denmark	0.0033	0.1842	-0.4013	0.3067	0.6677	0.3776	0.1876				-0.1057	0.2005			
	(0.381)	(0.089)	(0.152)	(0.679)	(0.362)	(0.015)	(0.503)				(0.690)	(0.394)			
Finland	0.0032	0.2079	-0.7443	0.9532		0.3290					0.2293				
	(0.181)	(0.048)	(0.009)	(0.000)		(0.000)					(0.041)				
France	0.0438	0.1461	-0.6606	0.9565		0.3246					0.0549				
	(0.299)	(0.139)	(0.005)	(0.000)		(0.000)					(0.084)				
Greece	0.0047	0.2000	-0.5047	0.9572		-0.1830	0.4275	-0.1334	0.0150	0.4504	0.9025	-0.1998	0.8019	-0.6849	0.1450
	(0.147)	(0.011)	(0.122)	(0.000)		(0.121)	(0.003)	(0.387)	(0.917)	(0.003)	(0.000)	(0.471)	(0.000)	(0.012)	(0.523)
Ireland	0.0061	0.4981	-0.0978	0.9806		-0.2289					1.2062				
	(0.011)	(0.000)	(0.752)	(0.000)		(0.013)					(0.000)				
Italy	0.0084	0.1176	-1.0935	0.9142		0.0794					0.6923				
	(0.343)	(0.250)	(0.010)	(0.000)		(0.411)					(0.000)				
Netherlands	0.0086	0.1441	-1.3103	0.9111		0.1545					0.3377				
	(0.020)	(0.152)	(0.004)	(0.000)		(0.026)					(0.007)				
Portugal	0.0071	0.0808	-0.5737	0.9588		0.0887	0.4512	-0.5434	0.5959		0.4998	0.4097	-0.1983	-0.3480	
	(0.148)	(0.274)	(0.007)	(0.000)		(0.551)	(0.003)	(0.015)	(0.003)		(0.048)	(0.202)	(0.504)	(0.207)	
Spain	0.0112	-0.0207	-0.4528	0.9641		0.2562					0.6174				
	(0.061)	(0.821)	(0.136)	(0.000)		(0.006)					(0.000)				
Sweden	0.0020	0.1814	-0.3014	0.9781		0.3974					0.4812				
	(0.391)	(0.044)	(0.046)	(0.000)		(0.000)					(0.000)				
UK	0.0056	0.2680	-0.3019	0.0360	0.9414	0.4320	0.1475	0.0506	-0.1133		0.2060	1.059	0.2196	-0.5109	
	(0.027)	(0.000)	(0.652)	(0.660)	(0.000)	(0.003)	(0.324)	(0.757)	(0.471)		(0.378)	(0.000)	(0.321)	(0.044)	

Table A.5: LM tests of heteroskedasticity

	EGARCH(p,q)		Lags of LM test				
Country	p	q	Lag 1	Lag 2	Lag 3	Lag 4	Lag 5
Austria	1	1	0.6374	0.6915	0.8518	0.9302	0.8979
Belgium	1	1	0.8352	0.9678	0.9583	0.9859	0.9960
Germany	2	1	0.9963	0.9087	0.9760	0.9908	0.9976
Denmark	2	2	0.8793	0.9281	0.9773	0.9174	0.9579
Finland	1	1	0.4619	0.5436	0.7010	0.8315	0.7690
France	1	1	0.4496	0.6142	0.5360	0.4093	0.5349
Greece	1	5	0.6870	0.8703	0.8898	0.5000	0.6129
Ireland	1	1	0.7268	0.6876	0.5992	0.6907	0.7951
Italy	1	1	0.5702	0.6637	0.8364	0.9279	0.8631
Netherlands	1	1	0.4657	0.7328	0.7614	0.0439	0.0715
Portugal	1	4	0.8151	0.9230	0.9231	0.9596	0.8238
Spain	1	1	0.8242	0.9663	0.9635	0.9913	0.9840
Sweden	1	1	0.8245	0.9490	0.9873	0.9937	0.9499
UK	2	4	0.6011	0.8859	0.9738	0.9935	0.9947

This table reports the p-values of the Lagrange Multiplier test at different lag lengths under the null hypothesis of no ARCH effects. This test of heteroskedasticity has been performed on the standardized residuals obtained from an AR(1)-EGARCH(p,q) univariate model applied to every country's 5-year CDS spread increments. The sample period spans from January 2008 to December 2010.

Table A.6: BEKK estimations

This table reports the BEKK estimations under the model,

$$\begin{pmatrix}\Delta PC_{r,t}\\ \Delta PC_{s,t}\end{pmatrix} = \begin{pmatrix}\alpha_{11} & 0\\ 0 & \alpha_{22}\end{pmatrix}\begin{pmatrix}\Delta PC_{r,t-1}\\ \Delta PC_{s,t-1}\end{pmatrix} + \begin{pmatrix}\epsilon_{r,t}\\ \epsilon_{s,t}\end{pmatrix}, \quad \epsilon_t \sim N(0, H_t)$$

$$H_t = CC' + \sum_{j=1}^{p} A_j' \epsilon_{t-j}\epsilon_{t-j}' A_j + \sum_{j=1}^{q} B_j' H_{t-j} B_j$$

where b_k^{ij} denotes the i-th row, j-th column element of the matrix B_k, with $k = 1, 2$ the number of variables. The sample period spans from January 2008 to December 2010.

