Sovereign credit default swap and bond markets' dynamics: evidence from the European debt crisis

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Abstract: This study investigates the sovereign credit market dynamics of the heavily indebted southern European countries, considering the dynamic relationship between credit default swap (CDS) and bond spreads. We employ a three-step econometric analysis, intending to shed light on whether the CDS spreads can trigger rises in bond spreads and on the relative efficiency of credit risk pricing in the CDS and bond spreads. The VECM analysis suggests that during an economic turbulence the CDS market leads the price discovery process in Portugal, Greece and Spain, while in Italy the Granger causality test indicates bilateral causality between CDS and bond spreads without identifying the leading market. Hence, an increase in the CDS spread may directly affect the sovereign cost of borrowing. Governments, investors and policy makers should place specific emphasis on the CDS market, since it constitutes the main source of information for sovereign credit risk.

Keywords: credit risk; CDS; sovereign bonds; debt crisis; cointegration; price discovery.

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1 Introduction

Bonds are issued by corporations, public authorities and sovereign states in order to meet their long-term financing needs. They are issued in the primary market and then are traded in an organised secondary market or over-the-counter. They are subject to various risks, of which credit risk is the prevailing one. Bondholders can transfer the credit risk of their investment to another party through a credit default swap (CDS). CDS are over-the-counter contracts that allow the investment in or speculation against the credit quality of a reference entity. CDS and bond spreads are in close connection since their main price driver is the bond issuer's credit worthiness. In theory, CDS spreads and the underlying bond spreads should be approximately equal (Hull and White, 2000; Hull et al., 2004) considering that both spreads are meant to compensate for investors' loss in the event of the issuer's default (Coudert and Gex, 2010). However, in practice this equality never holds due to the imperfect match between the two contracts. The lead–lag relationship between CDS and bond spreads constitutes a favourable research area, since the determination of which contract has the leading role affects the behaviour of issuers, market participants and policy makers.[1]

The bulk of research studies investigates the relation between CDS and bond spreads for corporate reference entities, suggesting the leading role of CDS in the price discovery process (Longstaff et al., 2003; ECB, 2004; Blanco et al., 2005; Zhu, 2006; Baba and Inada, 2007; Forte and Pena, 2009; Norden and Weber, 2009). The empirical findings for the sovereign credit markets are inconclusive and often contractive. The early studies focus on developing countries (Chan-Lau and Kim, 2004; Bowe et al., 2009; Ammer and Cai, 2011; Aktug et al., 2012; Hassan et al., 2015), since the developed ones had very low levels of perceived credit risk and, thus, low trading activity in CDS markets. However, the recent global financial crisis and the subsequent debt crisis in Europe led to a fundamental reassessment of the default risk of the developed sovereigns, as well. Bond and CDS spreads, especially in the euro area, increased considerably and so did the CDS market trading volume. This has contributed to a wave of research studies, which once again fail to provide converging findings. In particular, many studies indicate the CDS market as the leading one (Palladini and Portes, 2011; Delatte et al., 2012; Andraz et al., 2015), while some others point to the opposite direction (Coudert and Gex, 2013;

Fontana and Scheicher, 2016). Other recent studies (Arce et al., 2013; Ito, 2016) cannot demonstrate any robust evidence for the leading role of any of the two markets.

Many of the above studies involve countries from the euro area, while the sampling periods begin after the mid-2000s, varying from 2 to 8 years. However, none of them focuses on the indebted southern European countries during the debt crisis. Indeed, there is a lack of empirical evidence regarding the effects of the crisis on the credit markets of the peripheral European countries that faced a dramatic deterioration of their risk profile. We believe that during a period of economic turmoil, it is particularly important to determine which market leads in the price discovery process on the country level. This information could assist governments to take the appropriate actions in order to curb spreads in a timely manner, while supervisors and authorities can assess the efficiency and transparency of these over-the-counter markets. Also, investors and speculators may adjust their behaviour following the leading market and, thus, effectively rebalance their portfolios.[2] Overall, this paper contributes to the literature on a highly controversial matter adding new empirical evidence for developed sovereign entities that are part of a politico-economic union which is facing a debt crisis period for the first time after its initiation (Bitzenis et al., 2014).

The overarching objective of the present paper is to evaluate the sovereign credit market dynamics of the heavily indebted southern European countries (Portugal, Italy, Greece and Spain), examining both the long-run and the short-run relationships between sovereign CDS and bond markets. In particular, we address two key issues: first, whether the CDS spreads are likely to cause rises in bond spreads during periods of economic turmoil and second, the relative efficiency of credit risk pricing in the CDS and bond markets. We aim to shed light on which market holds the leading role, providing an individual country analysis that focuses on a specific period of escalation of the debt crisis in the Eurozone. The rest of the paper is structured as follows: Section 2 depicts the results of previous studies in the field. Section 3 presents the dataset and a description of the selected econometric methods. Section 4 records the empirical results, while Section 5 discusses the conclusions of the paper and suggests areas for further research.

