"EMPIRICAL INVESTIGATION OF THE DYNAMIC RELATION BETWEEN THE CORPORATE BOND MARKET AND THE CREDIT DEFAULT SWAP MARKET"

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Abstract

In this paper we test empirically the dynamic relation between the credit default swap market and the cash bond market. Our purpose is to investigate whether the credit spread of a corporate bond converges to a CDS contract of equivalent maturity, indicating that the two markets price credit risk equally in the long-run. This is achieved through Vector Autoregression model (VAR) in the cases where we have stationary variables, or through a Vector Error Correction Model (VECM) in the cases where we find unit roots. Our dataset refers exclusively to the European market and to the issues of Eurobonds and covers a period of 5 years. In most cases we observe a very consistent pattern of cointegration which confirms the existence of a long-term arbitrage relationship between the two markets. Furthermore, through Granger Causality tests, we find that the CDS prices lead credit spreads in the price discovery of credit risk.

1. INTRODUCTION

A remarkable innovation in the credit risk market over the past ten years has been the development of the credit derivatives market. Credit derivatives are over-the-counter financial contracts whose payoffs are linked to changes in the credit quality of an underlying asset. Since the introduction of these credit protection instruments, the market has grown dramatically and become an important tool for financial institutions to shed or take on credit risk. The credit derivatives market continues to expand rapidly, reaching a notional amount of $20.2 trillion in 2006 (US GDP for the same period was near $14 trillion), up 302% from 2004[1] (Figure 1).

The most important and widely used credit derivative instruments are credit default swaps (CDS) which cover about 63% of credit derivatives trading. A credit default swap is an over-the-counter contract that provides insurance against credit risk. In essence, a CDS transfers a defined credit risk from one party to another. The protection buyer pays a fixed fee or premium, often termed as the “spread”, to the seller for a period of time. If a certain pre-specified credit event occurs, the protection seller pays compensation to the protection buyer. A credit event can be a bankruptcy of the reference entity (i.e. the underlying credit that is being transferred), or a default of a bond or other debt issued by the reference entity. If no credit event occurs during the term of the swap, the protection buyer continues to pay the premium until maturity. Should a credit event occur at some point before the contract’s maturity, the protection seller makes a payment to the protection buyer that equals the par value less the recovery value on the delivered obligation.

CDS contracts can be used as a way to gain exposure to credit risk. Although the risk profile of a CDS is similar to that of a corporate bond of the reference entity, there are several important differences. A CDS does not require an initial funding, which allows leveraged positions. A CDS transaction can be entered where a cash bond of the reference entity at a particular maturity is not available. Furthermore, by entering a CDS contract as a protection seller, an investor can easily create a short position in the reference credit. With all these attributes, CDS contracts are a great tool for diversifying or hedging an investor’s portfolio.

[1] JP Morgan, “Credit Derivatives Handbook”, December 2006

The literature on credit derivatives and on credit default swaps in particular is growing rapidly. Interesting research on the field includes the study of Blanco et al (2005) that tested the theoretical[2] arbitrage relationship[3] between the prices of credit default swaps and credit spreads for 33 investment-grade US and European entities. According to this relationship, the credit spread of a par risky bond should equal the CDS price of the same maturity for a given reference entity. Their data cover the period January 2001 – June 2002. Their results revealed that the arbitrage relationship exists for all US entities in their sample as well as for some European ones. In the cases where the two types of spreads were found to deviate from each other, it was evident that CDS spreads had a clear lead in price discovery compared to credit spreads. The authors state that the main reasons for this deviation are 1) the Cheapest-to-Deliver option contained in physically settled CDS contracts and 2) the repo cost which increases the actual credit spread in the cases of short selling the bond. Longstaff et al (2004) try to identify the size of the default and non default components in corporate yield spreads by using the information in credit default swap premia. They assume that the CDS spread is a direct measure of credit risk in corporate spreads and use it as a benchmark to identify the liquidity component of the corporate yield spread. Similar to Blanco et al (2005), they find that default risk accounts for 55% - 85% of corporate bond spreads (according to the credit rating of the bond). Their results are consistent with those of Elton et al. (2001) who find that spreads include an important risk premium in addition to compensation for the expected default loss. This risk premium is related to a liquidity component. Zhu (2004) also confirmed the existence of an arbitrage relationship between the CDS prices and credit spreads in the long term. However, in the short term, he found that the two markets do not price credit risk equally. The author suggests that the reason for these differences in pricing is that the two markets do not react in the same way in changes in credit conditions. Specifically, the CDS market usually leads the bond market, mostly for US entities.

In this paper we test empirically the dynamic relationship that links CDS spread to credit spreads of corporate bonds for the European market. To the best of

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[2] The term “theoretical” is used here because in reality the relationship can be highly volatile and the levels can diverge greatly. Some of the reasons for this divergence are that it is not always easy to “to short” on a bond and in practise most bonds are not priced at par.

[3] The arbitrage relationship between CDS prices and corporate bond spreads is also discussed in Duffie (1999) and in Hull and White (2000a).

our knowledge, there have not been any studies investigating the arbitrage relationship in this particular bond category, due to the, until now, unavailability of data. We believe this topic is of great importance to market participants who perform trades between the two markets for hedging or speculative purposes, as well as for risk managers who have the responsibility of measuring and minimizing credit risk using the CDS market as a tool.

Our sample consists of 229 Eurobonds issued by 41 different issuers (37 European entities and 4 countries specialized in Eurobond issuance). Specifically, we use Vector Autoregression Models (VAR) in the cases where we have stationary variables or Vector Error Correction Models (VECM) in the cases where we find unit roots. In both cases we try to investigate whether the credit spread of a corporate bond converges to a CDS contract of equivalent maturity, indicating that the two markets price credit risk equally in the long run. In a next step, through Granger Causality tests, we test for price leadership between the CDS and the bond market.

The contribution of our paper to the existing literature can be summarized in the following: Our dataset refers exclusively to the European market and to the issues of Eurobonds. Furthermore, in the analysis we have included the entire term structure of bond issuance, as opposed to earlier studies (Blanco et al, 2005) that used only the 5-year segment in order to match it with the 5-year maturity of the CDS contracts. The authors included only 5-year CDS contracts in their dataset, since they believed that these are the most liquid CDS contracts in the market. However, we believe that the use of the 5-year segment only is not representative of all active issuers, since different issuers are more active at different portions of the term structure (e.g. highly-rated issuers are more active at the longer end of the term structure, whereas issuers of lower credit rating normally issue bonds with maturities of up to 2-3 years). Finally, our interpolation scheme (interpolating between different maturities of CDS contracts) is much more consistent with actual basis trading that takes place in the market, whereas interpolating between different bond maturities is something that cannot be replicated naturally in the market. Finally, the extent of our dataset is much larger in terms of history, number of active issuers and enhanced liquidity of individual issues.

