Has the CDS market influenced the borrowing cost of European countries during the sovereign crisis?

Anne-Laure Delatte* Mathieu Gex† Antonia López-Villavicencio‡

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Abstract

This paper assesses the potential influence of the growing CDS market on the borrowing cost of sovereign states during the European sovereign crisis. We analyze the sovereign debt market to ascertain the pattern of information transmission between the CDS and corresponding bond markets. Our methodological innovation is the use of a non-linear specification rather than the linear VECM specification customarily employed. Using a panel smooth transition model during 2008-2010 period, we find that: 1) linearity tests clearly reject the null hypothesis of a linear transmission mechanisms between the bond and the CDS markets; 2) market distress alters the mutual influence and 3) the higher the distress the more the CDS market dominates the information transmission between CDS and bond markets.

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1 Introduction

The recent European sovereign debt crisis has raised concerns regarding the use of credit default swaps (CDS). It has been suspected that a few investors drove up the prices in the CDS market, a fact that may have influenced the funding cost of sovereign states. This issue has attracted much interest in policy circles because overreactions in the CDS market may have exacerbated the sovereign debt crisis. The CDS premia of Greece, Spain, Portugal and other European countries have reached record highs (see Fig. A.1 in the appendix). Have these dynamics influenced the sovereign bond cash market during the financial crisis? If this were the case, it would be the case that derivatives spurred financial instability rather than reducing risk (Stulz (2010)). This paper precisely assesses the potential influence of the growing CDS

*Rouen Business School. 1, rue du Maréchal Juin, 76130 Mont-Saint-Aignan, France. E-mail: ald@rouenbs.fr.

†Banque de France and University of Grenoble. DGO, DSF, 31, rue Croix des petits champs, 75001 Paris, France. E-mail: Mathieu.GEX@banque-france.fr

‡*Corresponding author.* CEPN-CNRS, University of Paris North, UFR de Sciences Economiques 99, Avenue Jean-Baptiste Clément 93430 Villetaneusse, France. E-mail: lopezvillavicencio@univ-paris13.fr. Tel: +33 0149402087/Fax: +33 0149403334

market on the borrowing cost of sovereign states. It is a topical issue likely to have an impact on the policy agenda for the regulation of financial markets.

Credit default swaps, the most commonly traded credit derivatives, are bilateral contracts between a buyer and seller under which the seller sells protection against the credit risk of the reference entity. The buyer pays a periodic premium to the seller. There is a strong relationship between the spread of a bond in respect with the risk-free rate and the premium of a credit default swap on the same reference entity of the same maturity. When the budget balance of a sovereign state deteriorates, the risk increases, which simultaneously increases the bond spread and the insurance cost, priced in the sovereign CDS premium. This arbitrage relationship between the derivative and the underlying market raises the issue of which market influences the other. More precisely, which market leads the price discovery process?

On the one hand, the net outstanding amount of CDS on European sovereign names was 2 trillion USD in May 2010, i.e. only a small proportion of the underlying government bonds market. Therefore, it has been argued that this small market could not influence the underlying cash market. On the other hand, the liquidity of the CDS market has increased significantly since 2008 which has allowed investors to leverage their opinion on sovereign credit risk. The CDS market may thus have gained much influence since then. This has constituted a key issue in the recent literature on CDS.

So far, empirical studies on sovereign CDS have focused on emerging countries because it was where the CDS were originally traded. In these markets evidence mostly converge towards a lead of the CDS market. On a sample of 8 emerging countries, Bowe, Klimavicienne and Taylor (2009) conclude to the lead of the CDS market. Ammer and Cai (2007), on a different sample of 7 emerging countries, find that the price discovery process occurs on the CDS when underlying bonds are relatively illiquid. To our knowledge, few articles have focused on CDS of developed countries, due to their recent emergence. Some exceptions include Coudert and Gex (2010) who worked on a sample of countries from the Euro zone and found that in the low-yield countries, the price discovery process takes place in the bond market. They found that the direction changes in high-yield countries[1]. An empirical investigation conducted by the European Commission on how the sovereign CDS and bond markets interact finds that changes in spreads in the two markets are mainly contemporaneous (European Commission, 2011).

However, a limit of the existing literature is that they assume a continuous and constant price discovery process (PDP in the following). Yet, it seems unrealistic to consider that the transmission from one market to the other always occurs in the same direction. The demand for protection is heterogeneous as the perception of risk in the market. The interaction of heterogeneous agents may realistically produce nonlinear systems as it has been theoretically evidenced by Hommes and Wagener (2009). By relaxing the linear PDP assumption, we can test whether or not the lead reverses above a certain (high) level of uncertainty/spread instead. Globally, our proposition is that the direction is neither continuous nor constant. Rather, the market where the price is primarily discovered may depend on some economic factors. To verify this assumption and to find the determinants of nonlinearity are precisely the objectives of this paper.

[1] Bowe et al. (2009) find the same pattern.

To address this issue, we adopt a nonlinear approach by introducing threshold effects in a linear error correction model of the price discovery process. More precisely, we rely on a panel smooth transition model for the adjustment process, initially proposed by González, Teräsvirta and van Dijk (2005). This modeling strategy allows us to relax the restricting hypothesis of a constant adjustment toward equilibrium. On the contrary, in our model, the adjustment speed smoothly changes as a function of economic variables.

Regarding the data, the construction of our sample is constrained by the availability and quality of developed sovereign CDS premia from January 2008. To overcome the issue of the structural break due to the Lehman bankruptcy during this period we estimate our model on two periods one starting in January 2008 and the other on September 15, 2008 and ending in July 2010. Last, in order to check the robustness of our results, we estimate our model on an individual basis for two high-risk profile countries, Greece and Belgium, which present data available from January 2006.

We find evidence that the adjustment process to the equilibrium relationship between CDS premia and bond spreads is not linear. On the contrary, it depends on market characteristics and varies with the level of market distress. Our results suggest two extreme dynamics. The bond market plays a dominant role in the price discovery process only in the core European countries during calm periods. However, the higher the distress the more the CDS market dominates the information transmission between CDS and bond markets. In the high-yield economies, we find that the CDS market has a dominant role over all regimes.

This remainder of this paper is organized as follows. The next section explains the interaction between the CDS market and the underlying bond market. Section 3 presents our methodology to examine the price discovery process and Section 4 our data set. Section 5 presents the empirical results. Finally, Section 6 concludes the paper.

2 Sovereign CDS Market and the Price Discovery Process: An Overview

The emergence of the activity on developed sovereign CDS is relatively recent phenomenon. Initially, the majority of the protection traded through CDSs regarded corporate reference entities. Prior to the crisis, participants had little incentives to negotiate CDS on developed countries, as sovereign risk was considered as insignificant for highly-rated countries. Yet, the modification of the perception of sovereign risk, following the set up of massive rescue plans and the deterioration of public balance, has led to an increasing activity on this segment of the CDS market. Notional amounts outstanding of sovereign CDS increased by 76% between December 2006 and December 2009 according to the BIS semiannual Over-The-Counter (OTC) market derivatives statistics (Bank for International Settlements (2010)).