2 Literature review of the relationship between CDS and bond spreads

The evaluation of the dynamic relationship between CDS and bond spreads comprises a fast-growing research field in the modern finance literature. The early empirical studies of the first half of 2000s focus on the corporate credit markets while the sovereign entities are examined later. More specifically, Longstaff et al. (2003), in a study of a sample of 68 actively traded North American firms in the credit derivatives market, assert that information flows first into the CDS and stock markets and then into the bond market. Zhu (2006) and Blanco et al. (2005), examining 24 and 33 firms, respectively, conclude that the long-run equilibrium relationship holds between CDS and bond spreads, while in the short run the deviation from the parity is mainly a result of the leading role of CDS in the price discovery process. Along the same lines, the empirical analysis of Forte and Pena (2009), on a sample of North American and European firms, also confirms the leading role of CDS. Norden and Weber (2009), analysing a sample of 58 corporate entities, verify the cointegration hypothesis between CDS and bond spreads in the majority of the firms examined and conclude that the CDS market contributes more to price discovery than the bond market, whereas this effect is stronger for the US firms compared to the European ones. Additionally, the authors note that the markets are more efficient for the former than for other non-US entities. Considering the European corporate credit markets, the study of the ECB (2004)[3] confirms the existence of cointegration relationship for the two-thirds of the examined entities. Moreover, the Gonzalo and Granger measure[4] for price discovery indicates that in 67% of the European entities the CDS markets are leading the bond markets. Last but not least, Baba and Inada (2007) examining the Japanese banking sector, conclude that CDS and bond spreads are cointegrated for most banks. In addition, price discovery measures suggest that the CDS spread plays a more dominant role in price discovery than the bond spread. Considering all the above studies, it is apparent that CDS has a dominant role in the price discovery process in corporate credit markets.

Considering the sovereign credit markets, most of the studies refer to developing markets. The early study of Chan-Lau and Kim (2004) reveals contradicting results in terms of cointegration existence and price discovery for a sample of eight emerging economies from 2001 to 2003. Ammer and Cai (2011) use daily data from nine sovereign entities for the first half of 2000s, underlying the cheapest-to-deliver (CTD)[5] option in the CDS contracts. In particular, they suggest that the CDS market is less likely to lead for entities that have issued more bonds, highlighting the relative liquidity of the two markets as a key determinant of the price discovery direction. Aktug et al. (2012) demonstrate the bond markets' leading role in the price discovery process, examining a considerable sample of developing sovereign markets.[6] In a similar study of eight emerging markets for the period 2003–2006, Bowe et al. (2009) also find that the bond markets contribute more to price discovery than the CDS markets. Lastly, the updated to the recent financial crisis studies of Hassan et al. (2015) and Coudert and Gex (2013), examining similar samples of emerging sovereigns,[7] suggest the existence of cointegration for each credit market. However, contrary to the previous studies, they find that in more cases the CDS market leads in price discovery by adjusting the new information regarding credit risk before the bond market does.

Taking into consideration the developed countries, the panel analysis of Fontana and Scheicher (2016) on weekly CDS and bond spreads of ten euro area countries from 2007 to 2012 suggests that since September 2008, in core European countries[8] price discovery takes place in the bond market, while the contrary appears to be the case in peripheral European countries.[9] Similar results, regarding the euro area countries, are revealed by the study of Coudert and Gex (2013) for the period 2007–2010. Palladini and Portes (2011) investigate the relationship between sovereign CDS and bond markets over the period 2004–2011, suggesting that both in core and peripheral European countries the CDS market moves ahead of the bond market in terms of price discovery. Contrariwise, Ito (2016) finds no evidence of unilateral influence from the CDS market to the government bond market in any of the 11 examined European countries.[10] Andraz et al. (2015)[11] focusing on Portugal during the period 2007–2011, suggest the absence of long-run relationship between government bond spreads and CDS spreads, and the dominant influence of the CDS market in price discovery. Interestingly, Delis and Mylonidis (2011), analyse the southern European countries in a dynamic context, providing evidence of causality from CDS to bond spreads after 2007 whereas feedback causality is detected only during periods of financial and economic turmoil. Delatte et al. (2012) examining a sample of 11 European countries from 2008 to 2010, find that in periods of financial distress the CDS market dominates the information transmission between CDS and bond markets. Contrarily, Arce et al. (2013) applying a statedependent analysis on 11 Eurozone countries from 2004 to 2012, assert that the effects of the recent debt crisis impair the ability of the CDS market to lead in the price discovery process.