The results from our empirical investigation revealed that the majority of the Eurobond spreads and the CDS spreads in our sample are cointegrated, providing evidence for the existence of a theoretical arbitrage relationship between the two markets. Furthermore, the Granger causality tests showed that the CDS spread leads the I-spread in the price discovery process for the majority of the bonds in the sample. These results provide evidence that the credit derivatives market incorporates faster the information in the market price, rather than the cash bond market and that the movements in the credit derivatives market affect the direction of the bond market.

The remainder of the paper is structured as follows. The next section describes the methodology that is used in the analysis; Section 3 discusses the properties of the data and section 4 offers the empirical results. Finally, Section 5 concludes this study.

2. METHODOLOGY

2.1 Arbitrage relationship between CDS spreads and credit spreads

As discussed in Duffie (1999), Hull and White (2000a), and Blanco et al. (2005), there exists an arbitrage relation between CDS prices and credit spreads for a given reference entity. Suppose an investor buys a T-year par bond with yield to maturity of y issued by the reference entity, and buys credit protection on that entity for T years in the CDS market at a cost of p_{CDS}[4]. In this way, the investor has transferred the credit risk associated with the bond to the seller of the CDS. The net annual return of this investment strategy for the buyer of the CDS is y - p_{CDS}, where y denotes the yield to maturity (expressed in basis points) of the risky par bond and p_{CDS} denotes the price of the CDS (or the CDS premium or the CDS spread expressed in basis points). By arbitrage, this net return should approximately equal the T-year risk free rate, denoted by x.

If y - p_{CDS} is less than x, then the investor can exploit riskless arbitrage profits by shorting the risky bond, writing protection in the CDS market, and buying the risk free instrument. Similarly, a reverse arbitrage opportunity arises when y - p_{CDS} exceeds x. In this case, buying the risky bond, buying protection, and shorting the risk free bond would be profitable. This suggests that the price of the CDS, p_{CDS}, should equal the credit spread of the bond $y - x$, that is:

$$\boldsymbol{p_{CDS,t} = y_t - x_t = p_{CS,t}} \qquad (1)$$

where $\boldsymbol{p_{CS,t}}$ denotes the credit spread of a par risky bond at time t.

[4] Where p_{CDS} is referred to as the “CDS premium” or “CDS spread”.

However, due to short-term imperfections[5], the difference between the two spreads is not zero (Houweling and Vorst (2002), Hull and White (2000a)) and therefore do not correspond to what is stated in this arbitrage relationship. For instance, Cheapest–to–Deliver options contained in physically-settled CDS contracts will lead to CDS price being grater than the credit spread. Since it is not possible to value this option analytically, we cannot simply subtract its value from the CDS price. Furthermore, short shelling the cash bond is not costless and sometimes is not even possible in illiquid corporate bond markets. If the repo cost[6] of shorting the bond is significant, then the calculated credit spread (bond yield minus risk-free rate) underestimates the true credit spread (bond yield minus risk free rate plus repo cost). In this case the CDS price will again tend to be greater than the calculated credit spread. Therefore we could say that the CDS price provides an upper limit on the price of credit risk while the credit spread provides a lower limit (Blanco et al, 2005). This difference is called the CDS Basis. In this case, equation (1) becomes:

$$\boldsymbol{Basis_t = p_{CDS,t} - y_t - x_t = p_{CDS,t} - p_{CS,t}} \qquad (2)$$

3.2 Granger Causality and Cointegration

The causal relationship between CDS spreads and credit spreads is investigated using the following Vector Error Correction Model (VECM) (Johansen, 1988):

$$\Delta X_t = \mu + \sum_{i=1}^{p-1} \Gamma_i \, \Delta X_{t-i} + \Pi X_{t-1} + \varepsilon_t \, ; \, \varepsilon_t = \begin{pmatrix} \varepsilon_{CDS,t} \\ \varepsilon_{CS,t} \end{pmatrix} \sim N(0, \Sigma), \quad (3)$$

where $X_t = (p_{CDS,t}\ p_{CS,t})'$ is the (2x1) vector of CDS spreads and credit spreads, each being I(1) such that the first differenced series are I(0); μ is a (2x1) vector of deterministic components; Δ denotes the first difference operator; Γ_i and Π are (2x2) coefficient matrices measuring the short- and long – run adjustment of the system to changes in X_t , ε_t is a (2x1) vector of white noise error terms and Σ is the variance/covariance matrix of the latter. The number of lags in the VECM (p=4) is determined through the Schwartz Criterion (Schwartz, 1978). Furthermore, for the

[5] Liquidity premiums, Cheapest-to-Deliver options, Call options on bonds, counterparty risk etc., are some of the factors that have a distorting impact on the CDS basis.

[6] In order to short sell the bond, the investor needs to borrow it first in the repo market.

choice of the deterministic components we used the following test proposed by Johansen (1991):

$-T[\ln(1-\hat{\lambda}_2^*) - \ln(1-\hat{\lambda}_2)]$, distributed as $\chi^2(1)$, where $\hat{\lambda}_2^*$ and $\hat{\lambda}_2$ represent the smallest eigenvalues of the model that includes an intercept term in the cointegration vector and an intercept term in the short-run model, respectively.

First, the existence of a stationary linear combination between CDS spreads and credit spreads is investigated in the VECM of equation (3) through the λ_{max} and λ_{trace} statistics (Johansen, 1988) which test for the rank of Π. If rank(Π) = 0, then Π is a (2x2) zero matrix implying that there is no cointegration relationship between CDS spreads and credit spreads. In this case, the VECM reduces to a Vector Autoregressive (VAR) model in first differences. If rank(Π) = 2, then all variables in X_t are I(0) and the appropriate modeling strategy is to estimate a VAR model in levels. If rank(Π) = 1 then there is a single cointegrating vector and Π can be factored as Π = αβ', where β' represents the vector of cointegrating parameters and α is the vector of error correction coefficients measuring the speed of convergence to the long-run equilibrium. If the two markets price credit risk equally in the long run, then their prices should be cointegrated with cointegrating vector [1, -1, c], suggesting that the basis is stationary. As it is stated in Blanco et al (2005), the constant in the cointegrating space c should equal zero, but since swap rates are an imperfect proxy for the risk free rate[7], it is better not to impose this restriction. If the markets do not cointegrate with the above restriction imposed, then, the two markets price credit risk differently, or at least one market price contains nontransient factors[8] that reflect something other than credit risk.

