Queen Mary, University of London

MSc Finance and Economics Dissertation

Comparing the Behavior and Relation of CDS Spreads and Bond Prices in Different Economies in Two Sub-periods

A comparative study of several high yielding and solid European economies

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Abstract

After the publication of CDS market data in 2007, a considerable amount of literature has been written about the relationship between CDS premiums and bond prices. This paper investigated whether this relationship is similar in several EU economies in very different two sub-periods: short recovery period in 2009 and EU debt crisis period. By using two different sub-periods which have opposite characteristics in terms of risk aversion, I tested whether the relationship of CDS premiums and bond yields are changing over time and over different periods or not. The results are interesting since the behavior is changing with increasing and decreasing risk aversion in the market.

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1. Introduction

The bankruptcy of Lehman Brothers at 15th September 2008 has affected every market in the financial world. After extensive fiscal and monetary stimulus packages issued by the governments and central banks, the markets calmed down for a short period, but these fiscal packages have increased the debt to GDP ratios of many advanced and high yielding countries. After a short recovery period, the increased debt stock in advanced and high yielding countries brought new worries to the markets. (IMF 14)

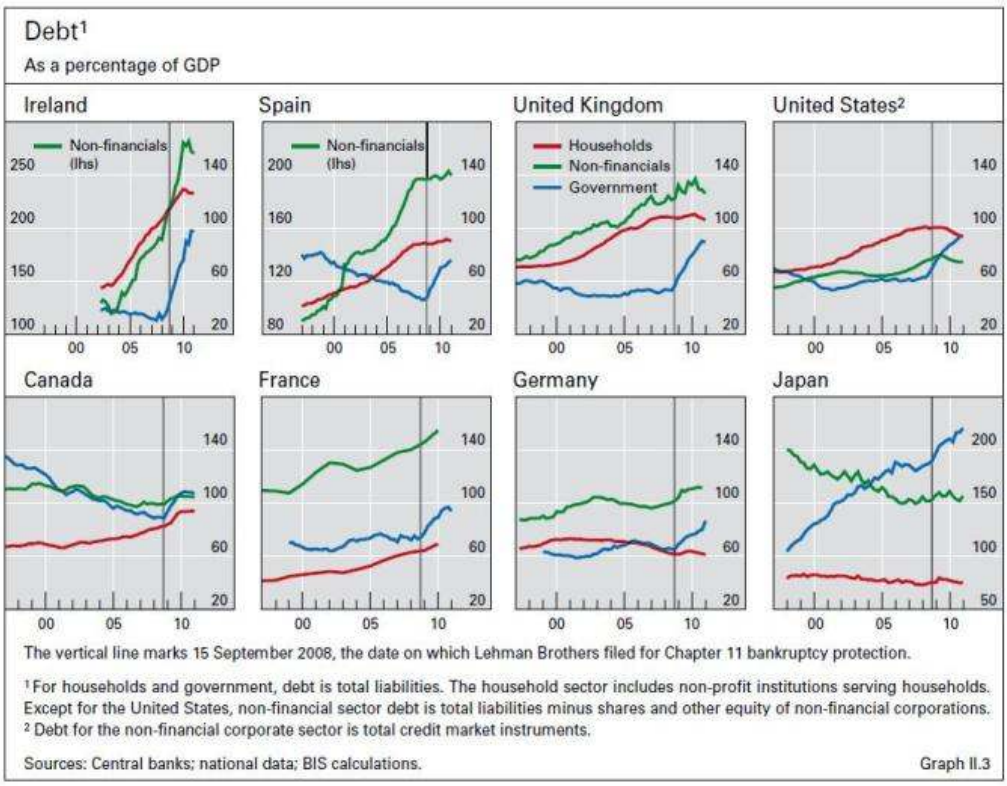


Figure 1: the debt stock of several countries (BIS 21)

The vertical line indicates the timing of "Lehman bankruptcy", and the blue line shows the public debt to GDP ratio. As seen on the graph above, the debt ratios have increased significantly after the stimulus packages. The increased level of sovereign debt implied a higher probability of default or restructuring risk of the bonds for some high yielding countries like Greece, Ireland, Portugal and Spain.

The increasing debt stock has affected the bond markets and also CDS contracts, which are their insurance policies. In this paper I studied the relation of CDS contracts

with bond yields, comparing high yielding EU countries with larger EU economies, i.e. France, Italy, Spain, in two different sub periods. I compared different countries within different periods, which have different properties in terms of risk aversion. The reasoning of why these specific periods have been chosen is analyzed in later parts of this paper.

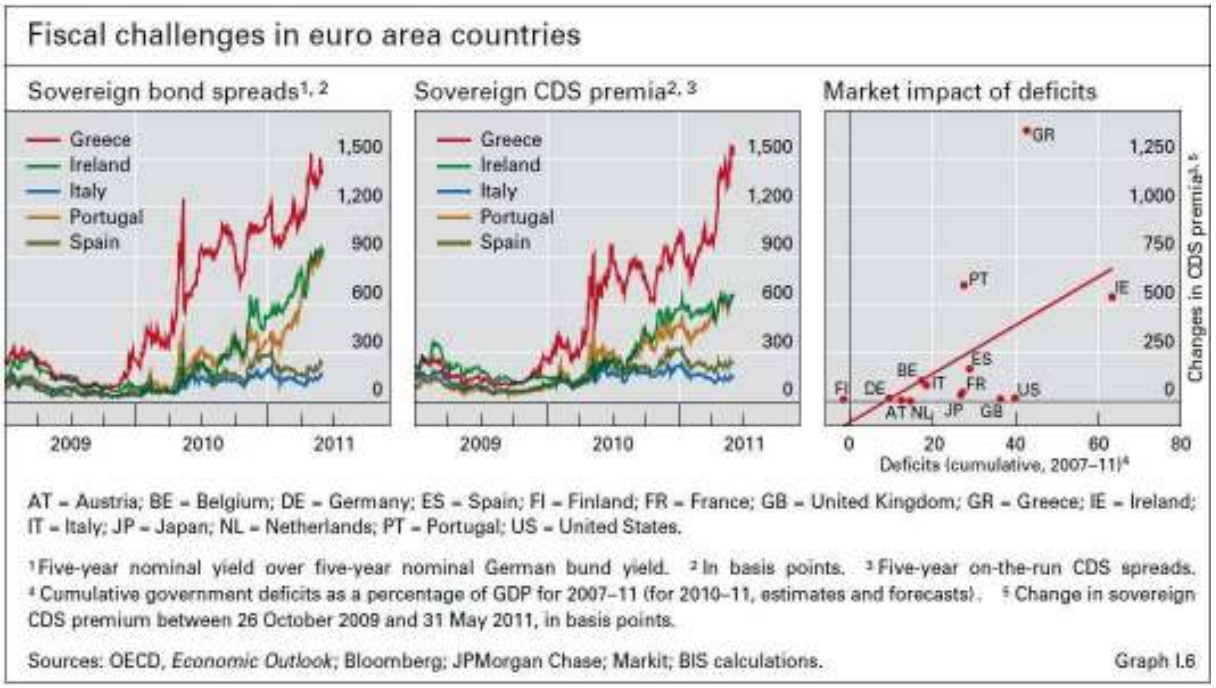


Figure 2: Bond spreads, CDS premiums and correlation of debt stock with CDS's (BIS 7)

The table above shows a clear picture of high volatility in bond and CDS markets in the last three years. The third graph in Figure 2 shows the correlation line of cumulative deficits and CDS premiums. As the graphs show there is a relation between the debt stock, bond yields and CDS premiums of a country. I have tried to look whether this relation is constant over time and within different countries.