However the sovereign CDS market, with notional amounts outstanding of 1.9 trillion USD, is still dwarfed by the size of the underlying market, amounting 36.4 trillion USD in December 2009 (BIS, 2010)[2]. In spite of the strong activity on sovereign CDSs, the ratio of gross notional amounts of CDS to outstanding amounts of underlying debt ranged between 3% and 33% for eurozone countries end-2009, far from the levels observed for corporate, exceeding

[2]This is contrary to corporate CDS notional amounts, which have nearly outsized the bond market.

100% in most cases[3]. As the volume of sovereign CDS of developed countries is dramatically small relative to the underlying government bonds, opponents of regulation argue that the CDS market cannot affect the bond market. Yet, the volume is probably not the main factor in determining price leadership. To understand it, it is important to identify how the transmission from one market to the other takes place.

There is a strong relationship between the spread of a bond and the premium of a CDS on the same maturity-same reference entity. Indeed, in theory, an investor may conduct a risk-free strategy combining the purchase of a CDS and of a bond with floating interest rate. At maturity, with or without credit event, the investor receives the notional, which makes this investment risk-free. Without a credit event, the investor receives floating Libor plus the credit spread (Spread). He/she pays Libor plus the CDS premium (CDS) (assuming a zero funding-margin to simplify). In the case of a credit event, the investor receives the principal amount of the bonds or, according to the details of the contract, a payment equal to the principal amount of the bonds minus their current value at the time of default. Hence, the parity between the bond spread and the CDS premium in absence of arbitrage opportunity (Duffie (1999), Hull, Predescu and White (2004) and Hull and White (2000)).

In reality, bond and CDS spreads are not at parity for several reasons, such as accrued interest, the cheapest-to-deliver option and counter-party risk. The existence of the basis, defined as the difference between the CDS premium and the bond spread has motivated financial strategies, called basis strategies, allowing to take either arbitrage or credit positions (Olleon-Assouan (2004)). For example, in the case of a negative basis ($CDS < Spread$), if the investor buys an obligation and the corresponding CDS, she gets a higher bond spread than the CDS premium she has to pay. Such strategy levels off the basis: the purchase of the CDS and the bond increases the CDS premium and reduces the corresponding bond spread respectively. It illustrates the transmission of price variations across the derivative and the underlying market. The transmission raises the issue of which market influences the other. Which market does lead the price discovery process? This has constituted a key issue in the recent literature on CDS.

The limit of the previous investigations is that they assume a linear price discovery process. We propose that it is more realistic to assume that the interaction of heterogeneous agents with different financial strategies may produce highly nonlinear systems (Hommes and Wagener (2009)). In the following Section we present the methodology of our paper.

3 Methodology

We first present the empirical strategy employed by existing studies to examine this issue and second we introduce the nonlinear model that overcomes the limits of the linear specifications.

[3]By the end-2009, the 6 most traded reference entities in terms of gross notional were sovereigns, including Italy and Spain, with notional of respectively 223 billion USD and 94 billion USD, according to DTCC.

3.1 The linear specification

Existing studies accurately use a vector error correction model (VECM) to examine the individual adjustment processes toward the long-term cointegration relationship. In fact, suppose that the efficient price is primarily discovered in a market, the price in the other market tends to converge to the price in the primary market, and thus the adjustment of the main market price is slower than the other price. This mechanism can be described by a VECM where the intensities of the price adjustments are measured by the error correction coefficients.

In theory, arbitrage activities imply that CDS and bond spreads should co-move together. Thus, the CDS and bond spreads for the same sovereign and maturity should have a long-run relationship (i.e. they are cointegrated). Following the previous considerations and in a panel data framework, this relationship can be express as follows:

$$CDS_{it} = \mu_i + \alpha_1 Bond_{it} + z_{it} \tag{1}$$

where i denotes the country ($i = 1, ..., N$), t the time dimension ($t = 1, ..., T$), Bond is a sovereign bond spread , CDS is the premium of the CDS contract on the subordinated bond with same maturity, μ_i denotes the country-specific intercepts, and $z_{i,t}$ is the vector of errors. In theory, $\alpha_1 = 1$, i.e. CDS and bond spreads should be proportional, at the exception of institutional factors such as the difference in transaction costs, represented by a constant individual fixed effects, μ_i.

Equation (1) represents the efficient price following a random walk process with equilibrium, given by $z_{it} = 0$. Theory predicts that, if the CDS and bond spreads are cointegrated, at least one of the spreads adjusts back to equilibrium in case of short-run deviations, or misalignments in the relationship (Engle and Granger (1987)). Hence, disequilibrium is given by:

$$z_{it} = CDS_{it} - \hat{\alpha}_1 Bond_{it} - \hat{\mu}_{it} \tag{2}$$

The contribution of price discovery can be assessed through the adjustment process of both spreads. Indeed the market where the price is primarily discovered leads the other. It implies that the market that follows the other adjusts more rapidly to target. In this sense, in order to investigate the adjustment speed towards the equilibrium, linear studies rely on the following panel VECM of market prices:

$$\Delta CDS_{it} = \lambda_1(CDS_{it-1} - \alpha_1 Bond_{it-1} - \mu_{i,t-1}) + \beta_{1j} \sum_{j=1}^{p} \Delta X_{it-j} + \varepsilon_{1it} \tag{3}$$

$$\Delta Bond_{it} = \lambda_2(CDS_{it-1} - \alpha_1 Bond_{it-1} - \mu_{i,t-1}) + \beta_{2j} \sum_{j=1}^{p} \Delta X_{it-j} + \varepsilon_{2it} \tag{4}$$

where λ_1 and λ_2 are the error correction coefficients (ECC) of the CDS premium and bonds spread, respectively, $X_{it} = [Bond_{it}, CDS_{it}]$, such that $\hat{\beta}_{1j}$ and $\hat{\beta}_{2j}$ stand for the estimated short-term effects and ε_{1it} and ε_{2it} are i.i.d shocks.

The contribution of price discovery depends on the relative values of λ_1 and λ_2. If the CDS market adjusts to incorporate information, then λ_1 is negative and statistically significant. In this case, it means that the bond market contributes to the price discovery process in the sense that the CDS adjusts to the price determined on the bond market. If the bond market adjusts toward equilibrium, then λ_2 will be positive and statistically significant. In this case, we conclude that the CDS is significant in the price discovery process. If both coefficients are significant, then both markets contribute to price discovery. The dominant market in the price discovery process has the lower adjustment speed. In other words, if the adjustment speed of the bonds is lower than that of the CDSs ($\lambda_2 < \lambda_1$), the bonds has a dominant role in price discovery and thus it leads the CDS market.