Non-Peripheral (r) *vs* Peripheral (s)			NonEMU (r) *vs* Peripheral (s)		
	Coeff	p-value		Coeff	p-value
α_{11}	0.5643	0.0000	α_{11}	0.2742	0.0008
α_{22}	0.5418	0.0000	α_{22}	0.1142	0.1519
$C^{1,1}$	0.1301	0.2936	$C^{1,1}$	0.0166	0.8027
$C^{2,1}$	0.0099	0.9667	$C^{2,1}$	-0.0372	0.4934
$C^{2,2}$	0.1356	0.0496	$C^{2,2}$	-0.0000	0.9993
$a^{1,1}$	0.5143	0.0001	$a^{1,1}$	1.2308	0.0024
$a^{1,2}$	-0.4379	0.0005	$a^{1,2}$	0.9168	0.0009
$a^{2,1}$	0.2456	0.0877	$a^{2,1}$	-0.3862	0.0054
$a^{2,2}$	1.4798	0.0000	$a^{2,2}$	-0.7171	0.0000
$b_1^{1,1}$	0.9796	0.0000	$b_1^{1,1}$	0.8208	0.0000
$b_1^{1,2}$	0.4454	0.0001	$b_1^{1,2}$	1.0858	0.0000
$b_1^{2,1}$	-0.2960	0.0008	$b_1^{2,1}$	-0.1350	0.1831
$b_1^{2,2}$	0.0757	0.6830	$b_1^{2,2}$	-0.9712	0.0000
Log-Likelihood	-224.6083		Log-Likelihood	-215.1349	

Table A.7: Ljung-Box Test Tests on BEKK residuals

	Non-Peripheral *vs.* Peripheral		NonEMU *vs.* Peripheral	
	Non-Peripheral	Peripheral	NonEMU	Peripheral
Standardized residuals	32.6740 (0.0366)	32.7826 (0.0356)	16.3089 (0.6973)	19.8191 (0.4693)
Squared-standardized residuals	19.5283 (0.4878)	17.9411 (0.5913)	10.4206 (0.9599)	13.1948 (0.8689)

This table reports the Ljung-Box Portmanteau tests for the null of absence of autocorrelation using 20 lags. P-values are reported in parentheses. Residuals come from the BEKK model. The sample period spans from January 2008 to December 2010.

Table A.8: Factor analysis for levels and variance of 5-year CDS increments.

	Mean				Variance			
Country	F1	F2	F3	Uniqueness	F1	F2	F3	Uniqueness
Panel A.- Loading factors								
Austria	0.8697	0.2114	0.2491	0.1177	0.8919	0.0049	0.1831	0.0321
Belgium	0.6322	0.3987	0.4022	0.2238	0.5701	0.2658	0.6348	0.1500
Germany	0.7321	0.3719	0.4475	0.1196	0.7740	0.0617	0.2580	0.2308
Denmark	0.9070	0.2187	0.0479	0.1200	0.8830	-0.0240	0.1031	0.0648
Finland	0.8327	0.2336	0.2589	0.1657	0.9577	0.0035	0.1473	0.0287
France	0.5836	0.5236	0.4921	0.1405	0.5530	0.4403	0.6001	0.1337
Greece	0.1839	0.7644	0.1455	0.3222	-0.0370	0.7738	-0.1619	0.3249
Ireland	0.5399	0.6367	0.0866	0.2239	0.2395	0.5212	0.1955	0.3803
Italy	0.4731	0.6870	0.1175	0.1811	0.0687	0.8759	0.1201	0.1813
Netherlands	0.8349	0.3001	0.1945	0.1087	0.7860	0.0484	0.1466	0.1189
Portugal	0.1173	0.9233	0.0697	0.1220	-0.0600	0.8287	0.0157	0.2640
Spain	0.3247	0.8623	0.1644	0.0757	-0.0301	0.9080	0.2931	0.0766
Sweden	0.8928	0.2004	-0.0427	0.1458	0.9720	-0.0220	0.0557	0.0315
UK	0.7940	0.3008	0.1300	0.1276	0.6843	0.0070	0.0930	0.2255
Panel B.- Explained variance (%)								
Total	55.44	34.94	7.58	–	50.98	29.96	9.58	–

Factor analysis (rotated) for the mean (columns two to four) and variance (columns six to eight) of 5-year CDS spreads increments. Time series of variance have been computed using the Nelson (1991) model. Panel A displays for each country the loading factors of the first three components and their uniqueness. Panel B exhibits the explained variance for each factor. The sample period spans from January 2008 to December 2010.