This paper is organized in the following way. After this short introduction, I will give some basic information about the CDS contracts and their history. A review of the existing work in the academia will follow this part. The fourth part is devoted to the theory of CDS-bond basis. After the theoretical information about CDS bond yield relation, I will check the CDS-bond basis graphs, which is the difference of CDS premium and the bond spread over the risk-free rate. I will give some possible explanations why there are deviations from the theory when we study the data. The fifth part is the main concentration of this paper, which consists of the comparison and study of CDS and

bond yields relations. After checking the time series data for being stationary or not, by applying augmented Dickey-Fuller test, I will work with the graphs of CDS premiums and bond yields, correlation tables, Johansen cointegration tests, VECM regressions and Granger causality tests. In the sixth part I will conclude the paper.

By writing this paper I also tried to test whether blaming the CDS market for high bond yields in some specific countries is supported by economic evidence or not. Many politicians in EU area blamed the CDS market by saying that the speculative nature of this market caused higher bond yields in countries like Greece and Ireland. (Schmerken) To support this claim we have to satisfy two basic conditions. First, we need to find cointegration between these two markets. I will check this condition for six different EU countries when dealing with Johansen cointegration tests. The second condition is that we need to explore the price discovery process by using Vector Error Correction Model (VECM) and Granger causality test.

2. CDS contracts and the background of CDS market

2.1 The CDS contract

In very broad terms, a CDS contract is an insurance policy for sovereign and corporate bonds. An investor holding a CDS contract will be protected against the default risk of *the reference entity*. (J. C. Hull, Fundamentals of Futures and Options Markets 497) *The reference entity* can be a corporate or a state, depending who issued the bond. The default of a company or the restructuring of the bond terms or the postponing of a payment is named *a credit event*. In case of *a credit event*, the CDS issuer has to pay the face value of the debt to the CDS buyer. (J. C. Hull, Fundamentals of Futures and Options Markets 497)

Another important aspect of CDS contracts are the pricing of the credit risk in the market environment. The speculative use of these contracts allows market participants to invest in the credit quality of a reference entity. If an investor believes that the credit quality of a specific reference entity will worsen in the future he can sell the CDS contract and if he is right, he will make money from this investment. (Brill ve Andenmatten 6)

CDS contracts are improving the market conditions in the bond markets, because they bring transparency for reference entities and hedging opportunities for investors. In a BIS working paper it is shown that the CDS contracts are improving the liquidity and decreasing costs in the Asian bond markets. (Shim ve Zhu 3)

2.2 The background of the CDS market

The largest of credit derivative markets in terms of volume is the CDS market. The formation of this kind of contracts has begun in the beginning of 1990's. Bankers Trust and J.P. Morgan are the first issuers of CDS like insurance policies. (Smithson ve Mengle 54)

Before the financial crisis in 2008, the gross notional amount of the market was $58 trillion. The volume of the CDS market increased steadily after the millennium, but in the aftermath of the 2008 crisis a decline in the volume has been observed. (Deutsche Bundesbank 46)

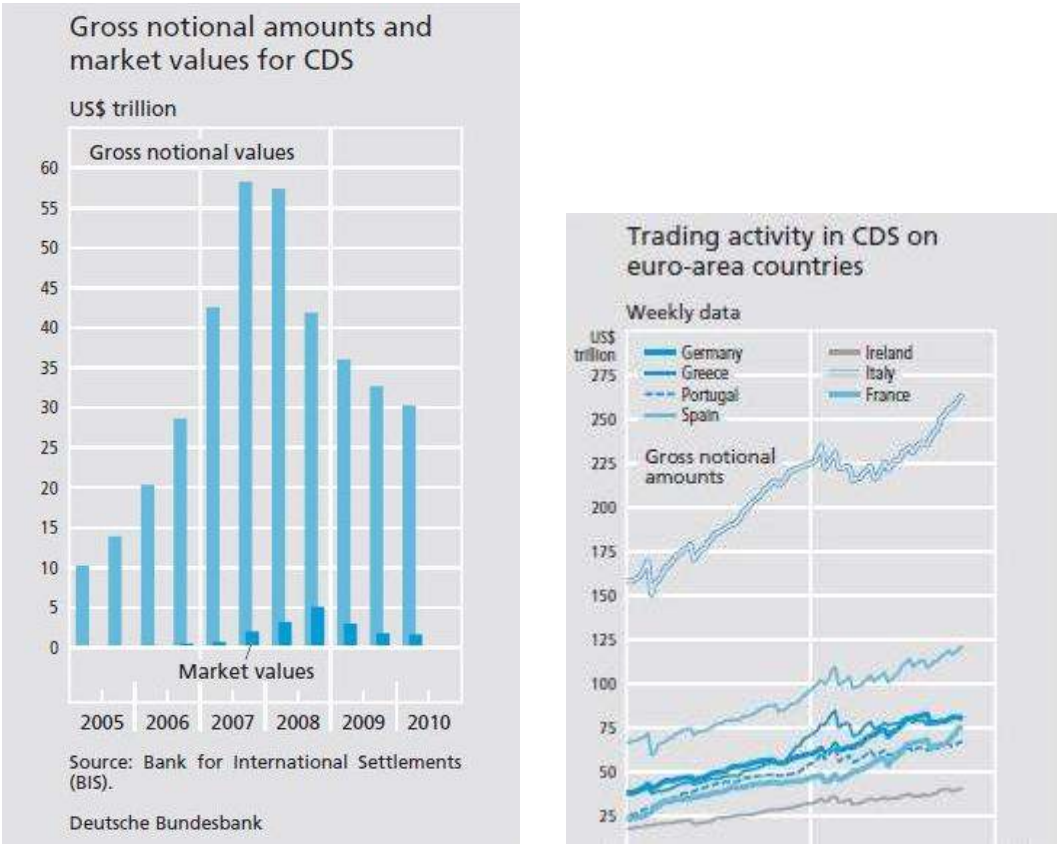


Figure 3-4: The volume and trading activity graphs of CDS market

(Deutsche Bundesbank 48)

Although the notional amount of CDS market has declined after 2008 crisis, the market activity for EU sovereign CDS contracts has increased as you can observe in the figure 4. The reason of higher trading activity in case of EU sovereign CDSs can be explained in few ways. A possible reason is that market players are more eager to hedge against default risks in EU countries. Another possible cause is that investors are betting against high yielding EU countries by using CDS contracts. For example, if an investor thinks that Greece may default on its debt obligations in forthcoming months, he can buy a CDS contract for Greek sovereign debt, and if he is right, he will make money.

3. A short review of existing literature

In this short review of the academic literature, I will mention the most important papers about CDS markets and their relation to bond yields. To review the academic literature about CDS contracts, I will begin with papers which are about the pricing of these contracts. Darrell Duffie's 1999 paper is one of the leading articles in pricing issues of credit derivatives. (Duffie) In addition to Duffie, two other papers have pioneered the pricing theories of CDS contracts. (Hull ve White, Valuing Credit Default Swaps I: No Counterparty Default Risk) (Hull ve White, Valuing Credit Default Swaps II: Modeling Default Correlations) I want to give some basic information about these two papers by Hull and White.