As an alternative way to identify where the price discovery takes place, Baba and Inada (2007), among others, use the price discovery measure of Gonzalo and Granger (GG), calculated as follows:

$$GG = \frac{\lambda_2}{\lambda_2 - \lambda_1} \tag{5}$$

Based on (4), the CDS (bonds) market has a dominant role in price discovery when GG is larger (smaller) than 0.5.

3.2 Introducing threshold effects: the nonlinear model

As mentioned before, a drawback of the previous specification is that it implicitly assumes that the speed of adjustment is continuous and of constant speed. In other words, the reversion is independent of the characteristics of the market. A way to overcome this restriction is to relax the linearity hypothesis by allowing λ_1 and λ_2 to vary according to market conditions.

To address this issue, and based on González et al. (2005), we introduce threshold effects in the linear error correction model presented in Equations (3) and (4). These models have several interesting features that make them suitable for our purposes. First, the error correction coefficient is allowed to vary according to observable economic variables. More precisely, the observations in the panel are divided into a small number of homogenous groups or "regimes", with different coefficients depending on the regimes. Second, regression coefficients are allowed to change gradually when moving from one group to another: the Panel Smooth Transition Regression model (PSTR) is a regime-switching model where the transition from one regime to the other is smooth rather than discrete. Finally, individuals are allowed to change between groups over time according to changes in the "threshold variable".

Following Béreau, López-Villavicencio and Mignon (2010), the Panel Smooth Transition Error Correction Model can be specified as follows:

$$\Delta CDS_{it} = \lambda_1(z_{i,t-1}) + \lambda_1^{*} z_{i,t-1} * g(s_{it;}\gamma, c) + \beta_{1j} \sum_{j=1}^{p} \Delta X_{it-j} + \varepsilon_{1it} \tag{6}$$

$$\Delta Bond_{it} = \lambda_2(z_{i,t-1}) + \lambda_2^{*} z_{i,t-1} * g(s_{it;}\gamma, c) + \beta_{2j} \sum_{j=1}^{p} \Delta X_{it-j} + \varepsilon_{2it} \tag{7}$$

with $z_{i,t-1}$ representing the last's period deviation from equilibrium (i.e $z_{it} = CDS_{it} - \hat{\alpha}_1 Bond_{it} - \hat{\mu}_{it}$). In Equations (6) and (7), $g\left(s_{i,t};\gamma,c\right)$ is the transition function defined by:

$$g\left(s_{i,t};\gamma,c\right) = \left[1+\exp\left(-\gamma\prod_{j=1}^{m}\left(s_{i,t}-c_j\right)\right)\right]^{-1} \tag{8}$$

This function is continuous, normalized and bounded between 0 and 1, γ is the speed of transition, and c denotes the threshold parameter ($c_1 \leq c_2 \leq ... \leq c_m$). Depending on the realization of the transition variable $s_{i,t}$, the cointegration relationship between the CDS and the Bond will be specified by a continuum of parameters, namely λ_i in Regime 1 (when $g(.) = 0$), and $\lambda_i + \lambda_i^*$ in Regime 2, when $g(.) = 1$. In eq. (8), g can be either a first-order logistic function (when m=1), in which case the two regimes are associated with small and large values of the transition variable relative to the threshold or an exponential function (when m=2) which, contrary to the logistic model, is characterized by symmetric dynamics in the two extreme regimes.

In other words, this model allows us to investigate if non-linearity in the reversion towards equilibrium could be associated with changes in the transition variable. Indeed, whereas the error correction coefficient in a linear model is constant and equal to λ_1 et λ_2 in Equations (3) and (4), in the PSTR model these coefficients vary between countries and time according to the value of the transition function which changes for each country in each period. In particular, the error correction coefficients (ECC) for the ith country at time t is defined as a weighted average of the parameters λ_1 and λ_1^* for the CDS and λ_2 and λ_2^* for the Bond:

$$ECC = \lambda_i + \lambda_i^* g(s_{it};\gamma,c) \tag{9}$$

As seen, the nonlinear specification allows the speed of adjustment to vary according to the value of the transition variable for each country and each period. This is an interesting advantage of the PSTR since, contrary to the linear specification that assumes a common ECC, our specification allows for sufficient heterogeneity given by the value of the transition function which, in turn, depends on the transition variables. In particular, we test whether the price formation in the CDS and bond markets depends on the following market characteristics:

$$s_{it} \in Q = \{CDS_{i,t-p}, Bonds_{i,t-p}, z_{i,t-p}, \Delta CDS_{i,t-p}, \Delta Bonds_{i,t-p}\}$$

Firstly, we test whether the PDP varies with the level of market distress, proxied by the level of spreads with $CDS_{i,t-p}$ and $Bond_{i,t-p}$ and by the volatility in the market with $\Delta CDS_{i,t-p}, \Delta Bonds_{i,t-p}$. Alternatively we include $z_{i,t-p}$, the short-run deviations from the long-run relationship, as a proxy for market confusion. Notice that these deviation can be either positive (when the CDS is higher that the bond) or negative (when the bond is higher than the CDS). We expect that above a certain threshold level, the direction reverses and the CDS influences the PDP.

As in the previous linear specification, the GG measure can be used in order to identify where the price discovery takes place. An advantage of the nonlinear specification is that GG can take a continuum of values depending on the transition function as follows:

$$GG = \frac{\lambda_2 + \lambda_2^* g(s_{it}; \gamma, c)}{[\lambda_2 + \lambda_2^* g(s_{it}; \gamma, c)] - [\lambda_1 + \lambda_1^* g(s_{it}; \gamma, c)]} \tag{10}$$

In sum, this specification takes into account the non-constancy of the adjustment process towards equilibrium. This is so because we allow the ECC to depend on economic variables. To our knowledge, this econometric procedure is novel in its application to the price discovery process in the CDS market. The following Section presents our data set.

4 Data description

Our investigation assesses the process of price discovery in the sovereign CDS and bond markets in developed member-States of the European Union. Central and Eastern European countries Union members are thus excluded from the sample.

To investigate the relationship between the CDS and the bonds markets, we need data of the same maturity. We select the 5-year maturity, which is the most traded in the CDS market. Firstly, we select CDS of Western European countries that are liquid enough to produce reliable prices data across time. Secondly, we compute bond spreads, defined as the difference between the bond yield and the risk free rate of the same maturity. To do so, we use the 5-year German yield, which is the benchmark risk free rate for the euro area, and the 5-year government yield of the country. Our choice for the risk-free rate is explained in Appendix D. Data of the bond yields and the 5-year senior CDS premia are taken from Bloomberg and Datastream respectively.