Apparently, the empirical findings regarding the sovereign credit market dynamics are conflicting, even when similar samples are examined during overlapping or parallel time periods. The current debt crisis of the southern European countries brought in the spotlight the advanced countries, attracting significant research interest. The recent empirical studies provide new evidence in the field, failing however to form converging conclusions. In that frame, our study is focused on the crisis period, investigating the credit market dynamics for the peripheral European countries that were at the heart of the crisis. The analysis that follows will contribute to the existing literature, adding new evidence for the relation between sovereign CDS and bond markets for each one of the heavily indebted southern European countries.

3 Data and methodology

3.1 Data analysis

For the purpose of our study, we use daily 5-year sovereign CDS spreads and daily 5-year government bond yields for four euro area countries, namely Portugal, Italy, Greece and Spain. All data series are obtained from Bloomberg.[12] The sample period runs from January 2008 to December 2011. It is worth noticing that there are no available observations for the Greek CDS spreads after the end of 2011, since there was no trading activity at the CDS market. Therefore, we limit the overall analysis up to December 2011 for comparability purposes. To be consistent with previous studies, we choose the 5-year maturity that is considered the most liquid and most actively traded maturity segment in the sovereign CDS market. For each entity we calculate the 5-year government bond yield spreads over the German Bund,[13] in order to match it with the corresponding CDS spreads.

Tables 1 and 2 present the descriptive statistics of CDS and bond spreads, respectively.

Figure 1 depicts the evolution of the examined spread series by country level, confirming the considerable repricing of default risk since the April 2010 and the escalation of the debt crisis, especially in Greece.

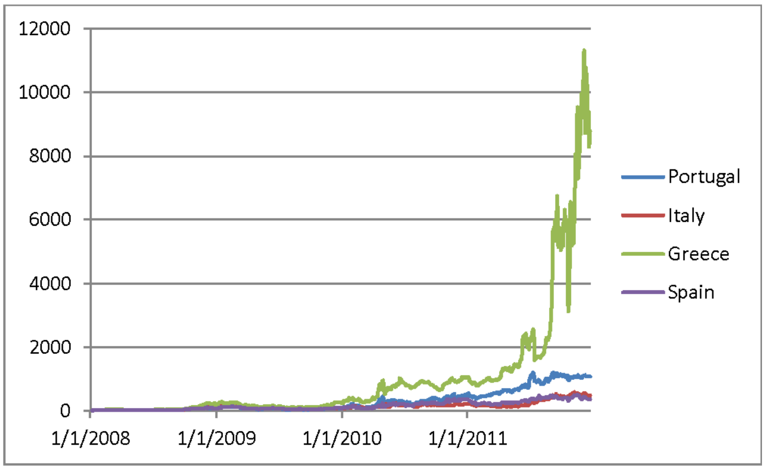
Table 1 CDS spreads' descriptive statistics

	Mean	*Median*	*Std. dev.*	*Skewness*	*Kurtosis*	*JB* (*prob.*)	*Obs.*
Portugal	3.076	1.301	0.139	1.271	3.397	286.457 (*0.000*)	1039
Italy	1.581	1.342	1.230	1.628	5.370	702.503 (*0.000*)	1039
Greece	10.241	2.833	18.899	3.207	13.375	6440.392 (*0.000*)	1039
Spain	1.703	1.148	1.308	0.792	2.470	120.778 (*0.000*)	1039

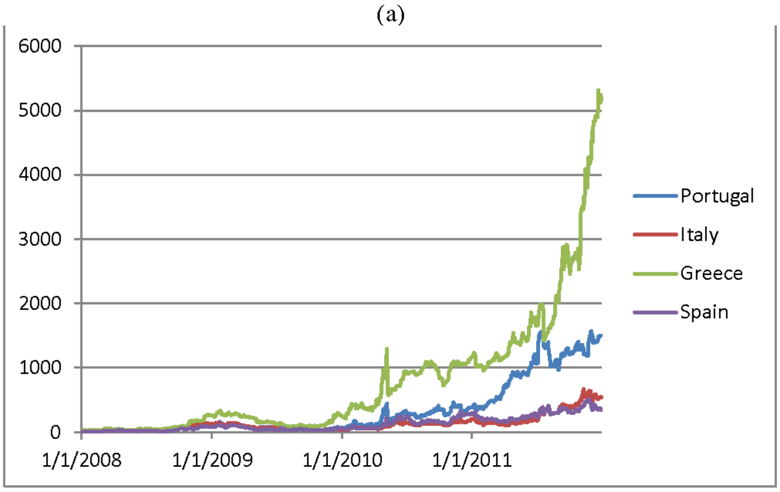
Table 2 Bond spreads' descriptive statistics