Table A.9: Variable definitions

Name	Definition	Main references
	Panel A.- Local variables	
LiqCDS	Fitch's Liquidity scores for each 5-year sovereign CDS. The higher the score, the more illiquid the CDS is	Blanco et al. (2005), Longstaff et al. (2005), Tang and Yan (2007), Bongaerts et al. (2011)
StM Local	Main Stock market index for each country. The indexes used are: ATX (Austria), BEL 20 (Belgium), DAX (Germany), OMXC 20 (Denmark), OMXH (Finland), CAC 40 (France), AEX (Netherlands), OMXS 30 (Sweden), and FTSE 100 (UK)	Longstaff et al. (2011), Dieckmann and Plank (2011)
StM Vol	20-day average realized volatility in of domestic stock market indexes using the open-high-low-close volatility estimator of Garman and Klass (1980) in %	Zhang et al. (2009)
Forex	Exchange rate of the domestic currency (Euro, Danish Krone, Swedish Krona or British Pound) relative to USD	
Forex Vol	1-month option implied volatility in % for the Exchange rate of the domestic currency (Euro, Danish Krone, Swedish Krona or British Pound)	Carr and Wu (2007), Hui and Chung (2011)
MP Rate	Monetary policy interest rate. Day-to-day money market interest rates on unsecured loans for each monetary region in %. The indexes used are the Euro OverNight Index Average (EONIA), the Danish Kroner Tomorrow/Next interest rate (DKTONXT), the Stockholm Interbank Offered Rate (STIBOR), and the Sterling OverNight Index Average (SONIA)	
	Panel B.- Global variables	
LiqCDS Sov	Fitch's Liquidity Score for all 5-year sovereign CDS worldwide. The higher the score, the more illiquid the overall sovereign CDS market is	
EuroStoxx50	EuroStoxx50 index	
Vol Premium	Difference between VSTOXX and the 20-day average realized volatility in the EuroStoxx50 index. The VSTOXX is the EuroStoxx50's 1-month option implied volatility in %. The realized volatility measure is calculated using the open-high-low-close volatility estimator of Garman and Klass (1980)	Collin-Dufresne et al. (2001), Pan and Singleton (2008), Carr and Wu (2006) , Carr and Wu (2009), Bollerslev et al. (2009)
Imp Corr	On-the-run CBOE S&P 500 Implied Correlation Index in %	Driessen et al. (2009)
5y Yield	Constant maturity 5-year US Treasury's yield in %	
IG AA-BBB	Price spread between AA and BBB rated European investment grade corporates. Calculated using the IBOXX Euro Corporate Price Indexes for 3-5 year maturity bonds.	
CDS Peripheral	The first factor of 5-year maturity sovereign CDS spreads for all peripheral countries	

The global variables are the same for each country. The local variables are specific for each country. Except the variables Forex, Forex Vol and MP Rate which are specific for each monetary region (Eurozone, Denmark, Sweden and UK). The source of the variables is Markit, Datastream, Thomson Reuters and Yahoo Finance. The displayed references are those that can provide a better description of the variable, or those that use a similar measure in their empirical research.

Table A.10: Regression for 5-year CDS increments

	EMU						Non-EMU		
	Austria	Belgium	Germany	Finland	France	Netherlands	Denmark	Sweden	UK
Cons.	0.000073	0.000089	0.000011	0.000006	0.000037	0.000021	0.000055	0.000019	0.000050
	(0.292)	(0.183)	(0.704)	(0.801)	(0.283)	(0.529)	(0.141)	(0.735)	(0.384)
					Panel A.- Local variables				
ΔLiqCDS	-0.000082	-0.000237	-0.000134	-0.000242*	-0.000173	-0.000252	-0.000095	-0.000230	-0.000796**
	(0.837)	(0.470)	(0.158)	(0.090)	(0.382)	(0.263)	(0.508)	(0.550)	(0.028)
ΔStM Local	-0.000002	-0.000000	0.000001	-0.000000	-0.000001	-0.000005	-0.000008	-0.000002	0.000001
	(0.166)	(0.839)	(0.302)	(0.893)	(0.454)	(0.568)	(0.167)	(0.551)	(0.396)
ΔStM Vol	0.000009	0.000016	-0.000002	0.000001	-0.000021	0.000030	0.000010	0.000051*	0.000029
	(0.626)	(0.533)	(0.825)	(0.887)	(0.194)	(0.146)	(0.417)	(0.086)	(0.317)
ΔForex	0.016306**	0.020345**	0.006924**	0.004710**	0.010953**	0.013328**	0.001430**	0.001381**	0.009109*
	(0.004)	(0.000)	(0.004)	(0.016)	(0.000)	(0.000)	(0.006)	(0.022)	(0.077)
ΔForex Vol	0.000079	0.000097*	0.000045	0.000053**	0.000099**	0.000032	-0.000034	0.000071	0.000091*
	(0.254)	(0.097)	(0.105)	(0.001)	(0.002)	(0.367)	(0.518)	(0.402)	(0.065)
ΔMP rate	0.000271	-0.000089	-0.000023	0.000046	-0.000194	-0.000156	0.000730**	-0.000506	0.000139
	(0.565)	(0.825)	(0.893)	(0.671)	(0.298)	(0.644)	(0.013)	(0.144)	(0.580)
					Panel B.- Global variables				
ΔLiqCDS Sov	0.000338	-0.000020	0.000036	0.000277	-0.000043	0.000545	0.000301	0.000465	0.000271
	(0.592)	(0.962)	(0.863)	(0.197)	(0.887)	(0.143)	(0.281)	(0.268)	(0.608)
ΔEuroStoxx50	-0.000002	-0.000001	-0.000003*	-0.000001*	-0.000000	-0.000001	-0.000001	-0.000000	-0.000004*
	(0.277)	(0.300)	(0.061)	(0.069)	(0.805)	(0.655)	(0.255)	(0.941)	(0.066)
ΔVol Premium	-0.000001	0.000003	-0.000000	-0.000002	-0.000002	-0.000001	-0.000005	0.000002	-0.000005
	(0.847)	(0.539)	(0.963)	(0.354)	(0.452)	(0.829)	(0.306)	(0.751)	(0.442)
ΔImp Corr	0.000000	0.000028	0.000008	-0.000004	0.000016	0.000010	0.000001	-0.000015	0.000027
	(0.997)	(0.251)	(0.564)	(0.659)	(0.416)	(0.495)	(0.971)	(0.423)	(0.301)
Δ5y Yield	0.000411	-0.000314	0.000075	-0.000051	0.000263	-0.000153	-0.000321	-0.000338	0.000076
	(0.366)	(0.289)	(0.631)	(0.726)	(0.223)	(0.521)	(0.181)	(0.336)	(0.804)
ΔIG AA-BBB	0.000251	-0.000109	-0.000028	-0.000036	0.000036	-0.000068	0.000037	-0.000160	-0.000103
	(0.222)	(0.544)	(0.729)	(0.609)	(0.706)	(0.637)	(0.762)	(0.541)	(0.545)
ΔCDS Peripheral	0.003982**	0.001548**	0.001058**	0.001274**	0.000723**	0.001858**	0.002202**	0.002239**	0.002058**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)
Obs.	143	143	143	138	143	131	139	127	111
R^2-Adj Before	0.2206	0.2028	0.2462	0.1752	0.3274	0.2352	0.2332	0.2328	0.3047
R^2-Adj	0.5872	0.3230	0.4927	0.6066	0.4023	0.6097	0.6442	0.5520	0.5602