The construction of our sample is constrained by the availability and quality of developed sovereign CDS premia. Indeed, reliable CDS data are available for a very low number of countries before 2008. After filtering, we end up with a balanced panel of 10 pairs of 5-year CDS and bonds spreads, for the following countries: Austria, Belgium, Denmark, France, Greece, Ireland, Italy, Netherlands, Portugal, Spain; on a period ranging from 1st January 2008 to 27 July 2010. During this period, the Lehman Brothers' bankruptcy has represented a structural change in the financial markets. In particular CDS premia and bond spreads have increased significantly, as well as the liquidity of the CDS market, fueled by raising incentives to negotiate protection against default risk. This is especially true for sovereign CDS, as the serious deterioration of the fiscal situation in European sovereign has motivated a larger activity on the CDS market of these countries. Therefore, we estimate our model on two periods one starting in January 2008 and the other on September 15, 2008. This is to check the robustness of our results and address the issue of the structural break due to the Lehman bankruptcy[4].

Given that heterogeneous panels yield poorly relevant and statistically less robust results, we estimate the model on the whole sample and on two sub-samples according to countries risk category. The "core Euro" group, which includes five European countries (Austria, Belgium, Denmark, France, Netherlands), is characterized by an average CDS spread below 100 bp over the whole period. In the second group including "peripheral" European countries (Greece, Ireland, Italy, Portugal, Spain), the spread of bonds and the CDS premia are considerably

[4]We thank an anonymous referee for this suggestion.

Table 1: **Descriptive statistics. 2008M9-2010M7**

	Mean	Std. Error	Minimum	Maximum
Full panel				
CDS	107.256	106.600	11.300	1125.810
Bond	87.198	111.869	-7.300	1293.800
Core Euro				
(a) **2008M9-2010M7**				
CDS	59.517	36.206	11.3	273.0
ΔCDS	0.083	3.851	-27.4	41.8
$Bonds$	42.323	27.549	-7.3	151.3
$\Delta Bonds$	0.014	3.227	-24.6	47.1
(b) **2008M1-2010M7**				
CDS	50.042	39.351	6.0	273.0
ΔCDS	0.073	3.574	-27.4	41.8
$Bonds$	37.350	26.992	-7.3	151.3
$\Delta Bonds$	0.034	2.997	-24.6	47.1
High Yield				
(a) **2008M9-2010M7**				
CDS	166.721	131.497	31.2	1125.8
ΔCDS	0.513	15.735	-361.5	197.1
$Bonds$	142.447	146.356	26.0	1293.8
$\Delta Bonds$	0.554	19.238	-701.9	134.9
(b) **2008M1-2010M7**				
CDS	131.067	126.357	16.1	1125.8
ΔCDS	0.392	13.445	-361.5	197.1
$Bonds$	111.951	134.455	11.0	1293.8
$\Delta Bonds$	0.445	16.425	-701.9	134.9

higher. The descriptive statistics in table 1 show a significant heterogeneity across them. In fact, volatility (as measured by the standard deviation) in the "core euro" is significantly lower.

Additionally, in order to check the robustness of our results, we estimate our model on an individual basis on a longer period, ranging from 2 January 2006 to 27 July 2010 for Greece and Belgium for which data is available for this period.

5 Results

This Section presents the results of our estimation based on a PST-EC model. For comparative purposes, we first present the results of the benchmark linear model before proceeding to the estimation of the nonlinear model.

5.1 The benchmark estimation

Building on the existing studies, we first estimate the long run coefficients in Equation (1) by the Fully Modified-OLS (FMOLS) estimator for panel data. Based on this estimation, we derived z_{it}, the deviation from equilibrium, as expressed in Equation (2)[5]. We then estimate the linear VECM model as defined in Equations (3) and (4). We use this estimation as a benchmark to check whether the coefficients are consistent with the literature[6]. Table 2 below reports the estimates of the error correction coefficient in our linear specifications for the whole panel as well as the two sub-groups of countries.

Table 2: **Linear error correction model.**

	Full panel		**Core Euro**		**High-yield Euro**	
Variable	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat
(a) **2008M9-2010M7**						
ΔCDS_{it} ($\Rightarrow \lambda_1$)	-0.0120	-4.05	-0.0115	-3.34	-0.007	-0.55
$\Delta Bond_{it}(\Rightarrow \lambda_2)$	0.0163	3.76	0.0103	2.49	0.041	2.54
(b) **2008M1-2010M7**						
ΔCDS_{it} ($\Rightarrow \lambda_1$)	-0.001	0.00	-0.009	-2.80	0.005	2.10
$\Delta Bond_{it}(\Rightarrow \lambda_2)$	0.024	5.36	0.009	2.74	0.009	3.79

Notes: (1) The corresponding cointegration vector is equal to $CDS_{it} = \mu_i + Bond_{it} + z_{it}$; (2) λ_1 and λ_2 correspond to the estimated coefficients in Equations (3) and (4), respectively; (3) The coefficients were obtained with Panel EGLS (Cross-section SUR).

Results in table 2 indicate that in the full and the Core European panels $\lambda_1(\lambda_2)$ is statistically significant and negative (positive) implying that both CDSs and bonds prices contribute to the price discovery process. In the high-yield European countries, only λ_2 is significant implying that bonds adjust to CDS whereas the CDS is not driven by mean-reverting dynamics.

In the full sample, bonds adjust more rapidly than CDS, implying that the CDS market has a dominant role in the price discovery process ($|\lambda_1| = 0.012, \lambda_2 = 0.016$, i.e $\lambda_2 > |\lambda_1|$ in Equations (3) and (4)). Yet this result is not homogenous across the two sub-samples. In the core-European group, the adjustment speeds are almost equal with a dominant role of the bond market in the price discovery process ($|\lambda_1| = 0.011 > \lambda_2 = 0.010$). In the high-yield countries, the bond market adjusts to the CDS market and not the other way round (λ_1 is not significant and $\lambda_2 = 0.04$).

The previous results confirm earlier findings based on linear VECM, on an earlier period (Bowe et al. (2009), Coudert and Gex (2010)) . The fact that the bond market has a dominant role in the core European is consistent with the large size and liquidity of the sovereign bonds market as compared with the market of CDS, still under development in this area. Coudert and Gex (2010) also find that in high-yield countries, the CDS market generally leads the bonds market.

[5]Our results indicate higher deviations from the equilibrium in the case of the high-yield European countries, which again suggests higher volatility.

[6]Both the Bond spread and the CDS premium are found to be integrated and cointegrated according to several panel unit root and cointegration tests. All the results are available upon request to the authors.

While giving a relevant global insight regarding the links between spreads, the linear VECM implies that the price discovery always takes place in the same market. In the following we present the results of our nonlinear estimation.

5.2 The nonlinear results

In order to estimate the nonlinear models presented above, the first step is to test the null hypothesis of homogeneity against the PSTR alternative. Given the difference in size, maturity and historical yields of both sub samples (see table 1), we estimate the PSTR model on the two samples in order to allow a different threshold value and a different adjustment process. If the null is rejected, we then proceed to the estimation of a threshold model (Equations (6) and (7))with the different transition functions. Following Gonzalez et al. (2005) in the time series context, we consider a variable as a possible transition variable if it rejects the null hypothesis of linearity. Then, we establish a statistical "ranking" of the threshold variables which corresponds to the variable that leads to the strongest rejection of the linearity hypothesis.