	Mean	*Median*	*Std. dev.*	*Skewness*	*Kurtosis*	*JB* (prob.)	*Obs.*
Portugal	3.381	1.202	4.288	1.490	3.865	419.001 (*0.000*)	1044
Italy	1.321	1.008	1.260	2.160	7.411	1658.587 (*0.000*)	1044
Greece	7.801	2.907	10.101	2.251	8.624	2257.529 (*0.000*)	1044
Spain	1.309	0.830	1.154	0.993	3.058	171.629 (*0.000*)	1044

Figure 1 CDS and bond spreads: (a) CDS spreads and (b) bond spreads (see online version for colours)



(a)



(b)

Source: Bloomberg

3.2 Methodology

To investigate the dynamic relationship between CDS and bond spreads, we employ a three-step methodological procedure that is widely used in the related empirical literature.[14] The first step examines the stationarity of the series. If both CDS and bond spreads' series are characterised by a unit root and are integrated in the same order, we can move to the next step where the Johansen cointegration test (Johansen, 1991) is performed in order to check whether a long-run equilibrium relationship holds for the two series. Then, if the cointegration is confirmed, a vector error correction model (VECM) is used to examine the price discovery process as the final step. Otherwise, if the series are not cointegrated, the Granger causality test (Granger, 1969) is performed to investigate the direction of influence between the two series.

With the intention of checking the stationarity of the two series the augmented Dickey–Fuller (Dickey and Fuller, 1979) and the Phillips–Perron (Phillips and Perron, 1988) unit root tests are performed. According to the former, the null hypothesis of a unit root is tested estimating the model:

$$\Delta y_t = \alpha_0 + \gamma y_{t-1} + \sum_{i=2}^{p} \beta_i \Delta y_{t-i+1} + \varepsilon_t, \tag{1}$$

where $\gamma = -\left[1 - \sum_{i=1}^{p} \alpha_i\right]$ and $\beta = \sum_{j=i}^{p} \alpha_j$. Then the null hypothesis H_0: $\gamma = 0$ is tested against the alternative H_1: $\gamma < 0$.

The Phillips–Perron unit root test involves the estimation of the model:

$$y_t = \alpha_0 + \alpha_1 y_{t-1} + \alpha_2 (t - T/2) + \varepsilon_t, \tag{2}$$

where T is the number of observations and the disturbance term is such, that $E(\varepsilon_t) = 0$. Then, the null hypothesis H_0: $a_1 = 1$ is tested. If H_0 cannot be rejected then a unit root is present in the series.

Given the non-stationarity of CDS and bond series, we can proceed to the cointegration test. The existence of a cointegration relationship between the levels of two non-stationary variables means that there is a linear combination of these variables that is stationary and should be taken into account in a vector autoregressive (VAR) analysis framework. The applied Johansen's cointegration test gives the cointegrating vectors and provides consistent estimations of the entire cointegrating matrix. Initially, the following VAR model of order p[15] is constructed:

$$Y_t = A_0 + A_1 Y_{t-1} + \cdots + A_p Y_{t-p} + \varepsilon_t, \tag{3}$$

where Y are 2 × 1 vectors of CDS and bond spreads, while A_0, A_i, and ε_t are 2 × 1 vectors of intercepts, coefficient estimates and error terms, respectively. Then the cointegration test assumes the following form:

$$\Delta Y_t = \Pi Y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta Y_{t-1} + e_t. \tag{4}$$

If the series are cointegrated, the coefficient matrix Π has a rank of one and there are 2 × 1 vectors α and β, such that $\Pi = \alpha\beta^T$, where β is the cointegrating vector and α is the vector of speed of adjustment parameters. After that, the null hypothesis against the alternative is tested as follows:

H_0: The coefficient matrix Π has a full rank of 2 (the series are not cointegrated).

H_1: The coefficient matrix Π has a full rank of 1 (the series are cointegrated).

The rejection of the null hypothesis implies the existence of a long-run equilibrium relationship between the CDS and the bond spreads.

