International Journal of Business, Human and Social Sciences
ISSN: 2517-9411
Vol:5, No:1, 2011

Sovereign Credit Risk Measures

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***Abstract*—**This paper focuses on sovereign credit risk meaning a hot topic related to the current Eurozone crisis. In the light of the recent financial crisis, market perception of the creditworthiness of individual sovereigns has changed significantly. Before the outbreak of the financial crisis, market participants did not differentiate between credit risk born by individual states despite different levels of public indebtedness. In the proceeding of the financial crisis, the market participants became aware of the worsening fiscal situation in the European countries and started to discriminate among government issuers. Concerns about the increasing sovereign risk were reflected in surging sovereign risk premium. The main of this paper is to shed light on the characteristics of the sovereign risk with the special attention paid to the mutual relation between credit spread and the CDS premium as the main measures of the sovereign risk premium.

***Keywords*—**cointegration, credit default swap, credit risk, credit spread, sovereign risk

I. Introduction

SOVEREIGN credit risk arises when government is not able to meet its contractual obligations, i.e. the government fails to repay principal, regular interest payments in a timely manner or does not fulfill its obligations in the form of guarantees that it provided to the entities in both public and private sector. With the financial crisis, that affected to a large extent the banking sector in the Europe due to the recent trend of globalization, the governments even in Europe became highly aware of the stability of its banking sector and potential contagion abroad in case of a default of any of the important player on the banking sector. Therefore the European governments accepted various measures to strengthen the liquidity of the banking sector, provided capital injections or impaired asset relief [8]. These actions affected the fiscal deficits and increased the level of public debt to a large extent. Fiscal situation further deteriorated due to lower economic activity resulting in lower tax receipts, higher unemployment etc.

Due to all these impacts, the market became more aware of the creditworthiness of individual European countries than prior to the crisis. The pre-crisis period was characterized by the generally low sovereign risk measures such as the credit spread or the credit default swap (CDS) premium. These measures and their development will be discussed further in more detail.

II. Measures of the sovereign credit risk

The riskiness of an asset is reflected by its yield. The higher the risk embedded in the bond, the higher price the investor requires in order to be compensated for the risk he bears by investing into the asset. The amount of risk of a bond is expressed in relation to a reference entity which is generally perceived to be risk-free, since its probability of default is very low. The most widely used risk-free assets are US Treasury bonds, German government bonds (so called Bunds) or swap curve rates. In our case, we used the German government bond yields. The resulting spread (also called credit spread) measures the additional risk of a bond relative to the risk-free security.

The second measure of default risk is credit default swap (CDS) premium. CDS is a bilateral agreement to transfer the default risk of one or more entities from one party to another [13]. In fact, CDS can be likened to an insurance contract, in which an insured agent (protection buyer) pays an insurance premium. As stated in [7] “the market price of the premium is therefore an indication of the perceived risk related to the reference entity”. In return, the insured agent obtains coverage for a loss given the occurrence of a credit event. The basic structure of a CDS contract is illustrated in Fig. 1.

“The main advantage of a CDS is that these contracts allow isolation the risk of default on credit obligation” as referred to in [5]. As a result, the party seeking for protection against default gets rid only of the credit risk and the underlying asset remains in her ownership.

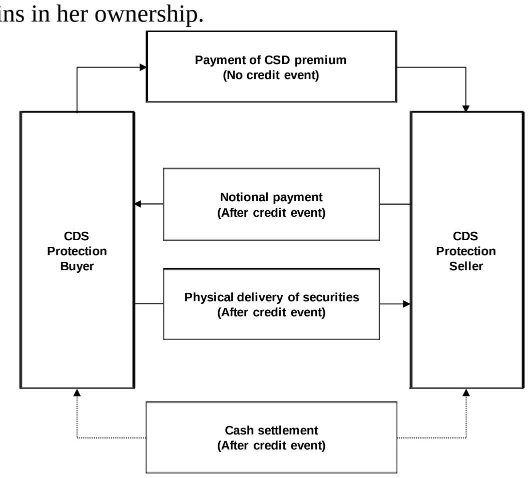

Fig. 1 Structure of a CDS contract
Source: ECB (2009)

