THE DYNAMIC INTERACTION OF CREDIT DEFAULT SWAPS, SOVEREIGN BONDS, AND STOCKS IN THE EUROPEAN MARKET

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Abstract

The paper focuses on finding the interaction among stock, bonds and CDS markets from a country's level to get the pattern of lead-lag relationship among three markets. It adopts a three-dimensional VAR model to analyse the lead-lag relationship in the European market of ten countries and different credit quality groups. To gain insight into the influence of debt crisis on the correlation of stock and different industries, the paper also uses the pairwise correlation coefficient method.

The paper finds that: Before the debt crisis, stocks took the leading position with respect to bonds and CDS. Bonds are also found in some cases due to the financial crisis in previous years. The countries with low CDS premium do not show significant change during the crisis. The stock market and CDS in the consumer has the lowest correlation and the market is stable. They relate most tightly in the financial market.

Keywords: Lead-lag relationship; Sovereign CDS; Sovereign bonds; Stock market; VAR

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1: Introduction

Since the last two decades, the credit derivatives market has been greatly developed, especially the Credit Default Swaps (CDS) market. As the CDS market is getting more and more popular, it has attracted the attention and concern from the public. Since CDS transactions are executed over-the-counter, the transparency of these operations is a concern for investors. Unlike traditional investment instruments such as equities and bond, credit derivatives are relatively new to investors. Therefore, the role that CDS is playing in the financial markets and whether or not it contributed to the latest financial crisis continues to be argued by some researchers. The CDS markets are also gaining greater attention from the regulators due to their complexity.

CDS provides a similar function as insurance products which can be used to hedge risk by allowing investors to transfer the credit risk of the underlying entity to the other counterparty of the CDS contract to separate funding from default risk. However, there is another function of CDS rather than insurance products, which is speculation. This is similar to other derivatives contracts. Both CDS premiums and bond spreads are measures of credit quality. The main participant in the CDS market is institutional investors since purchasing CDS instruments allows them to hedge and diversify their exposure to illiquid bonds and outstanding loans or receivables. The negative correlation between CDS markets and stock markets also helps them diversify their portfolio and offers them market protection. One important point of view that is in favour of such credit derivatives instrument is that it helps promote risk sharing among the stock markets, CDS markets and bond markets, which offers extra liquidity to their portfolio.

CDS spreads reflect the credit risk of the reference entity, whose final payoff of the contracts depends on a certain credit event and the credit quality is embedded in the credit spreads. In practice, both bonds spread and CDS spreads provide a way to assess the interaction between stocks' financial performance and its credit risk.

The relationships among these three markets have attracted increasing attention from the market. People are interested in knowing how the sovereign CDS market, the sovereign bond market and the stock market are interacting with each other and the association among stock, CDS and bond in different sectors as well as how their relationships change due to the financial shock. This paper collects a wide sample of ten European countries, some of which were significantly affected by the recent Europe sovereign debt crisis. Three European stock sectors are also included in the sample. The purpose of the research is to analyse how the interaction among stock markets, CDS markets and bond markets has possibly changed before, during, and after the debt crisis in the observed ten countries and the three selected sectors, and whether these changes are different in the observed countries and sectors.

A Vector Autoregression (VAR) model is used to identify the lead-lag relationships among the three markets in every single country. The ten European countries are then pooled together based on their credit quality to examine whether the changes in their interaction are affected by the credit quality of the underlying entity to some extends. The Granger causality test is subsequently adopted to show if there exits causal relationship among the three markets. This paper then analyses the difference in the correlation between stocks and CDSs to identify how the financial shock is affecting their correlation.

The stock market played a leading role in most European countries in the pre-debt crisis period. The bidirectional Granger causality can be observed between the CDS and stock markets, and also the CDS and bond markets. The situation changed when the debt crisis occurred, the CDS market took over the lagging indicator in the market. Instead of the bidirectional Granger causality observed in the pre-crisis period, bonds and stocks are the major Granger-cause of CDS. The counties with lower risk premium do not display significant changes in correlation among the three markets before, during and after the debt crisis. Those countries with higher risk premium show the same trend which mentioned before. Moreover, the consumer and energy industries are more stable compared to the financial sector which revealed an increasing correlation during the crisis.

This paper is structured as follows: section two provides a literature review of the related topics; section three outlines the linkage among stock, CDS, and bond; section four contains the data description and the methodology utilised to carry out the research; section five provides the findings and results of the researched topic; and the final section outlines the conclusion of our research.

2: Literature Review

As the financial market is developing, the relationship between stock, CDS and bond market is gaining greater attention from the public. The empirical research about this topic is extensive. Starting from the late 20th century, some studies revealed the empirical relations among these three markets. The conclusion of Merton's study (1974) regarding the credit market and the stock market is one of the most widely accepted findings. Merton denoted that the value of any credit derivative must be linked to the probability of the underlying reference entity being exposed to a credit event at some point in the future. He considers the value of equity and debt of a firm as contingent claims over a firm's assets. His findings also suggest that the default probability has a non-linear relationship with the equity price, asset price and the capital structure (i.e. debt-to-equity ratio). Moreover, a correlation between the return of bond and stock of each firm exists, and this correlation was observed to be higher during market distress.

Blume et al. (1991), Cornell and Green (1991), and Fama and French (1993) offer findings about the statistically significant association between stocks and bond returns. Kwan (1996) concluded that the bond spreads are negatively correlated to the contemporaneous and lagged stock returns. For financially distressed firms, Alexander and Ferri (2000) reported that there exists a positive co-movement between the stock return and bond return from 1994 to 1997. Campbell and Tasksler (2002) conducted the empirical analysis and showed the relation between the volatility of stock return. According to Norden and Weber (2004), Blanco (2005), Zhu (2006) and Forte and Peria (2009), the CDS market tends to lead the bond market when new information shows up in the market. Most of the financial theories indicate that in the efficient stock market, the probability of default of each individual firm has been

reflected, which suggests that the firm specific information has already been embedded into the stock price before it is embedded into CDS spreads. Fung (2008) furthers the study and concludes that when the credit quality of a company decreases, the CDS market tends to offer a stronger feedback to the stock market.

Longstaff et al. (2003) examined Granger causality between the weekly changes of CDS spreads and the difference of bond credit spreads and stock returns. They focused their analysis focuses on the US markets and the results show that the stock and CDS markets lead the corporate bond market. According to the study of Zhang (2007), the CDS spreads have a more instant reaction to the deterioration of the credit quality than the stock market. Norden and Weber (2009) offer a more thorough analysis on the relationship of the stock markets, bond markets as well as the CDS markets from 2000 to 2002 covering countries from USA, Europe and Asia. They come up with two important findings: (i) the CDS market is the reactor to the stock market movements, and the magnitude of that reaction is affected by the firm's credit quality and the liquidity of the bond market; and (ii) the stock returns are playing a leading role in the co-movement between stocks and CDSs.

Studies exist that focus on whether there exists a causal relationship among the stock markets, bond markets and CDS markets. The study of Bystrom (2005) analysed the relationship between the performance of the CDS index (iTraxx) and stock market returns from 2004 to 2005. According to their results, the stock market returns Granger cause the difference of CDS spreads, but it is not a bidirectional relationship between the two markets. Fung et al. (2008) studied the relationship between CDS indices and stock indices and concluded that the performance of CDS markets is negatively correlated to that of stock markets. The correlation between the two markets increases during the financial distress,

which is in-line with the findings of Merton's 1974 study. This study also suggests that no matter if the firm is in good or bad financial condition, the stock market Granger causes the CDS market.

3: The Interaction between CDS, Stock and Bond Markets

With the development of derivative markets, the co-movement of CDS, stock and bond have attracted increasing attention and concern from the markets. The stock market is the most timely and sensitive to market information. Sovereign bonds are used as the traditional method to hedge risks as well as CDS. Because of the sombre situation that occurred in Europe during 2010 and 2011, the markets have started to take the issues surrounding sovereign credit risk into consideration as a factor of generalized systematic risk.

In the credit market of a country, the two major components are CDS and bonds. Many previous studies contributed to discussing the relationship between CDS and bond markets from both corporate level and sovereign level. Norden and Weber (2009) found that compared to the bond market, the CDS market was more sensitive to the stock market and new information. Forte and Peña (2009) offered evidence that there is a lead-lead relationship between CDS and bond markets, and CDSs lead bonds in most instances. However, only a few studies currently exist that focus on the interaction between CDS and stock markets from the country level in the US market. Most of the available studies take an indirect approach to analyzing the relationship between credit spreads and the stock market. Longstaff et al. (2011) illustrated that CDS markets had a higher correlation with the US stock market compared to the local market. Berndt and Obreja (2010) found an economic measure called economic catastrophe risk related to CDS in the European market.

