Did the CDS Market Push up Risk Premia for Sovereign Credit?

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1. Introduction

After the worst of the financial crisis seemed to be over and the recovery under way, financial markets started to focus on the fiscal situation of certain countries. The financial crisis had caused the deficits of many countries to increase substantially. Stimulus programs, bail-outs of financial institutions and reduced tax revenues were the main drivers of the deteriorating fiscal conditions. For instance, the United States ran a budget deficit equivalent to 9.9% of gross domestic product (GDP) in 2009, the biggest since 1945. The total outstanding federal debt is predicted to be approximately 90% of GDP in 2010. But the US was not alone. The UK almost doubled its debt-to-GDP ratio and the euro area as a whole is expected to run a budget deficit of around 7% in 2010 (6.1% in 2009). This caused the average debt-to-GDP ratio in the euro area to approach 84% (cf. Figure 1). Pro memoria: the Maastricht Treaty stipulates a maximum budget deficit for member states of 3%, and a 60% ceiling for the debt-to-GDP ratio. Is this development sustainable? Most likely not. For instance, in their empirical study, Reinhart and Rogoff (2010) show that a debt-to-GDP ratio of 90% is a critical threshold. Above 90%, growth rates of real GDP fall significantly.

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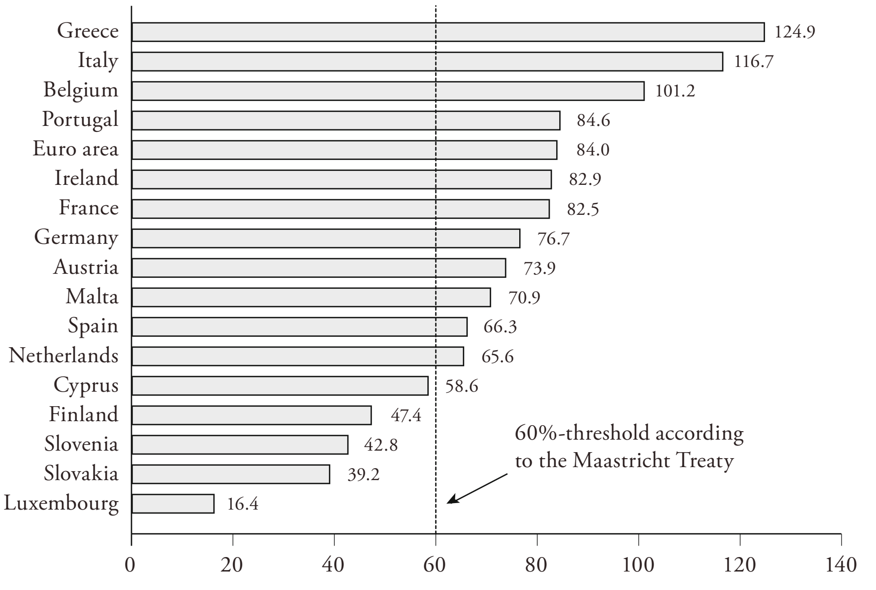
Figure 1: Estimated Debt-to-GDP Ratio for 2010 in Percent



Source: European Commission

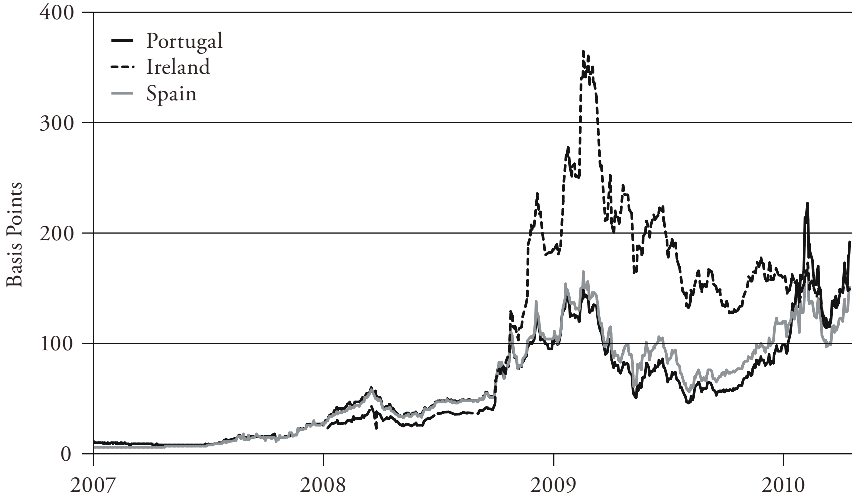
Clearly, the increased budget deficits and the worsening fiscal conditions of sovereigns attracted the attention of financial market participants. After the contagion in the banking system, the next sources of trouble for global markets were localised. Consequently, activity on the sovereign credit default swap (CDS) market increased and gained more attention among the financial market community. The focal points of this development were the PIIGS countries (Portugal, Italy, Ireland, Greece, Spain), which are characterised by very high debt-to-GDP ratios, exceptionally high deficits, a high ratio of net debt interest payments to GDP and fundamental structural economic problems. The situation in Greece has received most attention: its high refinancing needs, along with fabricated statistics and financial transactions designed to hide liabilities, as well as a weakening economic situation and increasing refinancing costs fuelled the market's fears of potential default. It was widely assumed that such a default would have a contagion effect on the other PIIGS countries and on the euro area as a whole. Hence, in the spring of 2010, sovereign risk was a main driver for financial markets and the sovereign CDS market was an important stress indicator.

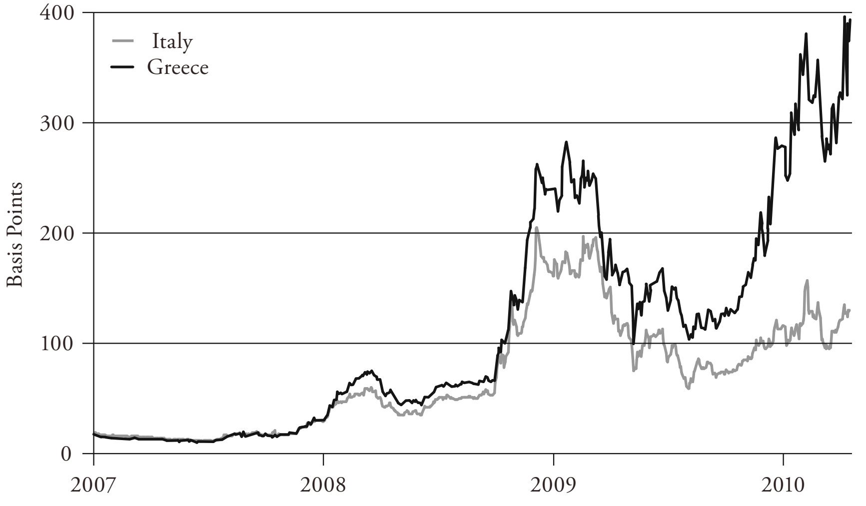
At some point, a public debate started on whether the widening of sovereign credit spreads and the worsening refinancing conditions was subject to market speculation, or even worse, to market manipulation. Particularly in the case of Greece, many suspected the CDS market was responsible for the widening in the spread of the underlying government bonds.