Second, if CDS spreads and credit spreads are cointegrated, then causality must exist in at least one direction (Granger, 1986). To test for causality, we estimate the following expanded VECM using OLS in each equation:

$$\Delta p_{CDS,t} = \lambda_1(p_{CDS,t-1} - a_0 - a_1 p_{CS,t-1}) + \sum_{j=1}^{p} b_{1j}\Delta p_{CDS,t-j} + \sum_{j=1}^{p} \delta_{1j}\Delta p_{CS,t-j} + \varepsilon_{1t}$$

$$\Delta p_{CS,t} = \lambda_2(p_{CDS,t-1} - a_0 - a_1 p_{CS,t-1}) + \sum_{j=1}^{p} b_{2j}\Delta p_{CDS,t-j} + \sum_{j=1}^{p} \delta_{2j}\Delta p_{CS,t-j} + \varepsilon_{2t} \qquad (4)$$

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[7] Swap rates contain credit premia because (i) the floating leg is indexed to LIBOR, which itself is a default risky interest rate (Sundaresan (1991)), and (ii) there is some counterparty risk, although Duffie and Huang (1996) show that this accounts for just 1-2 basis points.

[8] Cheapest-to-Deliver options, non zero repo costs, etc.

where $\varepsilon_{1t} \sim iid(0, \sigma^2_{1t})$ and $\varepsilon_{2t} \sim iid(0, \sigma^2_{2t})$.

In equation (4), $p_{CS,t}$ Granger causes $p_{CDS,t}$ if some of the δ_{1j} coefficients are not zero and/or λ_1, the error correction coefficient in the equation for CDS spreads is significant at conventional levels. Similarly, $p_{CDS,t}$ Granger causes $p_{CS,t}$ if some of the b_{2j} coefficients are not zero and/or λ_2 is significant at conventional levels. If both $p_{CS,t}$ and $p_{CDS,t}$ Granger cause each other then there is a two-way feedback relationship between the two markets. The error correction coefficients λ_1 and λ_2 serve two purposes: to identify the direction of causality between CDS spreads and credit spreads and to measure the speed with which deviations from the long-run relationship are corrected by changes in the CDS spreads and credit spreads.

3. DATA DESCRIPTION

3.1. Corporate Bond Yield Data

The sample used in the analysis consists of daily observations of 229 eurobond yields. These are issues from 41 entities, 36 of which are investment-grade European firms from various sectors of the economy (Banks, telecommunication, car industry, retail, etc.) and have a history in bond issuance. Each firm has at least two Eurobonds with various maturities. Furthermore, the sample contains issues of 5 countries (Croatia, Hungary, Poland, Tunisia and Turkey). These countries were selected because they are typical Eurobond issuers and because they all had issued at least two Eurobonds for which we had available observations. The data were provided by BNP Paribas, one of the biggest market makers in the CDS market, and cover the period between August 2002 and August 2007 (5 years).

In order to overcome the possible impact of illiquidity, we selected bonds that were marked as very liquid by the data provider. We excluded floating-rate bonds, callable bonds, bonds with step-up coupons or any special feature that would cause distortions in pricing. Furthermore, we excluded bonds trading away from par so that the theoretical arbitrage relationship was not compromised.

3.2. Credit Default Swap Data

The dataset contains daily mid prices, expressed in basis points, of CDS contracts that refer to the above issuers, with maturities of 6 months, 1,2,3,5,7, and 10 years. Unlike previous studies (Blanco et al, 2005) that use only the 5–year CDS contract as the most liquid in the market, we include in our study the entire term structure of the CDS contracts. The reason is that depending on the issuer, there exists enhanced liquidity in different parts of the CDS curve. In this article, we picked the maturities of the CDS contracts that were marked as very liquid by the data provider (BNP Paribas).

In order to test for the existence of the arbitrage relationship between the CDS spreads and credit spreads of Eurobonds in our sample, we needed to match the remaining maturity of each bond on each day of our dataset with the maturities of the CDS contracts. Therefore, we used the linear interpolation method (Predescu et al, 2004) in order to retrieve a corresponding CDS spread with equivalent maturity. This method differs from the one that was used in previous studies (e.g. Blanco et al, 2005), who interpolated between different bond maturities in order to match the maturity of the CDS contract. The reason is that our interpolation scheme is much more consistent with actual basis trading that takes place in the market, whereas interpolating between different bond maturities is something that cannot be replicated naturally in the market.

3.3. Risk-free Rate Data

The risk-free rate is used for the calculation of the yield spread for each bond in our dataset. We consider the swap rate as the most reliable measure for the risk-free rate, since many studies have shown that swap rates are a better proxy for the risk-free interest rate compared to government bond yields (Kosic, 2000, Hull, 2004 etc). The main reasons are that government bond yields are affected by taxation treatment (Reinhart and Sack (2002)), repo specials[9] and scarcity (or liquidity)

[9] A bond is repo special when, in the case of short-selling it in the market, it is difficult to obtain it as collateral. Therefore, the repo rate R that the investor receives for the particular bond after entering a repo transaction may be below the general collateral rate, raising the costs of shorting (Duffie, 1996).

premia. Swap rates on the other hand, being synthetic[10], are available in unlimited quantities so that liquidity is not an issue, and the have the advantage of being quoted on a constant maturity basis (McCauley, 2002).

The data include daily observations of mid swap rates with maturities of 3 months up to 30 years and were provided by JP Morgan. Because the maturities of the swap rates did not match exactly the remaining maturity of each bond, we again used the linear interpolation method in order to retrieve a corresponding swap rate with equivalent maturity.

Table 1 presents the reference entities in our sample, together with basic descriptive information.

4. EMPIRICAL RESULTS

4.1. Results on Unit Root Tests

The Augmented Dickey-Fuller (ADF) and Phillips-Perron unit root tests that were conducted on the levels and first differences of each pair of CDS spread – credit spread in the sample, confirm the existence of a unit root in 72 out of 229 cases. In 66 cases the non-stationarity was evident in either the CDS spread or the credit spread of the bonds. These cases were excluded from the dataset, since they provide no information about the relationship between the two markets. The remaining 91 bonds were found stationary.