It is important to mention that, as noticed by González et al. (2005), heteroskedasticity and contemporaneous correlation causes positive size distortion in linearity tests, which increases with the cross-section and time dimensions of the panel. In addition, if this is the case, González et al. (2005) also report size distortion of more than 20% in the estimates in a PSTR. Given that we rely on daily data for European countries, controlling for both heteroskedasticity and correlation becomes imperative in order to use the asymptotic critical values and to be able to draw any conclusion[7]. In order to overcome these issues, we estimate the PSTR models by feasible GLS (Cross-section SUR) correcting for both cross-section heteroskedasticity and contemporaneous correlation. Alternatively, the Newey and West robust coefficient covariances, which is consistent in the presence of both heteroskedasticity and autocorrelation of unknown form, was also implemented. Given that they offer similar results, we only provide results on the FGLS specifications.

The linearity tests clearly reject the null hypothesis of a linear relationship in several cases (see table B in the appendix). This result is very important because it highlights the nonlinear dynamics in the price formation in the CDS and bond markets. This result, reported here for the first time to our knowledge, indicates that it is relevant to adopt a nonlinear approach to model the price discovery process of sovereign credit price. It strongly supports the novel hypothesis of an influence of adverse market conditions on the price discovery process. Note that several threshold variables reject linearity at 1% which indicates that they are all statistically well suited in accounting for non-linearity in the price discovery process.

Since the hypothesis of linearity is rejected, we estimate the corresponding panel smooth transition regression models for our two sub-samples on two periods. After confirming that our results are robust across the different models and period, we focus our comments on the model that yield the highest linearity rejection and on the period starting in September 2008[8]. Table

[7]We thank an anonymous referee for pointing out this issue.

[8]Notice that linearity is rejected with several possible transition variables. Since we are interested in the conditions that make the bond market to adjust to the CDS market, we comment the models that point to this result. Table 6 in the appendix present alternative models that ensures the robustness of our results.

(3) reports the estimated value of the main parameters of interest: the location parameter, c, the slope parameter, γ and the error correction coefficients in the extreme regimes (λ_i and $\lambda_i + \lambda_i^*$). Notice, however, that in the case linearity is not rejected, the coefficients λ_1 and λ_2 correspond to the linear estimated values presented in table (2).

Table 3: **PSTR error correction models.**

Dependent variable	Transition variable	λ_i	t-stat	λ_i^*	t-stat	$\lambda_i + \lambda_i^*$	t-stat	$\hat{c}$	γ
1. Core Euro									
(a) 2008M9-2010M7									
ΔCDS_{it} $(\Rightarrow \lambda_1)$	$\Delta CDS_{i,t-1}$	-0.028	-3.41	0.019	2.20	-0.009	-2.31	-3.28	167.2
$\Delta Bond_{it}(\Rightarrow \lambda_2)$	$\Delta CDS_{i,t-1}$	0.0103	2.46						
(b) 2008M1-2010M7									
ΔCDS_{it} $(\Rightarrow \lambda_1)$	$\Delta CDS_{i,t-1}$	-0.045	-3.77	0.040	3.31	-0.005	-1.45	-1.35	2596
$\Delta Bond_{it}(\Rightarrow \lambda_2)$	$\Delta CDS_{i,t-1}$	0.009	2.75						
2. High-yield Euro									
(a) 2008M9-2010M7									
ΔCDS_{it} $(\Rightarrow \lambda_1)$	$CDS_{i,t-3}$	-0.007	-0.55						
$\Delta Bond_{it}(\Rightarrow \lambda_2)$	$CDS_{i,t-3}$	0.014	1.99	0.024	2.08	0.038	3.88	231.3	44.71
(b) 2008M1-2010M7									
ΔCDS_{it} $(\Rightarrow \lambda_1)$	$CDS_{i,t-2}$	-0.007	-2.00	0.007	2.09	0.001	0.38	36.98;196.13	5.00
$\Delta Bond_{it}(\Rightarrow \lambda_2)$	$CDS_{i,t-2}$	0.011	2.67	0.002	0.54	0.013	4.51	33.37;163.77	11.87

Notes: (1) λ_i correspond to the error correction terms in Equations (6) and (7); (2) The coefficients were obtained with Panel EGLS (Cross-section SUR) and White cross-section standard errors and covariances.

Several important conclusions can be drawn from our estimated models. We start with the interpretation of the Core European Countries. In this first panel, the speed of adjustment is linear in the bond market and $\lambda_2 = 0.010$ and varies in the CDS market: the higher the threshold variable (ΔCDS_{t-1}) the lower the adjustment speed (from $|\lambda_1| = 0.028$ to $|\lambda_1 + \lambda_1^*| = 0.009$). More precisely, when the variation of the CDS premium is below $\hat{c} = -3.3$, the CDS market adjusts at a higher speed than the bonds market implying that the bond market leads the price discovery process (when $g(q_{it}; \gamma, c) = 0$, $|\lambda_1| = 0.028$ and $\lambda_2 = 0.010$). But as the market distress increases, the adjustment speed of the CDS market decreased. In the second regime, the speed is reduced threefold ($|\lambda_1 + \lambda_1^*| = 0.009$) and becomes slightly lower than the speed of the bond market, implying a reversal of the transmission direction. This is confirmed by the GG measure reported in table 4 which changes from 0.27 (when F=0) to 0.54 (when F=1). It means that in the second regime, the CDS market leads the price discovery process, contrary to previous findings based on linear specifications. Between these two extreme regimes, the error correction term takes a continuum of values depending on the realization of the nonlinear transition function.

An advantage of our specification is that we can provide country and time specific GG measures depending not only on the estimated coefficients but also on the particular value of the transition variables, which varies for each panel member in each period. This is a extra source of heterogeneity in non-linear panels with fixed effects.

Table 4: **The GG price discovery measure.**

	Transition variable	F=0	F=1
1. Core Euro			
(a) 2008M9-2010M7	$\Delta CDS_{i,t-1}$	0.269	0.546
(b) 2008M1-2010M7	$\Delta CDS_{i,t-1}$	0.167	0.643
2. High-yield Euro			
(a) 2008M9-2010M7	$CDS_{i,t-3}$	0.667	0.844
(b) 2008M1-2010M7	$CDS_{i,t-2}$	0.611	≥1

Notes: (1) F=0 (F=1) represents the linear (nonlinear) regime in Equations (6) and (7) (i.e the extreme regimes); (2) We judge that market 1 (CDS) has a dominant role in price discovery when this GG measure is larger than 0.5.