Motivated by this debate and the fact that the European CDS market is a relatively young market which has not been the subject of a great deal of research so far, we analyse the empirical relationship between sovereign CDS and the government bond market for the PIIGS countries. Most existing papers on sovereign CDS deal with emerging markets, which were the birthplace of the sovereign CDS market. For instance, Longstaff, Pan, Pedersen and Singleton (2011) explore the factors driving sovereign CDS, while Pan and Singleton (2008) analyse the term structure of sovereign CDS. What most of these studies have in common is that they do not cover a crisis in sovereign credit markets. Our analysis, however, focuses on the CDS markets of the PIIGS countries since their inception in 2007, and thus also includes a period of crisis.

This paper proceeds as follows: In Section 2 we introduce basic features of sovereign CDS markets and discuss the role of CDS in financial markets as well as movements in the volumes of outstanding CDS contracts. In Section 3 we examine the empirical relationship between CDS premia and government bond spreads. Our analysis is based on the theoretical equivalence of CDS premia and credit spreads, as derived by Duffie (1999). The author shows that under certain conditions the CDS premium should be approximately equal to the credit spread, i.e. the yield minus risk-free rates of a reference bond of the same maturity. By applying cointegration techniques, Blanco, Brennan and Marsh (2005) find support for Duffie's theoretical equivalence based on a sample of 33 corporate bonds and the CDS premia for these bonds. Motivated by their findings, we apply this approach to CDS premia and government bond spreads for the PIIGS countries. In doing so, we first test whether we are able to find any support for a long-run equilibrium in the sense of Duffie's theoretical equivalence. Second, we analyse potential deviations from this equilibrium and test whether one of the two markets might be inefficient with respect to the price discovery process. Third, we examine whether potential inefficiency in one of the markets might be related to measures of market liquidity. Section 4 concludes.

Figure 2: CDS Premia for Portugal, Italy, Ireland, Greece, and Spain





Source: Bloomberg

2. Introduction to the CDS Market

2.1 CDS in General

CDS are bilateral contracts used to transfer risk between market participants and are basically defined by four parameters: the reference entity, the notional amount, the price (usually referred to as 'spread' or 'premium'), and the maturity. One participant is the 'protection buyer' who wishes to buy insurance against the default of a specific entity, the so-called 'reference entity'. The other party is the 'protection seller', who writes the insurance on the reference entity. To compensate the seller of the insurance for the assumed risk, the protection buyer pays a spread (which is initially fixed) each year (or each quarter) on the insured notional value. If a credit event occurs, the CDS is triggered and the protection seller has to pay the difference between the insured notional value and the recovery value.[1] Settlement is always made by means of an auction and is mandatory (either cash or physical delivery), i.e. investors are signed up automatically for all auctions.

A CDS is an easy way to invest in the credit quality of a corporate entity or a country. If an investor believes that the credit quality will decrease in future and that this is not yet priced into the current CDS premium, he should buy protection. Once the premium increases, he will make money because his insurance will increase in value. He can terminate the insurance contract whenever he wants and monetise his gains. Thus, buying protection on Germany does not mean that somebody is speculating on the country going bankrupt. It merely means that somebody believes the credit quality of Germany will decrease in the future. At the same time, the seller of the protection on Germany believes that – given the current spreads – it is attractive to agree to the contract. The view that credit quality will deteriorate is hard to play in the case of bonds, since shorting bonds is not always an easy endeavor. Since the CDS market makes betting on a deterioration in credit quality easy, it has the potential to supplement and improve the price discovery process in underlying sovereign bond markets.

1 The so-called ISDA Credit Derivative Determination Committee – consisting of buy and sell side members – will decide whether the requirements for a credit event are fulfilled. The decision of the determination committee is binding for the whole market.

2.2 Special Features of the Sovereign CDS Market

In the case of sovereign CDSs there are basically three credit events that can be triggered, based on the framework provided by the International Swaps and Derivatives Association (ISDA). GHOSH, HAGEMANS, LEEMING and WILLEMANN (2010) classify these events in the following way:[2]

1. Failure to pay: This event is recognised if the country has failed to pay a minimum amount, usually USD 1 million.
2. Restructuring: This event is triggered if bonds with an outstanding volume of at least USD 10 million are restructured.[3]
3. Repudiation or moratorium: This event is triggered if "an authorised government official disclaims, repudiates or rejects the validity of one or more obligations or imposes a moratorium or standstill. In addition to this, there has to be a failure to pay or a restructuring event, not subject to the minimum amounts given above, within 60 days or the next bond payment date (whichever is later)" (GHOSH, HAGEMANS, LEEMING and WILLEMANN, 2010).

A further special feature of sovereign CDS is the quotation. Sovereign CDSs are denominated in a different currency than the bulk of the outstanding government debt, e.g. European CDSs are quoted in USD and vice versa. This is based on the assumption that, if a credit event has occurred, the local currency would depreciate significantly.

2.3 History of the Sovereign CDS Market

CDSs on the government debt of emerging markets have been used regularly since the late 1990s. According to AMMER and CAI (2007), emerging market sovereigns are among the largest high-yield borrowers in the world, typically with more bonds outstanding, longer maturities, larger issues, and more liquidity than their corporate counterparts. At an early stage, CDS contracts satisfied market needs to insure against a default by these countries. In 1998 the whole CDS market profited from the standardisation of contracts, which led to a fast growing CDS market. In 2002, JP Morgan introduced the first sovereign CDS index – the TRAC-X index – where the constituents were almost exclusively

2 In case of a credit event, however, the ISDA Credit Derivative Determination Committee may interpret things differently.

3 For more information regarding restructuring events cf., for example, VERDIER (2004).

emerging market sovereigns (Mexico, Russia and Brazil made up more than 37% of the index). In 2003 only 10% of all sovereign CDS trades were on non-emerging market countries.

The financial crisis changed the situation as the level of public debt increased massively in industrialised countries. As a consequence, volumes of sovereign CDS contracts on developed countries began to grow. This increased interest led to the introduction of the Western Europe Sovereign CDS index in September 2009. The outstanding net volume of this index has increased massively since the launch. The Bank for International Settlements (BIS) reports a downward trend in the outstanding gross volume of CDS worldwide (-40% since the first half of 2008). However, according to data from the Depository Trust and Clearing Corporation (DTCC) the subcategory of sovereign CDS is still growing sharply and faster than the rest of the CDS market.

2.4 The Role of CDS in Financial Markets

On the one hand, CDS may increase efficiency in the allocation of capital. Historically, investors who lend money to a company had to bear the credit risk of that company. With the advent of CDS it became possible for investors to outsource some of the funding risks of a company to the market. As a result, companies can obtain more credit than they would otherwise and on better terms. Furthermore, CDS make financial markets potentially more efficient and transparent in price discovery as they increase liquidity. Stulz (2010) argues that despite huge and unexpected losses in underlying products the CDS market remained fairly liquid for long periods during the financial crisis when the corporate bond market was totally illiquid.

On the other hand, CDS might create adverse incentives in the market. For example, a bank which lends money to a company and hedges itself in the market has fewer incentives for monitoring the firm. Additionally, a hedged investor could prefer the bankruptcy of a company in financial distress rather than working out a restructuring plan with the debtor.

2.5 Outstanding Volumes of CDS Contracts

The DTCC provides an electronic platform for banks and clients to confirm the agreed contracts electronically. Virtually all electronically confirmed transactions run through this platform. Since November 2008, the DTCC has provided weekly data for outstanding CDS positions on specific reference entities and trading activity. This measure helps to increase transparency in the market.