The first paper of Hull and White assumes that there is no counterparty risk involved in CDS trading. The second paper models the pricing calculation on default correlations. Meaning, in default case of a reference entity, other bond and CDS contract issuers will also be affected. The first paper's approach to pricing is straight forward and assumes non-arbitrage arguments and known expected recovery ratios (Hull ve White, Valuing Credit Default Swaps I: No Counterparty Default Risk). In the second paper, the writers add an important aspect to the issue. The seller of CDS of contract can also be affected from a widespread market risk (Hull ve White, Valuing Credit Default Swaps II: Modeling Default Correlations). AIG, one of the biggest issuers of CDS contracts in pre-Lehman period, was severely affected from the global crisis and rescued by the U.S. government. If AIG has not been rescued, the CDS contracts they have sold would have been worthless. Of course, the market players are pricing this kind of risks in the CDS premiums. Although this paper is not about the pricing of these credit derivatives contracts, in the next section, I will check the CDS-bond basis data, which is the difference between CDS premium and the bond spread above the risk-free rate. I will try to investigate whether this basis is different than zero just by checking the graphs.

After mentioning the papers about the pricing of CDS contracts, I want to give some examples for papers about CDS-bond yield dynamics. In the last years it has written many articles about the dynamics of CDS and bond yields. One of the leading papers in this field is written by (Blanco, Brennan ve Marsh). Although this article is about corporate bonds, the methods they used are followed by many others. The writers

found solid evidence for most of the companies that CDS premium and bond yields are connected. Blanco and others concluded that the CDS market imperfections can be responsible for some companies where the relation is not clear.

Another important contribution to the academic literature is made by (Hull, Predescu and White). This paper explores the relationship of corporate bonds and their CDS premiums. The authors find evidence for the theoretical relationship between these two variables. The original contribution of this paper is that the authors review whether the CDS market provides helpful information to forecast the credit rating announcements. According to this paper there is a significant relationship between negative announcements and CDS premium changes. With other words CDS spreads are containing useful information to forecast credit rating changes. (Hull, Predescu and White 26)

After the surge of EU-debt crisis, several papers published to investigate the CDS-bond yield relationship. One of the current papers is written by Fontana and Schleicher. (Fontana ve Scheicher, An Analysis of Euro Area Sovereign CDS and their Relation with Government Bonds) This paper investigates the CDS and bond yields for EU countries, and also studies the CDS-bond basis behavior. Their study of CDS-bond basis provided evidence for non-zero basis. I will study the basis in the next section.

Another paper about the determinants of CDS spreads is written by (Barbosa and Costa).This article focuses on the variables which are affecting the CDS spreads of several EU countries over Germany. The results indicate that the spreads are affected from three important variables: The creditworthiness of the country, the liquidity of the debt market of this specific country and the risk appetite in international markets. (Barbosa and Costa 23)

In the following parts (in Part 5) of my paper I will study whether the risk appetite in the international markets affects the behavior of both markets or not. Barbosa and Costa paper shows that the risk appetite is a determinant of CDS spread, which makes sense, but in this paper I will look from a different perspective and try to solve whether differences in the level risk appetite changes the price discovery process for example.

4. CDS and bond yield relation in theory

4.1 Theoretical approach about the CDS and bond yield relation

CDS-bond basis is the difference between CDS premium and bond spread, where bond spread is the difference of bond yield and risk-free rate. Many traders in investment banks are trading the basis because in theory the basis must be near to zero. During the financial crisis many traders lost huge amounts of money by trading the basis. For example, in 2009 Boaz Weinstein, one of the heads of Deutsche Bank's credit trading, was down for $1bn. (Fontana, The Persistent Negative Cds-Bond Basis during the 2007/08 Financial Crisis 2) The reason is during the crisis the basis was different than zero for a long time.

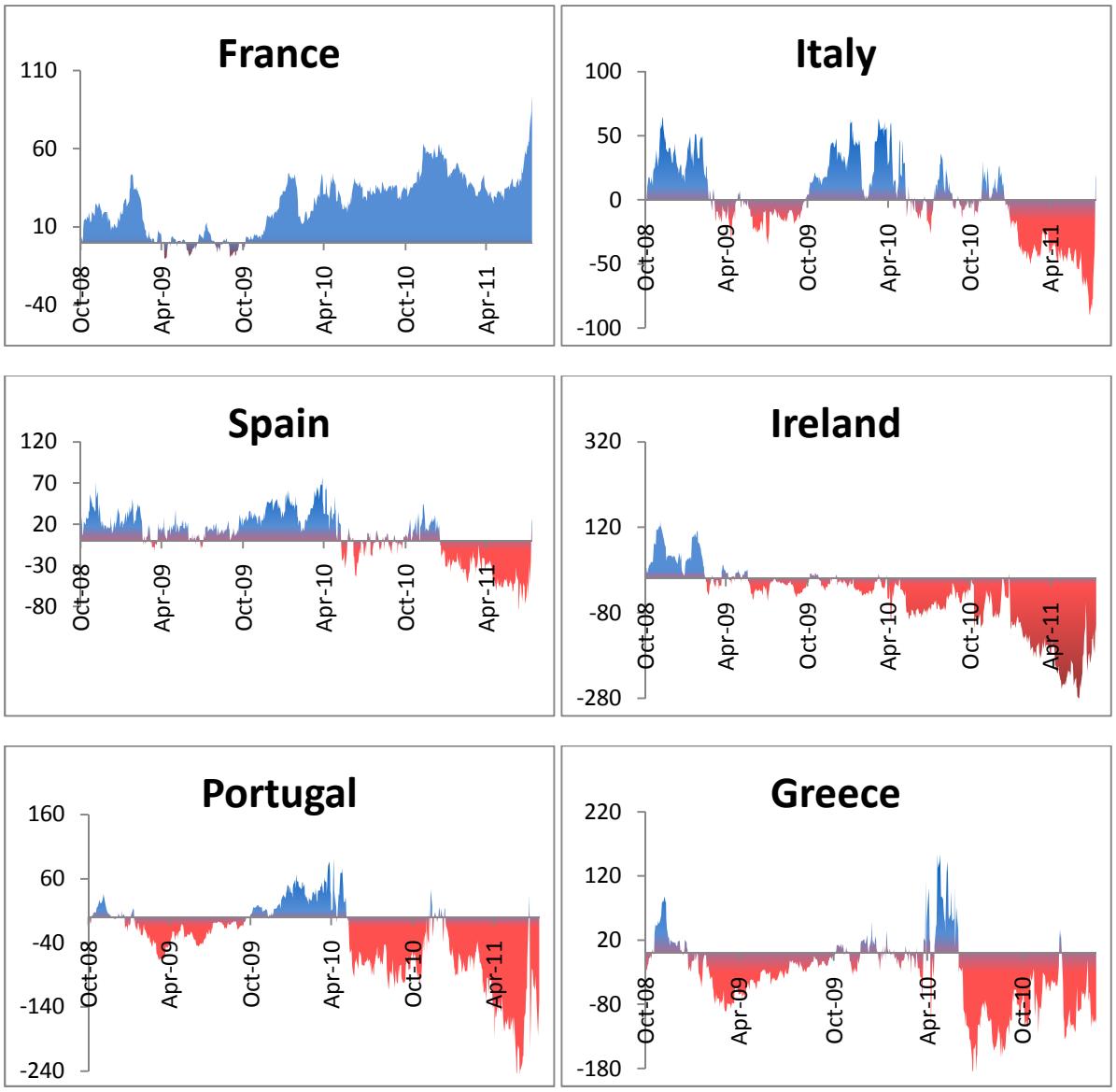
To understand the basics of the theory behind CDS-bond basis we can use the following relationship. By using a simple non-arbitrage assumption, we can find a close relation between CDSs and bond yields. Under this assumption, one can replicate a CDS contract by shorting a risky bond and buying the risk free bond. (Zhu 3) Following another important paper, one can have the equation below (Hull, Predescu and White 10):

$$s = y - r$$

where "s" is the CDS premium, "y" is the yield for the bond on which CDS is written and "r" is the risk free rate. All the maturities are the same. As risk-free rate I used the German Bunds with same maturity. The choice of risk-free rate will be discussed in detail in Part 5.2.