The interaction between stock and CDS markets still requires further research. When some credit events occur, and the credit quality of the countries worsens, the performance of the stock market will reflect this information. At this time, investors may use different financial

tools to hedge the risk such as CDS or other derivatives. The interaction of CDS and stock markets of a company has been fully analyzed by previous studies. However, the link between the credit market and the country's stock market needs more attention. It is not obvious so far what economic measure can be used as an analogy of a firm's equity in a country's market. Some studies used the stock market as a proxy for the countries' equity. There are also many studies that use GDP as the measure of equity. Not only GDP, but other macroeconomic measures, such as the total domestic consumption and interest rates, are related to the whole risk condition in a country. To make a clear analysis of the current condition of debt holding in the country, the ratio of total debt holding by the country to the GDP is analyzed. After considering all the existing methods and their strengths and weaknesses, our paper will take a similar approach as observed in previous research that outlines that the stock market can be considered a proxy for equity for a country and CDS and bond markets are taken as the measure of credit quality. All these financial instruments possess some exposure to systematic risk. They all contributed to the price discovery process for the country, as outlined in Blanco et al (2005), which is not the main focus of the paper. These factors have an influence on the pricing of the country's equity performance, which is the stock.

Compared to the bond market, CDS has some advantages as the ideal method to trade and transfer risk from the market. First, it has fewer restrictions including the constraints of short-sales and limits on trading quantities. The counterparties in the market can use CDSs to hedge loans and transfer the credit exposure which is not permitted by bonds. What's more, a report released by ISDA (2010) analyzed the role of CDS as a proxy hedge for credit risk for a country. In the report, it showed that sovereign CDSs can not only be used to hedge the credit risk associated with sovereign bonds, but it can also permit those international banks who

have exposure to market risk to transfer the potential downside risk from some particular corporates and countries. CDSs can also help investors who hold shares in sizable real estate assets or in some corporates to transfer the risk from the public to the private. As a means to transfer the risk between private and public, CDS transfers the risk premium associated with the firm and the country according to different credit quality in the market. When the news about the risk quality of a country comes out, based on the market's view and expectation of how the change will influence the future credit quality of firms which operate in this country, the risk premium will be moved around the firm and the sovereign market. The movement of risk premium will directly lead to a fluctuation of the firm's stock price and return. When the credit quality of the country deteriorates, from the corporate level, the market will be more worried about its future credit level and ability to pay back debt. The risk premium will increase, and the stock price will drop. The sovereign market possesses a lower risk premium, and some financial tools can be utilized as an effective means to hedge the exposure from the private sector. Investors will invest in sovereign bonds to prevent the potential loss from the deteriorating credit situation, which is absorbing the risk premium from the public to the private sector. It is referred to as the public-to-private risk transfer in the market. This change will also affect the stock performance of those firms that are not listed in the country's stock exchange. Investors can also take advantage of CDS as an investment opportunity to realize a profit. Because of the increasing trading frequency of CDS in the market, its liquidity is preferred by investors. As a result, with respect to bonds, CDSs take the lead-lag position.

Besides analyzing the interaction among these markets, which focus on the relationship of prices changes, the volatilities of both stock and CDS market also have the lead-lagging relationship. Fung et al. (2008) indicated that the CDS market takes the leading position among the market in the case of volatility spillover. In the financial market, compared to the

price changes, the market is more interested in the volatility changes of the asset. Ross (1989) showed that in a no-arbitrage market, the volatility of assets' price change is more sensitive to the new information compared to the price change. The changes of any market condition will be embedded into the volatility of price before it is reflected in the price change. According to the findings from Fung et al. (2008), the volatility of CDS market is the leading indicator with respect of that of stock. There may be some additional information included in CDS market which cannot be found in the stock market. By utilizing this information, investors may get early warnings about the deterioration of market risk quality.

4: Data Description

4.1: General Description

The weekly data of the closing prices of the 5-year sovereign Credit Default Swap (CDS) spreads, the 5-year sovereign bond spreads, the country stock index, and the financial, energy and consumer sectors stock and CDS indices are observed. Weekly data is utilized because there is less noise in the weekly data than the daily data, and enough data sample can be guaranteed as well.

The sample contains data for ten European countries: Austria, Belgium, Denmark, France, Germany, Greece, Ireland, Italy, Portugal, Spain and the United Kingdom. This set is determined by the need of having a subset of risky countries with higher risk premium and a subset of less risky countries with the lower risk premium. The subset of less risky countries can be used as the 'control' sample which can be used to compare with the risky countries on the changes in the relationship between CDS and stocks when the volatility of the market is high and low. In this paper, countries with CDS premiums higher than 100 bps are considered to be risky countries and categorized in Panel A. The two subsets of data are shown in Table 1.

This paper studies the stability of the co-movement between the bond, CDS and stock market and how the relationship is changing in different sectors. Therefore, not only the countries' stock indices are selected, but the three sector's stock index of Europe as well. The total data sample covers from December 2011 to January 2018. The data is then divided into three different sub-periods: pre-sovereign debt crisis (2008-2009); during the sovereign debt crisis

(2010-2011); and after the sovereign debt crisis (2012-2013). The peak of the turbulence and the uncertainty in the sovereign credit risk are covered in the data sample.

4.2: CDS Data Description

CDSs are over-the-counter (OTC) derivatives mainly traded in London and New York. The mid spread of 5-year maturity CDS denominated in euro is used for two reasons. First, the target market is European countries, using the euro price can eliminate the fluctuation of foreign exchange rate to some extent. Besides, the 5-year CDS spread is the most liquid maturity in the CDS market, which can offer some information that reflects the up-to-date market information. Besides the sovereign CDS spreads data, the CDS sector indices are chosen as follows: DS EUROPE CSM GOODS 5Y CDS INDEX, DS EUROPE OTHER FIN 5Y CDS INDEX (financial sector); DS EUROPE CSM GOODS 5Y CDS INDEX (consumer sector); and DS EUROPE ENERGY CO 5Y CDS INDEX (energy sector). The CDS spread data is obtained from Thomson Reuters.

4.3: Stock Data Description

The closing price of the country's main stock index is used as the proxy for the stock market in each economy. The ten countries' stock indices are selected from Bloomberg as follows: ATX (Austria), OMX Copenhagen 20 (Denmark), DAX (Germany), BEL20 (Belgium), ASE Quote (Greece), FTSE 100 (United Kingdom), ISEQ (Ireland), CAC (France), FTSE MIB (Italy), PSI20 (Portugal), and IBEX 35 (Spain). Since the stock price data is very volatile and not stationary, so the log return of stock is used to represent the behaviour in the stock market. The Sector indices are selected as follows: MXEUOFN (financial); MXEUOEN

(energy); and MXEUOCS, MXEUOCD (consumer). The reason for selecting these three sectors are: (i) to analyse whether the co-movement of stock and CDS differs in different sectors under the great financial shock (Europe sovereign debt crisis); and (ii) compared to the other two sectors, financial sector was greater affected by the financial shock and CDSs are more widely used than the other two sectors, so the co-movement between CDSs and stocks might change differently in the financial sector.

4.4: Bond Spread Data Description

The 5-year government bond yield of every country is taken corresponding to the maturity of the sovereign CDSs. In order to calculate the bond spread, a reference rate yield data which is used to proxy the risk-free interest rate should be determined. Since the credit risk of each country's government bond should be taken into consideration, the euro currency swap rates with 5-year of maturity denominated in euro are therefore considered as the benchmark. The reasons are as follows: (i) Swaps are synthetic and available in nearly unlimited quantities, so liquidity of the market can be ensured, and the data can reflect the most up-to-date market behaviours. Besides, they have the further advantages that they are quoted on a constant maturity basis, so it is easy to find the one that corresponds to the 5-year maturity. (ii) Swaps contain credit premium since the floating leg is indexed to LIBOR, so credit risk has already been priced in swap rates. As a result, the 5-year swap rate is picked over the government bond yield as the proxy of the reference rate yield. The 5-year bond spread is calculated using the 5-year government bond yield to minus the 5-year euro currency. The 5-year bond spread of every country is used to represent the behaviour of the bond market.