Proceeding to the next step, in case there is evidence of cointegration[16] a VECM is estimated in order to determine the dynamic lead–lag relationship between CDS and bond markets, since the two spreads in the short run may deviate from the long-run cointegration relationship that takes the following form:

$$\text{CDS\_spread}_t = \alpha + \beta \text{bond\_spread}_t + z_t. \tag{5}$$

Equation (5) can be written as follows:

$$\text{CDS\_spread}_t - \beta \text{bond\_spread}_t - \alpha = z_t = I(0). \tag{6}$$

The cointegration coefficient β indicates the long-run equilibrium relationship, while the error term z_t should be stationary ($I(0)$). Then the VECM takes the form:

$$\Delta\text{CDS\_spread} = c_1 + \alpha_1 z_{t-1} + \sum_{j=1}^{p} \gamma_{1j} \Delta\text{CDS\_spread}_{t-j} + \sum_{j=1}^{p} \delta_{1j} \Delta\text{bond\_spread}_{t-j} + \varepsilon_{1t} \tag{7}$$

$$\Delta\text{bond\_spread} = c_2 + \alpha_2 z_{t-1} + \sum_{j=1}^{p} \gamma_{2j} \Delta\text{CDS\_spread}_{t-j} + \sum_{j=1}^{p} \delta_{2j} \Delta\text{bond\_spread}_{t-j} + \varepsilon_{2t} \tag{8}$$

In such a framework we focus on the alphas, α_1 and α_2, which represent the error correction or speed of adjustment coefficients and are interpreted as price discovery measures. In particular, the comparison of the magnitudes and the signs of alphas indicate whether the CDS or the bond spreads are leading in price discovery. If α_1 is significantly negative, then the CDS spread adjusts to close the pricing gap. This means that the bond spread leads CDS spread in price discovery. Contrarily, if α_2 is significantly positive, the bond spread adjusts to close the gap implying that the CDS spread is leading in price discovery process. Finally, if both α_1 and α_2 are significant and correctly signed, the price discovery takes place in both CDS and bond markets. In such a case, the slower adjusting market is considered as the primary market in which the efficient price is first discovered. Intending to assess the relative importance of the CDS and bond markets in price discovery the Gonzalo and Granger measure (Gonzalo and Granger, 1995) is employed, which is defined as $CG = \alpha_2/(\alpha_2 - \alpha_1)$.[17]

If cointegration is rejected, the lead–lag relationship between CDS and bond markets is determined through the Granger causality test (Granger, 1969), since the VECM representation is not valid anymore. In this context, a VAR model of order p[18] is estimated in level form if the series in question are stationary or in first differences form if the series are not stationary. The VAR(p) model takes the following form:

$$y_t = c_1 + \sum_{j=1}^{p} \beta_{1j} y_{t-j} + \sum_{j=1}^{p} \varphi_{1j} x_{t-j} + \varepsilon_{1t} \tag{9}$$

$$x_t = c_2 + \sum_{j=1}^{p} \beta_{2j} y_{t-j} + \sum_{j=1}^{p} \varphi_{2j} x_{t-j} + \varepsilon_{2t}. \tag{10}$$

Granger causality from x to y is detected if the estimated coefficients on the lagged x in equation (9) are statistically different from zero as a group $\left(\sum \varphi_{1j} \neq 0\right)$, implying that price discovery occurs in the market that is represented by series x. Correspondingly, there is Granger causality from y to x if the estimated coefficients on the lagged y in equation (10) are statistically different from zero as a group $\left(\sum \beta_{2j} \neq 0\right)$, implying that price discovery occurs in the market that is represented by series y. In case bilateral causality is found, price discovery occurs in both markets.

To implement the Granger causality test the null hypothesis of non-causality from x to y $\left(H_0 : \varphi_{11} = \varphi_{12} = \cdots = \varphi_{1p} = 0\right)$ is tested using the standard F-test. The rejection of H_0 implies that x Granger causes y. Respectively, the existence of causality from y to x is examined testing the null hypothesis $H_0 : \beta_{21} = \beta_{22} = \cdots = \beta_{2p} = 0$.

4 Empirical findings

The following paragraphs present the empirical results of the comparative econometric analysis on the sovereign CDS and bond markets of Portugal, Italy, Greece and Spain.

Regarding the stationarity of CDS and bond spreads, we find similar results for all countries in the sample (Tables 3 and 4). Both the augmented Dickey–Fuller and Phillips–Perron tests indicate that all the examined series are non-stationary. Indeed, the two tests fail to reject the null hypothesis of unit root at 1%, 5% and 10% significance levels. Contrarily, examining the first differences of the series we find strong evidence of stationarity (no unit root). The latter finding allows us to move to the cointegration test.