Under specific assumptions (Hull, Predescu and White 11), we can expect that CDS premium is equal to the spread of a bond yield over the risk free rate. Otherwise an arbitrator will buy the cheaper side of the equation and sell the expensive side and will make money. The scope of this paper is not testing the CDS-bond basis, but before moving to the behavior analysis of CDS – bond yields, I want to take a look to CDS-bond basis graphs whether in the real world this non-arbitrage argument works, and if it does not work, I will try to give some possible explanations. The data I use for CDS-bond basis calculation is the same data as the core part of this paper. The detailed information about the time series data can be found in Part 5.1.

4.2 Are there any deviations from the theories?



The graphs are based on 10 year government bond yields, 10 year CDS premiums and 10 year German Bunds as the risk-free rate. As I mentioned before the detailed discussion of the data and the choice of the risk free rate will be at Part 5. As we see on the graphs, the CDS-bond basis is significantly different than zero; the basis is above 100 basis points for high yielding countries for most of 2010.

4.3 Possible explanations of these deviations

The graphs at 4.2 show a clear picture of basis: The CDS-bond basis is not zero for the majority of the time. Another interesting observation is that CDS-bond basis are negative during the EU-debt crisis period for all EU countries except France. In this part I will only focus to the possible reasons of these deviations and Part 5 will contain the study of different periods and countries in deep detail. There can be different reasons why non-arbitrage argument does not hold.

A possible problem can arise from the choice of risk free rate. If the risk free rate involves a marginal default probability, CDS-bond basis would not be zero. Following this argument, the choice of the risk-free rate is critical. In part 5.1, I will explain the different aspects of different risk-free rates and I will also give examples from academic literature. For now, I would only say that testing with swap rates instead of German bunds would give similar results, because there are other important reasons behind the deviation from the theory.

Three of the assumptions of Hull, Predescu and White paper are important to note (Hull, Predescu and White 11). First of these assumptions is that by pricing the CDS contract we assume that there is no counterparty risk involved. As I explained during my academic literature review, in 2008 AIG, one of the largest insurance companies was in crisis. The CDS contracts they had written were faced the risk of being not honored. The market demands a premium for the risk of insurance company default. As I underlined in the literature review part, financial institutions are dependent to each other and a crisis which leads to default of some companies or countries, probably will also affect the writers of insurance policies. An extra premium for this default risk of the counterparty is the first factor that affects the CDS-Bond basis.

The second important assumption by pricing CDS contracts is that we do not face any liquidity risks in the CDS market. In reality, market players will demand a liquidity premium for such contracts. In a very detailed paper about the liquidity premium in CDS markets, Brigo, Predescu and Capponi concluded with the following statement: "CDS expected liquidity and liquidity risk premia are priced in CDS expected returns and premium rates." (Brigo, Predescu and Capponi 32)

Another plausible explanation is tax and transaction cost related issues. In some cases the arbitrage cannot be profitable because of the tax burden of the transactions. Risk free bond and the high yielding bond may have different tax rates, which would affect the theory in the real world. Again transaction costs can also affect the basis.

An extensive work in the literature about CDS-Bond basis investigated the consistent negative basis during the financial crisis for corporate bonds and their CDS contracts. (Fontana, The Persistent Negative Cds-Bond Basis during the 2007/08 Financial Crisis) The author found solid evidence for corporate bond market that during the financial crisis, liquidity and counter-party risks have caused to negative signed basis. (Fontana, The Persistent Negative Cds-Bond Basis during the 2007/08 Financial Crisis 24) The paper also states that arbitrage opportunities were not available.

At this point it is important to note that there are certain conditions and limits to exploit arbitrage opportunities. In a paper about the limits of the arbitrage, two authors concluded that in extreme market conditions investors are not eager to exploit arbitrage opportunities. (Shleifer ve Vishny 54) Although it is possible to earn high returns in volatile markets, in some extreme cases players choose not to risk their investment by trying to exploit arbitrage opportunities. (Shleifer ve Vishny 54)

Another influential paper about CDS-bond basis relation is written by Jan De Wit. De Wit finds 14 economic drivers which affect the basis in his paper. (Wit 7) Some of these drivers have positive effects and some have negative on CDS-bond basis. As an addition to other points above, I want to underline the rule of "CDS cheapest delivery option." If you sell a CDS contract, you are responsible to deliver a bond with certain qualities. But most of the time there are several options, and the seller would choose the cheapest one of these options to deliver. The buyer has the same information, so he will demand higher premium to buy the CDS contract which will increase the basis. (Wit 7)

As we have seen above, there are several reasons why the CDS-bond basis is different than zero and why non-arbitrage arguments can fail. I will continue with the core part of my paper, which is the study of CDS premium and bond yield relation.

5. Behavior of CDS premiums and bond yields for different countries in two sub periods

5.1. The data

The data has been collected from Thompson Reuters DataStream. I have used 10 year CDS premiums and 10 year benchmark discounted sovereign bond yields, for six different countries: Italy, France, Spain, Greece, Portugal and Ireland. The bond market is very liquid in 10 year maturity and 10 year is the second most liquid maturity in case of CDSs. Basis points are used for all calculations and graphs. STATA 11 is used to study the data.

5.2. The choice of risk-free rate

For risk free rate I have chosen 10 year German Bund yields. There is a debate in the finance literature whether to use 10 year swap rates or 10 year German Bund yields. Pioneering papers like (Blanco, Brennan ve Marsh) and (Hull, Predescu and White) have used swap rates for risk free rate in CDS-Bond basis calculations, but it is important to note that these papers deal with corporate CDSs and swap rate is more suitable in these cases. In the case of sovereign bonds, swap rates are resulting negative bond spreads during some periods which is not suitable to use. Swap rates like LIBOR or EURIBOR are the borrowing rate between AA rated banks. Governments like Germany have AAA rating and that's why the swap rates can result by having a negative spread. On the other hand by using German Bunds we also have to note that there is an idiosyncratic risk associated with Germany (Osepkin 7). Papers dealing with sovereign bonds like (Foyle-Fisher) and (Brill ve Andenmatten) are using German Bunds. Foyle-Fisher showed that the correlation for CDSs and bond spreads are higher with German bunds compared to interbank swap rate. (Foyle-Fisher 7) We have to underline that German bunds are not the ultimate benchmark for risk free rate, since CDS premiums are positive for Germany which indicates that there is a default risk for Germany, too. After noting this point, in the case of sovereign bonds, the German bunds are the best indicator in the hand to use as default-risk free. Also the economic neighborhood in EU is important by reflecting some common economic effects in the prices.