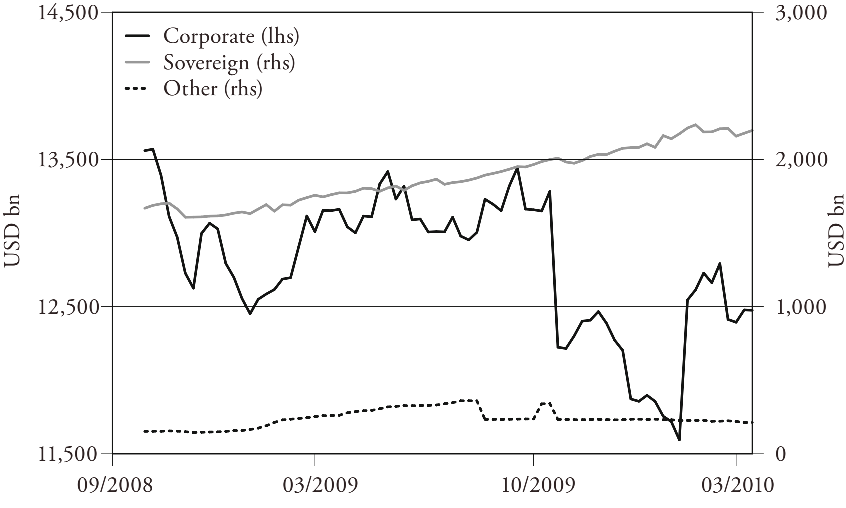
The DTCC data is the only hard data available for the CDS market. The BIS, the ISDA and the British Bankers Association (BBA) reports are all based on surveys, provide only aggregated data, and are published less frequently. However, the DTCC is not representative for the whole market, as more bespoke products like CDS on collateralised debt obligations (CDO) or asset backed securities (ABS) are not confirmed electronically. There are different measures for the size of the CDS market and outstanding positions on specific reference entities. Every measure tells a different story. As the DTCC and BIS data are the most important and the most frequently cited sources, the following concepts are crucial for understanding the inner workings of the CDS market. Hence, in the following, we refer to the definitions used by DTCC and BIS.

Based on DTCC's definition, 'gross notional value' measures the sum of the notional of all outstanding CDS contracts on a per trade basis. This can be illustrated by the following example: Assume a transaction of USD 10 million notional between buyer and seller of protection. DTCC reports this transaction as one contract with a USD 10 million gross notional value, and not as two contracts worth USD 20 million. The problem with gross data is that from a risk perspective it overestimates the size of the market. To close an existing deal, an offsetting trade is often done. The actual risk of a default of the reference entity would be zero for the involved parties. However, the deal actually closed would flow into the calculation of the gross notional volume twice. Because most CDS traders have a netting agreement in place, the systemic risk is not increased through this practice. Therefore, the gross notional value overestimates the size of the market. However, for evaluating the trading activity, the gross value can be viewed as an indicator. Figure 3 illustrates the movements in outstanding gross volumes for different entities.

Additionally to gross volumes, the BIS publishes 'gross market values'. These values are defined as the sum of the total gross positive market value of contracts and the absolute value of the gross negative market value of contracts with non-reporting counterparties. Gross market values supply information about the potential scale of market risk in CDS markets.

Finally, the DTCC defines the 'net notional value' for any single reference entity as the sum of the net protection bought by net buyers or the sum of the net protection sold by net sellers, respectively. The aggregate net notional value is calculated based on the concept of counterparty families, which for example includes all of the accounts of a particular asset manager. Based on this, DTCC reports the aggregate net notional value as the sum of net protection bought, or equivalently sold, across all counterparty families. Accordingly, the net notional value for a particular reference entity indicates the maximum possible exchange

Figure 3: Outstanding Gross Notional Volumes by Entities



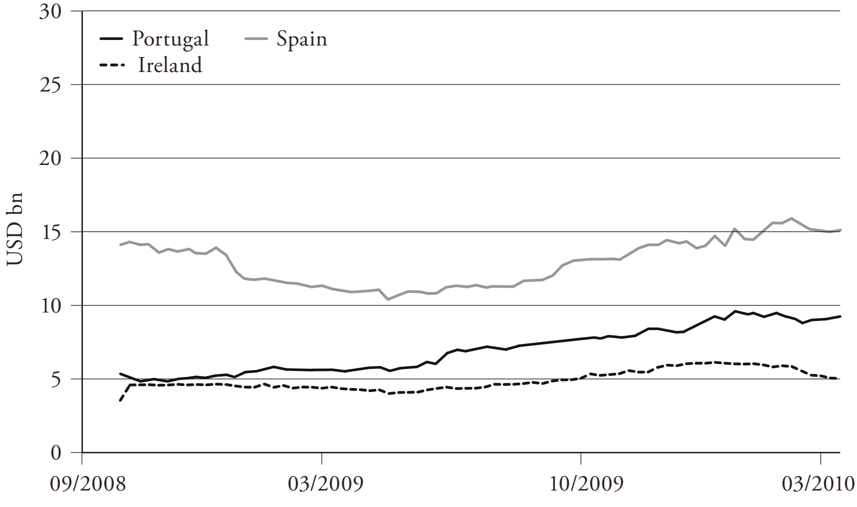
Source: DTCC

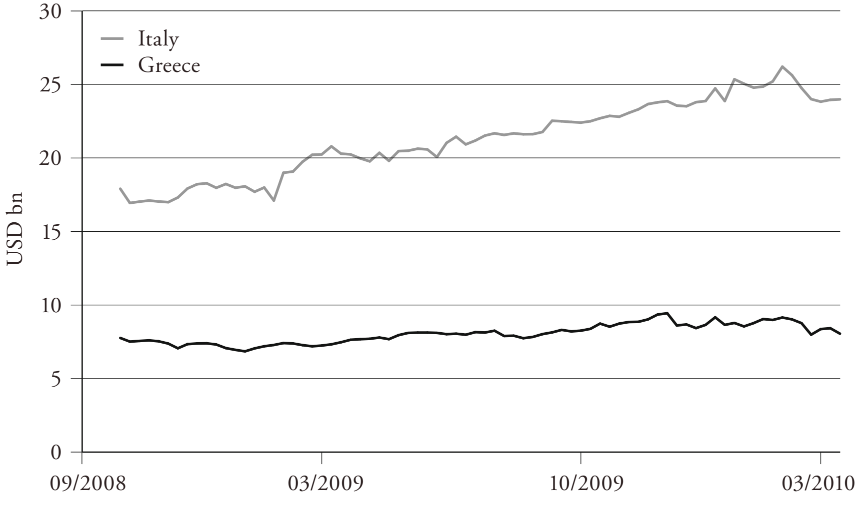
between net sellers of protection and net buyers of protection that could be required in case of a credit event. Figure 4 illustrates the development of outstanding net volumes of sovereign CDS contracts for the PIIGS countries.

Stulz (2010) uses the example of the bankruptcy of the investment bank Lehman Brothers to illustrate the difference between gross and net volumes: When Lehman went bankrupt, there were CDS records on Lehman for a gross notional value of USD 72 billion registered at DTCC's Trade Information Warehouse. According to the recovery rate that had been determined in the auction process protection sellers had to pay 91.375 cents on the dollar to settle the contracts. The settlement for these contracts went without many difficulties and on a net basis only USD 5.2 billion was exchanged through the DTCC. One important reason for both the smooth process and the relatively small amount of net positions was that many institutions were both buyers and sellers of protection on Lehman. Accordingly, the gross notional value had overstated the risks.