The results from the unit root tests are presented in Table 2. Panel A of Table 2 reports the percentage of bonds and CDS spreads for each individual issuer that were found stationary (with P Value<5%, rejecting the null hypothesis of the existence of unit root). The issuers are categorized according to sector and the last column presents the total number of issues in each case. Panel B of Table 2 depicts the aggregate results for different sectors of our data. According to the results, there is strong evidence of stationarity in many firms of our dataset. The existence of stationarity in a significant number of bonds can be explained by the fact that the sample covers a time period of tightening of spreads (credit tightening phase), causing

[10] Swap contracts have maturities over 1 year, so for shorter maturities swap rates are calculated from money market rates.

the spreads to present a mean reverting trend. Specifically in the banking sector, more than 80% are stationary. We believe that this is due to the fact that banks issue mostly highly-rated bonds (above AA) and therefore their spreads are relatively tight and low during our examination period.

4.2. Results on Johansen Cointegration Tests & Granger Causality tests

Johansen cointegration test is estimated in the non-stationary variables in order to identify the existence of a long-term relationship between the credit spreads and the CDS spreads of the bonds in the sample. The lag length ($p = 4$) in the VECM of Equation (4) was chosen on the basis of SBIC (Schwartz, 1978). Table 3 reports the results. Panel A of Table 3 reports the percentage of pairs that are cointegrated for each issuer, while Panel B depicts the aggregate results for different sectors.

From the results it is evident that almost 92% of the non-stationary pairs of variables (66 out of 72 cases) are cointegrated. This suggests that for each of these pairs there exists at least one stationary linear combination, which constitutes the cointegrating vector. Therefore, the implication of this test is that the arbitrage relationship between the two markets (cash bond and derivatives market) is not violated in the long-run.

Furthermore, the cointegrating relationship is evident in almost all sectors of our sample. Specifically, 100% of the non-stationary variables of the Sovereign, Auto, Financial, Retail and Building issues are cointegrated, while for the remaining sectors this ratio is above 50%. Figures 2 - 5 plot the CDS spread and credit spread of selected bonds issued by Lafarge, BAT International Finance, France Telecom, and Koninklijke KPN during our examination period. The graphs indicate that the spreads move closely together over time, suggesting the existence of a long-run relation between them.

In a next step, Granger Causality tests were conducted on the non-stationary (through a VECM setup) and stationary pairs (through a VAR setup) of variables in order to test for price leadership between the CDS and bond market. The results on the VECM and VAR models are presented in Tables 3 and 4, respectively. The third column of Panel A of Table 3 reports the percentage of cases for each issuer where CDS spread leads credit spread in the pricing of credit risk. Column 4 reports the percentage of cases where credit spread leads CDS spread in the price discovery process and the last column reports the percentage of cases with bi-directional causality. Panel B illustrates the aggregate results for different sectors of our sample. A similar display is shown in Panels A and B of Table 4.

According to the results, CDS spread Granger-Causes credit spread for the majority of the entities in our sample. The opposite is evident in only a few issuers, while in a significant number of cases the causality is bi-directional. The bi-directional causality is mostly evident in the Sovereign issues (Panel B of Table 4). This may be explained from the fact that sovereign bonds are subject to renegotiation risk, which is another kind of optionality that is reflected in the bond price and therefore makes these bond more liquid and attractive to investors.

In the remaining 30% of the sample (mainly in bonds from the banking sector) causality was not evident in either direction. The failure of the causality test in these cases is probably due to the fact that banks are very active issuers of structured debt, creating in this manner a very significant Cheapest-to-Deliver option (since deliverable issues increase). This feature may be responsible for the dilution of credit information in the bond market.

5. CONCLUSIONS

In this paper we tested empirically the existence of a long term arbitrage relationship between the cash bond market and the CDS (derivatives) market. The data we chose were yield spreads and CDS spreads from Eurobonds issued by various reference entities characterized by high liquidity and good credit rating.

The empirical results showed that in a large part of our sample during our examination period there was strong evidence of stationarity. This could be explained from the fact that our data do not cover an entire business cycle, but describe a period of tightening of spreads. In those cases where the hypothesis of an existing unit root was not rejected, we observed a very consistent pattern of cointegration relationships between the two markets. This result suggests that in the long-run the two markets price credit risk equally. Therefore, the arbitrage relationship between the CDS market and the cash bond market is not violated in the long-run.

Finally, in that same part of our dataset the results from the Granger Causality tests provide evidence that the CDS market is more often the leader in the price discovery of credit risk rather than the other way round. This is not surprising, since the CDS contracts are unfunded instruments (i.e. they require no initial cash outlay), and are equally easy to go long or short. This attribute makes them preferable to speculators and hedgers in comparison to cash bonds. As a result, the CDS market absorbs faster the credit information.

The results derived from the Granger Causality tests are in line with those of previous studies who have focused mostly in the US market (Blanco et al, 2005, Hull, Predescu et al, 2004). Furthermore, the evidence of cointegration is much stronger in our analysis compared to previous research, perhaps because the extent of our dataset is much larger in terms of history and of number of active issuers. Finally, our findings have several implications to traders and hedgers who perform trades between the two markets for hedging or speculative purposes, as well as for risk managers who have the responsibility of measuring and minimizing credit risk using the CDS market as a tool.

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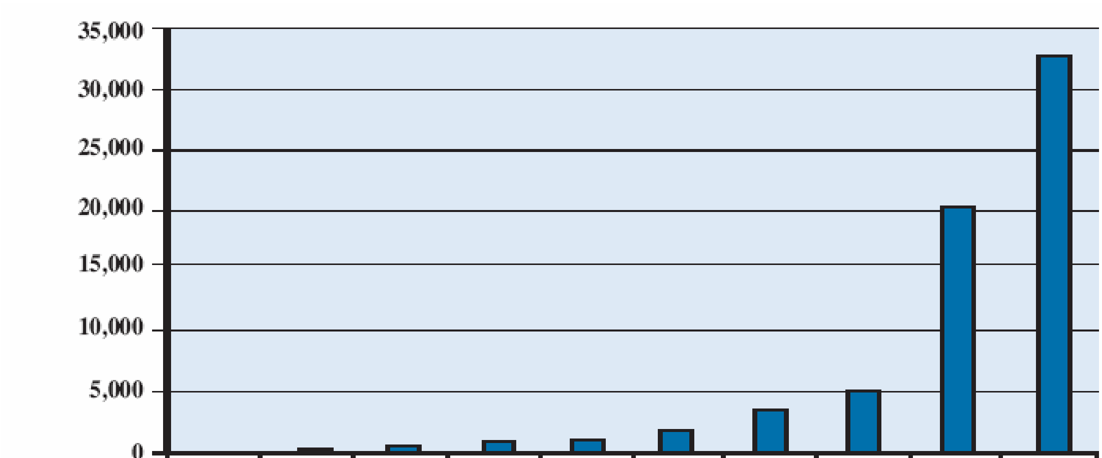
Figure 1 – Credit Derivatives Market ($ bn)