Table 3 CDS spreads' unit root tests

	ADF test		*PP test*	
	Test statistic	*Unit root*	*Test statistic*	*Unit root*
Portugal (level)	–1.598521 (*0.7933*)	Yes	–1.370728 (*0.8690*)	Yes
Portugal (1st diff.)	–21.79536 (*0.000*)	No	–24.61040 (*0.000*)	No
Italy (level)	–1.583498 (*0.7991*)	Yes	–1.668179 (*0.7647*)	Yes
Italy (1st diff.)	–21.08625 (*0.000*)	No	–26.64076 (*0.000*)	No
Greece (level)	0.047069 (*0.9968*)	Yes	0.217344 (*0.9982*)	Yes
Greece (1st diff.)	–7.794485 (*0.000*)	No	–27.75235 (*0.000*)	No
Spain (level)	–2.893613 (*0.1649*)	Yes	–3.034565 (*0.1232*)	Yes
Spain (1st diff.)	–19.61920 (*0.000*)	No	–26.53350 (*0.000*)	No

In parentheses are reported the p-values.

Table 4 Bond spreads' unit root tests

	ADF test		*PP test*	
	Test statistic	*Unit root*	*Statistic*	*Test*
Portugal (level)	–0.972486 (*0.9457*)	Yes	–0.847701 (*0.9597*)	Yes
Portugal (1st diff.)	–17.64414 (*0.000*)	No	–23.96625 (*0.000*)	No
Italy (level)	–0.699291 (*0.9721*)	Yes	–0.615103 (*0.9776*)	Yes
Italy (1st diff.)	–21.56034 (*0.000*)	No	–27.21402 (*0.000*)	No
Greece (level)	3.109565 (*1.000*)	Yes	3.487306 (*1.000*)	Yes
Greece (1st diff.)	–30.26167 (*0.000*)	No	–30.19638 (*0.000*)	No
Spain (level)	–2.923342 (*0.1554*)	Yes	–3.009974 (*0.1299*)	Yes
Spain (1st diff.)	–20.48161 (*0.000*)	No	–25.38057 (*0.000*)	No

In parentheses are reported the *p*-values.

The Johansen cointegration methodology that is applied primarily requires the estimation of the optimal lag–length VAR model.[19] Then we proceed to the cointegration test. Table 5 demonstrates that the rank test statistics (both trace and maximum eigen value statistics) indicate the rejection of the null hypothesis of no cointegration, at 5% significance level for Portugal, Greece and Spain.[20] Contrarily, the rank test statistics fail to reject the null hypothesis of no cointegration for Italy, thus being at odds with previous studies (Palladini and Portes, 2011; Fontana and Scheicher, 2016).

Table 5 Cointegration test

	Trace statistic	*Max-eigenvalue statistic*	*Cointegration*
Portugal	16.53115 (*0.0348*)	14.26460 (*0.0404*)	Yes
Italy	10.83090 (*0.2221*)	10.45822 (*0.1835*)	No
Greece	39.26565 (*0.000*)	34.02547 (*0.000*)	Yes
Spain	22.56257 (*0.0036*)	21.52894 (*0.0030*)	Yes

In parentheses are reported the *p*-values.

Hence, we conclude that a long-run equilibrium relationship exists between CDS and bond spreads for Portugal, Greece and Spain as already evidenced by several previous studies (Palladini and Portes, 2011; Coudert and Gex, 2013; Fontana and Scheicher, 2016). This finding implies that eventually market forces eliminate arbitrage opportunities in the above credit markets. Table 6 presents the cointegrating equations.

The cointegration coefficient β ranges from 0.53 to 1.14. In particular, β exceeds 1 for Spain meaning that, over the long-run, a 1 bps change in the CDS spread is accompanied by a larger change in the bond spread. This implies that the bond market seems to be more volatile than the CDS market, while the opposite applies for Portugal and Greece. The latter finding for Portugal and Greece is in line with Palladini and Portes (2011).

Table 6 Cointegrating equation

	Equation
Portugal	$\text{CDS\_spread} = 0.509308 + 0.773690^{*}\text{bond\_spread} + z_t$
Greece	$\text{CDS\_spread} = 6.224637 + 0.531735^{**}\text{bond\_spread} + z_t$
Spain	$\text{CDS\_spread} = 0.218600 + 1.144905^{*}\text{bond\_spread} + z_t$

*, ** and *** denotes significance in the 1%, 5% and 10% level respectively.

Considering that CDS and bond spreads are cointegrated, they can be considered in a VECM representation in order to examine the adjustment process. Table 7 reports the estimation of speed of adjustment coefficients and the calculation of the Gonzalo and Granger price discovery measure for the cointegrated sovereign credit markets of Portugal, Greece and Spain.

Table 7 VECM estimations

		Coeff.	*t-statistic*	*GG*
Portugal	α_1	–0.006187	–0.70678	0.830526
	α_2	0.030320*	3.76097	
Greece	α_1	0.006483	1.22704	5.749451
	α_2	0.007848*	5.71878	
Spain	α_1	0.013552	1.00906	1.482913
	α_2	0.041615*	4.47205	

*, ** and *** denotes significance in the 1%, 5% and 10% level respectively.