4.5: Statistics and Correlation

Table 2 shows the descriptive statistics of the stock indices return, the CDS spread, and the bond spread of every country as well as that of the stock indices return, the CDS spread of the three selected sectors during the debt crisis period. The return of stock indices is on the log base while both CDS spread and bond spread is quoted in percentage. It can be concluded from the result that there is a wide dispersion within the data sample regarding CDS spread. The highest CDS spread was 6.34% for Greece while the lowest one was only 0.286% for Denmark. In the same period, the highest bond spread was 8.27% for Greece while the lowest was 0.065% for France. Compared to CDS spread and bond spread, there was less dispersion.

Figure 1 and 2 are the examples that visualized the co-movement during the selected subperiods of CDS spreads and stock indices in Greece and Germany. It can be observed from the graph that there exists a negative correlation between the CDS market and the stock market. The reason for it is intuitive: when the stock market is experiencing downturn meaning that the higher credit risk is perceived in the market, the CDS premium is greater. As the CDS spreads widen, the price of stock indices goes down because investors are more sceptical to the market and therefore seize to sell stocks. In other words, bad news in the market will have impact stock performance. At the same time, CDS spreads will increase given the higher likelihood of a credit event. It can be observed from the example of Greece that such impact will be greater when bankruptcy is closer (Greece was bankruptcy in 2012).

Table 3 shows the pairwise correlation matrix between each sovereign CDS index during and after the debt crisis. The subperiod ‘before debt crisis’ is not used in the comparison because the data may be affected by the financial crisis. By comparing the pairwise correlation during and after the crisis, it can be concluded that the pairwise correlation is large between the

selected European countries and it is larger during the sovereign debt crisis period than after the debt crisis. Therefore, when one country became riskier and its CDS was getting more popular, it may affect the credit quality of other countries as well. For example, the correlation between Spain and Italy was 0.96 during the sovereign debt crisis period and it decreased to 0.88 after the debt crisis. However, there is an exception, Greece, whose pairwise correlation with other countries after the debt crisis is negative. It is due to the bankruptcy of Greece (2012), which leads to the unusual behaviour of the CDS market.

5: Methodology

There are a few methodologies that we can use to study the co-movement of the selected markets. The most widely used two are Vector Error Correlation Model (VECM) and Vector Autoregression (VAR). Since the price of the stock, CDS and bond market doesn't obey the equilibrium relationship meaning that the price can't be cointegrated, the VECM model is not applicable in modelling the co-movement behaviour among the three markets. This paper chooses the VAR framework to analyse the co-movement among the three markets instead.

VAR is a stochastic process model used to capture the linear interdependencies among multiple time series. VAR model allows multiple variables in the equation, which is the generalized version of the Autoregressive model (AR model). It is defined that every variable in the VAR model can be explained by its own lagged values and the lagged values of other model variables. In this case, the model variables are the stock return, CDS spread and the bond spread and each of them can be explained by their lagged values, other variables and their lagged values. There are three dimensions of the VAR model when doing analysis in every country:

$$R_t = \alpha_1 + \sum_{i=1}^{n} \beta_{1i} R_{t-i} + \sum_{i=1}^{n} \gamma_{1i} \Delta CDS_{t-i} + \sum_{i=1}^{n} \varphi_{1i} \Delta B_{t-i} + \varepsilon_{1t}$$

$$\Delta B_t = \alpha_1 + \sum_{i=1}^{n} \beta_{3i} R_{t-i} + \sum_{i=1}^{n} \gamma_{3i} \Delta CDS_{t-i} + \sum_{i=1}^{n} \varphi_{3i} \Delta B_{t-i} + \varepsilon_{3t} \quad (1)$$

$$\Delta CDS_t = \alpha_2 + \sum_{i=1}^{n} \beta_{2i} R_{t-i} + \sum_{i=1}^{n} \gamma_{2i} \Delta CDS_{t-i} + \sum_{i=1}^{n} \varphi_{2i} \Delta B_{t-i} + \varepsilon_{2t}$$

where R_t stands for the return of the stock indices in period t, ΔB_t is the sovereign bond spread in period t, and ΔCDS_t is the sovereign CDS spread change in period t. In the equation, i and ε_i are the lag order and the innovation in period t respectively.

There are generally three steps to apply the VAR framework:

1. determine the stationary of the data sets;
2. build the VAR model and choose the appropriate lag of the model; and
3. determine whether there exists a causal relationship between each pair of variables.

1. Determine the stationary of the data sets

The hypothesis tests to examine the statistical significance of the coefficients either singly or jointly requires that all the components in the VAR are stationary. Data stationary means that the statistical parameters such as mean and standard deviation of the process are constant over time. The most important property of a stationary process is that the autocorrelation function doesn't change over time. A weak stationary process requires constant mean while a strong stationary process requires the higher-order moments such as variance to be constant over time. Therefore, the Unit Root Test of the data set is performed to test whether the data is stationary. The main test in Unit Root Test is Augmented Dickey-Fuller test. The null hypothesis of is that there exists a unit root and the alternative hypothesis is that the data is stationary. Table 4 shows the p-value of the Unit Root Test of the stock return, bond spread and CDS spread at 95% significance level. It can be concluded from Table 4 that the data sample meets the requirement of stationary.

2. Build the VAR model and choose the appropriate lag of the model

There are a few criteria to determine the lag structure such as the Mean-Squared Error (MSE), the Akaike Information Criterion (AIC), and the Schwarz Information Criterion (SIC). SIC, with the highest penalty factor is the strictest criteria, which is consistent over

time. Therefore, it is used to determine the lag structure and the maximum lag order i of the model.

3. Determine whether there exists a causal relationship between each pair of variables

Granger causality is a statistical process based on the prediction. When a time series X is said to Granger-cause another series Y, it can be concluded that the past values of X would contain statistically significant information that can be used to predict the value of Y and it is beyond the information contained in Y. When using the past values of variable Y and the past values of variable X can provide a better prediction of the future value of variable Y than only using the past values of variable Y itself, it can be concluded that variable X Granger-causes variable Y. The results of Granger causality test are in Table 5. It is useful to know whether there exists Granger causality among the stock market, CDS market and the bond market in different countries under different market conditions, since it provides a hint regarding the prediction of prices. To examine whether there is a lead-lad relationship exists between the volatilities of CDS and stock markets, Granger causality can be used to test the causality relationship of volatilities of these two markets. The square of stock returns and percentage changes of the CDS can be used as the proxy of volatility of both markets. Through this test, if there is a Granger causality relationship found in these two markets, the lead-lagging relationship then can be observed. The leading market may contain additional information. But this analysis is not the focus of the paper. The paper focuses on the interaction among the price change in CDS, stock and bond markets.

6: Result Analysis

6.1: Country-by-Country Analysis

The model result of all ten countries is shown in Table 5. The time period used in the analysis has been divided into three non-overlapping periods, which are pre-debt crisis period, during debt crisis period and post-debt crisis period. The paper only reports the results of stocks, sovereign CDSs, and bonds with the first four legs to make the analysis clearer.

During the pre-debt crisis period, the stock took the lead role in the market for most of countries, which are Spain, Portugal, France, Italy, Denmark, and Germany. The result also shows that CDSs took the leading position with respect to the bond and stock in some countries such as Ireland. A bidirectional Granger causality between CDSs and stocks can be observed in most countries, which is different from previous studies. They found a bidirectional Granger causality between bonds and stocks. For the case of Ireland, the stock and CDS are the Granger-cause of the bond, consisting of the leading position of CDS in Ireland. This can be explained by the fact of the financial crisis during 2008 and 2009, which is also the pre-debt crisis defined in the paper. Because of this serious situation, some countries had already taken some strategies to hedge their position from the market, taking the long position in CDS. So, CDS became in the leading position in some countries. The financial crisis had a significant influence on countries' financial market. Although the paper defines 2008 and 2009 as the pre-debt crisis period as the control group to get the insights of change of co-movement relationship between these three markets, the effect of financial crisis must be taken into consideration.

The stock market lost its leading position when the debt crisis happened. The debt crisis in the European market especially Greece draw everyone's attention. As shown in Table 5, CDS replaced stock in the market becoming the lagging indicator compared to stock and bond in most countries (Spain, Portugal, Italy, France, Ireland, Greece, and Austria) except for the UK. The previous lagging relationship of stock does not change in Denmark and Germany. In these countries, CDS became more significant compared to the pre-debt crisis period, although it is not statistically significant. The bidirectional Granger causality cannot be observed in this situation, but CDS is still the major Granger-cause with respect of stock and bond indicating that CDS takes a leading indicator role in the market.