	1996	1998	1999	2000	2001	2002	2003	2004	2006	2008 (est.)
USD (bn)	180	350	586	893	1,189	1,952	3,548	5,021	20,207	33,120

Source: JP Morgan, “Credit Derivatives Handbook”, December 2006

Figure 2

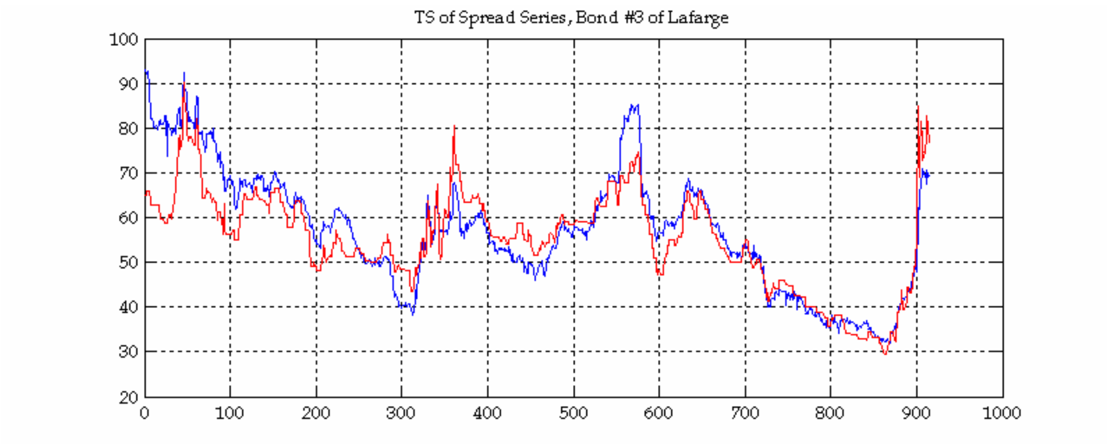


***Figure 2*:** CDS spread and credit spread for bond with maturity 12/4/2013 of Lafarge

Figure 3

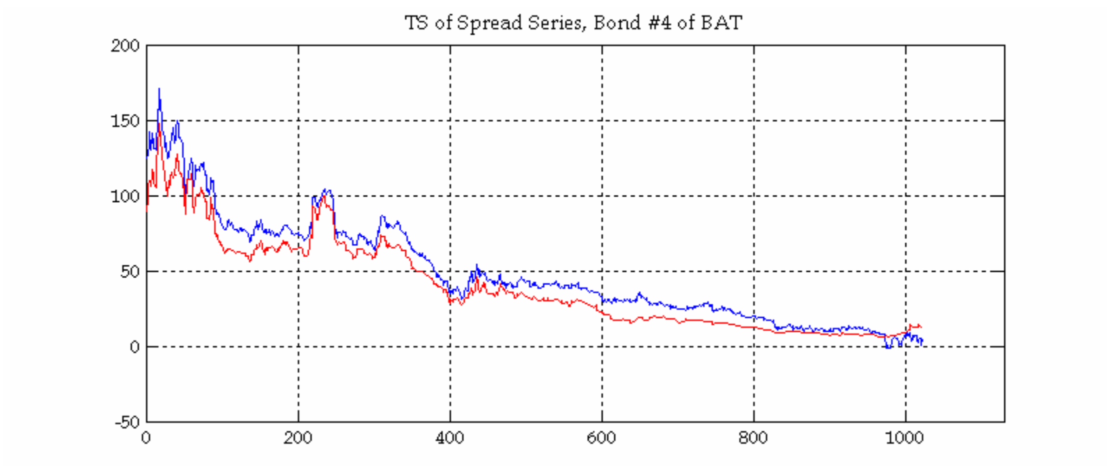


Figure 3: CDS spread and credit spread for bond with maturity 25/2/2009 for BAT International Finance.

Figure 4

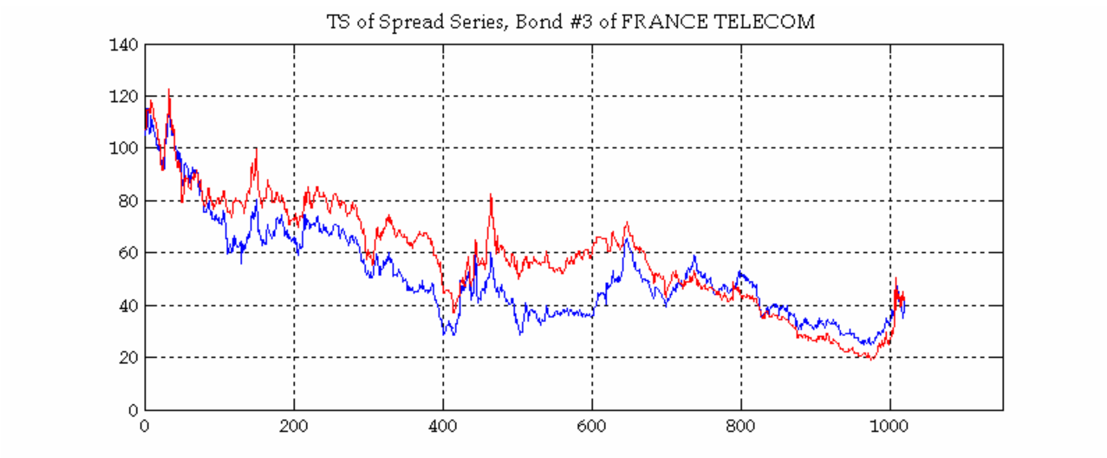


Figure 4**:** CDS spread and credit spread for bond with maturity 28/1/2013 of France Telecom

Figure 5

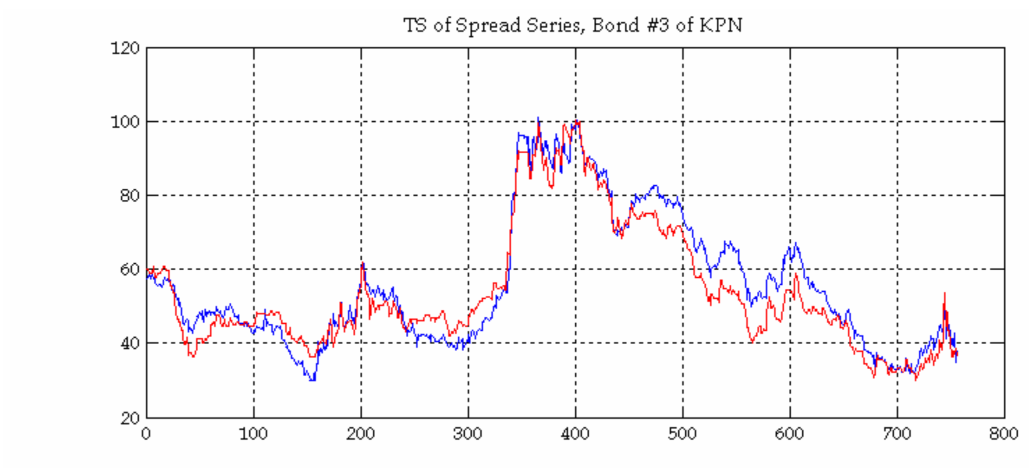


Figure 5**:** CDS spread and credit spread for bond with maturity 21/7/2011 of Koninklijke KPN.