**Significant at the 5 percent level. *Significant at the 10 percent level.

The p-values (in parentheses) come from White (1980) t-statistics. The "R^2-Adj Before" row refers to the R-squared for the same regression but without including the variable "ΔCDS Peripheral". And the "R^2-Adj" row is the adjusted R-squared for the displayed regression that includes the variable "ΔCDS Peripheral" .The sample period spans from January 2008 to December 2010.

Table A.11: ML estimates for logOU model

Country	κ^Q	$\kappa^Q\theta^Q$	σ^Q	κ^P	$\kappa^P\theta^P$	$\sigma(1)$	$\sigma(5)$	LogLk
Austria	0.0712	-0.4611	0.8831	0.2407	-1.4315	0.0010	0.0005	2585.59
	(0.0083)	(0.0330)	(0.0104)	(0.3718)	(2.0198)	(0.0001)	(0.0000)	
Belgium	0.0555	-0.4507	0.9290	0.3406	-1.8007	0.0007	0.0004	2667.49
	(0.0095)	(0.0393)	(0.0090)	(0.4918)	(2.7401)	(0.0000)	(0.0000)	
Germany	-0.0894	-0.0346	1.1606	1.3854	-8.5424	0.0005	0.0004	2858.69
	(0.0049)	(0.0183)	(0.0128)	(1.0646)	(6.5135)	(0.0000)	(0.0000)	
Denmark	0.0589	-0.5592	1.0416	0.5589	-3.5673	0.0006	0.0003	2785.16
	(0.0093)	(0.0382)	(0.0080)	(0.7000)	(4.2773)	(0.0000)	(0.0000)	
Finland	0.1886	-1.2723	1.1773	1.0127	-6.8512	0.0004	0.0003	2916.18
	(0.0100)	(0.0455)	(0.0078)	(0.7085)	(4.6367)	(0.0000)	(0.0000)	
France	0.0046	-0.3242	1.0321	0.7633	-4.4472	0.0005	0.0004	2792.39
	(0.0033)	(0.0159)	(0.0098)	(0.7005)	(4.1855)	(0.0000)	(0.0000)	
Netherlands	0.1315	-0.8723	1.0201	0.4747	-3.0049	0.0005	0.0003	2768.82
	(0.0076)	(0.0339)	(0.0069)	(0.5523)	(3.3628)	(0.0000)	(0.0000)	
Sweden	0.1637	-0.9531	1.0207	0.4421	-2.9870	0.0005	0.0004	2767.79
	(0.0075)	(0.0324)	(0.0065)	(0.4035)	(2.5018)	(0.0000)	(0.0000)	
United Kingdom	0.1649	-0.9301	1.0561	0.3533	-2.2637	0.0007	0.0003	2737.86
	(0.0090)	(0.0365)	(0.0091)	(0.4385)	(2.7568)	(0.0000)	(0.0000)	

This Table provides the maximum likelihood estimates for the Pan and Singleton (2008) model. Standard errors are in parenthesis. κ^Q, θ^Q and σ^Q denote the mean reversion, long run mean and instantaneous volatility of default intensity process λ^Q under the Q probability measure, respectively. Analogously, κ^P and θ^P are the mean reversion rate and long run mean under the objective measure P. $\sigma(M)$ is the deviation of CDS spread misspricing for maturities 1 and 5-years. Weekly data are used from January 2008 to December 2010.

Table A.12: Projections of sample values onto fitted values for logOU model

	$\Delta CDS_t^{sample} = \beta_0 + \beta_1 \Delta CDS_t^{theo} + \epsilon_t$				
Maturity	$\hat{\beta_0}$	$\hat{\beta_1}$	R^2	std. res. (bps)	N
1 Year	-0.00	1.16	0.65	5.23	1305
	(0.00)	(0.02)			
5 Year	0.00	0.89	0.84	3.08	1305
	(0.00)	(0.01)			
Overall	0.00	0.99	0.72	4.39	2610
	(0.00)	(0.01)			

This Table shows the projections of CDS data increments onto their model counterparts, respectively. Standard deviation of the coefficients are in parenthesis. Standard deviation of residuals (std. res.) are shown in basis points.