Considering the speed of adjustment parameters, we find similar results for the three examined credit markets. In particular, α_1 coefficients are insignificant while α_2 coefficients are significantly positive, implying that bond spreads adjust to close the pricing gap. Therefore, findings suggest that CDS markets lead bond markets in price discovery, since they firstly price the sovereign credit risk. These results verify previous studies that examine peripheral European countries (Palladini and Portes, 2011; Delatte et al., 2012; Coudert and Gex, 2013; Fontana and Scheicher, 2016). The interpretation of the Gonzalo and Granger measure is ignored since α_1 coefficients are insignificant.

Indeed, the empirical results indicate that during the European debt crisis, the CDS market leads the price discovery process in Portugal, Greece and Spain. The CDS markets seem to incorporate new information on credit risk timely and efficiently. The fact that more than a few market participants act as CDS sellers (issuers), while buyers can take highly leveraged positions, make CDS products the most representative way to trade credit risk. Evidently, the sovereign CDS market is considered a better source of information about sovereign default risk compared to the larger (in nominal value) and more mature bond markets.[21]

Contrary to Portugal, Greece and Spain, there is no evidence of cointegration between CDS and bond spreads series for Italy (see Table 5). In that frame, the Granger causality test is used to investigate the dynamic relationship between the two markets in the short run. To implement the test and since both series are not level stationary, a VAR(*10*)[22] model in first differences form of CDS and bond spreads is estimated (Table 8).

Table 8 Granger causality test

Null hypothesis	*F-statistic*	*Causality*
ΔCDS_spread does not Granger cause Δbond_spread	43.1827 (*0.00*)	Yes
Δbond_spread does not Granger cause ΔCDS_spread	3.65547 (*0.00*)	Yes

In parentheses are reported the *p*-values.

The above results confirm the rejection of the null hypothesis of non-causality in both cases, suggesting that there is bilateral causality between the two series. This, in turn, implies that past values of CDS spreads help predict the future values of bond spreads and vice versa. Indeed, price discovery occurs in both markets. However, neither CDS market nor bond market can be detected as price leader in the short run. The latter finding is in line with Ito (2016) who finds bilateral influence between CDS and bond markets for Italy. Contrarily, Delis and Mylonidis (2011) find unidirectional causality from bond to CDS market for Italy. On the other hand, Palladini and Portes (2011) and Fontana and Scheicher (2016) suggest that the CDS market leads the bond market in the price discovery process.

5 Conclusions

The relationship between bond and CDS spreads constitutes a particularly interesting research field in the financial literature. As far as corporate entities are concerned, there is consensus among the studies regarding the leading role of the CDS market in the price discovery process. For sovereigns, the empirical findings are inconclusive since a number of studies underline the leading role of CDS while some others suggest the bond market as the leading one. The investigation of the dynamics between bond and CDS spreads became further complicated after the recent debt crisis in the southern European countries considering the diverging conclusions of the related studies. However, there is a lack of evidence regarding the relation between bond and CDS markets during the crisis period, particularly for the countries that were at the spotlight at that time.

The main objective of the present study was to evaluate the sovereign credit market dynamics of the over-indebted southern European countries, namely Portugal, Italy, Greece and Spain. We examined the dynamic relationship between CDS and bond spreads of the related countries during a period of increased uncertainty and market turmoil. We intended to shed light on whether the CDS spreads can trigger rises in bond spreads and on the relative efficiency of credit risk pricing in the CDS and bond markets.

In this context, we employed a three-step econometric methodology, whose main conclusions are summarised below.

The performed unit root tests suggest that both CDS and bond spreads are integrated in first differences for all the examined counties, indicating potential cointegration relationships. The Johansen cointegration test verifies the existence of a long-run equilibrium relationship between CDS and bond spreads for Portugal, Greece and Spain. On the contrary, the null hypothesis of no cointegration cannot be rejected for Italy. Given that cointegrated series are allowed to deviate in the short run, the cointegrated markets are considered in a VECM analysis framework, with the intention of examining the lead–lag relationship between the two spreads. The empirical results highlight the fact that during the European debt crisis, the CDS market leads the price discovery process in Portugal, Greece and Spain. As far as Italy is concerned, the results suggest that price discovery occurs in both CDS and bond markets since the Granger causality test detects bilateral causality between CDS and bond spreads. However, the leading market in the short run cannot be identified.