The situation changed again during the post-debt crisis period. Due to the severity of this debt crisis that many countries faced that challenge of bankruptcy, sovereign bonds and stock took over the position against CDS with the exception of the UK in which none of those indicators found significant. Sovereign bonds are used as another method to hedge from potential downside risk. Compared to CDS, bonds market had more restrictions. In Greece, CDS was still at the leading position which may cause by the seriousness of the debt crisis in Greece. The market experienced a continuous turmoil and it didn't recover to its normal situation. The stock did not take back the leading position and bonds regained attention.

6.2: Credit Quality Analysis

To get an insight into the overall co-movement between stock, CDS and bond, the paper also divided the countries based on their credit quality. As shown in Table 1, the countries with higher CDS premium which is above 100 bps are the group as Panel A. Higher CDS

premium shows the lower credit quality of the country. The result from the VAR model is shown in Table 6.

In the pre-debt crisis period, the countries with higher CDS premium shows that bond and stock are the leading indicators with respect to CDS. This is not true for another subset with the lower credit risk premium. In these markets, stock takes the position compared with bond and CDS. This difference between riskier countries and relative safer countries is the result of the financial crisis. Because countries which are riskier were influenced more by the financial crisis happened in 2008 and 2009, they had already taken some actions to protect the investors and the market. Bond came in the role as an effective hedge method. The Granger causality test indicates that there is a bidirectional relationship between bond and CDS.

During the crisis period, the relationship changed considerably for those high-risk premium countries. CDS and bond consolidate their leading roles comparing to stock. What's more, from the perspective of statistics, CDS and bond become more and more significant as the lagging factor in explaining the change of other factors. The bidirectional Granger causality is also shown between CDS, bond and stock which is not only observed in bond and CDS in previous years. But there is not much change in the case of the less risky countries. The debt-crisis had less influence on these countries which may have relatively small markets and less debt with other countries in Europe. These markets preferred to use the sovereign bond as a relative moderate method compared to CDS to hedge the risk. CDS becomes more significant compared to its position in the pre-debt crisis period, even though it is not statistically significant. And the Granger causality test doesn't show the dramatic change of the causality relationship between three markets which performs a more temperate reaction towards the crisis.

The situation changed again in post-debt crisis. Bond took over the position in both high-risk and low-risk premium groups. Stock shows its role in the group of high-risk premium countries, which is a sign of getting back to the normal market. The co-movement of three markets became more synchronized than the time when the debt crisis happened according to the Granger causality test. There is no evidence shows that there is any bidirectional Granger causality between three markets. For the panel B, bond replaced stock in the pre-debt crisis period pointing out that the debt crisis did not disappear in this time. The low-risk premium which are countries with higher credit quality showed more moderate and stable in the case of the debt crisis. The result of groups with different credit quality is consistent with the previous finding of a single country.

6.3: Sector Analysis

In addition to the analysis towards of countries and different credit qualities, to get a co-movement relationship of three markets in case of industries with different characteristics, the analysis result of industries is shown in Table 7. Because the point of this paper is to examine the co-movement between CDS and stock and excess to the data source, the paper only uses CDS and stock data to conduct the analysis calculating the correlation coefficient between these two factors. The purpose of choosing Consumer, Energy and Financial sectors is that the consumer industry is often considered as a very stable industry and it won't change a lot compared to the energy and financial industry. The financial industry has a closer correlation during the debt crisis. While, the energy industry is always exposed to the higher market risk considering the commodity price and oil price. From Table 7, the result proves the previous finding. The correlation of stock and CDS is always negative which makes sense. The

consumer industry has the lowest correlation among all three industries during all time horizons and the trend is quite stable, changing from -0.112 to -0.2088. The energy industry has a relatively high absolute value compared to the consumer industry suggesting that it is more sensitive to the market condition. The trend of correlation is similar to that of the consumer. The last one is the financial industry, which is the most influenced sector in the crisis. The financial sector has the highest correlation and it fluctuates a lot from -0.3979 to -0.6388, a 60% increase. It falls back to the normal level of -0.3237 after the debt crisis.

7: Conclusion

Since the financial crisis happened in 2009, the derivatives market draws a lot of attention as an effective method to hedge risk, especially the CDS market and the traditional sovereign bond market. The debt crisis in 2010 and 2011 exposed the potential concerns about the sovereign bond market. The previous studies focused on the association between stocks and bond returns from a corporate level. They found that stock returns are playing a leading role in the co-movement between stocks and CDSs and this relationship is affected by the financial status of corporates. The paper pays attention to the sovereign level which doesn't draw too much attention compared to the research about corporates.

To gain the insight of the interaction of the sovereign CDS market, the sovereign bond market and the stock market with respect of different countries, credit qualities and selected sector. The VAR model is used to analyse the lead-lag relationships among the three markets and see whether and how the relationship changed before, during and after the debt crisis in every single country and sectors. According to the model, the stock played the leading role in the pre-debt crisis period. But due to the influence of the financial crisis, the bond has a significant leading position in some countries. The bidirectional Granger causality can be observed between CDS and stock, CDS and bond. The picture changed during the crisis. CDS took over the lagging indicator in the market. The bidirectional Granger causality disappeared. Instead, bond and stock are the major Granger-cause of CDS. For the group of counties with a lower risk premium, the change of interaction among three markets is not obvious. After the debt crisis, the bond or the stock took back the leading position. And the co-movement became more synchronized especially in the group with a higher risk premium. For the sector, with the focus of the relationship between stock and CDS, the result shows

that the more stable the industry is, the less fluctuation it will experience. The consumer industry has the lowest correlation and the correlation within the energy industry is bigger than that of the consumer. The trend of interaction between these two industries was quite moderate. The financial industry is more sensitive to the market and the absolute value of correlation during the crisis period increased a lot. Then, it dropped back to its normal level. This fluctuation cannot be observed in consumer and energy industries.

The lead-lag relationship among three markets and the change of correlation can be applied to risk management strategies under the circumstances of the financial crisis. During the crisis, the investors can take the long position in the CDS instead of the bond because the CDS performs more leading power with respect to bond and stock. The CDS market reflects the information in the market timelier when the market in a deteriorating situation. The stock market has the lead-lag comparing to CDS and bond in a good scenario capturing more information and changes in the market.

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Appendices

Appendix A

Table 1: Average CDS Spreads

Country	Average CDS Spread	Rank	
Greece	1789.56	1	
Portugal	506.44	2	
Ireland	467.91	3	Panel A
Spain	208.58	4	
Italy	187.55	5	
France	75.87	7	
Austria	68.96	8	
UK	66.32	9	Panel B
Denmark	46.17	10	
Germany	38.43	11	

Appendix B

Table 2: Descriptive Statistics

Spain	During Sovereign Debt Crisis		
	Rt	CDS spread	Bond spread
Mean	-0.00162	1.643461847	1.006816916
Standard deviation	0.004292	2.983693252	0.030424101
Median	0.004381	1.630739508	0.983957692
Minimum	-0.1483	0.986640507	2.997457692
Maximum	0.166676	346.1138508	0.331957692
Kurtosis	3.218937	11.78468999	16.84489414
Skewness	-0.05768	1.927925901	2.752967496
Portugal	During Sovereign Debt Crisis		
	Rt	CDS spread	Bond spread
Mean	-0.00072	2.40345202	-1.966015
Standard deviation	0.003213	5.41765067	0.05900222
Median	0.004995	2.346497635	-1.8744538
Minimum	-0.11188	1.333109535	-4.8300538
Maximum	0.074267	5.763225535	-0.6245538
Kurtosis	1.584496	12.93407939	10.2166468
Skewness	-0.80688	-2.28284304	-2.4688097

Ireland	During Sovereign Debt Crisis		
	Rt	CDS spread	Bond spread
Mean	-0.00033	2.587484	1.97278279
Median	0.003207	5.2915771	0.0532177
Standard deviation	0.005597	2.57663	2.01087308
Minimum	-0.13006	3.627429	-1.1674269
Maximum	0.047618	-1.565829	5.03977308
Kurtosis	3.366532	31.017954	31.4863549
Skewness	-1.36172	-4.051921	-2.0967466