Table A.13: Decomposition of CDS for Non-peripheral countries

	Risk premium (bps)			Risk premium Fraction		
Country	Mean	Median	Std.	Mean	Median	Std.
Austria	30.28	28.29	28.53	0.27	0.39	0.26
Belgium	15.39	7.03	23.86	0.03	0.13	0.36
Germany	13.58	13.33	17.29	0.08	0.45	0.76
Denmark	23.63	16.29	27.10	0.35	0.48	0.37
Finland	18.29	16.19	14.69	0.56	0.62	0.18
France	17.60	14.05	21.84	0.11	0.36	0.59
Netherlands	19.96	17.33	19.73	0.36	0.46	0.26
Sweden	30.12	23.51	25.78	0.58	0.61	0.13
United Kingdom	37.05	38.15	23.96	0.53	0.58	0.10

Descriptive statistics of risk premium for 5-year CDS spreads. Risk premium is computed as the difference between CDS^Q and CDS^P. Risk premium fraction is the ratio between risk premium and CDS^Q. Risk premiums are in basis points.

Table A.14: Regression for risk premium

	EMU						Non-EMU		
	Austria	Belgium	Germany	Finland	France	Netherlands	Denmark	Sweden	UK
Cons.	0.000032	0.000052	0.000004	-0.000007	0.000025	0.000002	0.000028	0.000007	0.000033
	(0.461)	(0.230)	(0.898)	(0.808)	(0.508)	(0.941)	(0.483)	(0.865)	(0.442)
					Panel A.- Local variables				
ΔLiqCDS	-0.000090	-0.000045	-0.000121	-0.000254	0.000051	-0.000251	-0.000080	-0.000123	-0.000683
	(0.725)	(0.810)	(0.171)	(0.275)	(0.786)	(0.201)	(0.624)	(0.689)	(0.015)
ΔStM Local	-0.000001*	0.000000	0.000000	0.000000	-0.000000	-0.000001	-0.000009*	0.000000	0.000000
	(0.095)	(0.838)	(0.845)	(0.731)	(0.989)	(0.897)	(0.088)	(0.925)	(0.883)
ΔStM Vol	0.000012	0.000011	0.000000	-0.000009	-0.000006	0.000010	0.000013	0.000049**	0.000005
	(0.383)	(0.476)	(0.993)	(0.399)	(0.692)	(0.599)	(0.394)	(0.033)	(0.771)
ΔForex	0.008044**	0.011537**	0.003681	0.004790*	0.008823**	0.006266**	0.000653	0.001133**	0.001871
	(0.012)	(0.001)	(0.184)	(0.074)	(0.001)	(0.036)	(0.221)	(0.007)	(0.646)
ΔForex Vol	0.000081*	0.000060*	0.000041	0.000087**	0.000084**	0.000030	-0.000039	0.000085	0.000121**
	(0.083)	(0.062)	(0.166)	(0.010)	(0.005)	(0.265)	(0.220)	(0.134)	(0.001)
ΔMP rate	0.000021	-0.000091	-0.000069	-0.000155	-0.000235	-0.000101	0.000196	-0.000339	0.000141
	(0.940)	(0.688)	(0.693)	(0.418)	(0.278)	(0.740)	(0.440)	(0.251)	(0.324)
					Panel B.- Global variables				
ΔLiqCDS Sov	0.000226	0.000008	0.000027	0.000166	-0.000159	0.000251	0.000218	0.000335	0.000114
	(0.581)	(0.976)	(0.906)	(0.643)	(0.627)	(0.458)	(0.450)	(0.307)	(0.833)
ΔEuroStoxx50	-0.000001	-0.000001	-0.000002	-0.000001	-0.000001	-0.000001	-0.000001	-0.000000	-0.000002
	(0.567)	(0.152)	(0.242)	(0.222)	(0.432)	(0.186)	(0.192)	(0.797)	(0.129)
ΔVol Premium	-0.000002	0.000004	-0.000003	-0.000004	-0.000002	-0.000007*	-0.000003	0.000007	-0.000004
	(0.671)	(0.191)	(0.483)	(0.259)	(0.572)	(0.050)	(0.505)	(0.172)	(0.341)
ΔImp Corr	0.000003	0.000022	0.000015	-0.000000	0.000015	0.000006	-0.000001	-0.000009	0.000007
	(0.867)	(0.161)	(0.294)	(0.994)	(0.380)	(0.642)	(0.941)	(0.568)	(0.698)
Δ5y Yield	0.000318	-0.000111	0.000315	0.000078	0.000294	-0.000130	-0.000172	-0.000061	-0.000061
	(0.267)	(0.533)	(0.139)	(0.683)	(0.195)	(0.544)	(0.549)	(0.838)	(0.798)
ΔIG AA-BBB	0.000085	-0.000077	-0.000063	-0.000075	-0.000038	-0.000029	-0.000046	-0.000107	-0.000049
	(0.537)	(0.475)	(0.603)	(0.469)	(0.686)	(0.797)	(0.690)	(0.595)	(0.679)
ΔCDS Peripheral	0.002299**	0.000954**	0.000941**	0.000914**	0.000710**	0.001203**	0.001633**	0.001645**	0.001302**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.003)	(0.000)	(0.000)	(0.000)	(0.000)
Obs.	143	143	143	138	143	131	139	127	111
R^2-Adj Before	0.1847	0.1883	0.1745	0.1271	0.2231	0.1887	0.1457	0.2463	0.3393
R^2-Adj	0.5384	0.3035	0.3498	0.3339	0.2969	0.4435	0.4427	0.5313	0.5459

**Significant at the 5 percent level. *Significant at the 10 percent level.

The p-values (in parentheses) come from White (1980) t-statistics. The "R^2-Adj Before" row refers to the R-squared for the same regression but without including the variable "ΔCDS Peripheral". And the "R^2-Adj" row is the adjusted R-squared for the displayed regression that includes the variable "ΔCDS Peripheral" .The sample period spans from January 2008 to December 2010.