Table 1

Descriptive Statisitcs

ISSUER	SYMBOL	Number of Bonds	Moody's/Standard and Poor's	SECTOR
ABN AMRO BANK NV	ABN	11	AA+	Financial - Banks
BANCO BILBAO VIZCAYA ARGENTARIA, S.A.	BBV	11	Aaa	Financial - Banks
BANQUE FEDERATIVE DU CREDIT MUTUEL	BFCM	2	Aa3/AA-	Financial - Banks
CAISSE CENTRALE DU CREDIT IMMOBILIER DE FRANCE	CCCI	4	A1/A+	Financial - Banks
RABOBANK	RABOBK	10	Aaa/AAA	Financial - Banks
COMMERZBANK AG	CMZB	4	A3/A-	Financial - Banks
DEUTSCHE BANK AKTIENGESELLSCHAFT	DB	4	Aa1/AA-	Financial - Banks
HSH NORDBANK AG	HSHN	6	Aa1/AA-	Financial - Banks
BANCO SANTANDER CENTRAL HISPANO	SANTAN	5	Aaa	Financial - Banks
UNICREDITO ITALIANO SOCIETA PER AZIONI	CRDIT	4	Aa2/A+	Financial - Banks
LAND BERLIN	BERGER	6	Aa1	Financial-Banks
HBOS TREASURY SERVICES PLC	HBOS	8	Aaa/AAA	Financial-Banks
NORTHERN ROCK PLC	NRBS	4	Aaa/AAA	Financial-Banks
EUROHYPO AG	EURHYP	10	Aaa/AAA	Financial-Banks
ALLIANZ FINANCE BV	ALZ	5	Aa3/AA	Financial - Insurance
GENERALI FINANCE BV	ASSGEN	4	AA-	Financial-Insurance
BAT INTERNATIONAL FINANCE	BATSLN	5	Baa1/BBB+	Financial-Corporates
ENEL SPA	ENEL	2	A1/A	Industrial-Electricity/Gas
RWE AG	RWE	4	A1/A+	Industrial-Electricity/Gas
GAZ CAPITAL S.A., SOCIETE ANONYME.	GAZPRU	5	Baa3/BBB	Industrial-Oil Coal Gas
GIE SUEZ ALLIANCE	LYOE	5	A2/A-	Industrial-Water
VIVENDI UNIVERSAL	VIEFP	7	A3/BBB	Industrial-Water

VOLKSWAGEN INTERNATIONAL FINANCE NV	VW	6	A3/A-	Industrial-Auto/Components
CARREFOUR	CARR	6	A2/A	Retail
CASINO GUICHARD PERRACHON& CIE	COFP	3	BBB-	Retail
BOUYGUES	BOUY	6	A-	Building
LAFARGE	LAFCP	4	Baa2/BBB	Building
BERTELSMANN AG	BERTEL	4	Baa1/BBB+	Media
KONINKLIJKE KPN N.V.	KPN	4	Baa2/BBB+	Telecom
DEUTSCHE TELEKOM INTERNATIONAL FINANCE B.V.	DT	9	A3/A-	Telecom
FRANCE TELECOM	FRTEL	5	A3/A-	Telecom
VODAFONE GROUP	VOD	4	Baa1/A-	Telecom
PORTUGAL TELECOM INTERNATIONAL FINANCE B.V.	PORTEL	4	Baa2/BBB-	Telecom
TELECOM ITALIA	TITIM	10	Baa2/BBB+	Telecom
TELEFONICA EUROPE BV	TELEFO	6	Baa1/BBB+	Telecom
TELENOR ASA	TELNOR	3	A2/BBB+	Telecom
REPUBLIC OF HUNGARY	REPHUN	7	A2/BBB+	Emerging-Sovereign
REPUBLIC OF POLAND	POLAND	5	A2/A-	Sovereign
REPUBLIC OF CROATIA	CROATI	4	Baa3/BBB	Emerging-Sovereign
REPUBLIC OF TURKEY	TURKEY	9	Ba3/BB-	Sovereign
BANQUE CENTRALE DE TUNISIE	BTUN	4	Baa2/BBB	Emerging-Sovereign

Note: This table presents the reference entities in the dataset, together with their symbol in the BNP database, the number of bonds issued, the credit rating each issuer has received from Moody's and S&P and their categorization in sectors.

Table 2

Results from the ADF & Phillips-Perron Unit Root Tests

Panel A						
		ADF Unit Root Test		Phillips - Perron Unit Root Test		
Sector	**Issuer**	**% of Bonds with P Value < 5%**	**% of CDS with P Value < 5%**	**% of Bonds with P Value < 5%**	**% of CDS with P Value < 5%**	**Total # of issues**
FINANCIAL - BANKS	ABN	100.00%	100.00%	100.00%	100.00%	11
	BBVA	90.91%	54.55%	100.00%	54.55%	11
	BANQUE DU CREDIT MUTUEL	100.00%	0.00%	100.00%	0.00%	2
	C.C.C. IMMOBILIER	75.00%	0.00%	75.00%	0.00%	4
	RABOBANK	100.00%	50.00%	100.00%	50.00%	10
	COMMERZBANK	100.00%	100.00%	100.00%	100.00%	4
	DEUTSCHE BANK	100.00%	75.00%	100.00%	50.00%	4
	HSH NORDBANK AG	50.00%	16.67%	66.67%	16.67%	6
	BANCO SANTANDER	40.00%	0.00%	80.00%	0.00%	5
	UNICREDITO ITALIANO	25.00%	25.00%	25.00%	0.00%	4
	LAND BERLIN	83.33%	100.00%	100.00%	100.00%	6
	HBOS TREASURY SERVICES	75.00%	25.00%	75.00%	25.00%	8
	NORTHERN ROCK PLC	75.00%	100.00%	100.00%	75.00%	4
	EUROHYPO AG	100.00%	50.00%	100.00%	50.00%	10
FINANCIAL - INSURANCE	ALLIANZ FINANCE	100.00%	80.00%	60.00%	80.00%	5
	GENERALI FINANCE BV	50.00%	25.00%	75.00%	0.00%	4
FINANCIAL - CORPORATES	BAT INT. FINANCE	80.00%	80.00%	60.00%	60.00%	5
ELECTRICITY - GAS	ENEL SPA	0.00%	0.00%	0.00%	0.00%	2
	RWE AG	50.00%	50.00%	25.00%	75.00%	4