During the Greek debt crisis, a debate arose as to whether the CDS market had been subject to manipulation, which might have worsened the magnitude of the crisis. According to Duffie (2010), one way to manipulate markets could be that speculators progressively increase their protection on a certain country to push out CDS premia. Due to this practice, contracts bought previously

Figure 4: Outstanding Net Notional Volumes by Countries





Source: DTCC

increase in value. Another possibility for market manipulation might be achieved by the placement of large trades in the market with the aim of spreading market rumours. As Duffie (2010) argues, both activities should manifest in an increase in outstanding net volumes.

However, we find no strong increase in outstanding net volumes in the DTCC data. As shown in Figure 4, net outstanding volumes for the PIIGS countries only increased slightly on average. In the case of Greece, there was actually a drop in outstanding net volumes at the start of the crisis in November 2009. The net position for Greece was USD 8.7 billion in the first week of January 2010, and ranged between USD 8.5 billion and USD 9.2 billion in the following months. This compares to a net position for Greece of USD 7.4 billion at the beginning of 2009. Hence, the data suggests that there was no surge of interest in either 2009 or 2010 and that the movement in outstanding net volume does not signal any increase in speculative activity during the Greek debt crisis.

3. The Empirical Relationship between Sovereign CDS Premia and Government Bond Spreads

After introducing basic features of CDS markets and discussing the changes in the outstanding volumes of CDS contracts we now turn to the empirical relationship between sovereign CDS premia and government bond spreads. The starting point for our analysis is the theoretical equivalence of CDS premia and credit spreads, as derived by Duffie (1999). The author shows that, under certain conditions,[4] the CDS premium should be approximately equal to the credit spread, i.e. the yield minus risk-free rates of the reference bond of the same maturity.[5]

According to Blanco, Brennan and Marsh (2005), this can be illustrated as follows: Suppose an investor buys an n-year par yield bond issued by a reference entity with y being the yield on this bond. In addition, suppose the investor buys credit protection on that entity for n years in the CDS market at a cost of s. If s is expressed annually as a percentage of the notional principle, then the annual return of the investor equals $y-s$. If r denotes the yield on an n-year par yield risk-free bond, the relationship $r=y-s$ should hold approximately. If r is greater than $y-s$, then shorting the risky bond, writing protection in the CDS

4 E.g. market participants should be able to short risk-free bonds, which is equivalent to assuming that they can borrow at the risk-free rate. Also, market participants should be able to short the risky bonds, while counterparty default risk in a CDS is assumed to be negligible.

5 Cf. also discussions in Hull, Predescu and White (2004) and Zhu (2006).

market, and buying the risk-free bond would be a profitable strategy for an arbitrageur. Similarly, if r is less than $y-s$, buying the risky bond, buying protection in the CDS market, and shorting the risk-free bond would be a profitable arbitrage opportunity.

By applying cointegration techniques, BLANCO, BRENNAN and MARSH (2005) find support for Duffie's theoretical equivalence based on a sample of 33 corporate bonds and the CDS premia for these bonds. The authors interpret this as a long-run equilibrium condition for the pricing of corporate credit risk. In addition, the authors show that there are two forms of deviations from the long-run equilibrium. One form of deviation is relatively long-lived and can be explained by "imperfections in the contract specification of CDSs and measurement errors in computing the credit spread." However, this form of deviation from the equilibrium is only apparent in three cases of their sample. The other form of deviation is short-lived and arises due to "a lead for CDS prices over credit spreads in the price discovery process."

In what follows, we apply the approach by BLANCO, BRENNAN and MARSH (2005) to CDS and government bond markets in the PIIGS countries. Therefore, we first test whether we find support for a long-run equilibrium in the sense of the theoretical equivalence derived by DUFFIE (1999). Second, we focus on the second form of deviation, i.e. short-run deviations from the equilibrium, and test whether one of the two markets might be inefficient with respect to the price discovery process. Finally, we examine whether potential inefficiency in one of the markets might be related to measures of market liquidity.

In order to do this we proceed as follows: First, we briefly describe our data and present descriptive statistics. Second, we look at cross-correlations between CDS premia and government bond spreads. Third, we analyse the possible long-run equilibrium behavior of the series by performing Johansen cointegration tests. Fourth, we look into the price discovery process, using vector error-correction models (VECM) of market prices and Granger causality tests. Finally, we perform analyses to detect any differences between the liquidity of the two markets, which might partly explain the lead-lag relations in the price discovery process.

3.1 Data Description

Our sample is based on daily data that runs from 1 January 2007 through 16 April 2010. Table 1 lists basic descriptive information and the number of observations for both CDS premia and government bond spreads in our sample.

We use CDS premia from Bloomberg with a notional value of USD 10 million. All prices are based on the standard ISDA contract for physical settlement with a constant 10-year maturity. For calculating the government bond spreads we use 10-year government bond yields from Thomson Reuters Datastream. As proxy for risk-free bonds we use German government bonds. However, we have to acknowledge that German government bonds are not an ideal proxy for the unobservable risk-free rate. One reason is that Germany's fiscal situation has also been deteriorating since 2007. Other reasons are related to government bonds in general, such as taxation treatment, repo specials, scarcity premia, and benchmark status (Blanco, Brennan and Marsh, 2005). Even though German government bonds are not an ideal proxy, they still seem to be the best available in our context.

As we mentioned earlier, activity on CDS and government bond markets increased and gained more attention among the financial market community due to the situation surrounding Greece. On 4 October 2009, George Papandreou became the new prime minister of Greece after his Panhellenic Socialist Movement (Greek: Panellinio Sosialistikó Kínima; PASOK) party won the general election. At that time, the Greek economy was still faced with the severe repercussions of the financial crisis. Around two weeks later, on 20 October, officials of the new government announced that Greek debt statistics had been forged in the past. Instead of a public deficit of 6% of GDP for 2009, the government now expected twice as much to materialise. This was the starting point of the Greek debt crisis. Based on this, we decided not only to look at the whole sample (cf. Panel A of Table 1), but also at two sub-samples. Accordingly, Panel B concentrates on the period prior to the Greek problem, i.e. the period from 1 January 2007 to 19 October 2009; Panel C on the period thereafter, i.e. on the period from 20 October 2009 to 16 April 2010.

3.2 Basic Analysis

Figure 5 plots CDS premia and government bond spreads for Portugal, Ireland, Greece, and Spain. It is evident that the relationship between CDS premia and the government bond spreads is very close. However, it is also obvious that there are periods when CDS premia and government bond spreads do not move in step. In Spain, for instance, CDS premia increase strongly at the end of our sample while government bond spreads move sideways.