Despite different levels of fiscal indicators such as deficit-to-GDP ratio or debt-to-GDP ratio, the sovereign risk was priced similarly in all countries. However, with the outburst of the crisis, the market participants became to differentiate between the countries even in Europe. To the most affected countries belonged Portugal, Italy, Greece or Spain (so called “PIGS” countries) with the most severe impact of the financial crisis with respect to the increase in the deficit-to-GDP ratio. The increased uncertainty of investors was expressed by the surging levels of the sovereign risk measures (see Fig. 2a for the CDS premiums of selected European countries and Fig. 2b for credit spread as a difference between the sovereign yield of a respective country and a German government bond as a "risk-free" reference asset[1]).

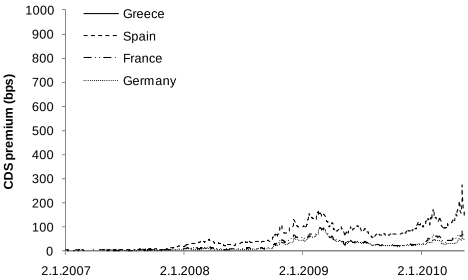

Fig. 2a Premium for 5Y sovereign CDS
Source: Bloomberg

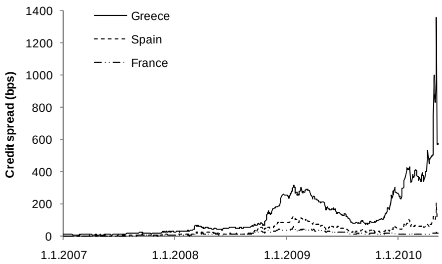

Fig. 2b Credit spreads based on 5Y sovereign bond
Source: Bloomberg

III. No-Arbitrage Condition

CDS premium is defined as the internal rate of return that equates the expected premium flows over the life of the swap to the expected loss if default occurs at various dates [13].

Given no arbitrage theory, the CDS spreads should approximately equal to the bond yield spread. Both measures are supposed to provide equal information regarding perception of the credit risk of the same asset (e.g. an obligation). If this assumption proves to be correct, the so called no-arbitrage condition holds. Otherwise, the market participants could gain from arbitrage opportunities by undertaking the most favorable trading strategy.

When deriving the theoretical framework of the no-arbitrage condition, we essentially refer to [19]. The fundamental assumption, underlying the no-arbitrage condition, is that the outcomes of two alternative investment strategies should be equivalent. We assume the following strategies. Under Strategy 1 we assume that the investor enters a CDS contract on the bond. Under the 2nd strategy, the investor shorts the bond and invests the proceeds into purchasing a risk-free note.

When entering a CDS contract (Strategy 1), both parties involved, i.e. the entity selling credit risk and the party assuming the risk, expect that the present value of all future outflows will be balanced by the present value of the future inflows. In other words, the protection buyer assumes that the present value of the CDS payment p_{CDS}, he pays regularly at time $t_1, t_2, \ldots, t_N$ unless a credit event occurs, will be equal to the contingent payment the protection seller is obliged to pay in case of a credit event.

For simplicity we assume that the face value of a bond equals 100. According to the risk neutral valuation principle (1) is received in [19].

$$\sum_{i=1}^{N} e^{-rt_i} Q(t_i) p_{CDS} = \int_0^{t_N} e^{-rt} (100 - M_t) q(t) dt \qquad (1)$$

Where is $q(t)$ the risk neutral probability of default of the reference asset at time t, $Q(t)$ stands for the risk neutral survival probability until time t, r is a risk-free rate which is assumed to be constant over time, M_t denotes the market value of the bond of interest. The market value M_t reflects the recovery rate of the bond – the investor does not receive the whole par value of a bond but only its proportion. The left side of the equation (1) expresses the present value of the premium payments which are paid by the protection buyer until credit event or maturity of the contract, whichever comes first. The right hand of the equation stands for the present value of the contingent payment the buyer of protection can receive should the credit event occur.