OIL COAL - GAS	GAZ CAPITAL S.A.	80.00%	40.00%	40.00%	40.00%	5
INDUSTRIAL - WATER	GIE SUEZ ALLIANCE	80.00%	100.00%	80.00%	100.00%	5
	VIVENDI UNIVERSAL	57.14%	71.43%	42.86%	57.14%	7
AUTO - COMPONENTS	VOLKSWAGEN INT. FINANCE	0.00%	100.00%	0.00%	33.33%	6
RETAIL	CARREFOUR	83.33%	66.67%	83.33%	66.67%	6
	CASINO GUICHARD	33.33%	66.67%	0.00%	0.00%	3
BUILDING	BOUYGUES	66.67%	83.33%	50.00%	0.00%	6
	LAFARGE	50.00%	50.00%	0.00%	25.00%	4
MEDIA	BERTELSMANN	25.00%	50.00%	0.00%	25.00%	4
TELECOMS	KONINKLIJKE KPN N.V.	0.00%	25.00%	0.00%	0.00%	4
	DEUTSCHE TELECOM	33.33%	55.56%	11.11%	33.33%	9
	FRANCE TELECOM	40.00%	80.00%	40.00%	80.00%	5
	VODAFONE	50.00%	50.00%	50.00%	25.00%	4
	PORTUGAL TELECOM	25.00%	0.00%	25.00%	0.00%	4
	TELECOM ITALIA	60.00%	90.00%	20.00%	90.00%	10
	TELEFONICA EUROPE BV	33.33%	16.67%	33.33%	16.67%	6
	TELENOR ASA	66.67%	33.33%	66.67%	0.00%	3
SOVEREIGN / EMERGING	REPUBLIC OF HUNGARY	85.71%	0.00%	85.71%	0.00%	7
	REPUBLIC OF POLAND	80.00%	20.00%	80.00%	20.00%	5
	REPUBLIC OF CROATIA	75.00%	50.00%	75.00%	75.00%	4
	REPUBLIC OF TURKEY	77.78%	55.56%	44.44%	33.33%	9
	BANQUE CENTRALE DE TUNISIE	100.00%	50.00%	100.00%	25.00%	4

Table 2 (cont.)

Panel B					
	ADF Unit Root Test		Phillips - Perron Unit Root Test		
Sector	**% of Bonds with P Value < 5%**	**% of CDS with P Value < 5%**	**% of Bonds with P Value < 5%**	**% of CDS with P Value < 5%**	**# of issuers in each sector**
FINANCIAL - BANKS	83.15%	53.93%	89.89%	50.56%	14
FINANCIAL - INSURANCE	77.78%	55.56%	66.67%	44.44%	2
FINANCIAL - CORPORATES	80.00%	80.00%	60.00%	60.00%	1
ELECTRICITY - GAS	33.33%	33.33%	16.67%	50.00%	2
OIL COAL - GAS	80.00%	40.00%	40.00%	40.00%	1
INDUSTRIAL - WATER	66.67%	83.33%	58.33%	75.00%	2
AUTO - COMPONENTS	0.00%	100.00%	0.00%	33.33%	1
RETAIL	66.67%	66.67%	55.56%	44.44%	2
BUILDING	60.00%	70.00%	30.00%	10.00%	2
MEDIA	25.00%	50.00%	0.00%	25.00%	1
TELECOMS	40.00%	51.11%	26.67%	40.00%	8
SOVEREIGN / EMERGING	82.76%	34.48%	72.41%	27.59%	5

Note: Panel A of Table 2 reports the percentage of bonds and CDS spreads for each individual issuer that were found stationary (with P Value<5%, rejecting the null hypothesis of the existence of unit root). The issuers are categorized according to sector and the last column presents the total number of issues in each case. Panel B of Table 2 depicts the aggregate results for different sectors of our data

Table 3

Results from Johansen Cointegration Tests & Granger Causality Tests

Panel A					
		Johansen cointegration test		Granger Causality test	
Sector	Issuer	% of cointegrating pairs	% of cases whereCDS GC I spread	% of cases where I spread GC CDS	% of cases with bi-directional causality
FINANCIAL - BANKS	C.C.C. IMMOBILIER	0.00%	0.00%	0.00%	0.00%
	RABOBANK	100.00%	0.00%	0.00%	0.00%
	DEUTSCHE BANK	100.00%	0.00%	0.00%	100.00%
	HSH NORDBANK AG	100.00%	0.00%	50.00%	0.00%
	BANCO SANTANDER	100.00%	0.00%	0.00%	33.33%
	UNICREDITO ITALIANO	75.00%	0.00%	25.00%	50.00%
	LAND BERLIN	100.00%	0.00%	0.00%	0.00%
	HBOS TREASURY SERVICES	66.67%	33.33%	33.33%	0.00%
	NORTHERN ROCK PLC	100.00%	0.00%	0.00%	0.00%
FINANCIAL - INSURANCE	GENERALI FINANCE BV	100.00%	50.00%	0.00%	50.00%
FINANCIAL - CORPORATES	BAT INT. FINANCE	100.00%	0.00%	0.00%	100.00%
ELECTRICITY - GAS	ENEL SPA	50.00%	0.00%	0.00%	50.00%
	RWE AG	50.00%	0.00%	50.00%	50.00%
OIL COAL - GAS	GAZ CAPITAL S.A.	100.00%	0.00%	0.00%	0.00%
INDUSTRIAL - WATER	VIVENDI UNIVERSAL	100.00%	0.00%	33.33%	33.33%
AUTO - COMPONENTS	VOLKSWAGEN INT. FINANCE	100.00%	100.00%	0.00%	0.00%
RETAIL	CARREFOUR	100.00%	0.00%	0.00%	0.00%
	CASINO GUICHARD	100.00%	0.00%	0.00%	100.00%
BUILDING	LAFARGE	100.00%	0.00%	0.00%	100.00%
MEDIA	BERTELSMANN	100.00%	33.33%	0.00%	66.67%
TELECOMS	KONINKLIJKE KPN N.V.	75.00%	75.00%	0.00%	0.00%
	DEUTSCHE TELECOM	100.00%	50.00%	0.00%	50.00%
	FRANCE TELECOM	100.00%	0.00%	0.00%	100.00%
	VODAFONE	100.00%	100.00%	0.00%	0.00%
	PORTUGAL TELECOM	100.00%	0.00%	0.00%	0.00%
	TELECOM ITALIA	100.00%	100.00%	0.00%	0.00%
	TELEFONICA EUROPE BV	100.00%	25.00%	0.00%	50.00%
	TELENOR ASA	100.00%	100.00%	0.00%	0.00%
SOVEREIGN / EMERGING	REPUBLIC OF HUNGARY	100.00%	100.00%	0.00%	0.00%
	REPUBLIC OF POLAND	100.00%	100.00%	0.00%	0.00%
	REPUBLIC OF CROATIA	100.00%	100.00%	0.00%	0.00%
	REPUBLIC OF TURKEY	100.00%	75.00%	0.00%	25.00%