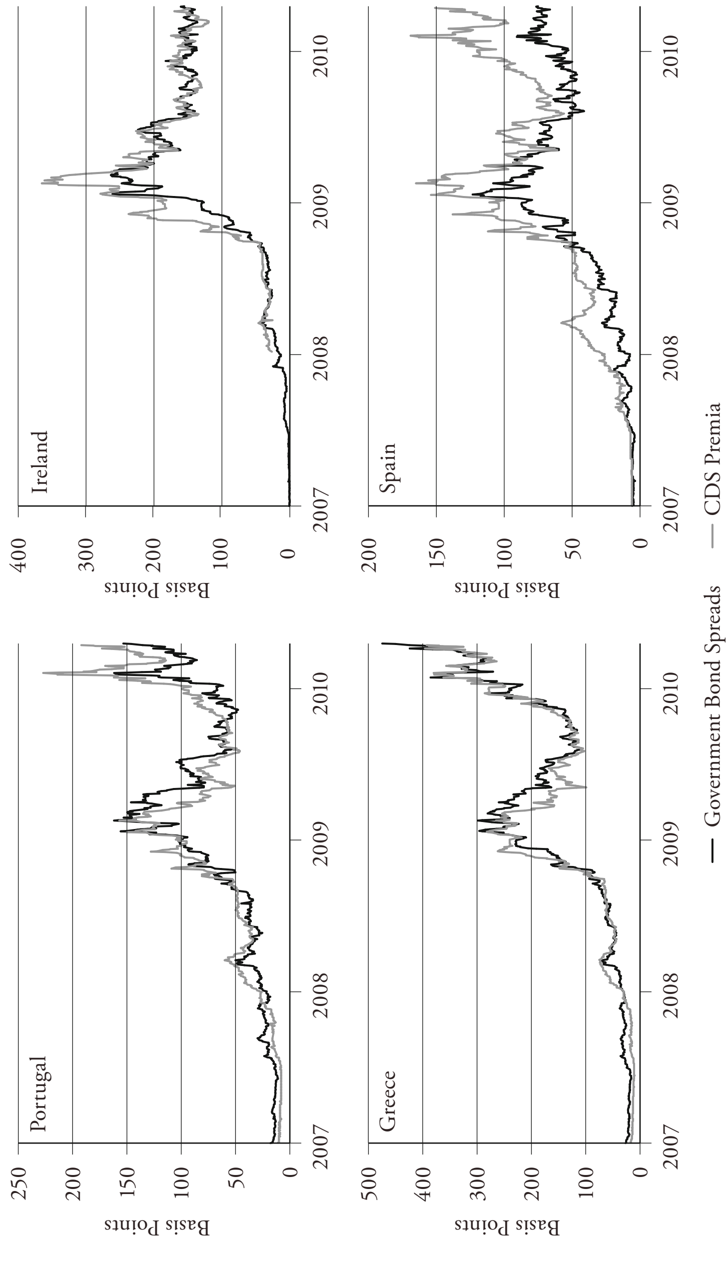
At first sight, this observation is supported by the correlation coefficients between CDS premia and government bond spreads. For all five countries correlation is above 0.90 over the whole time period of the sample if calculated in levels (cf. Panel A of Table 2).

Table 1: Descriptive Statistics

	CDS Premia					Government Bond Spreads				
	Obs.	Mean	S.D.	Min.	Max.	Obs.	Mean	S.D.	Min.	Max.
Panel A: January 1, 2007 until April 16, 2010										
Portugal	832	60.6	44.1	8.0	227.0	860	56.7	39.3	10.9	161.8
Italy	850	70.8	50.8	11.0	205.0	860	61.8	36.9	16.1	155.9
Ireland	593	132.0	82.2	22.0	365.0	860	81.0	79.9	–3.7	262.4
Greece	835	114.6	99.1	10.0	396.0	860	116.7	98.7	16.2	424.4
Spain	839	61.9	43.4	6.0	169.0	860	40.6	30.4	3.6	123.3
Panel B: January 1, 2008 until October 19, 2009										
Portugal	468	68.6	28.9	26.0	157.0	470	70.0	36.3	21.3	161.8
Italy	469	89.3	47.7	29.0	205.0	470	80.5	35.6	25.7	155.9
Ireland	464	126.8	92.0	22.0	365.0	470	107.0	78.9	9.6	262.4
Greece	469	122.3	68.1	30.0	282.0	470	128.1	75.6	29.8	298.5
Spain	469	73.9	32.6	26.0	165.0	470	52.3	27.5	7.4	123.3
Panel C: October 20, 2009 until April 16, 2010										
Portugal	129	118.9	40.4	60.0	227.0	129	86.9	28.4	47.7	161.7
Italy	129	108.8	16.4	79.0	157.0	129	71.1	7.2	55.5	85.6
Ireland	129	150.7	14.3	117.0	178.0	129	147.5	9.3	133.3	180.9
Greece	129	268.0	70.5	134.0	396.0	129	260.2	78.2	131.4	424.4
Spain	129	112.9	20.4	77.0	169.0	129	64.9	11.1	46.4	90.7

This table lists basic descriptive information and the number of observations for both CDS premia and government bond spreads in our sample. We use daily CDS premia from Bloomberg with a constant 10-year maturity. For calculating the government bond spreads we use 10-year government bond yields from Thomson Reuters Datastream. All spreads are based on German government bonds. The data run from 1 January 2007 to 16 April 2010. Panel A shows the descriptive statistics for the whole sample. Panel B concentrates on the period prior to the Greek problem, Panel C on the period thereafter.

Figure 5: Government Bond Spreads and CDS Premia



Source: Bloomberg, Thomson Reuters Datastream

However, if we focus on the period after October 2009, when the Greek problem started, we find that correlation is lower in the cases of Italy and Ireland. For Italy, for instance, the correlation coefficient drops to 0.24. Also, in the case of Spain, our observation based on Figure 5 is supported, as the correlation coefficient falls to 0.79 in the period between 20 October 2009 and 16 April 2010. In the period 1 January 2008 to 19 October 2009, the correlation coefficient was 0.93. This approach might be problematic, however, if we deal with non-stationary variables as these variables usually show instability in the estimation of correlation coefficients.

Therefore, we calculate first differences, i.e. daily changes, of all variables in order to transform the time series into stationary ones. Augmented Dickey-Fuller tests confirm that the variables in first differences are all stationary. In Panel B of Table 2, we see that the correlation coefficients are much lower for the whole time period of the sample than they are in Panel A. What is more, the correlation coefficients increase for all five countries if we focus on the period after the Greek problem started. This is most apparent in the case of Greece. While the correlation coefficient for the period prior to the Greek debt crisis is 0.40, it increases to 0.82 in the period from 20 October 2009 to 16 April 2010. This might be an indication for contagion effects as defined by FORBES and RIGOBON (2002), i.e. a significant increase in cross-market linkages after a shock to one country.[6]

3.3 Long-run Relations

The correlation coefficients indicate that there has indeed been a close relationship between CDS premia and government bond spreads for the PIIGS countries since 2007. In the next step, we now test whether we find support for the theoretical equivalence between the two markets as derived by DUFFIE (1999). In order to do this, we follow the approach of BLANCO, BRENNAN and MARSH (2005) by using cointegration techniques. The authors argue that this approach (and use of the term 'long-run') is valid, even though it might appear inappropriate at first sight as their data set covers only 18 months. Our data set covers 28 months and is thus considerably longer. What is more, HAKKIO and RUSH (1991) argue that it is not only the length of the data set that matters but that the ratio of the length of the data set to the half-life of deviations is even more relevant. With a half-life of only a few days, our data set should allow us to use the cointegration approach.