Valuation of Strategy 2 will be based derivation of the current price of a par fixed coupon bond. Under this strategy, we assume that the investor goes short on a defaultable bond (he is relieved of a credit risk). In return, he purchases a risk-free note which yields a coupon rate of r. By this procedure, the CDS is replicated synthetically. As in the Strategy 1 we assume zero initial investment[2] and bond face value equal to 100. The valuation of Strategy 2 is derived in (2).

$$0 = -\left[\sum_{i=1}^{N} e^{-rt_i} Q(t_i) c + e^{-rt_N} 100\, Q(t_N) + \int_0^{t_N} e^{-rt} M_t q(t) dt\right] + \left[\sum_{i=1}^{N} e^{-rt_i} Q(t_i) r + e^{-rt_N} 100\, Q(t_N) + \int_0^{t_N} e^{-rt} 100\, q(t) dt\right] \qquad (2)$$

The first bracket approximates the proceeds from short selling the bond. The first component in the bracket denotes the value of expected coupon payments c. The second term relates to repayment of the principal at the maturity date on condition that a credit event does not occur. The last term approximates the market value of the bond after a credit event. Components in the second bracket reflect the cash flow from purchasing the par fixed rate risk-free note. Meaning of individual terms is equivalent to the corresponding terms in the first bracket. Only one remark should be noted with respect to the last term. Since the risk-free rate, which determines the coupon rate of the risk-free note r, is constant the risk-free note can be always sold at its face value assumed to be equal to 100.

Equation (3) shows a modified version of (2) which is more convenient for further proceeding.

[1]For the sovereign bond yields, the data for the bonds with 5Y maturity extracted from the Bloomberg Fair Value (BFV) curve were used.

[2]When the CDS contract is originated, there are no initial costs from the protection buyer's perspective when ignoring dealer's margin or transaction costs. The first expenses for the protection buyer are spent with the first premium payment.

$$\sum_{i=1}^{N} e^{-rt_i} Q(t_i)(c-r) = \int_{0}^{t_N} e^{-rt}(100 - M_t)q(t)dt \qquad (3)$$

Since we can see that the right sides of (1) and (3) are identical we can put the left sides of these equations into equality. Equation (4) shows the resulting form which enables us to define the essential condition for the so called no-arbitrage condition to hold.

$$\sum_{i=1}^{N} e^{-rt_i} Q(t_i)[p_{CDS} - (c-r)] = 0 \qquad (4)$$

So that the last equality is fulfilled, the expression in the bracket must be zero. Equation (5) describes the no-arbitrage condition.

$$p_{CDS} = c - r = p_{CS} \qquad (5)$$

According to the no-arbitrage condition in (5), the credit spread noted as p_{CS} should reach exactly the same value as the CDS premium Otherwise the traders can profit from arbitrage opportunities. If the CDS premium overweighs the credit spread, the trader can gain from selling the CDS contract, invest in a risk-free asset and short the bond. Reverse strategy will be adopted, if the credit spread is higher than the CDS premium.

In the later text, we will also mention the term CDS basis (hereinafter also noted as basis only) which expresses the difference between the CDS premium and the credit spread as shown in (6).

$$Basis = p_{CDS} - p_{CS} \qquad (6)$$

IV. CDS BASIS

In reality the theoretical relation shown in (5) does not always hold. In the recent economic research dealing with the problematic of CDS contracts, the main impediments affecting the basis have been identified. These general barriers will be shortly discussed in this section.