5.3. The choice of sub-periods

The whole period I will study will cover the dates from 31.10.2008 until 11.08.2011. The start date of my sample is the start date of CDS data of Portugal and Ireland in DataStream. The sub periods I have used have chosen in the following way:

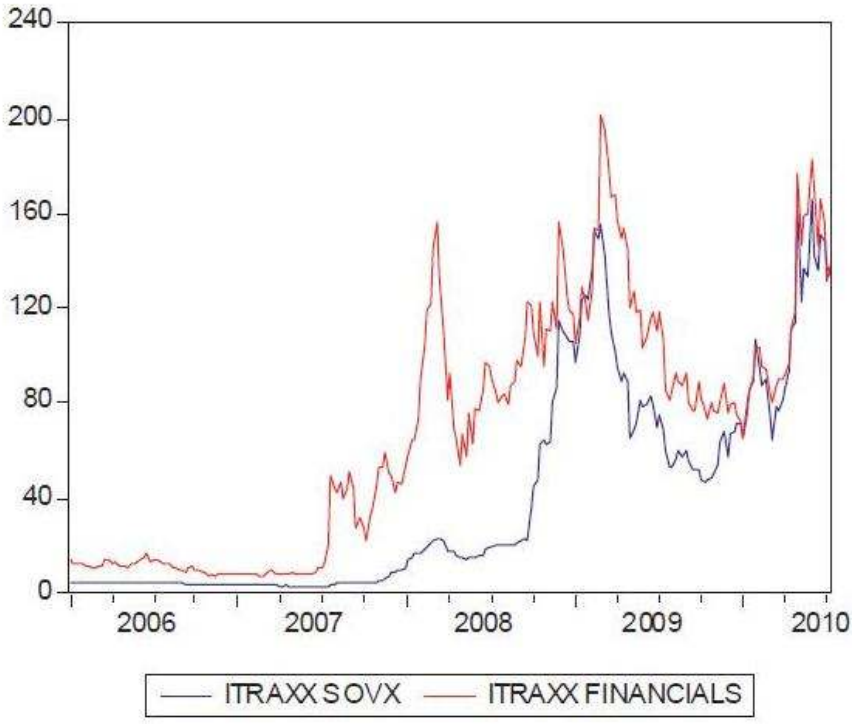


Figure 5: iTraxx indices (Fontana and Schleicher 28)

There is an index called iTraxx to follow the CDS market. iTraxx is an index consisting of several investment grade credits, and is issued by International Index Company (IIC). The graph above shows the iTraxx indices for West-European sovereign bonds (blue line) and for EU based financial companies (red line). As we see on the figure 5 above, the CDS premiums were increasing in post Lehman period and decreasing during the short recovery period. The EU debt crisis increased the premiums once again.

The main difference of this paper compared to other studies is that I will try to compare two different sub-periods which have exactly different characteristics. My first sub period is from 17.03.2009 to 14.10.2009. This is the short recovery period after the Lehman crisis. The extensive stimulus packages improved the stock indices all over the world in this period. The CDS premiums for EU countries were declining and perceived risks were smaller compared to the end of 2008.

My second sub period is from 15.10.2009 until 11.08.2011. This is the period where concerns about debt stocks of some EU countries affected markets. Ireland, Greece and Portugal played the main role since the debt stock to GDP ratio of these countries were very high and the qualities of their debts were not in the league of Germany and France.

Public debt[1]

As a percentage of GDP

	2002	2007	2010	2011	2012
United States	56.8	62.0	93.6	101.1	107.0
Euro area	75.2	71.6	92.7	95.6	96.5
Germany	62.2	65.3	87.0	87.3	86.9
France	67.3	72.3	94.1	97.3	100.0
Italy	119.4	112.8	126.8	129.0	128.4
Spain	60.3	42.1	66.1	73.6	74.8
Netherlands	60.3	51.5	71.4	74.3	75.2
Belgium	108.4	88.1	100.7	100.7	100.4
Greece	117.6	112.9	147.3	157.1	159.3
Portugal	65.0	75.4	103.1	110.8	115.8
Ireland	35.2	28.8	102.4	120.4	125.6
Japan	152.3	167.0	199.7	212.7	218.7
United Kingdom	40.8	47.2	82.4	88.5	93.3
Total OECD	71.6	73.1	97.6	102.4	105.4

[1] General government gross financial liabilities; for 2011 and 2012, forecasts.

Source: OECD, *Economic Outlook*, vol 2011/1. Table II.1

Figure 6: The debt to GDP ratios for several countries (BIS 27)

By comparing these six countries I will divide them in to two groups. Group 1 will consist of France, Italy and Spain and Group 2 will have Greece, Ireland and Portugal. Although there were also fiscal concerns about Spain and Italy, the first group has EU countries with larger GDP's. On the other hand the second group has high yielding EU countries with smaller nominal GDP figures. This grouping is only to check whether I can find a difference between large and small GDP countries. The main aim of this paper is to study the relation of CDS premiums and bond yields over different time periods within different countries.

5.4.The methods

In this study of the relationship of bond yields and CDS premiums, I will follow the methodology of many papers in this field. Some examples of these papers which have used similar methods are the followings: (Fontana ve Scheicher, An Analysis of Euro Area Sovereign CDS and their Relation with Government Bonds) (Blanco, Brennan ve Marsh), (Brill ve Andenmatten)

I will start by representing the descriptive statistics. As most of the economic time series data, I expect to have a non-stationary data set. I will test my time series data whether it is stationary or not. I will apply Augmented Dickey-Fuller test (ADF) to check whether there is a unit root of the series or not. If I have a non-stationary data, I will take the first differences and repeat the ADF to confirm that I have a stationary set. After obtaining the non-stationary data, I will continue with investigation of correlation tables. Johansen cointegration test will follow the correlation tables. This test will help us to investigate whether there is a long term relationship between CDS premiums and bond yields. Countries which have cointegration in their data, I will construct a Vector Error Correction Model (VECM) and focus on the price discovery process. If I could not find cointegration evidence for some countries, I will continue with Granger causality tests for these specific ones. The descriptive statistics can be found below.

5.5.Descriptive statistics

On the tables below the descriptive statistics can be found. As I mentioned before, I will use three different panels for all of the following studies. Panel A will cover the whole sample; Panel B is the short recovery period where CDS premiums were declining and Panel C will be the EU-debt crisis period. CDS premiums and bond yields are in 10 year and the government bond spreads are based on German 10 year Bunds as risk-free rate. The numbers are as basis points.

TABLE 1

Panel A - 31.10.2008 - 11.08.2011

	Credit Default Swaps					Government Bond Spreads				
	Obs	Mean	Std. Dev.	Min	Max	Obs	Mean	Std. Dev.	Min	Max
France	725	62	23	25	165	725	38	10	14	81
Italy	725	128	44	51	310	725	127	50	56	386
Spain	725	143	61	49	350	725	137	78	35	391
Ireland	725	286	170	99	1,020	725	330	229	80	1,129
Portugal	725	227	186	40	1,031	725	263	228	48	1,067
Greece	624	405	276	89	933	624	438	298	107	969

Panel B - 17.03.2009 - 14.10.2009

	Credit Default Swaps					Government Bond Spreads				
	Obs	Mean	Std. Dev.	Min	Max	Obs	Mean	Std. Dev.	Min	Max
France	152	37	11	25	75	152	36	9	14	56
Italy	152	85	23	51	156	152	96	18	66	140
Spain	152	77	16	49	116	152	67	16	35	110
Ireland	152	171	35	114	245	152	182	30	137	258
Portugal	152	62	13	40	104	152	90	26	51	146
Greece	152	129	24	89	187	152	170	42	107	260

Panel C - 15.10.2009 -11.08.2011

	Credit Default Swaps					Government Bond Spreads				
	Obs	Mean	Std. Dev.	Min	Max	Obs	Mean	Std. Dev.	Min	Max
France	476	69	22	26	165	476	36	10	18	81
Italy	476	135	42	66	310	476	137	57	56	386
Spain	476	170	57	66	350	476	168	78	37	391
Ireland	476	335	188	99	1,020	476	412	244	133	1,129
Portugal	476	304	187	51	1,031	476	349	239	48	1,067
Greece	375	564	248	114	933	375	603	280	131	969

As we can observe from the table 1, the mean of CDS premiums in Panel B is significantly lower than Panel C where the perceived risk for EU countries was higher. In the following parts of this paper I will check whether this difference in terms of risk aversion has an effect on the behavior of CDS premiums and bond yields.