Table A.15: Regression for default risk

	EMU						Non-EMU		
	Austria	Belgium	Germany	Finland	France	Netherlands	Denmark	Sweden	UK
Cons.	0.000029	0.000031	0.000001	-0.000001	0.000004	0.000002	0.000007	0.000004	0.000016
	(0.336)	(0.299)	(0.843)	(0.835)	(0.573)	(0.874)	(0.455)	(0.753)	(0.395)
					Panel A.- Local variables				
ΔLiqCDS	-0.000049	-0.000079	-0.000012	-0.000037	0.000001	-0.000102	-0.000019	-0.000045	-0.000310**
	(0.770)	(0.562)	(0.108)	(0.258)	(0.976)	(0.201)	(0.610)	(0.627)	(0.020)
ΔStM Local	-0.000001**	-0.000000	0.000000	0.000000	0.000000	-0.000001	-0.000002	0.000000	0.000000
	(0.026)	(0.568)	(0.953)	(0.851)	(0.690)	(0.678)	(0.118)	(0.867)	(0.904)
ΔStM Vol	0.000009	0.000009	-0.000000	-0.000001	-0.000001	0.000005	0.000004	0.000015**	0.000005
	(0.334)	(0.439)	(0.640)	(0.351)	(0.731)	(0.541)	(0.250)	(0.021)	(0.576)
ΔForex	0.006315**	0.008212**	0.000308	0.000746*	0.001581**	0.002586**	0.000135	0.000340**	0.000806
	(0.005)	(0.001)	(0.214)	(0.058)	(0.008)	(0.035)	(0.241)	(0.006)	(0.649)
ΔForex Vol	0.000062*	0.000050*	0.000003	0.000012**	0.000016**	0.000012	-0.000006	0.000027*	0.000054**
	(0.050)	(0.054)	(0.219)	(0.008)	(0.014)	(0.240)	(0.418)	(0.098)	(0.002)
ΔMP rate	-0.000012	-0.000014	-0.000005	-0.000023	-0.000046	-0.000039	0.000046	-0.000072	0.000050
	(0.947)	(0.931)	(0.716)	(0.359)	(0.321)	(0.736)	(0.365)	(0.426)	(0.472)
					Panel B.- Global variables				
ΔLiqCDS Sov	0.000135	0.000001	0.000006	0.000020	-0.000024	0.000109	0.000034	0.000110	0.000068
	(0.623)	(0.996)	(0.743)	(0.684)	(0.696)	(0.408)	(0.631)	(0.259)	(0.772)
ΔEuroStoxx50	-0.000000	-0.000001	-0.000000	-0.000000	-0.000000	-0.000000	-0.000000	-0.000000	-0.000001
	(0.868)	(0.243)	(0.360)	(0.303)	(0.265)	(0.399)	(0.137)	(0.717)	(0.118)
ΔVol Premium	-0.000002	0.000003	-0.000000	-0.000000	0.000000	-0.000002*	-0.000001	0.000002	-0.000002
	(0.566)	(0.234)	(0.513)	(0.332)	(0.943)	(0.072)	(0.601)	(0.130)	(0.272)
ΔImp Corr	0.000003	0.000017	0.000002	-0.000000	0.000003	0.000002	0.000000	-0.000002	0.000003
	(0.795)	(0.151)	(0.122)	(0.901)	(0.315)	(0.629)	(0.952)	(0.682)	(0.709)
Δ5y Yield	0.000221	-0.000148	0.000015	0.000007	0.000049	-0.000048	-0.000028	0.000013	-0.000023
	(0.251)	(0.269)	(0.262)	(0.792)	(0.213)	(0.575)	(0.692)	(0.883)	(0.836)
ΔIG AA-BBB	0.000079	-0.000084	-0.000002	-0.000008	-0.000007	-0.000011	-0.000010	-0.000026	-0.000031
	(0.411)	(0.383)	(0.803)	(0.600)	(0.733)	(0.811)	(0.723)	(0.669)	(0.570)
ΔCDS Peripheral	0.001297**	0.000531**	0.000043**	0.000098**	0.000087**	0.000342**	0.000254**	0.000423**	0.000513**
	(0.000)	(0.000)	(0.001)	(0.001)	(0.038)	(0.000)	(0.000)	(0.000)	(0.000)
Obs.	143	143	143	138	143	131	139	127	111
R^2-Adj Before	0.2523	0.2636	0.2125	0.1437	0.2386	0.1832	0.1639	0.2612	0.3451
R^2-Adj	0.5104	0.3317	0.2785	0.2703	0.2663	0.3298	0.3075	0.4851	0.5128

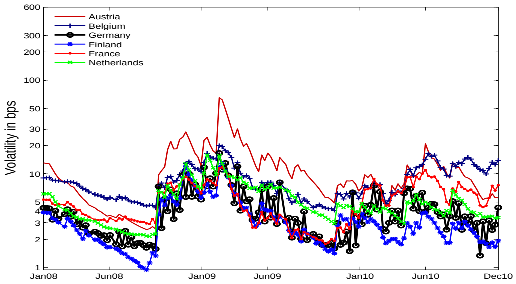
**Significant at the 5 percent level. *Significant at the 10 percent level.