Cheapest-to-delivery option tends to widen the CDS basis. Upon the credit event, if the physical settlement was contracted, the protection buyer does not have to deliver a concrete bond as in the contract specifying the conditions, there are only general characteristics determined but not the concrete bond which becomes deliverable in case of credit event occurrence. Instead he has the possibility to deliver the less valuable bond from the basket of deliverable bonds. Since the protection sellers are aware of this option, CDS spreads tend to result in the wider basis. [3] also provided the evidence, that after the issuance of new bonds or loans the probability of utilization of the cheapest-to-deliver option increases which consequently causes the basis to widen. For more detailed discussion of the consequences of the cheapest-to-deliver option see e.g. [2].

Also difficulties in shorting the bonds contribute to the widening of the basis. This constraint is accented if the creditworthiness of the issuer deteriorates due to impaired liquidity. According to [1], the CDS markets serve as a financial tool for investors and traders to short the sovereign bonds without any liquidity problem instead.

Counterparty risk tends to have negative effect on the basis meaning that it causes the basis to tighten. When entering a CDS contract the protection buyer is exposed to the uncertainty that default of the reference entity might induce the protection seller to default as well. In case of such a simultaneous default, repayment of the difference between par and the recovery value of a defaulted bond would be at stake Moreover, the additional counterparty risk is stemming due to a long and complex risk transfer chains with high contagious potential. The protection seller enters subsequently another CDS contract to hedge himself against the default risk. The protection buyer therefore looses track who is the final party of the "chain" as the CDS contracts are over-the-counter (OTC). Counterparty risk is further discussed in [7], [16] or [6].

Accrued interest differences on default tend to tighten the basis according to [11]. He argues that purchase of the CDS contract provides the protection buyer with the right to sell the par bond for its face value plus the accrued interest. However, in practice, the protection buyer receives only a face value of a par bond. Therefore, the CDS spread should be lowered by the amount of the foregone accrued interest.

Synthetic CDO issuance is expected to have a negative effect on the basis. However, as the widespread and almost unregulated use of complex structured credit products is deemed to exacerbate the recent financial turmoil, its future importance is questionable. Moreover, according to the survey realized by [9], market participants expect that complex credit derivatives products such as CDO squared, CDS on structured finance, CDOs on ABS will not make a comeback in future.

Liquidity in segmented markets is another important factor influencing the basis. If the liquidity deteriorates, the risk the investors are exposed to increases. Consequently, the investors require higher spreads to be compensated for the less liquid (more risky) market. Therefore, if the CDS market becomes more liquid compared to the bond market, the CDS basis narrows, and vice versa. According to [12], the CDS should be traded at higher spread than the referenced bond since they found sovereigns bond markets to be more liquid relative to the CDS market. Hence, higher CDS spreads are required to compensate the investor for higher risk due to less liquid market. On the other hand, some authors give the evidence that during the periods of distress when the bond liquidity might be seriously constrained and even credit squeeze may occur, the activity moves on the CDS market where the trading continues. This is supposed to hold especially for the mature markets. For further details on this issue see e.g. [18] or [15].

Structured classification of the main factors driving the basis either up or down are summarized in Table I.

TABLE I
OVERVIEW OF THE CDS BASIS DRIVERS

	Positive Effect	*Negative Effect*	*Undecided*
Fundamental Factors	• Cheapest-to-deliver option • CDS spread is always non-negative • Problematic restructuring clause • Bond trading below par	• Funding issues • Counterparty default risk • Accrued interest differences on default • Bond trading above par	• Coupon specificities
Technical Factors	• Limited ability to short bonds • Issuance patterns	• Synthetic CDO issuances	• Relative liquidity in segmented markets

Fundamental factors –factors related to a precise specification of a CDS contract which can cause the CDS to behave diversely from the market where the bonds are traded
Technical factors – factors related to the nature of the CDS and bond market
Positive effect – equivalent to widening of the basis
Negative effect – equivalent to tightening of the basis
Undecided – direction of the movement depends on the precise specification

Source: De Wit (2006)

V. LINKS BETWEEN THE CDS AND BOND MARKET

As discussed in the previous chapter, there are factors which cause the CDS basis to deviate from the theoretically derived level. Also for the countries in the sample, i.e. Greece, Spain and France, the theoretical relation does not hold (see Fig. 3).