The large fluctuations of Belgium's GG measure, represented in Figure 1, confirm that the price discovery process is strongly non-linear. We observe that the GG measure has been more often closed to its upper limit (above 0.5) during the period. It suggests that CDS have dominated the pricing of sovereign credit risk since the beginning of the global crisis. In particular in fall 2009 when tensions started on developed Sovereign, the GG measure has remained above 0.5, meaning that the CDS was already driving the market prices. In general, the graphical representation illustrates for one country that the activity on the CDS market has indeed influenced the sovereign financing cost.

Our results suggest that during periods of relatively low distress, the bond market unambiguously leads the price discovery process. But as distress increases, the direction changes and the CDS market dominates the process. To understand this result, we need to comprehend that the CDS market offers a convenient way of shorting bonds. In fact the investor buys CDS contract which in turn exerts a downward pressure on the underlying bonds. The effect is amplified by the fact that CDS can be sold at anytime, contrary to options. In sum, the investors buy CDS not because they expect a default but because they expect that the sovereign spreads will increase further implying an appreciation of the CDS. To cash in the profits, the investor is not required to wait for a default but can rather sell the CDS. In sum, CDS allow pessimistic to leverage their opinion that market prices are too high. This is the most probable reason why during financial turmoil, as agents turn more pessimistic, the CDS market takes the lead over the bond market. This suggests that speculation is a significant driver of activity in the CDS market during distress. Summing up, we find that the argument about size and liquidity in the sovereign bond markets in the core European countries does not hold during periods of distress. Even in low-yield countries with long-established sovereign bond markets, the CDS market influences the sovereign bond spread during confused times.

Turning to the high-yield countries, remember that most linear estimations find that the CDS market leads the price discovery process. Our results confirm this finding in the first regime when the market distress is low. In fact, as in the linear estimation, we find that only the bond market adjusts to equilibrium, suggesting that the equilibrium price is determined in the CDS market (λ_1 is not significant while $\lambda_2 = 0.014$). Yet relaxing linearity yields an interesting finding: the higher the market distress (proxied by lagged CDS premium, CDS_{t-3}), the faster the bond market adjusts toward equilibrium. The transition occurs when the bond spread increases by more than 231 basis points (the threshold parameter value $c = 231$). In fact the speed of adjustment of the bond market almost triples (from λ_2= 0.014 to $\lambda_2 + \lambda_2^* = 0.038$), suggesting an improving market efficiency in crisis time. In turn, the CDS market never adjusts to equilibrium (λ_1 and $\lambda_1 + \lambda_1^*$ are not significant) indicating that the CDS market always leads the bonds market. The GG measures reported in table 4 thus increases from 0.66 to 0.84 which means that the CDS market keeps a dominant role over all regimes.

The graphical representation of the GG measure for Greece in Figure 1 indicates that the country has transited from one extreme regime to the second at the end of 2009, precisely when serious uncertainty on its fiscal sustainability spread. Then the GG measure remains at its upper limit suggesting that the CDS market has strongly dominated the pricing of sovereign risk during the crisis.

To summarize, the diverging results across samples are consistent if one considers the probability of default in each sub-sample. In the core European countries, even during a period of distress, the sovereign default probability has remained very low so far. Bearish market participants take long positions in the CDS market to bet against the price. On the contrary, in the peripheral countries, where default probabilities are much higher, market participants turn to the underlying market to sell bonds and exit the market.

In order to check the robustness of our results, we proceed to the analysis of two individual countries on a longer period of estimation. From a statistical perspective, a country specific analysis addresses the heterogeneity issue that may remain in each sub-panel. For a few countries only, data are available on a period starting in 2006 which allows us to include a long pre-Lehman period and check the existence of two distinct regimes[9]. In each panel, we examined two countries whose risk profile has been strongly altered by the crisis, namely, Greece and Belgium. Indeed, in the core European countries, Belgium experienced the highest bond spreads average during the crisis (with a mean equal to 71 in comparison with 42 in the panel) because of the difficulties encountered by its main bank, Fortis. Greece was the country the most severely hit by the crisis (mean=564 in comparison with 142 in the panel).

In Belgium, both markets show a non-linear adjustment toward equilibrium. Adjustment is sharp in the CDS market (the slope parameter $\gamma = 19.4$) while it is smooth in the bond market ($\gamma = 0.2$). Below the threshold, there is no adjustment across both markets (λ_1 and λ_2 are not significant). This is probably due to the lack of liquidity in the market of CDS before the crisis which limited arbitrage opportunity and dampened transmission. Therefore we find that the CDS market did not play its role of price discovery before it got liquid enough. However above the threshold, the adjustment speeds increase from 0 to a significant high value ($|\lambda_1 + \lambda_1^*| = 0.4$ and $\lambda_2 + \lambda_2^* = 0.8$), which suggests improving market efficiency. In particular, the derivative market does efficiently play its role of price discovery when the market gets distressed. We also find that the CDS market leads the discovery of prices in the second regime, which confirms the result obtained in panel on a longer period.

In Greece, the threshold variable is the lagged level of CDS premium rather than the volatility. Below the threshold, we find no transmission across markets (again λ_1 and λ_2 are not significant) implying that the derivative market does not play a role of price discovery in normal times. In the second extreme regime however, the adjustment speed increases significantly from 0 to 0.6 suggesting improving market efficiency in time of crisis. This result suggests that the CDS market has influenced the sovereign bond spread conditions during the Greek crisis. CDS became a bear-market instrument to speculate against the deteriorating conditions of Greece. The transmission direction from the CDS to the bond market detected by our model suggests that the shorting of stocks and buying CDS mutually amplified and reinforced each other.

[9] We thank the anonymous referee for this helpful suggestion.

Table 5: **PSTR error correction models. Belgium and Greece. 2006M1-2010M7**

Dependent variable	Transition variable	λ_i	t-stat	λ_i^*	t-stat	$\lambda_i + \lambda_i^*$	t-stat	$\hat{c}$	γ
Belgium									
ΔCDS_t ($\Rightarrow \lambda_1$)	$\Delta Bonds_{t-1}$	-0.009	-0.83	0.412	1.85	0.403	1.80	26.57	19.46
$\Delta Bond_t(\Rightarrow \lambda_2)$	$\Delta Bonds_{t-1}$	0.014	0.85	0.208	1.36	0.797	2.29	26.57	0.208
Greece									
ΔCDS_t ($\Rightarrow \lambda_1$)	CDS_{t-1}	-0.026	-0.507	0.328	1.04	0.302	1.03	919.76	703.19
$\Delta Bond_t(\Rightarrow \lambda_2)$	CDS_{t-1}	-0.023	-0.982	0.617	13.26	0.594	13.72	904.30	425.19

Notes: (1) λ_i correspond to the error correction terms in Equations (6) and (7)

6 Conclusions

In this paper we analyze the post-Lehman Brothers' sovereign debt market in different European Union member countries to ascertain the pattern of information transmission between the CDS and corresponding bond markets. We challenge the belief that the relatively small CDS market cannot influence bond spreads in countries with long-established and large sovereign debt markets. Our methodological innovation is the use of a non-linear PSTR regime-switching specification rather than the linear VECM specification customarily employed in these studies. This methodology allows us to accommodate variations in the speed of adjustment towards equilibrium.