The p-values (in parentheses) come from White (1980) t-statistics. The "R^2-Adj Before" row refers to the R-squared for the same regression but without including the variable "ΔCDS Peripheral". And the "R^2-Adj" row is the adjusted R-squared for the displayed regression that includes the variable "ΔCDS Peripheral" .The sample period spans from January 2008 to December 2010.

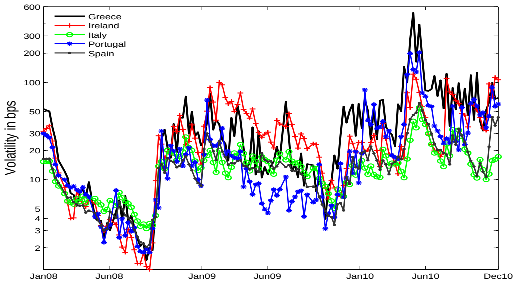
Appendix B. Figures

Figure B.1: Volatility of 5-year CDS spread changes

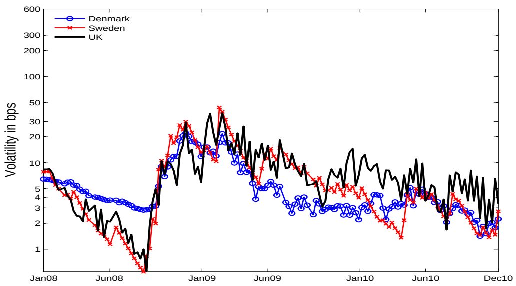
Panel A.- Central EMU countries



Panel B.- Peripheral EMU countries



Panel C.- Non-EMU countries



This graph plots in a logarithmic scale (base 10) the conditional volatility (in basis points) from the estimated AR(1)-EGARCH(p,q) model for 5-year sovereign CDS spread increments. Central EMU countries are Austria, Belgium, Germany, Finland, France and Netherlands. The peripheral EMU countries are Portugal, Ireland, Italy, Greece and Spain. Non-EMU countries are Denmark, Sweden and UK. The sample frequency is weekly and it spans from January 2008 to December 2010.

Figure B.2: Time-varying conditional correlation between factors

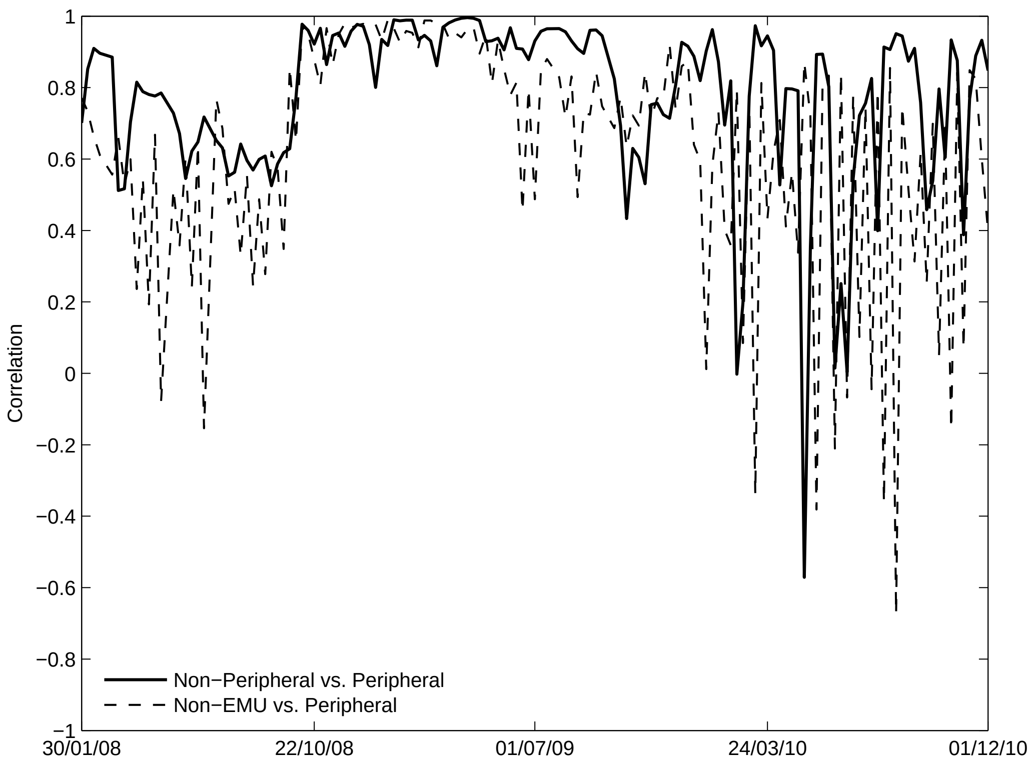
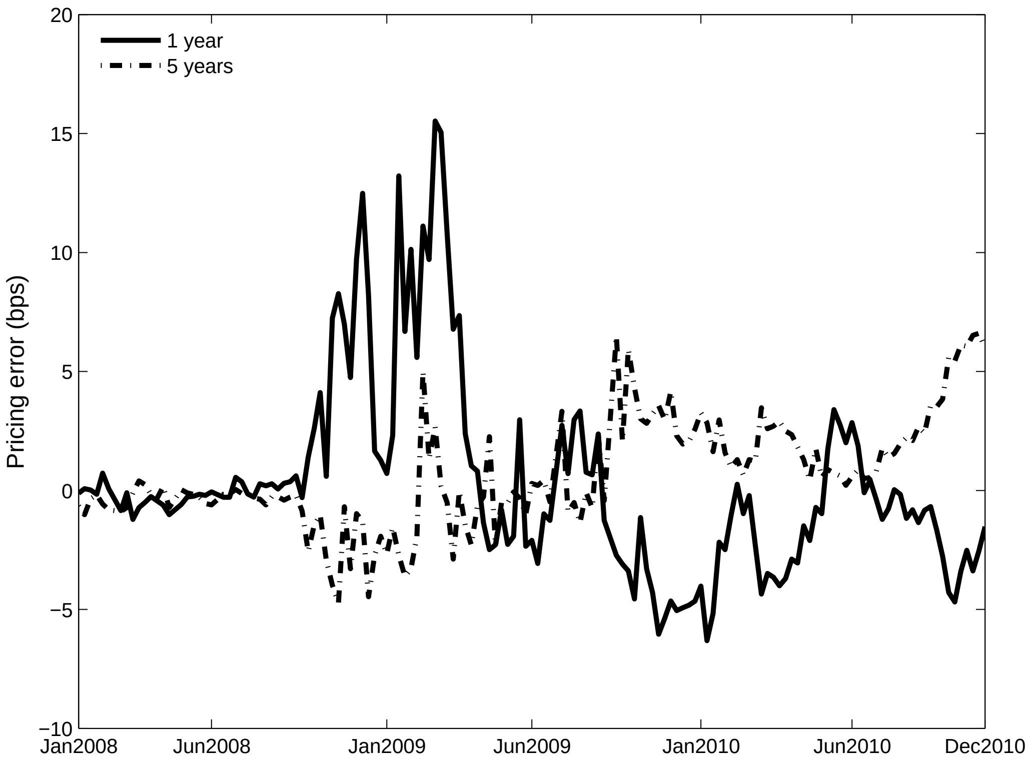