6 Testing for contagion in CDS markets during the Greek debt crisis is beyond the scope of this paper. However, the interested reader is referred to ANDENMATTEN and BRILL (2011).

Table 2: Correlation Coefficients

	January 1, 2007 until April 16, 2010	January 1, 2008 until October 19, 2009	October 20, 2009 until April 16, 2010
Panel A: In Levels			
Portugal	0.90	0.88	0.98
Italy	0.94	0.94	0.24
Ireland	0.94	0.94	0.44
Greece	0.97	0.93	0.97
Spain	0.95	0.93	0.79
Panel B: In First Differences			
Portugal	0.50	0.39	0.63
Italy	0.37	0.37	0.42
Ireland	0.42	0.40	0.51
Greece	0.68	0.40	0.82
Spain	0.42	0.33	0.58

This table reports correlation coefficients between CDS premia and government bond spreads; the results in Panel A are based on calculations in levels, the results in Panel B on calculations in first differences. When using first differences, i.e. daily changes in levels, we obtain stationary time series (we performed augmented Dickey-Fuller tests to test for unit roots). We distinguish between three time periods as in Table 1.

We report Johansen trace test statistics[7] for the number of cointegrating relations between CDS premia and government bond spreads in Table 3. The test statistics are based on a model with a constant and up to three lags. The number of lags in the underlying VAR is optimised using the Schwartz Bayesian Information Criterion (SBIC) for each entity. For selecting the number of lags to include in the VAR equations we also looked at the Akaike Information Criterion (AIC). On average, the AIC indicates 1.1 more lags than the SBIC. However, the Johansen trace test statistics signal another result in only one of 15 cases if we use the AIC for optimising the underlying VAR. Hence, the test statistics appear to be robust with respect to these two information criteria. As in the previous sections we distinguish three time periods.

7 Cf. Johansen (1991).

If we focus on the whole sample, we find evidence of cointegration for Italy and Greece (as indicated by *). For these two countries, the CDS and government bond markets appear to price risk equally, on average, up to some constant term that might reflect mis-measurement of the risk-free rate. For Portugal and Spain, however, cointegration is rejected, suggesting no long-term relationship between CDS premiums and government bond spreads.

Table 3: Johansen Trace Test Statistics

Trace Statistics for the Number of Cointegrating Vectors						
	January 1, 2007 until April 16, 2010		January 1, 2008 until October 19, 2009		October 20, 2009 until April 16, 2010	
	None	At Most 1	None	At Most 1	None	At Most 1
Portugal	12.22*	1.55	24.50	5.03	20.28	1.10*
Italy	15.48	3.02*	22.10	2.20*	9.89*	4.17
Ireland	23.50	3.79	18.92	2.93*	16.69	5.17
Greece	16.66	0.18*	25.02	3.49*	9.49*	0.39
Spain	13.16*	2.68	17.29	2.90*	7.95*	2.18

This table reports Johansen trace test statistics for the number of cointegrating relationships between CDS premia and government bond spreads. The test statistics are based on a model with a constant and up to three lags. The number of lags in the underlying VAR is optimised using the SBIC for each entity. The 5% critical values (as indicated by *) for the trace statistics are 15.41 for none and 3.76 for at most one cointegrating vector. We distinguish three time periods as in Table 1.

If we concentrate only on the time period up to the starting point of the Greek debt crisis, there is stronger evidence for cointegration. We find support for cointegration in four out of the five entities. This is rather surprising, given that the sample period is shorter than the one in Panel A. In the case of Ireland, one reason might be that this country already had its own debt crisis at the end of 2009 due to the troubles encountered by the Irish banks.

Finally, if we focus on the time period after Greece's problems started, we only find evidence for cointegration in the case of Portugal. In the other four cases we have to reject a long-term relationship in the sense of cointegration. This might be due to the relative shortness of the sample period (only about six months). Another reason might be that the Greek debt crisis has led to an increased focus on the fiscal situation in other European countries, too. As we discussed earlier, this led to increased market activity in both the CDS and government bond markets. It may also have disrupted the pricing of risk in both markets as well as some short-term disconnection.

3.4 Price Discovery

After we found some support for a long-run equilibrium between the sovereign CDS and government bond market in the previous section we now turn to the dynamic behaviour of CDS premia and government bond spreads with a focus on short-run deviations from the equilibrium. As Blanco, Brennan and Marsh (2005) point out, an important function of financial markets is price discovery, which according to Lütkepohl (2005) can be defined as the efficient and timely incorporation in market prices of information that is implicit in the trading of investors. The intuition behind this is straightforward. Let us assume there is only one place where an asset is traded. Then, by definition, all price discovery must take place in this market location. However, if there are closely related assets that trade in different market places, then usually there is fragmentation and the price discovery process is probably split among the different market locations.

As discussed earlier, the CDS and government bond markets are closely related in terms of how credit risk is priced. Then, if CDS premia and government bond spreads are cointegrated $I(1)$ variables, the common factor can be viewed as the implicit efficient price of credit risk (Blanco, Brennan and Marsh, 2005). Therefore, we first focus on those entities where we found evidence for cointegration according to Table 3.

In order to do that we rely on the bivariate VECM that we estimated for the Johansen trace test statistics, where the number of lags to include in the equations is identified again by the SBIC. The specification of the VECM is as follows:

$$\begin{aligned} \Delta p_{CDS,t} &= \lambda_1 (p_{CDS,t-1} - \alpha_0 - \alpha_1 p_{GBS,t-1}) \\ &\quad + \sum_{i=1}^{p} \beta_{1i} \Delta p_{CDS,t-i} + \sum_{i=1}^{p} \delta_{1i} \Delta p_{GBS,t-i} + \varepsilon_{1t} \end{aligned} \tag{1}$$

and

$$\begin{aligned} \Delta p_{GBS,t} &= \lambda_2 (p_{CDS,t-1} - \alpha_0 - \alpha_1 p_{GBS,t-1}) \\ &\quad + \sum_{i=1}^{p} \beta_{2i} \Delta p_{CDS,t-i} + \sum_{i=1}^{p} \delta_{2i} \Delta p_{GBS,t-i} + \varepsilon_{2t} \end{aligned} \tag{2}$$

where ε_{1t} and ε_{2t} are i.i.d. shocks. Two important parameters for our purpose are λ_1 and λ_2. They can be interpreted as follows: If the government bond market is contributing significantly to the price discovery process, then λ_1 should be negative and statistically significant. The reason for this is that in this case the CDS market adjusts to incorporate this information. Using the same line of argument, if λ_2 is positive and statistically significant then the CDS market contributes significantly to the price discovery process. If both coefficients are statistically significant, then both markets contribute to the price discovery process. According to the Granger representation theorem, the existence of cointegration means that at least one market has to adjust (ENGLE and GRANGER, 1987). Adjusting to publicly available information means, however, that this market is reacting more slowly than the other one. BLANCO, BRENNAN and MARSH (2005) conclude that the adjusting market is inefficient.

Table 4 reports λ_1 and λ_2 along with the respective p-values. In all seven cases where we found a long-run relation λ_2 is positive and significant (at a 1% significance level except for Portugal in Panel C, where we find significance at the 5% level). This indicates that the CDS market contributes to the price discovery process. By contrast, only in two cases is λ_1 negative and significant at a 10% level of significance – an indication that the government bond market contributes to price discovery. Overall, we find that in five of the seven cases only the CDS market contributes to price discovery while in the other two cases both markets contribute.