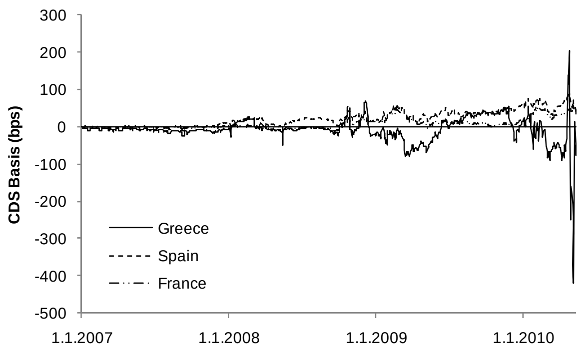

Fig. 3 CDS Basis
Source: Bloomberg

However, these deviations are expected to be only short run. The data shown in Fig. 3 indicate that the largest differences between the CDS basis and corresponding credit spread were recorded in the stress period, i.e. in autumn 2008 with the Lehman Brothers bankruptcy and in Greece in 2010 when the real fiscal conditions were revealed. The absolutely biggest difference was recorded in May 2010 in Greece and is related to the sudden decrease in both CDS premium and credit spread after the announcement of launching the Securities Markets Programme on May 10, 2010 [10].

According to the economic research, both measures are linked through a long run relationship. For testing the hypothesis of the long-run relationship, the cointegration procedure has been used. This method is recommended since both time series – CDS premium and credit spreads – have been proven to usually follow a unit root process (i.e. the series are non-stationary). For evidence see e.g. [18], [3], [12] or [14].

As stated in [17], the cointegration equation has the form derived in (7).

$$p_{CDS,i} = \alpha + \beta p_{CS,i} + \varepsilon_i , \tag{7}$$

where ε_i is stationary. Should both measure co-move in the long run, the parameter β is supposed to be equal to zero, the cointegration vector should be [1,-1] and α equal to zero. However, these very strong assumptions are not usually fulfilled in reality. In reality, there is evidence for a weaker form of relation allowing for short term deviation. In [17] both measures cointegrate for the selected countries (e.g. for Hungary, Poland, Slovakia) in the long run, but they deviate in the short run (i.e. the hypothesis of the cointegration vector equal to [1,-1] is rejected) due to different liquidity and additional unobserved factors. For developed sovereigns, similar results were obtained in [4] and for developing countries e.g. in [12], [2] or [1]. Cointegration between CDS premium and credit spread holds also for corporate entities (see e.g. [18] or [19]).

The obtained results suggest that one of the markets leads the other market in the price discovery. The vector error correction framework (VECM) has been adopted to test which market is more efficient in the price discovery process and in providing the most up-to-date information about the market perception of the sovereign credit risk and which market lags behind. Interesting evidence is provided in [17] who observed the price discovery process in the period 2005-2008. In this long time range, the CDS market has a leading role only in three countries out of the sample which included ten countries in total. However, in 2008 the situation reversed – the leading role of the bond market has been proven only for three countries. This indicates that the CDS market began to overtake the leading role in the pricing of the sovereign credit risk. This is consistent with the results obtained in [4] who showed that the CDS market is ahead of the bond market for the riskier areas such as developing countries or the group of the so called “PIGS” countries in Europe. On the other hand, the bond market seems to be more efficient in pricing the credit risk in the less risky countries such as Austria, Denmark or Finland.

VI. CONCLUSION

This paper discusses the main measures of the sovereign credit risk which has become a matter of great concerns due to the situation in Greece or Ireland and even contributed to discussions regarding the future of the common European currency, the Euro. We have shown the basic characteristics of two measures of the credit risk, the credit spread and the CDS premium. Despite the short run deviations, these measures have been proven to cointegrate in the long run. In the short run, these measures differ due to various factors such as liquidity differences and other unobserved factors.

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