5.6.Augmented Dickey-Fuller test

In economic time series analysis, it is important to know the nature of the data. For specific tests, if the time series data is non-stationary, the results can be ambiguous or misleading. I used Augmented Dickey-Fuller test to check whether I have a stationary or non-stationary data set. A non-stationary data means that the mean and variance of the data are changing over time in each panel. Using the following equation I will apply Augmented Dickey-Fuller test to check whether the time series data has a unit root or not. If we have a unit root, then it means we have a non-stationary data as most of the economic time series data. In this case we can take the first differences instead of levels and we can apply the Augmented Dickey-Fuller test again.

$$\Delta y_t = \alpha + \beta t + \gamma y_{t-1} + \delta_1 \Delta y_{t-1} + \cdots + \delta_{p-1} \Delta y_{t-p+1} + \varepsilon_t,$$

In the equation above I assume that there is a trend in the data and I also added an intercept coefficient. The test proved that none of the time series data are stationary. The test with first differences has proved not having a unit root. The results can be found in the table below. With 5% significance level, all of time series are not stationary. After taking the first differences all of them are stationary even at 1% significance level.

TABLE 2

Panel A - 31.10.2008 - 11.08.2011

ADF	Level		1st Differences				
	CDS	Bond	CDS	Bond	1%	5%	10%
France	-0.674	-2.721	-16.295	-18.549	-3.96	-3.41	-3.12
Italy	-2.603	-2.597	-19.556	-19.266	-3.96	-3.41	-3.12
Spain	-3.224	-3.155	-19.249	-19.861	-3.96	-3.41	-3.12
Ireland	-2.706	-2.13	-16.302	-14.834	-3.96	-3.41	-3.12
Portugal	-3.402	-1.717	-17.574	-17.527	-3.96	-3.41	-3.12
Greece	-2.693	-2.397	-17.148	-17.269	-3.96	-3.41	-3.12

Panel B - 17.03.2009 - 14.10.2009

ADF	Level		1st Differences				
	CDS	GBS	CDS	GBS	1%	5%	10%
France	-3.006	-2.101	-7.4	-8.895	-4.023	-3.443	-3.143
Italy	-3.151	-3.061	-7.045	-9.092	-4.023	-3.443	-3.143
Spain	-2.964	-2.815	-6.975	-12.081	-4.023	-3.443	-3.143
Ireland	-3.229	-2.899	-7.042	-7.804	-4.023	-3.443	-3.143
Portugal	-3.055	-1.914	-7.466	-8.39	-4.023	-3.443	-3.143
Greece	-3.274	-2.397	-7.416	-8.08	-4.023	-3.443	-3.143

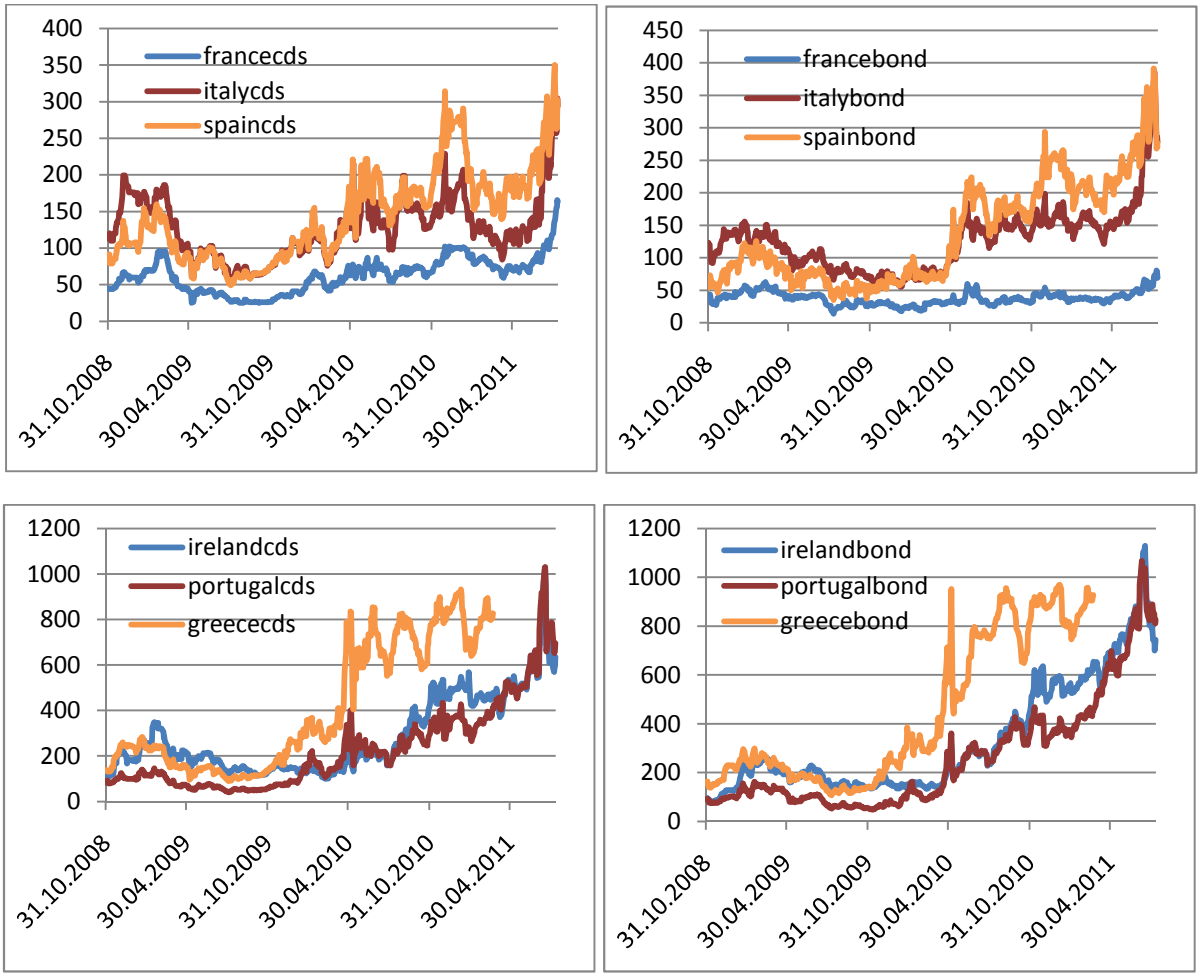
Panel C - 15.10.2009 -11.08.2011

ADF	Level		1st Differences				
	CDS	GBS	CDS	GBS	1%	5%	10%
France	-1.028	-2.388	-13.835	-15.453	-3.981	-3.421	-3.13
Italy	-3.114	-2.283	-16.376	-15.818	-3.981	-3.421	-3.13
Spain	-3.411	-2.847	-15.887	-15.697	-3.981	-3.421	-3.13
Ireland	-3.238	-2.601	-13.417	-12.109	-3.981	-3.421	-3.13
Portugal	-3.241	-2.746	-14.238	-14.191	-3.981	-3.421	-3.13
Greece	-3.162	-2.854	-13.369	-13.502	-3.981	-3.421	-3.13

5.7.Graphs and simple correlation tables

On the graphs below, the CDS premiums and bond yields of studied countries can be found. The graphs are for the entire sample which is beginning from 31.10.2008 and ends at 11.08.2011.