We find evidence that the adjustment process to the equilibrium relationship between CDS premia and bond spreads is not linear. It depends on market characteristics and varies with the level of market distress. In particular, these conditions are the high levels of CDS premium or bonds spreads. These distress thresholds vary across different groups of countries, with higher thresholds in the higher risk category. By performing several robustness checks with different periods and in a country-by-country analysis we ensure the robustness of our results.

Our results suggest two extreme dynamics. The bond market plays a dominant role in the price discovery process only in the core European countries during calm periods. Yet, the higher the distress the more the CDS market dominates the information transmission between CDS and bond markets. In the high-yield economies, we find that the CDS market has a dominant role over all regimes. We extend the panel analysis with a country-specific analysis on Belgium and Greece, which confirms the panel findings.

We put forward that CDS become a bear-market instrument to speculate against the deteriorating conditions of Sovereign. The shorting of stocks and buying CDS mutually amplify and reinforce each other. Our findings are hopefully likely to stimulate the debate of the policy agenda for the regulation of financial markets.

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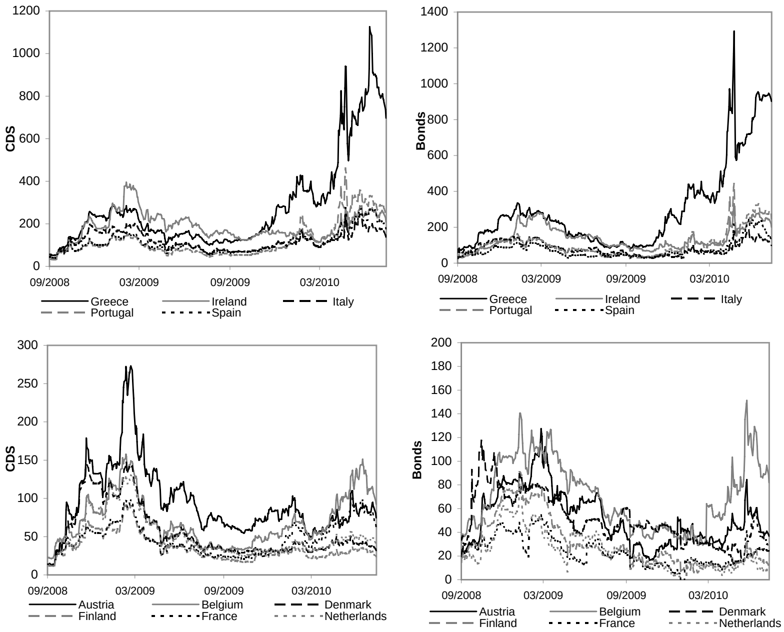
We have benefited from important remarks from Nathalie Rey, Dominique Plihon and Virginie Coudert. We are grateful to the anonymous referee and Julien Fouquau for helpful comments and suggestions. We would like to thank the participants to the International Conference on Macroeconomic Analysis and International Finance, Rethymon, May 2011 and the participants to the "Journées d'économétrie sur les Développements récents de l'économétrie appliquée à la finance", Paris, November 2010. Any remaining errors are our responsibility.

Appendix

A Sovereign Bonds spreads and CDS (in basis points)



B LM linearity tests, p-values

Transition variable	High-yield Euro ΔCDS	High-yield Euro $\Delta Bonds$	Core Euro ΔCDS	Core Euro $\Delta Bonds$
CDS_{t-1}	0.010**	0.002**	0.675	0.002**
CDS_{t-2}	0.010**	0.002**	0.467	0.006**
CDS_{t-3}	0.121	0.000**	0.484	0.006**
CDS_{t-4}	0.147	0.000**	0.315	0.029**
CDS_{t-5}	0.792	0.566	0.107	0.147
ΔCDS_{t-1}	0.000**	0.000**	0.000**	0.265
ΔCDS_{t-2}	0.001**	0.378	0.013**	0.863
ΔCDS_{t-3}	0.011**	0.798	0.084*	0.865
ΔCDS_{t-4}	0.056*	0.698	0.038**	0.624
ΔCDS_{t-5}	0.004**	0.332	0.000**	0.704
$Bonds_{t-1}$	0.000**	0.000**	0.006**	0.056*
$Bonds_{t-2}$	0.000**	0.000**	0.020**	0.381
$Bonds_{t-3}$	0.000**	0.000**	0.111	0.547
$Bonds_{t-4}$	NC	0.349	0.000**	0.723
$Bonds_{t-5}$	NC	0.221	0.054*	0.765
$\Delta Bonds_{t-1}$	0.000**	0.000**	0.324	NC
$\Delta Bonds_{t-2}$	0.043**	0.054*	NC	NC
$\Delta Bonds_{t-3}$	NC	0.001**	0.270	0.296
$\Delta Bonds_{t-4}$	NC	0.001**	0.003**	0.342
$\Delta Bonds_{t-5}$	NC	0.002**	0.881	0.158
z_{t-1}	0.000**	0.481	0.515	0.058*
z_{t-2}	0.001**	0.000**	0.517	0.008**
z_{t-3}	0.010*	0.000**	0.622	0.011**
z_{t-4}	0.030**	0.000**	0.612	0.080*
z_{t-5}	0.129	0.000**	0.739	0.120

Notes: (1) **(*) Indicates rejection of the null hypothesis of linearity at the 5 (10)%; (2) z represents misalignment as expressed in Equation 2; (3) NC implies no convergence.

C Alternative PSTR error correction models

Dependent variable	Transition variable	λ_i	t-stat	λ_i^*	t-stat	$\lambda_i + \lambda_i^*$	t-stat	$\hat{c}$	γ
1. Core Euro									
(a) 2008M9-2010M7									
ΔCDS_{it} ($\Rightarrow \lambda_1$)	$\Delta Bonds_{i,t-4}$	-0.017	-4.86	0.012	2.56	-0.005	-1.40	-0.152	38.73
$\Delta Bond_{it}$($\Rightarrow \lambda_2$)	$\Delta Bonds_{i,t-4}$	0.0103	2.46						
%									
(b) 2008M1-2010M7									
ΔCDS_{it} ($\Rightarrow \lambda_1$)	$\Delta Bonds_{i,t-4}$	-0.017	-3.05	0.015	1.51	-0.002	-0.37	-0.034	1.65
$\Delta Bond_{it}$($\Rightarrow \lambda_2$)	$\Delta Bonds_{i,t-4}$	0.005	2.12	0.023	4.71	0.029	6.31	2119.65	1.62
2. High-yield Euro									
(a) 2008M9-2010M7									
ΔCDS_{it} ($\Rightarrow \lambda_1$)	$\Delta Bonds_{i,t-1}$	-0.021	-3.38	0.006	0.53	-0.015	-1.32	5.60	431.84
$\Delta Bond_{it}$($\Rightarrow \lambda_2$)	$\Delta Bonds_{i,t-1}$	0.018	2.69	0.018	1.39	0.036	3.03	5.65	252.5
(b) 2008M1-2010M7									
ΔCDS_{it} ($\Rightarrow \lambda_1$)	$\Delta Bonds_{i,t-2}$	-0.006	-2.82	0.051	8.38	0.045	7.58	41.39	22.05
$\Delta Bond_{it}$($\Rightarrow \lambda_2$)	$\Delta Bonds_{i,t-2}$	0.007	2.45	0.076	9.56	0.082	10.54	39.50	0.21