Table 3 (cont.)

Panel B

Sector	**% of cointegrating pairs**	**% of cases whereCDS GC I spread**	**% of cases where I spread GC CDS**	**% of cases with bi-directional causality**
FINANCIAL - BANKS	82.4%	5.9%	17.6%	23.5%
FINANCIAL - INSURANCE	100.0%	50.0%	0.0%	50.0%
FINANCIAL - CORPORATES	100.0%	0.0%	0.0%	100.0%
ELECTRICITY - GAS	50.0%	0.0%	25.0%	50.0%
OIL COAL - GAS	100.0%	0.0%	0.0%	0.0%
INDUSTRIAL - WATER	100.0%	0.0%	33.3%	33.3%
AUTO - COMPONENTS	100.0%	100.0%	0.0%	0.0%
RETAIL	100.0%	0.0%	0.0%	75.0%
BUILDING	100.0%	0.0%	0.0%	100.0%
MEDIA	100.0%	33.3%	0.0%	66.7%
TELECOMS	95.2%	47.6%	0.0%	28.6%
SOVEREIGN / EMERGING	100.0%	87.5%	0.0%	12.5%

Note: Panel A of Table 3 reports the issuers categorized in sectors. Column 2 presents the percentage of pairs that are cointegrated for each issuer, column 3, 4 and 5 present the results from the Granger Causality tests derived through the VECM setup. Column 3 reports the percentage of cases for each issuer where CDS spread leads credit spread in the pricing of credit risk. Column 4 reports the percentage of cases where credit spread leads CDS spread in the price discovery process and the last column reports the percentage of cases with bi-directional causality. Panel B illustrates the aggregate results for different sectors of our sample.

Table 4

Granger Causality tests in the stationary pairs of variables

Panel A				
Sector	**Issuer**	**% of cases where CDS GC I Spread**	**% of cases where I Spread GC CDS**	**% of cases with bi-directional causality**
FINANCIAL - BANKS	**ABN**	9.1%	27.3%	0.0%
	BBVA	0.0%	20.0%	0.0%
	RABOBANK	20.0%	20.0%	20.0%
	COMMERZBANK	25.0%	25.0%	25.0%
	DEUTSCHE BANK	0.0%	0.0%	50.0%
	LAND BERLIN	0.0%	0.0%	0.0%
	HBOS TREASURY	0.0%	0.0%	0.0%
	NORTHERN ROCK PLC	0.0%	0.0%	0.0%
	EUROHYPO AG	40.0%	0.0%	0.0%
FINANCIAL - INSURANCE	**ALLIANZ FINANCE**	40.0%	20.0%	0.0%
	GENERALI FINANCE BV	100.0%	0.0%	0.0%
FINANCIAL - CORPORATES	**BAT INTERNATIONAL FINANCE**	100.0%	0.0%	0.0%
ELECTRICITY - GAS	**RWE AG**	50.0%	0.0%	50.0%
OIL COAL - GAS	**GAZ CAPITAL S.A.**	50.0%	0.0%	50.0%
INDUSTRIAL - WATER	**GIE SUEZ ALLIANCE**	75.0%	0.0%	25.0%
	VIVENDI UNIVERSAL	33.3%	0.0%	66.7%
RETAIL	**CARREFOUR**	75.0%	0.0%	25.0%
BUILDING	**BOUYGUES**	0.0%	0.0%	100.0%
	LAFARGE	100.0%	0.0%	0.0%
MEDIA	**BERTELSMANN**	100.0%	0.0%	0.0%
TELECOMS	**DEUTSCHE TELECOM**	100.0%	0.0%	0.0%
	FRANCE TELECOM	50.0%	0.0%	50.0%
	VODAFONE	100.0%	0.0%	0.0%
	TELECOM ITALIA	50.0%	0.0%	33.3%
	TELENOR ASA	100.0%	0.0%	0.0%
SOVEREIGN / EMERGING	**POLAND**	0.0%	0.0%	100.0%
	CROATIA	0.0%	0.0%	100.0%
	TURKEY	60.0%	0.0%	40.0%
	BANQUE CENTRALE DE TUNISIE	0.0%	0.0%	100.0%

Table 4 (cont.)

Panel B			
Sector	**% of cases where CDS GC I Spread**	**% of cases where I Spread GC CDS**	**% of cases with bi-directional causality**
FINANCIAL - BANKS	12.2%	14.6%	0.0%
FINANCIAL - INSURANCE	50.0%	16.7%	0.0%
FINANCIAL - CORPORATES	100.0%	0.0%	0.0%
ELECTRICITY - GAS	50.0%	0.0%	0.0%
OIL COAL - GAS	50.0%	0.0%	0.0%
INDUSTRIAL - WATER	57.1%	0.0%	0.0%
RETAIL	75.0%	0.0%	0.0%
BUILDING	50.0%	0.0%	0.0%
MEDIA	100.0%	0.0%	0.0%
TELECOMS	66.7%	0.0%	0.0%
SOVEREIGN / EMERGING	30.0%	0.0%	0.0%

Note: Panel A of Table 4 reports the issuers categorized in sectors. Column 3 reports the percentage of cases for each issuer where CDS spread leads credit spread in the pricing of credit risk. Column 4 reports the percentage of cases where credit spread leads CDS spread in the price discovery process and the last column reports the percentage of cases with bi-directional causality. Panel B illustrates the aggregate results for different sectors of our sample.