According to GONZALO and GRANGER (1995), we can use the relative magnitudes of the λ coefficients to determine which of the two markets leads the price discovery process.

The contribution of the CDS market to price discovery can be calculated using the Gonzalo-Granger measure, which is defined as follows.

$$GG = \frac{\lambda_2}{\lambda_2 - \lambda_1} \tag{3}$$

For the first five cases in Table 4, the Gonzalo-Granger measure produces a statistic of one or greater than one which is difficult to interpret. In none of these cases, however, is λ_1 statistically significant. Hence, without loss of generality, we could replace the value of λ_1 by zero. For the Gonzalo-Granger measure we would then obtain a statistic of one in all cases, which is equivalent to stating that only the CDS market contributes to price discovery. In the two cases of Spain and Portugal in Panels B and C, respectively, we find for both λ coefficients significant values with the expected sign. Accordingly, the Gonzalo-Granger measure yields values of less than one in both cases.

Table 4: Contributions to Price Discovery

	Contribution of GBS		Contribution of CDS		Gonzalo-Granger	
	λ_1	(Std. Err.)	λ_2	(Std. Err.)	GG	(Std. Err.)
Panel A: January 9, 2008 until April 16, 2010						
Italy	0.002	(0.007)	0.021	(0.006)	1.08	(0.02)
Greece	0.014	(0.013)	0.047	(0.013)	1.43	(0.02)
Panel B: January 9, 2008 until October 19, 2009						
Italy	0.000	(0.011)	0.043	(0.010)	1.00	(0.01)
Ireland	0.011	(0.010)	0.025	(0.006)	1.71	(0.05)
Greece	0.014	(0.010)	0.044	(0.009)	1.44	(0.02)
Spain	–0.024	(0.014)	0.029	(0.010)	0.54	(0.01)
Panel C: October 20, 2009 until April 16, 2010						
Portugal	–0.147	(0.086)	0.112	(0.058)	0.43	(0.02)

This table reports various measures of the contribution to the price discovery process for those entities where the results in Table 3 indicate a long-run relation between CDS premia and government bond spreads. The parameters are estimated via a bivariate VECM. The Gonzalo-Granger measure shows the relative contribution of the CDS premia to the price discovery process. Standard errors are in brackets. For calculating the standard errors of the Gonzalo-Granger measure we use the delta method. Panel A reports the results for the whole sample since 9 January 2008. Panel B concentrates on the period prior to the Greek problem, Panel C on the period thereafter.

In the case of Spain we find a value of 0.54, i.e. the CDS market is contributing 54% to price discovery. Hence, the CDS market is slightly more dominant than the government bond market. In the case of Portugal, however, we find a value of 0.43, which means that the government bond market is contributing slightly more to price discovery than the CDS market.

Based on the Johansen trace test statistics in the previous section, however, cointegration is rejected for 8 of the 15 cases and therefore the VECM representation is not valid. Accordingly, we cannot use this approach for examining the price discovery process in these cases. Instead, we rely on the concept of Granger causality, which is motivated by the approach by Blanco, Brennan and Marsh (2005) as well.

Since one precondition for performing Granger causality tests is that the variables are stationary, we use the transformed variables in first differences. For selecting the number of lags to include in the VAR equations we looked at three different information criteria: the Akaike Information Criterion (AIC), the Hannan Quinn Information Criterion (HQIC), and the Schwartz Bayesian Information Criterion (SBIC). We find that in 87% of the cases the HQIC and the SBIC yield the same number of lags. Only in 20% (27%) of the cases, however, does the AIC yield the same number of lags as the SBIC (HQIC).

In all other cases the number of lags indicated by the AIC is significantly higher than the ones indicated by the SBIC or the HQIC, respectively. As Lütkepohl (2005) demonstrates, the SBIC and the HQIC provide consistent estimates of the true lag order, while minimising the AIC tends to overestimate the true lag order with positive probability. Therefore, we tend to rely either on the SBIC or the HQIC, respectively. As discussed above, both information criteria yield the same lag order in most cases. The SBIC, for instance, yields at most two lags in the case of Greece, and only one lag in all other cases. The results of the Granger causality tests based on the SBIC are summarised in Table 5.

We again distinguish three different time periods. First, we look at the whole sample from 9 January 2008 to 16 April 2010. The results for this time period are reported in Panel A of Table 5. CDS premia Granger-cause government bond spreads for four out the five entities (at a 1% significance level). Only in the case of Ireland are we unable to reject the null. However, in this case we found that government bond spreads Granger-cause CDS premia instead. This is also the case for Portugal and Spain, indicating bi-directional causality.

The results for the second time period – from 9 January 2008 to 19 October 2009 – are reported in Panel B of Table 5. It is interesting that only the results for Greece change. We now find Granger-causality in the opposite direction, i.e. from government bond spreads to CDS premia (at a 5% significance level).

This changes again if we examine the third time period, from 20 October 2009 to 16 April 2010 (Panel C). Moreover, only for two out of the five entities did we find that CDS premia Granger-cause government bond spreads. In contrast, government bond spreads Granger-cause CDS premia in four out of five cases, at least at a 10% significance level.

We find this very interesting given the perception that the turbulence surrounding the Greece debt crisis was, to a large extent, due to speculation in the CDS market. At least in terms of Granger-causality, this perception seems not to hold for the period October 2009 – April 2010.

Overall, the Granger causality test results signal that there is a lot of predictability in both instruments while the VECM analysis indicates that CDS premia contribute more to the price discovery process in the event of a long-run equilibrium. Also, the results do not appear to be very stable if we compare the two sub-samples of Panel B and Panel C. Still, we think that our results are in line

Table 5: Granger Causality Test Results

	H_0: CDS Do Not Cause GBS		H_0: GBS Do Not Cause CDS	
	χ^2-Statistic	p-Value	χ^2-Statistic	p-Value
Panel A: January 9, 2008 until April 16, 2010				
Portugal	13.98	0.000	18.46	0.000
Italy	16.73	0.000	2.25	0.133
Ireland	1.96	0.161	32.45	0.000
Greece	11.35	0.001	0.70	0.403
Spain	6.56	0.010	16.77	0.000
Panel B: January 9, 2008 until October 19, 2009				
Portugal	5.11	0.024	6.43	0.011
Italy	21.27	0.000	0.99	0.320
Ireland	1.45	0.229	29.72	0.000
Greece	0.002	0.967	4.84	0.028
Spain	7.13	0.008	12.44	0.000
Panel C: October 20, 2009 until April 16, 2010				
Portugal	7.13	0.008	8.25	0.004
Italy	0.005	0.944	3.01	0.083
Ireland	1.33	0.249	3.79	0.051
Greece	6.27	0.012	0.45	0.501
Spain	0.58	0.445	4.00	0.046

This table reports Granger causality test results. We use first differences, i.e. daily changes in levels, to obtain stationary time series (we performed augmented Dickey-Fuller tests to test for unit roots). For selecting the number of lags to include in the VAR-equations we rely on the SBIC. In the case of Greece this yields two lags, in other cases one lag. Panel A reports the results for the whole sample since 9 January 2008. Panel B concentrates on the period prior to the Greek problem, Panel C on the period thereafter.

with the findings of Blanco, Brennan and Marsh (2005), as they suggest that bond spreads only react sluggishly to long-term imbalances as measured by the cointegrating relationship. In light of this we can conclude that CDS markets are in most cases leading markets if there is a long-run relation between the CDS and government bond spread markets.