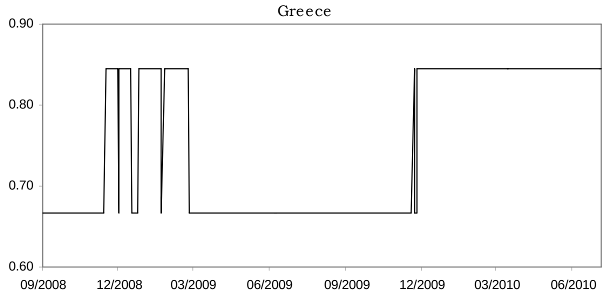
Notes: (1) λ_i correspond to the error correction terms in Equations (6) and (7); (2) The coefficients were obtained with Panel EGLS (Cross-section SUR) and White cross-section standard errors and covariances.

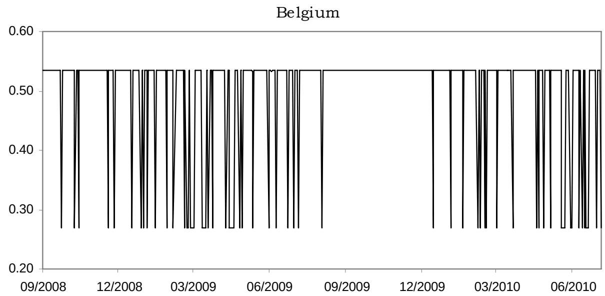
D The GG price discovery measure.

sub-panel	Transition variable	F=0	F=1
1. Core Euro			
(a) 2008M9-2010M7	$\Delta Bonds_{i,t-4}$	0.376	0.661
(b) 2008M1-2010M7	$\Delta Bonds_{i,t-4}$	0.190	0.931
2. High-yield Euro			
(a) 2008M9-2010M7	$\Delta Bonds_{i,t-1}$	0.462	0.706
(b) 2008M1-2010M7	$\Delta Bonds_{i,t-2}$	0.538	0.710

Notes: (1) F=0 (F=1) represents the linear (nonlinear) regime in Equations (6) and (7) (i.e the extreme regimes); (2) We judge that market 1 (CDS) has a dominant role in price discovery when this GG measure is larger than 0.5.)

E The GG measure: selected countries





F Data definition

In order to study the relationship between the CDS market and the underlying market, we need to gather CDS premia and bond spreads.

CDS premia

Obtaining CDS premia is straightforward, as these premia are actually CDS quotes. We opt for CDSs on a five year maturity, which is the most traded compared to other maturities, extracted from Datastream.

We impose filtering in order to ensure that series of CDS premia are of good quality. To do so, we rely on the veracity score, an indicator calculated by CMA, Datastream's supplier of CDS data. This veracity score shows how the price displayed every day was calculated. It is expressed on a scale from 1 to 7. A veracity score of 1 indicates an actual trade. A veracity score of 2 or 3 indicates that the price was posted by at least one market maker, with or without a firm commitment to trade respectively. When the veracity score is above 3, the premium is calculated using bond market data and not a market quote. Consequently, a premium displaying a veracity score above 3 is equivalent to a missing value.

We select the countries among Western European countries that display the following characteristics: (i) the ratio of the number of days with a price posted with or without a firm commitment to trade or an actual trade on the total number of days (excl. week-ends) for a given year is higher than 75%; (ii) the ratio of the number of days with an actual trade on the total number of days (excl. week-ends) for a given year is higher than 50%; (iii) the ratio of the number of missing values on the total number of days (excl. week-ends) for a given year is lower than 10%; (iv) the number of consecutive missing values must not exceed 10 days on the period under review. From January 2008 onwards, almost all the premia are market quotes, a large majority being actual trades. In parallel, the number of missing value is close to zero in 2008 and null in 2009 and 2010. In order to include a sufficient number of countries in our panel, we thus exclude data prior to 2008 and restrict the sample to a period ranging from 1st January 2008 to 27 July 2010. We end up with the following panel: Austria, Belgium, Denmark, France, Greece, Ireland, Italy, Netherlands, Portugal, Spain.

Bond spreads

Corresponding bond yields are generic 5-year yields taken from Bloomberg. These generic series display, at each date, the yield of the bond considered by the market as the benchmark bond on a 5 year maturity.

The calculation of bond spreads, defined as the difference between the bond yield of a given issuance and a risk free rate, raises the issue of the choice of the risk free rate. For corporate entities, several studies use the yield of the U.S. Treasuries (for instance, Longstaff, Mithal and Neis (2005)). Other studies use the swap rate on the same maturity (for instance, Blanco, Brennan and Marsh (2005)). Choosing a swap rate as a risk free rate can be justified by market practices. Indeed, traders on derivative markets working for major financial institutions use the swap rate as a benchmark for their pricing models, the swap rate being close to their opportunity cost of capital (Hull et al. (2004)). Empirically, Houweling and Vorst (2005) and Hull et al. (2004) show that swap rates are closer to the risk free rate used by markets than Treasuries yields.

Regarding sovereign issuances of developed countries, using a swap rate leads to negative bond spreads in most cases. This reflects the low risk of these issuances (theoretically risk free).

Literature on emerging markets provides an alternative approach. In order to assess emerging sovereign spreads' dynamics, several studies which investigate emerging sovereign spreads (see McGuire and Schrilvers (2003), Sy (2001), Sy (2003), Hartelius and Kodres (2008) and Hilscher and Nosbrusch (2010)) or the relationship between emerging sovereign CDS premia and underlying bonds (Chan-Lau and Kim (2004), Andritsky and Singh (2006) and Powell and Martinez (2008)), rely on EMBI spreads. These spreads, provided by J.P. Morgan, are calculated from benchmark sovereign issuances of a given geographical area, i.e. U.S. Treasuries or a Western Europe benchmark bond (generally the German Bund). Alternately, Ammer and Cai (2007) use sovereign bond spreads calculated by Bloomberg with a similar way.

It is therefore consistent for developed countries to choose, as a risk free rate, the bond yield of the country considered the less risky of a given area. We thus compute, for each country in the sample, a bond spread as the difference between the government yield of this country and the German yield, which is the benchmark for the euro area. We calculate these spreads for the same maturity than the maturity of the CDSs, i.e. 5 years.

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