Figure B.3: Averaged pricing errors over time

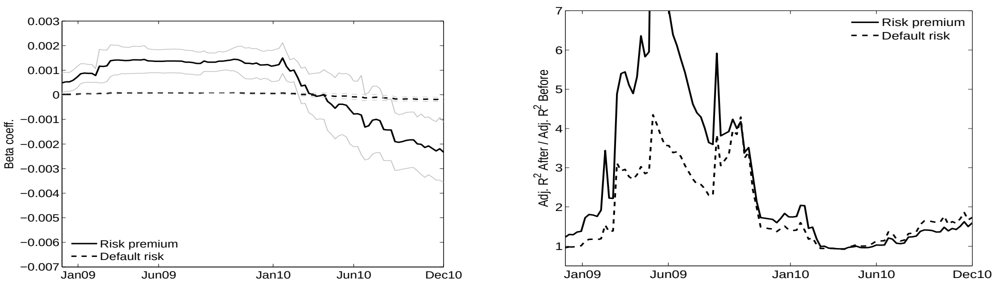


Averaged pricing errors for 1- and 5-years CDS spreads, respectively. Theoretical spreads are computed using ML estimates of Pan and Singleton (2008) model in Table A.11. The sample frequency is weekly and it comprises from January 2008 to December 2010.

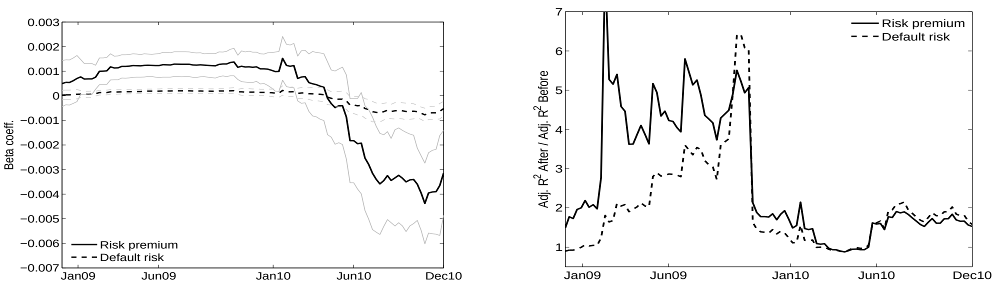
Figure B.4: Rolling window regressions

Time varying beta	Added explanatory power

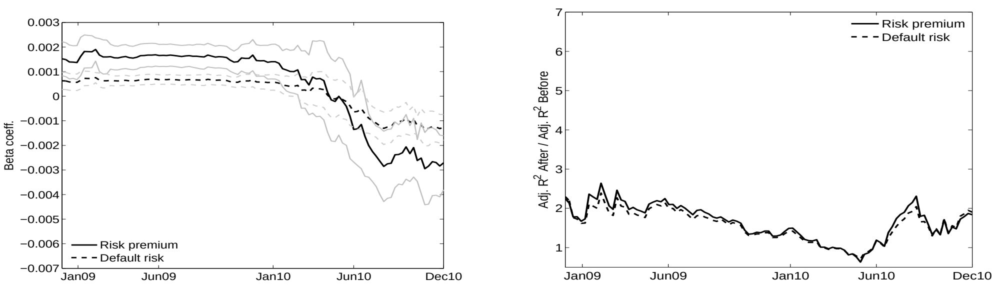
Panel A.- Germany



Panel B.- France



Panel C.- United Kingdom



The graphs come from regressions with a rolling window of 1 year. The regressions are estimated by OLS. The graphs in the first column are the beta sensitivities to the first factor of the peripheral countries. The grey lines represent the 95% confidence interval using White (1980) standard errors. The second column is the ratio of the Adj. R^2 from the regression that includes the first factor of peripheral CDS, and the Adj. R^2 from the same regression without including the first factor of peripheral CDS.