3.5 Liquidity Analysis

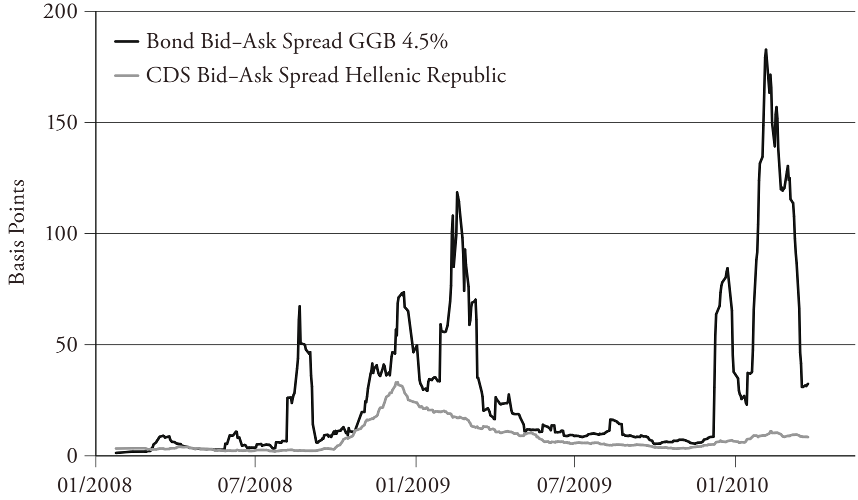
Now, we can ask whether the potential inefficiency of government bond markets in terms of the price discovery process might be related to measures of market liquidity. The liquidity of a financial instrument is the cost of opening and closing a position. According to ANDERSON (2010), liquidity in derivative markets is often better compared to the underlying markets due to the higher degree of standardisation. He argues that the liquidity is positively influenced by "low bid/ask spreads", "the ability to trade large quantities without having much price impact" and "the speed with which the market absorbs a large trade". What is more, the liquidity of sovereign CDSs has increased sharply in the past decade as the market benefited from the standardisation of contract forms and definitions in 1998 and 1999 as well as successful executions in various defaults (e.g. Russia (1998), Argentina (2001)).

The introduction of an ISDA auction process in 2005 further smoothed processes in a default case.[8] In emerging markets, sovereign CDSs are considered the most liquid credit derivative instruments. According to PACKER and SUTHIPHONGCHAI (2003) sovereign CDSs have the potential to supplement and increase efficiency in underlying sovereign bond markets as their liquidity increases. In general, the more liquid a sovereign CDS, the more it shows signs of financial stress. A relatively liquid CDS market is also an indication that there is agreement between market participants about the present value, but disagreement about future value due to increased uncertainty surrounding the country's fiscal situation.

According to liquidity score data from Fitch Solutions, liquidity on the developed market sovereign CDS index surpassed that of the emerging market sovereign CDS index for the first time in November 2009. This highlights the fact that, on average, the CDS market indicated more uncertainty with respect to the fiscal situation of developed economies, compared to the situation of emerging countries. Although the 10 most liquid sovereign CDS markets are all from the emerging market index, overall liquidity in this index has only increased marginally compared with the significant increase in the developed market index. The increase in liquidity of the developed market index has been driven by persistent market uncertainty about the strength of economic recovery and the sustainability of fiscal developments on the back of fiscal stimulus packages and expected

8 So far, there has only been one example of the auction process being used to determine the recovery rate for sovereign CDS: After the last default by Ecuador in 2008, the auction settled at a recovery rate of 31.4%.

Figure 6: Bid-Ask Spreads



lower tax revenues. For countries considered safe, the government bond market is in general more liquid than the sovereign CDS market. A good example for this relationship is Germany, where the sovereign CDS market is less liquid than the highly liquid bond market. Dresdner Kleinwort Wasserstein Research (2002) and JP Morgan (2001) have found that, generally, bid-ask spreads for credit default swaps in the more liquid sovereign names are 10 to 20 basis points wider than those observed in the bond market.

However, for countries in financial trouble the bond market becomes more illiquid than the sovereign CDS market. Hence, liquidity shifts towards CDS markets during distress periods, making them more liquid. According to consistent anecdotal evidence, during the financial crisis, the CDS markets for most PIIGS countries was more liquid in certain phases than the equivalent bond market.[9] An investment bank[10] provided us with a time series of bid-ask prices for Greek government bonds. We compared the data with market bid-ask prices for Greek CDS (CMAN prices). Figure 6 shows that CDS instruments were

9 According to traders from the Swiss National Bank and investment banks.
10 The bank is a major global market maker in the fixed income market. The bank explicitly requested to stay anonymous.

consistently more liquid than government bonds with the same maturity.[11] It is obvious that the more liquid market should be the leading market, since higher liquidity enables market participants to process information more efficiently (i.e. at lower costs). Hence, the threshold for acting on new information is lower in the more liquid market.

4. Conclusion

Motivated by the dramatic developments on the sovereign CDS market in spring of 2010 and the discussion about the use and abuse of this market that followed, we examined the empirical relationship between CDS premia and government bond spreads in a time-series framework for Portugal, Italy, Ireland, Greece, and Spain. We found some evidence for a long-run relationship in the sense of cointegration for the two markets. In most cases (five out of seven), only CDS premia contribute to the price discovery process. In the remaining cases, both markets make a more or less equal contribution.

This suggests that bond spreads react only sluggishly to long-term imbalances, as measured by the cointegrating relationship. In light of this we can conclude that, in most cases, CDS markets are leading if there is a long-run relationship between the CDS and government bond spread markets. This may be partly due to liquidity effects. However, based on the Granger-causality tests we also found a reaction to lagged differences between bond spreads and CDS premia, indicating that there is a lot of predictability in both instruments. In this light, the cointegration-based evidence on market inefficiency is less conclusive. We think that further research, which would involve extending the analysis (both the number of countries and the time period), might offer valuable insights in this area.

Still, our results suggest that the sovereign CDS market is potentially an enrichment for the financial market community as it appears to be more liquid than the underlying government bond market during periods of stress. However, it is important to note that, due to the relatively young European CDS market, our results are based only on the period from January 2007 to April 2010. Consequently, the sample period is heavily influenced by the Greek debt crisis. It thus remains to be seen how the European sovereign CDS markets behave in 'normal' times.

11 The pricing depends on the positioning of the individual bank. However, the result is robust and is based on anecdotal evidence.

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SUMMARY

We examine the empirical relationship between credit default swap (CDS) premia and government bond spreads for Portugal, Italy, Ireland, Greece, and Spain (the 'PIIGS' countries). We find some evidence for a long-run relationship in the sense of cointegration for the two markets. In most cases (five out of seven), only CDS premia contribute to the price discovery process. In the other cases, both markets make a more or less equal contribution. All in all, this suggests that bond spreads react only sluggishly to long-term imbalances, as measured by the cointegrating relationship. In light of this, we can conclude that, in most cases, CDS markets are leading markets if there is a long-run relationship between the CDS and government bond spread markets. This may partly be due to liquidity effects.