TABLE 3



As we can observe on the graphs, the CDS premiums and bond yields are following similar paths for most of the countries. An exception is France, since the CDS premiums for France are increasing during the EU debt period, but bond yields are nearly constant.

The EU debt crisis has increased the CDS premiums and bond yields for every country in EU. The levels are much higher for Greece, Portugal and Ireland. In the hike of the crisis the CDS premiums were over 1000 basis points for high yielding countries Greece, Portugal and Ireland. To illustrate the case more clearly, one has to pay 100 Euro to buy an insurance policy for 1000 Euro sovereign debt of these countries. Even for a

solid economy like France, the CDS premiums increased substantially; from 70 basis point levels to levels close to 150 basis points. Following this basic analysis, I will study the correlation tables. Although we observed similar paths for both variables on the graphs, it will make sense to study the correlation tables as a second step, before investigating the cointegration of both data.

TABLE 4

Two different correlation tables can be found below. The first table is calculated with level data, and the second table is calculated with first difference. It makes more economic sense to concentrate on the table with first differences, which is a stationary time series data.

Correlation table with levels

Correlations	Panel A	Panel B	Panel C
France	0.52	0.85	0.68
Italy	0.78	0.92	0.79
Spain	0.94	0.85	0.93
Ireland	0.95	0.86	0.98
Portugal	0.95	0.85	0.94
Greece	0.98	0.92	0.98

Correlation table with first differences

Correlations	Panel A	Panel B	Panel C
France	0.41	0.40	0.45
Italy	0.71	0.33	0.76
Spain	0.56	0.13	0.64
Ireland	0.64	0.37	0.67
Portugal	0.69	0.34	0.69
Greece	0.90	0.46	0.90

When we investigate the correlation tables, it is important to concentrate to different periods. The table with first differences shows an interesting point between Panel B and C. (To remember the properties of the Panels: Panel A is the whole sample, Panel B is a rising market, where CDS premiums are decreasing and Panel C is the period of EU debt crisis.) In Panel B we observe a lower correlation coefficient for all 6

countries compared to Panel C. That means, in a market period with high risk aversion the behavior of CDS premiums and bond yields are more correlated compared to a market period with low risk level. Although correlation tables are not informative about the causation direction, it is important to note that there is a difference between two periods with different properties. The paper will continue with Johansen cointegration test, I will study the behavior of two variables in the long run

5.8.Johansen trace tests

Johansen trace test will be used to test cointegration, which will indicate for a long run relationship. In this point it is important to note that a short sample like Panel B has to be investigated carefully, because a short sample may be not enough to prove a cointegrating behavior; I will talk about this issue after the tests. After the study of the test results, I will continue with Vector Error Correction Model (VECM) for series which have cointegration vectors. If I cannot observe any cointegrating vector in some samples, I will do Granger causality tests for these specific series. The test is based on the following VAR equation. I assume to have a constant trend and the equation is based up to two lags.

$$\Delta \mathbf{y}_t = \mu + \mathbf{\Pi} \mathbf{y}_{t-1} + \sum_{i=1}^{p-1} \mathbf{\Gamma}_i \Delta \mathbf{y}_{t-i} + \varepsilon_t$$

p is the number of lags and

$$\mathbf{\Pi} = \sum_{i=1}^{p} \mathbf{A}_i - \mathbf{I} \qquad \mathbf{\Gamma}_i = -\sum_{j=i+1}^{p} \mathbf{A}_j$$

*If the coefficient matrix Π has reduced rank r<n, then there exist nxr matrices A and B each with rank r such that Π = A*B' and B'*y is stationary. r is the number of cointegrating relations. The elements of matrix A are the adjustment parameters in VECM and each column of B is a cointegrating vector. This method is named after Soren Johansen, who used this method in his 1991 Econometrica paper.* (Johansen) *The lags in VAR equations are optimized by using Bayesian Information Criterion. The test results can be found below on TABLE 5.*

TABLE 5

Panel A

	Cointegrating vectors			
	None		At most 1	
	Trace	5% cv	Trace	5% cv
France	15.62	15.41	0.17*	3.76
Italy	11.90*	15.41	1.83	3.76
Spain	18.24	15.41	1.55*	3.76
Ireland	18.34	15.41	0.44*	3.76
Portugal	26.63	15.41	0.33*	3.76
Greece	18.32	15.41	0.64*	3.76

Panel B

	Cointegrating vectors			
	None		At most 1	
	Trace	5% cv	Trace	5% cv
France	16.66	15.41	3.69*	3.76
Italy	28.67	15.41	8.62	3.76
Spain	22.63	15.41	5.01	3.76
Ireland	18.14	15.41	3.49*	3.76
Portugal	20.45	15.41	2.87*	3.76
Greece	20.89	15.41	2.72*	3.76

Panel C

	Cointegrating vectors			
	None		At most 1	
	Trace	5% cv	Trace	5% cv
France	19.22	15.41	0.03*	3.76
Italy	15.76	15.41	2.92*	3.76
Spain	16.13	15.41	2.46*	3.76
Ireland	18.25	15.41	0.79*	3.76
Portugal	24.80	15.41	0.01*	3.76
Greece	15.61	15.41	2.28*	3.76

On TABLE 5, cointegrating samples are shown by asterisk below "at most 1" column. If we focus on Panel A, which is the whole sample, 5 out of 6 countries have evidence for cointegration. Only for the case of Italy we don't have evidence for cointegration. Since Panel A is large sample, the results are not surprising. On the other panels we still have strong evidence for cointegration. Only in Panel B, there is no evidence for Spain and Italy, but it is important to note that Panel B is the smallest sample. On Panel C, which is the EU debt crisis period, each of 6 countries has strong evidence for cointegration. These results on all panels are encouraging for further investigation of price discovery process. Since the test result are showing a long run relationship for CDS premiums and bond yields, it is critical to check whether one of them is leading the other one. In other words, I will study the price discovery process on both markets.

5.9.VECM and Gonzalo-Granger method

I will use VECM and Gonzalo-Granger method (J.Gonzalo ve C.W.J.Granger) to study the price discovery process. The countries which had evidence for cointegration are used in VECM regressions. After having the VECM results, Gonzalo-Granger numbers are calculated to determine the percentagewise contribution of CDS market to the price discovery process of bond markets. With other words, if we have 100% under "Gonzalo Granger" column, then the result indicates that CDS market leads bond market. I will follow Fontana and Scheicher for the VECM equation and Gonzalo-Granger calculations. (Fontana ve Scheicher, An Analysis of Euro Area Sovereign CDS and their Relation with Government Bonds)

The estimated regression is the following:

$$\Delta CDS_t = \lambda_1 (Z_{t-1}) + \sum_{j-1}^{p} \alpha_{1j} \Delta CDS_{t-j} + \sum_{j-1}^{q} \beta_{1j} \Delta BondSpread_{t-j} + \varepsilon_{1t}$$

$$\Delta BondSpread_t = \lambda_2 (Z_{t-1}) + \sum_{j-1}^{p} \alpha_{2j} \Delta CDS_{t-j} + \sum_{j-1}^{q} \beta_{2j} \Delta BondSpread_{t-j} + \varepsilon_{2t}$$

The error terms are i.i.d. The error correction terms are critical for the price discovery process. By calculating the Gonzalo-Granger number I will use these coefficients. As Fontana and Scheicher explained, if the bond market is contributing to

price discovery process, then the first coefficient (λ-1) will be negative and statistically significant. This result will indicate that the CDS market adjusts after the bond market. Otherwise, the second coefficient (λ-2) will be positive and significant and it will indicate that bond market adjusts following CDS market. If both coefficients are significant, then both markets are contributing to the discovery process. Since we found evidence for cointegration in most of countries by using Johansen trace test at part 5.8., at least one of the markets has to contribute to the price discovery. The error correction term is the following:

$$Z_{t-1} = CDS_{t-1} - \alpha_0 - \alpha_1 BondSpread_{t-1}$$

The relative contribution of the variables is calculated by Gonzalo-Granger method:

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

As I mentioned before, if GG is 100%, then CDS market is leading the bond market. 0% indicates that the price discovery takes place at bond market. The VECM is used only for countries for which there is evidence for cointegration.