Greece	During Sovereign Debt Crisis		
	Rt	CDS spread	Bond spread
Mean	-0.00822	6.348235974	8.266486161
Standard deviation	0.006153	11.08284628	0.198829992
Median	-0.00651	6.409765346	8.278905769
Minimum	-0.13706	3.435126346	15.96090577
Maximum	0.084601	8.222565346	3.581005769
Kurtosis	0.364258	2.744389904	19.11460654
Skewness	-0.25677	0.901548271	2.478276042

Denmark	During Sovereign Debt Crisis		
	Rt	CDS spread	Bond spread
Mean	0.006053	0.2864634	1.80347971
Standard deviation	0.004167	0.4232294	0.03510641
Median	0.010106	0.2886046	1.78453462
Minimum	-0.10327	-0.1988593	1.46853462
Maximum	0.084813	0.3485045	3.42323462
Kurtosis	3.740723	1.7617836	36.2539037
Skewness	-1.04214	0.6447531	5.51599757

Germany	During Sovereign Debt Crisis		
	Rt	CDS spread	Bond spread
Mean	0.003323	0.3149143	0.44355023
Standard deviation	0.003414	0.7085339	0.0178087
Median	0.008378	0.3183947	0.46463846
Minimum	-0.07101	0.1840947	0.14993846
Maximum	0.058057	0.4079947	0.71613846
Kurtosis	0.752075	0.1456688	-0.1198723
Skewness	-0.45685	0.4379324	-0.3308005

Italy	During Sovereign Debt Crisis		
	Rt	CDS spread	Bond spread
Mean	-0.00571	2.369522	-1.6245884
Standard deviation	0.006634	5.67636	0.05089106
Median	-0.00103	2.409378	-1.6384904
Minimum	-0.1406	1.110188	-2.9144904
Maximum	0.10472	3.379788	-0.4474904
Kurtosis	0.450202	2.0095747	4.3524273
Skewness	-0.33015	0.6931636	-0.1267355

France	During Sovereign Debt Crisis		
	Rt	CDS spread	Bond spread
Mean	-0.004	0.9358539	0.06526414
Standard deviation	0.005598	2.0951869	0.02601664
Median	-0.00377	0.9346885	0.06002885
Minimum	-0.11314	0.4998284	-0.4139712
Maximum	0.102376	1.478128	0.41752885
Kurtosis	0.58513	3.9084601	-0.1630558
Skewness	-0.16771	-0.124814	-0.0681622

UK	During Sovereign Debt Crisis		
	Rt	CDS spread	Bond spread
Mean	-0.00082	0.644141156	0.63593684
Standard deviation	0.003988	0.823235245	0.021033588
Median	0.000947	0.645691744	0.663721154
Minimum	-0.09721	0.524241844	0.285721154
Maximum	0.070822	0.751211644	1.026221154
Kurtosis	1.990089	0.652962964	0.383508215
Skewness	-0.58825	0.246413473	0.082323127

Austria	During Sovereign Debt Crisis		
	Rt	CDS spread	Bond spread
Mean	-0.00851	0.763494	-0.0909376
Standard deviation	0.005816	1.6860154	0.02926717
Median	-0.00757	0.776445	-0.0976827
Minimum	-0.14169	,0.459335	-0.8356827
Maximum	0.098422	1.102916	0.44881731
Kurtosis	2.130526	0.7563126	3.12617374
Skewness	-0.59065	-0.043919	-0.2353908

Appendix C

Table 3: Correlation Matrix of Sovereign CDS Spread Changes

	Portugal	Spain	Italy	France	Ireland	UK	Greece	Germany	Austria	Denmark
Portugal	1.00									
Spain	0.72	1.00								
Italy	0.78	0.96	1.00							
France	0.91	0.83	0.90	1.00						
Ireland	0.95	0.84	0.90	0.97	1.00					
UK	0.83	0.70	0.82	0.91	0.90	1.00				
Greece	0.53	0.11	0.29	0.44	0.47	0.62	1.00			
Germany	0.87	0.75	0.85	0.94	0.94	0.95	0.59	1.00		
Austria	0.95	0.79	0.86	0.97	0.98	0.90	0.46	0.94	1.00	
Denmark	0.94	0.84	0.89	0.97	0.99	0.90	0.45	0.93	0.99	1.00
	Portugal	Spain	Italy	France	Ireland	UK	Greece	Germany	Austria	Denmark
Portugal	1.00									
Spain	0.86	1.00								
Italy	0.86	0.88	1.00							
France	0.85	0.92	0.95	1.00						
Ireland	0.88	0.79	0.61	0.67	1.00					
UK	0.25	0.34	0.57	0.48	0.10	1.00				
Greece	-0.82	-0.73	-0.88	-0.81	-0.57	-0.46	1.00			
Germany	0.72	0.75	0.86	0.89	0.49	0.66	0.73	1.00		
Austria	0.65	0.76	0.90	0.88	0.38	0.65	0.79	0.85	1.00	
Denmark	0.83	0.78	0.95	0.93	0.56	0.58	0.87	0.91	0.89	1.00

Appendix D

Table 4: Unit Root Test Result of Stock Return, Bond Spread and CDS Spread

P-value	Austria	Denmark	France	Greece	Germany	Ireland	Italy	Portugal	Spain	UK
	Pre-debt crisis									
Stock return		0	0	0	0	0	0	0	0	
Bond spread		0	0	0	0	0	0	0	0	
CDS spread		0	0	0	0.04	0	0.05	0	0	
	During debt crisis									
Stock return	0	0	0	0	0	0	0	0	0	0
Bond spread	0	0	0	0	0	0	0	0	0	0
CDS spread	0	0	0	0	0	0	0	0	0	0
	After debt crisis									
Stock return	0	0	0	0	0	0	0	0	0	0
Bond spread	0	0	0	0	0	0	0	0	0	0
CDS spread	0	0	0	0	0	0	0	0	0	0

Appendix E

Table 5: Country-by-Country Lead-lag Analysis with Three-dimensional VAR Model

Portugal	Pre-Debt Crisis						During Debt Crisis						After Debt Crisis					
	Rt		CDSt		Bondt		Rt		CDSt		Bondt		Rt		CDSt		Bondt	
	Coeff	t-stats	Coeff	t-stats	Coeff	t-stats	Coeff	t-stats	Coeff	t-stats	Coeff	t-stats	Coeff	t-stats	Coeff	t-stats	Coeff	t-stats
R_{t-1}	-0.22913	[-1.16031]	-29.9575	[-1.00112]	0.267348	[0.31487]	-0.21448	[-1.70157]	199.2309	[0.89776]	7.298235	**[3.23525]**	0.040922	[0.36714]	-70.1443	[-0.41123]	3.486534	[1.23447]
R_{t-2}	0.258123	[1.28150]	-104.134	**[-3.41164]**	0.357581	[0.41288]	0.115942	[0.97860]	-192.65	[-0.92360]	3.273386	[1.54382]	0.04318	[0.38599]	66.19945	[0.38670]	0.952579	[0.33606]
R_{t-3}	-0.55477	[-2.31093]	66.1881	[1.81943]	-1.16787	[-1.13143]												
R_{t-4}	0.036202	[0.14489]	15.02245	[0.39674]	-0.89602	[-0.83400]												
ΔCDS_{t-1}	-0.00442	**[-3.33637]**	0.138527	[0.68958]	0.007186	[1.26066]	-1.85E-04	**[-2.66104]**	-0.11813	[-0.96466]	0.002025	[1.62654]	1.17E-05	[0.22115]	-0.38234	[-4.73328]	3.42E-05	[0.02556]
ΔCDS_{t-2}	0.002107	[1.38501]	-0.47779	[-2.07296]	-0.00328	[-0.50122]	0.000028	[0.39159]	-0.18692	[-1.48231]	0.004358	**[3.39974]**	-3.51E-05	[-0.90488]	-0.13238	[-2.23051]	-0.00132	[-1.33857]
ΔCDS_{t-3}	-0.00215	[-1.42177]	0.140477	[0.61284]	0.004579	[0.70402]												
ΔCDS_{t-4}	-0.00103	[-0.67590]	0.09893	[0.42987]	-0.00555	[-0.85005]												
$\Delta Bond_{t-1}$	-0.0235	[-0.57651]	-1.67985	[-0.27197]	0.010887	[0.06212]	-0.00705	[-0.98168]	2.074034	[0.16406]	-0.11193	[-0.87103]	-0.00708	[-1.86771]	63.49937	**[10.9520]**	0.301889	[3.14455]
$\Delta Bond_{t-2}$	-0.03072	-0.03072	7.722378	[1.30225]	-0.75912	[-4.51159]	-0.00794	[-1.14990]	11.15343	[0.91788]	-0.11331	[-0.91737]	0.001738	[0.36300]	50.21479	**[6.85499]**	-0.2138	[-1.76269]
$\Delta Bond_{t-3}$	-0.01545	[-0.35142]	-0.60915	[-0.09144]	0.022724	[0.12022]												
$\Delta Bond_{t-4}$	-0.00027	[-0.00669]	-6.03153	[-0.99044]	-0.12432	[-0.71950]												
	0.499168		0.562428		0.591639		0.128584		0.078828		0.198312		0.05418		0.698332		0.192792	
R^2		p val		p val		p val		p val		p val		p val		p val		p val		p val
GC test for R_t				0.0014												5.00E-03		
GC test for CDS_t		0.0006						0.0056										
GC test for $Bond_t$																3.00E-24		
Optimal Legs	4						2						2					