The main conclusion stemming from the present study is that at least in Portugal, Greece and Spain the bond market tends to follow the CDS market. Hence, during a period of economic turbulence an increase in the CDS spread raises the corresponding bond spread, severely affecting the sovereign cost of borrowing. During the debt crisis, the yields of the peripheral and core euro area countries respond to news announcement (Bouzgarrou and Chebbi, 2015); however, the new information is initially reflected in the credit derivatives market. Therefore, governments should closely monitor the price movements in the CDS market, in order to be properly prepared to take the necessary precautionary measures to avoid any subsequent increase in the bond spreads. Likewise, investors, intending to take advantage of any price changes in the CDS spread, should concentrate on the CDS market, since it constitutes a better source of information for sovereign credit risk. On the basis of the information of the CDS market, investors can rebalance their portfolios in order to improve the risk-return trade off. Indeed, the significance of CDS spreads to market participants should be seriously considered by policy makers especially in the EU, in order to create the appropriate legal framework for the operation of a reliable and more liquid credit derivatives market.[23] This process towards the establishment of an efficient credit market should be done taking into account the different status of individual countries with respect to EU integration (Rossi and Dafflon, 2012; Gradev et al., 2014) and the political attitudes of the member states (Qerimi and Sergi, 2007; Sergi and Qerimi, 2009).

The results of this study could raise new routes for further research. First, our paper examines the relationship between CDS and bond spreads for a sample of highly indebted countries in the EU. Future research can focus on other developed countries beyond EU, which faced similar economic problems in the past. Also, we show that the CDS market is the leading one in the majority of the examined countries. Investigating the persistence of the leading role of the CDS market before and after the crisis will be important. Finally, future empirical research should determine the level of interaction between CDS and bond markets while bodies at international and national level should concentrate on reforms that lead to increased market efficiency and transparency.

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Notes

[1]In general, there is a lead–lag relationship between derivatives and the underlying assets. For a discussion for the direction of information flow between stocks and derivatives markets, see also Aloulou and Boujelbene (2015).

[2]For the investment motives and alternatives, see also Bitzenis (2007) and Bitzenis et al. (2007).

[3]ECB (2004) examines financial and non-financial companies, which are the most important reference entities in the European CDS marker.

[4]Gonzalo and Granger (1995).

[5]The CTD option constrains CDS liquidity for riskier borrowers.

[6]They examined 30 sovereign markets for the period 2001–2007.

[7]Hassan et al. (2015) examine Argentina, Brazil, China, Colombia, Mexico, Philippines and South Africa from 2004 to 2013, while Coudert and Gex (2013) examine Argentina, Brazil, Mexico, Lithuania, Poland, Turkey and Philippines from 2007 to 2010.

[8]The core European countries are Germany, Netherlands, Austria, Belgium and France.

[9]The peripheral European countries are Italy, Ireland, Spain, Portugal and Greece.

[10]Ito (2016) examines Austria, Belgium, Finland, France, Germany, Greece, Italy, Ireland, Netherlands, Portugal and Spain.

[11]Andraz et al. (2015) consider both 2-year and 5-year maturity markets.

[12]Data are expressed in basis points (bps).

[13]German bund is considered as the risk-free bond.

[14]Blanco et al. (2005), Zhu (2006), Norden and Weber (2009), Bowe et al. (2009), Palladini and Portes (2011), Ammer and Cai (2011), Delatte et al. (2012), Aktug et al. (2012), Arce et al. (2013), Coudert and Gex (2013), Fontana and Scheicher(2016), etc.

[15]In order to determine the optimal lag–length of the VAR model, we use the final prediction error (FPE), Akaike's information criterion (AIC), Schwarz information criterion (SC) and the Hannan and Quinn information criterion (HQ).

[16]The existence of cointegration means that at least one market has to adjust towards the long-run equilibrium.

[17]If both coefficients are significant and correctly signed ($a_1 <0$, $a_2 <0$) and *GG* is equal to 0.5, both markets contribute to price discovery to the same degree. Whereas, if *GG* is less than 0.5 the bond market leads CDS market and *vice versa.*

[18]See Footnote 5.

[19]The optimal number of lags of the VAR model is determined using the final prediction error (FPE), Akaike's information criterion (AIC), Schwarz information criterion (SC) and the Hannan and Quinn information criterion (HQ).

[20]Ito (2016) finds no evidence of cointegration regarding Portugal, Greece and Spain. Andraz et al. (2015) find no cointegration in case of Portugal, while Delis and Mylonidis (2011) find evidence of cointegration only in the case of Spain, using Johansen's procedure.

[21]For a discussion of the investment risk, see also Bitzenis and Marangos (2008).

[22]The number of lags of the VAR model is determined using FPE and Akaike's, Schwarz and Hannan and Quinn information criteria.

[23]For a discussion regarding the relationship between liquidity and credit spreads, see also Chebbi and Hellara (2010).