TABLE 6

Panel A

	CDS		Bonds		Gonzalo Granger
	Error Correction	p-values	Error Correction	p-values	
France	-3.59	0.00	0.11	0.92	100%
Italy					
Spain	-0.89	0.38	3.03	0.00	0%
Ireland	1.26	0.21	4.39	0.00	0%
Portugal	2.46	0.01	5.67	0.00	100%
Greece	-2.25	0.03	0.92	0.36	100%

Panel B

	CDS Contribution		Bond Spread Contribution		Gonzalo Granger
	Error Correction	p-values	Error Correction	p-values	
France	-0.21	0.84	3.37	0.00	0%
Italy					
Spain					
Ireland	-3.38	0.00	-0.03	0.98	100%
Portugal	-2.24	0.03	3.29	0.00	41%
Greece	-0.01	0.99	3.99	0.00	0%

Panel C

	CDS Contribution		Bond Spread Contribution		Gonzalo Granger
		p-values		p-values	
France	-3.01	0.00	1.87	0.06	100%
Italy	2.53	0.01	3.58	0.00	100%
Spain	0.43	0.67	3.15	0.00	100%
Ireland	1.78	0.08	4.57	0.00	0%
Portugal	3.05	0.00	5.56	0.00	100%
Greece	0.31	0.02	1.67	0.10	100%

The results are interesting: During the EU debt crisis period, in 5 out of 6 countries CDS premiums are leading the price discovery process. For the whole period we have mixed results, and during the short recovery period in 3 out of 4 countries, bonds are either leading the process or contributing to the price discovery more compared to CDS market. These results indicate that during periods with high risk aversion, CDS premiums are affecting the bond prices and during rising markets with declining CDS premiums this effect of CDS market fades.

During the analysis of correlation tables, we have seen that during the short recovery period (Panel B) the correlation coefficients were lower compared to Panel C. In times of crisis, the correlation between the CDS and bond market increases and the CDS market starts to lead the price discovery process.

The results indicating CDS market has a leading role during crises can be explained by several reasons. One of the possible explanations is the liquidity effect. Since bond markets are far more liquid than CDS market, investors may fly to quality. A solid work about the liquidity effect in CDS markets is written by (Brigo, Predescu and Capponi) and I mentioned this paper when I was studying the CDS-bond basis in Part 4. The lower liquidity of CDS market can have intense effects on CDS prices when the risk perception increases.

Another possible reason can be the counterparty risk. During crises investors are again flying to quality. Buying insurance from a weak financial institution is also a risky investment as in the case of AIG. A probable bankruptcy of a big financial insurance company is priced in the financial world. People would invest in markets where counterparty risks are smaller.

Also the CDS cheapest to deliver option can have some affect on CDS markets. As I explained in Part 4, this property of CDS contracts have an adverse effect on CDS market. By stating these other possible reasons, I wanted to underline that the leading role of CDS markets in price discovery process cannot be explained only by speculators in this market.

5.10. Granger causality tests

For countries which I could not find a cointegrating vector, I will apply Granger causality test. (Granger) Granger causality test is useful to understand the causation direction of correlations. But it is important to underline some shortcomings of this method. If the variable A is said to "Granger-cause" the variable B, it does not mean that changes in the variable A is the reason of changes in the variable B. Granger causality test cannot calculate the effect of a third variable. For example a country with high sovereign debt level is facing pressure in the market. For sure both CDS premiums and bond yields of this country will increase to compensate the increased risk level. In this specific case the high debt stock of the country is the reason behind the change of CDS and bond prices. By holding this shortcoming in mind, I would use the following equation and apply the Granger causality test. The number of lagged variables by using the first difference data has been determined again by using Bayesian Information Criterion.

$$\Delta CDS_t = a_0 + a_1 \Delta CDS_{t-1} + b_1 \Delta Bondprem_{t-1} + residual_t$$

$$\Delta Bondprem_t = a_0 + a_1 \Delta Bondprem_{t-1} + b_1 \Delta CDS_{t-1} + residual_t$$

TABLE 7

Panel A

Null Hypothesis		*CDS do not Granger cause Bond premium*		*Bond premium do not Granger cause CDS*	
		chi-2	**p-value**	**chi-2**	**p-value**
Italy	Z(t)	3.55	0.04	0.00	0.95

Panel B

Null Hypothesis		*CDS do not Granger cause Bond premium*		*Bond premium do not Granger cause CDS*	
		chi-2	**p-value**	**chi-2**	**p-value**
Italy	Z(t)	1.02	0.31	23.97	0.00
Spain	Z(t)	0.52	0.47	5.00	0.03

In Panel A, I had only Italy without a cointegrating vector. The Granger causality test shows that we fail to reject the hypothesis "*CDS do not Granger cause Bond Premium"* in 5 % significance level because the corresponding p-value is less than 0,05. On the other hand, we reject the second hypothesis for the same case. The result in Panel A for Italy shows that by keeping the shortcomings of the model in mind, the CDS premiums "Granger-cause" bond yields.

In Panel B, we have two countries without conintegrating vectors. For both countries we reject the hypothesis "CDS do not Granger cause Bond premium" and we fail to reject the alternative hypothesis. This result is similar to our findings for other countries in VECM part. In the recovery period, bonds are Granger causing CDS premiums. On the other hand, in whole sample (most of it is crises periods where CDS premiums are increasing) CDS premiums are Granger-causing bond yields.

6. Conclusion

My aim by writing this paper was to investigate the behavior of CDS premiums and bond yields of six EU countries in periods which have completely different properties.

The claims of some EU politicians were that CDS markets are affecting bond markets in an adverse way. This paper tried to check whether these claims are valid or not, by looking to different sub-periods. The main findings are the following:

The relationship and behavior of CDS premiums and bond yields are changing according to the risk aversion level of the market. When the markets are calm and the CDS premiums are decreasing, the bond market has a leading role for most these 6 countries. On the other hand, during times of crises CDS market contributes more to the price discovery process. Actually, my findings in Part 5.9 show that in 5 out of 6 countries the CDS premiums are leading the market during the debt crisis.

In the first sight it looks that EU politician are right about blaming the CDS markets, but it is not that easy to solve. Liquidity effects, counterparty risks and cheapest to deliver options are also affecting the CDS market and the fast reaction in CDS market during the crisis can be dependent to one or more of these reasons.

This work can be expanded by using a longer term data in future, since the history of the market and the available data is limited for now. Because of limited history of this market, the results cannot be taken as a rule. Although the data is short, the results are interesting, because I have showed that in different periods (in terms of risk aversion), the price discovery process changes in CDS and bond markets.

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