Spain	Pre-Debt Crisis						During Debt Crisis						After Debt Crisis					
	R_t		CDS_t		$Bond_t$		R_t		CDS_t		$Bond_t$		R_t		CDS_t		$Bond_t$	
	Coeff	t-stats	Coeff	t-stats	Coeff	t-stats	Coeff	t-stats	Coeff	t-stats	Coeff	t-stats	Coeff	t-stats	Coeff	t-stats	Coeff	t-stats
R_{t-1}	-0.3991	[-2.26235]	-72.2609	**[-2.93630]**	0.013227	[0.01915]	-0.09135	[-0.59255]	51.61903	[0.50432]	1.718379	[1.69350]	-0.07048	[-0.56313]	-223.997	**[-3.44752]**	-0.66397	[-0.58827]
R_{t-2}	0.408084	[1.96518]	-130.423	**[-4.50225]**	0.259903	[0.31962]	-0.03444	[-0.22243]	39.65254	[0.38575]	2.426208	[2.38089]	-0.00523	[-0.03946]	-46.7338	[-0.67909]	-0.32662	[-0.27321]
R_{t-3}	0.08249	[0.34208]	5.191141	[0.15432]	-0.43523	[-0.46091]	0.117821	[0.71813]	-98.8297	[-0.90726]	-1.06044	[-0.98198]						
R_{t-4}	-0.11143	[-0.54336]	46.47694	[1.62461]	-0.69649	[-0.86731]	0.016374	[0.10055]	-232.201	[-2.14749]	-0.93943	[-0.87641]						
ΔCDS_{t-1}	-0.00086	[-0.68832]	-0.25672	[-1.47647]	0.00652	[1.33589]	-7.66E-05	[-0.32592]	-0.0689	[-0.44182]	0.002655	[1.71757]	0.000219	[1.12638]	-0.27134	[-2.69123]	-0.00133	[-0.75727]
ΔCDS_{t-2}	0.002252	[1.68265]	-0.28249	[-1.51314]	-0.00685	[-1.30668]	0.000198	[0.79729]	-0.31328	[-1.89821]	0.006669	**[4.07640]**	2.21E-05	[0.16841]	-0.14108	[-2.06786]	-0.00056	[-0.47449]
ΔCDS_{t-3}	0.000674	[0.51762]	-0.05237	[-0.28840]	0.006101	[1.19701]	-0.00019	[-0.68427]	0.092833	[0.49564]	0.001919	[1.03368]						
ΔCDS_{t-4}	-0.00239	[-1.81171]	0.253052	[1.37539]	-0.0084	[-1.62572]	0.000304	[1.09602]	-0.45976	[-2.49380]	0.001956	[1.07020]						
$\Delta Bond_{t-1}$	-0.01188	[-0.29441]	-3.39295	[-0.60270]	0.10998	[0.69596]	-0.02055	[-0.85796]	11.10365	[0.69807]	-0.23307	[-1.47807]	-0.0161	[-1.11796]	44.12512	**[5.90445]**	-0.241	[-1.85638]
$\Delta Bond_{t-2}$	-0.01285	[-0.32205]	1.702815	[0.30601]	-0.72531	[-4.64346]	-0.02009	[-0.78730]	43.129	[2.54575]	-0.19753	[-1.17614]	-0.0457	**[-2.82086]**	11.16651	[1.32780]	0.187479	[1.28332]
$\Delta Bond_{t-3}$	-0.04956	[-1.18221]	1.268749	[0.21697]	0.06897	[0.42018]	0.043566	[1.92611]	-20.5753	[-1.37007]	-0.39775	[-2.67167]						
$\Delta Bond_{t-4}$	-0.01445	[-0.34618]	-8.2952	[-1.42487]	-0.13446	[-0.82281]	-0.02287	[-1.06561]	17.78188	[1.24767]	-0.281	[-1.98887]						
	0.528281		0.496777		0.461545		0.137992		0.228681		0.268781		0.097531		0.560772		0.090684	
R^2		p val		p val		p val		p val		p val		p val		p val		p val		p val
GC test for R_t				0.005												9.00E-11		
GC test for CDS_t		0.0136										0.0059						
GC test for $Bond_t$										0.0055						7.00E-15		
Optimal Legs	4						4						2					

Italy	Pre-Debt Crisis						During Debt Crisis						After Debt Crisis					
	Rt		CDSt		Bondt		Rt		CDSt		Bondt		Rt		CDSt		Bondt	
	Coeff	t-stats	Coeff	t-stats	Coeff	t-stats	Coeff	t-stats	Coeff	t-stats	Coeff	t-stats	Coeff	t-stats	Coeff	t-stats	Coeff	t-stats
R_{t-1}	-0.26665	[-1.53252]	-5.38782	[-0.20196]	0.489127	[0.72207]	-0.26555	[-1.44348]	257.2746	**[2.12473]**	3.804708	**[3.44262]**	0.003329	[0.02833]	-408.555	**[-5.91560]**	-0.91909	[-0.92383]
R_{t-2}	0.41398	[2.40682]	-175.246	**[-6.64497]**	0.352897	[0.52699]	-0.05618	[-0.28126]	1.627543	[0.01238]	4.109978	**[3.42481]**						
R_{t-3}							0.047793	[0.19934]	-438.487	**[-2.77867]**	-0.39537	[-0.27450]						
R_{t-4}																		
ΔCDS_{t-1}	-0.0008	[-0.97378]	0.236986	[1.88075]	0.006555	**[2.04883]**	-2.31E-04	[-0.89145]	0.045325	[0.26561]	0.003015	[1.93611]	-3.7E-05	[-0.30152]	-0.10891	[-1.49792]	-0.00017	[-0.16534]
ΔCDS_{t-2}	0.001675	[1.96218]	-0.40719	[-3.11094]	-0.00127	[-0.38242]	-0.00022	[-0.90313]	-0.15636	[-0.96214]	0.005139	**[3.46436]**						
ΔCDS_{t-3}							-0.00016	[-0.52724]	-0.15363	[-0.76199]	0.005853	**[3.18077]**						
ΔCDS_{t-4}																		
$\Delta Bond_{t-1}$	0.046647	[1.43951]	-11.086	**[-2.23124]**	-0.14957	[-1.18556]	0.026851	[1.07647]	-13.4988	[-0.82220]	-0.23261	[-1.55231]	-0.00998	[-0.72808]	24.26785	**[3.01115]**	-0.09868	[-0.85001]
$\Delta Bond_{t-2}$	0.006062	[0.19351]	8.660568	[1.80296]	-0.55661	[-4.56343]	-0.01425	[-0.56954]	58.0582	**[3.52642]**	-0.14314	[-0.95258]						
$\Delta Bond_{t-3}$							-0.03124	[-1.23182]	-20.9333	[-1.25426]	-0.1282	[-0.84161]						
$\Delta Bond_{t-4}$																		
	0.264913		0.583593		0.447439		0.24033		0.549096		0.546355		0.00895		0.468389		0.010897	
R^2		p val		p val		p val		p val		p val		p val		p val		p val		p val
GC test for R_t				4.E-0.7												3.00E-13		
GC test for CDS_t		0.0373										0.0192						
GC test for $Bond_t$										0.0037						2.00E-08		
Optimal Legs	2						2						1					

France	Pre-Debt Crisis						During Debt Crisis						After Debt Crisis					
	Rt		CDSt		Bondt		Rt		CDSt		Bondt		Rt		CDSt		Bondt	
	Coeff	t-stats	Coeff	t-stats	Coeff	t-stats	Coeff	t-stats	Coeff	t-stats	Coeff	t-stats	Coeff	t-stats	Coeff	t-stats	Coeff	t-stats
R_{t-1}	-0.35302	[-2.19370]	-14.1399	[-1.48773]	-0.1135	[-0.19678]	-0.52927	[-2.42580]	87.00705	[1.17017]	0.634937	[0.60445]	-0.01284	[-0.13230]	-163.266	**[-5.18960]**	-1.27717	**[-2.08809]**
R_{t-2}	0.055732	[0.31601]	-37.4573	**[-3.59603]**	0.357958	[0.56627]	-0.10743	[-0.52217]	24.04167	[0.34288]	0.606031	[0.61180]	0.136798	[1.17572]	-29.1898	[-0.77412]	0.242236	[0.33043]
R_{t-3}	-0.39886	[-1.94958]	33.86919	**[2.80301]**	-0.94866	[-1.29371]	-0.48049	[-1.96368]	2.173614	[0.02607]	0.12086	[0.10259]						
R_{t-4}							-0.63543	[-2.78522]	162.7455	**[2.09322]**	0.532392	[0.48469]						
ΔCDS_{t-1}	-0.00588	[-2.19661]	0.198167	[1.25260]	0.002065	[0.21505]	-1.14E-03	[-1.87313]	-0.32054	[-1.54421]	-0.00011	[-0.03662]	-1.2E-05	[-0.03857]	-0.15044	[-1.45772]	0.003848	[1.91783]
ΔCDS_{t-2}	0.000265	[0.11931]	-0.08354	[-0.63678]	-0.00391	[-0.49042]	-0.00064	[-0.94474]	0.012368	[0.05379]	-0.00158	**[-0.48513]**	4.45E-04	[1.66059]	0.050601	[0.58297]	0.002155	[1.27711]
ΔCDS_{t-3}	-0.00013	[-0.05638]	0.109186	[0.82953]	0.003902	[0.48852]	-0.0018	**[-2.48799]**	0.28321	[1.14883]	-0.00055	[-0.15761]						
ΔCDS_{t-4}							-0.00167	**[-2.39987]**	0.698115	[2.94837]	-0.0031	[-0.92685]						
$\Delta Bond_{t-1}$	0.03656	[0.81336]	-6.17237	**[-2.32499]**	0.002482	[0.01541]	0.075258	**[2.01287]**	-2.71694	[-0.21323]	-0.09141	[-0.50783]	0.017878	[1.20510]	5.61766	[1.16844]	-0.08656	[-0.92606]
$\Delta Bond_{t-2}$	-0.03773	[-1.04294]	7.147415	**[3.34518]**	-0.69278	[-5.34280]	0.047033	[1.05175]	-6.58624	[-0.43218]	-0.56343	[-2.61694]	-0.03064	**[-2.17019]**	3.24413	[0.70902]	-0.42895	[-4.82199]
$\Delta Bond_{t-3}$	0.001494	[0.03008]	-3.64727	[-1.24340]	0.031446	[0.17665]	0.090704	**[2.51282]**	-27.2732	**[-2.21711]**	-0.20925	[-1.20403]						
$\Delta Bond_{t-4}$							0.072441	[1.42853]	5.91064	[0.34202]	-0.22018	[-0.90182]						
	0.296618		0.542749		0.486394		0.368613		0.482362		0.299965		0.118156		0.263952		0.262632	
R^2		p val		p val		p val		p val		p val		p val		p val		p val		p val
GC test for R_t				0.0007								0.0014				6.00E-06		
GC test for CDS_t																		
GC test for $Bond_t$		0.0006						0.0005						0.0227				
Optimal Legs	3						4						2					

Ireland	Pre-Debt Crisis						During Debt Crisis						After Debt Crisis					
	Rt		CDSt		Bondt		Rt		CDSt		Bondt		Rt		CDSt		Bondt	
	Coeff	t-stats	Coeff	t-stats	Coeff	t-stats	Coeff	t-stats	Coeff	t-stats	Coeff	t-stats	Coeff	t-stats	Coeff	t-stats	Coeff	t-stats
R_{t-1}	-0.07301	[-0.49860]	160.006	[1.84244]	-0.71103	[-1.04457]	-0.15316	[-1.43325]	-87.3784	[-0.46727]	0.892568	[0.67196]	-0.20031	[-1.62971]	229.4755	[1.90900]	1.32197	[0.70392]
R_{t-2}							0.130446	[1.20372]	46.40474	[0.24470]	-0.06127	[-0.04549]	0.042433	[0.34369]	226.4402	[1.87529]	-3.54007	[-1.87653]
R_{t-3}							-0.02661	[-0.24448]	-51.1449	[-0.26853]	1.421138	[1.05044]	-0.13894	[-1.09570]	278.7531	**[2.24764]**	3.773998	[1.94777]
R_{t-4}							-0.22466	[-2.13879]	-197.166	[-1.07264]	1.461515	[1.11935]	-0.18694	[-1.42646]	152.8916	[1.19289]	1.868586	[0.93317]
ΔCDS_{t-1}	-0.00059	**[-2.18972]**	0.186964	[1.16492]	0.003741	**[2.97380]**	-1.11E-04	[-1.61177]	-0.07021	[-0.58167]	-1.5E-06	[-0.00170]	0.000108	[1.05718]	-0.01139	[-0.11366]	-0.00169	[-1.07647]
ΔCDS_{t-2}							0.000027	[0.38843]	-0.17346	[-1.42635]	0.000698	[0.80790]	-2.97E-05	[-0.29002]	-0.08564	[-0.85577]	0.000112	[0.07189]
ΔCDS_{t-3}							-2.8E-06	[-0.04022]	0.094339	[0.77593]	-0.00012	[-0.13970]	0.000249	**[2.47818]**	-0.13862	[-1.41319]	0.000242	[0.15769]
ΔCDS_{t-4}							2.94E-05	[0.42144]	0.045879	[0.37576]	0.00352	**[4.05915]**	-4.8E-05	[-0.47249]	-0.16235	[-1.64016]	0.000968	[0.62627]
$\Delta Bond_{t-1}$	0.018089	[0.61643]	-10.2312	[-0.58789]	-0.18072	[-1.32487]	0.003909	[0.57759]	-8.03368	[-0.67839]	0.014632	[0.17394]	0.000536	[0.06595]	61.81884	**[7.77639]**	0.327523	[2.63711]
$\Delta Bond_{t-2}$							-0.00245	[-0.36312]	-0.70655	[-0.05986]	-0.01071	[-0.12772]	-0.0157	[-1.57032]	5.008679	[0.51238]	-0.01422	[-0.09310]
$\Delta Bond_{t-3}$							-0.00588	[-0.87323]	3.206166	[0.27214]	-0.0135	[-0.16129]	-0.01181	[-1.15036]	18.09425	[1.80148]	0.137707	[0.87756]
$\Delta Bond_{t-4}$							0.007109	[1.05540]	5.61638	[0.47645]	-0.19137	[-2.28545]	-0.01979	**[-2.01046]**	-6.41827	[-0.66658]	0.041949	[0.27886]
	0.096355		0.079586		0.23503		0.15293		0.063407		0.299126		0.219566		0.579489		0.23003	
R^2		p val		p val		p val		p val		p val		p val		p val		p val		p val
GC test for R_t						0.0388										3.63E-02		0.0149
GC test for CDS_t		0.0397				0.0008						0.0064						
GC test for $Bond_t$																3.00E-11		
Optimal Legs	1						4						5					

UK	Pre-Debt Crisis						During Debt Crisis						After Debt Crisis					
	Rt		CDSt		Bondt		Rt		CDSt		Bondt		Rt		CDSt		Bondt	
	Coeff	t-stats	Coeff	t-stats	Coeff	t-stats	Coeff	t-stats	Coeff	t-stats	Coeff	t-stats	Coeff	t-stats	Coeff	t-stats	Coeff	t-stats
R_{t-1}							-0.01471	[-0.08860]	2.930096	[0.08922]	0.699919	[0.83162]	-0.11588	[-1.10635]	-27.1685	[-1.55607]	-0.894	[-1.24334]
R_{t-2}							-0.06736	[-0.41752]	-15.5495	[-0.48714]	0.78164	[0.95555]	0.130476	[1.20399]	-16.3178	[-0.90333]	-0.89816	[-1.20734]
ΔCDS_{t-1}							0.001298	[1.53311]	-0.36137	[-2.15661]	0.005892	[1.37202]	-0.00011	[-0.17332]	0.073153	[0.71507]	-0.0052	[-1.23499]
ΔCDS_{t-2}							0.000928	[1.06904]	-0.09687	[-0.56392]	0.004882	[1.10886]	0.000412	[0.68995]	0.145687	[1.46250]	0.003578	[0.87214]
$\Delta Bond_{t-1}$							3.79E-02	[1.27157]	-6.89319	[-1.17014]	-0.20473	[-1.35614]	0.004808	[0.33917]	-1.04562	[-0.44250]	-0.10922	[-1.12231]
$\Delta Bond_{t-2}$							0.024398	[0.80480]	6.14361	[1.02431]	-0.3077	[-2.00190]	1.76E-03	[0.12475]	-0.6538	[-0.27887]	-0.33362	[-3.45545]
							0.099163		0.182537		0.203615		0.038099		0.071587		0.160609	
R^2		p val		p val		p val		p val		p val		p val		p val		p val		p val
GC test for R_t												0.0455						
GC test for CDS_t																		
GC test for $Bond_t$										0.0164								
Optimal Legs							2						2 (No GC)					

Greece	Pre-Debt Crisis						During Debt Crisis						After Debt Crisis					
	Rt		CDSt		Bondt		Rt		CDSt		Bondt		Rt		CDSt		Bondt	
	Coeff	t-stats	Coeff	t-stats	Coeff	t-stats	Coeff	t-stats	Coeff	t-stats	Coeff	t-stats	Coeff	t-stats	Coeff	t-stats	Coeff	t-stats
R_{t-1}							-0.23579	[-1.51793]	262.3951	[0.89502]	17.45416	**[4.93016]**	0.306907	[1.85730]	-4613.98	[-1.40341]	4.142594	[0.19094]
R_{t-2}							0.024691	[0.14374]	-566.373	[-1.74707]	3.746775	[0.95708]	-0.04337	[-0.26771]	4265.785	[1.32347]	3.014487	[0.14173]
R_{t-3}													0.097343	[0.81400]	-215.917	[-0.09075]	1.036404	[0.06601]
ΔCDS_{t-1}							-0.00019	**[-2.41230]**	0.153984	[1.04902]	0.008806	**[4.96767]**	-9.8E-06	[-1.12585]	0.367579	[2.12521]	0.000495	[0.43356]
ΔCDS_{t-2}							-9.75E-05	[-1.06608]	-0.39753	[-2.30375]	0.010732	**[5.15019]**	1.93E-06	[0.21341]	0.012428	[0.06921]	0.002837	**[2.39451]**
ΔCDS_{t-3}													4.43E-06	[0.59714]	-0.09712	[-0.65744]	-0.00893	**[-9.16272]**
$\Delta Bond_{t-1}$							-0.00171	[-0.31324]	15.59762	[1.51620]	-0.30482	[-2.45374]	-0.00484	**[-6.89176]**	9.92344	[0.70965]	-0.04335	[-0.46980]
$\Delta Bond_{t-2}$							-0.00336	[-0.74302]	5.798688	[0.67867]	-0.00489	[-0.04743]	[-6.89176]	[-0.26005]	[0.70965]	[-0.77921]	[-0.46980]	[0.24527]
$\Delta Bond_{t-3}$													0.002388	**[2.32278]**	13.55396	[0.66253]	0.057278	[0.42427]
							0.172892		0.170741		0.628183		0.69762		0.235664		0.735189	
R^2		p val		p val		p val		p val		p val		p val		p val		p val		p val
GC test for Rt																		
GC test for CDSt								0.0271				0.00003						4E-10
GC test for Bondt																8E-08		
Optimal Legs							2						3					

Austria	Pre-Debt Crisis						During Debt Crisis						After Debt Crisis					
	Rt		CDSt		Bondt		Rt		CDSt		Bondt		Rt		CDSt		Bondt	
	Coeff	t-stats	Coeff	t-stats	Coeff	t-stats	Coeff	t-stats	Coeff	t-stats	Coeff	t-stats	Coeff	t-stats	Coeff	t-stats	Coeff	t-stats
R_{t-1}							-0.67809	[-3.76758]	118.0289	**[2.09238]**	1.100354	[1.06198]	0.018441	[0.18429]	-109.485	**[-4.91829]**	-0.75866	[-1.43950]
R_{t-2}							-0.3022	[-1.62044]	49.38719	[0.84495]	1.519256	[1.41507]	-0.01531	[-0.13613]	-5.35213	[-0.21387]	-0.1468	[-0.24777]
R_{t-3}							-0.38769	[-2.18499]	135.725	**[2.44061]**	-0.71537	[-0.70032]						
ΔCDS_{t-1}							-0.00269	**[-4.51283]**	0.201992	[1.08281]	4.22E-03	[1.23127]	-0.00052	[-1.11685]	-0.10219	[-0.98432]	0.000768	[0.31254]
ΔCDS_{t-2}							-0.00118	[-1.81071]	-0.08526	[-0.41693]	0.006091	[1.62155]	0.000481	[1.36985]	-0.08032	[-1.02766]	-0.00017	[-0.08946]
ΔCDS_{t-3}							-0.00265	**[-3.97895]**	0.636768	[3.04585]	-0.00086	[-0.22420]						
$\Delta Bond_{t-1}$							0.037459	[1.38675]	-14.0162	[-1.65555]	-0.11357	[-0.73029]	0.013582	[0.74266]	3.658673	[0.89928]	-0.07841	[-0.81404]
$\Delta Bond_{t-2}$							-0.00372	[-0.14680]	0.621559	[0.07833]	-0.18629	[-1.27809]	-0.02315	[-1.29491]	2.890758	[0.72694]	-0.35527	[-3.77360]
$\Delta Bond_{t-3}$							0.02246	[0.88243]	-5.69093	[-0.71340]	-0.31605	[-2.15690]						
							0.449262		0.347344		0.262906		0.06511		0.218497		0.155282	
R^2		p val		p val		p val		p val		p val		p val		p val		p val		p val
GC test for R_t										0.0341						0.00002		
GC test for CDS_t								0.00009										
GC test for $Bond_t$																		
Optimal Legs							3						2					

Denmark	Pre-Debt Crisis						During Debt Crisis						After Debt Crisis					
	Rt		CDSt		Bondt		Rt		CDSt		Bondt		Rt		CDSt		Bondt	
	Coeff	t-stats	Coeff	t-stats	Coeff	t-stats	Coeff	t-stats	Coeff	t-stats	Coeff	t-stats	Coeff	t-stats	Coeff	t-stats	Coeff	t-stats
R_{t-1}	-0.15864	[-1.00497]	75.65438	**[2.27109]**	-2.53995	[-1.57525]	-0.41973	[-2.95919]	31.95087	**[2.05858]**	0.715123	[0.53682]	-0.11831	[-1.15745]	-36.8682	[-1.79081]	0.319546	[0.47186]
R_{t-2}	-0.06527	[-0.38402]	23.03785	[0.64233]	-0.79929	[-0.46041]							0.129291	[1.24457]	-7.72485	[-0.36920]	-0.0214	[-0.03109]
ΔCDS_{t-1}	-0.00131	[-1.68365]	0.345956	[2.10607]	0.000644	[0.08097]	-8.55E-05	[-0.06132]	0.080057	[0.52449]	0.001521	[0.11609]	-0.00069	[-1.36304]	-0.00954	[-0.09371]	-0.00559	[-1.66984]
ΔCDS_{t-2}	-0.00168	**[-2.40910]**	0.020152	[0.13686]	0.000499	[0.07005]							-0.00014	[-0.29236]	0.151986	[1.56894]	0.00399	[1.25216]
$\Delta Bond_{t-1}$	0.002802	[0.18670]	-1.1243	[-0.35501]	0.103321	[0.67401]	-0.00261	[-0.16687]	0.652362	[0.38097]	-0.11536	[-0.78491]	0.012931	[0.92948]	-6.8536	**[-2.44595]**	-0.05785	[-0.62762]
$\Delta Bond_{t-2}$	-0.00691	[-0.48011]	-0.83468	[-0.27502]	-0.19549	[-1.33074]							0.00814	[0.56548]	-0.41549	[-0.14330]	-0.43365	[-4.54689]
	0.204694		0.174666		0.129186		0.179515		0.086122		0.021624		0.07716		0.126961		0.19446	
R^2		p val		p val		p val		p val		p val		p val		p val		p val		p val
GC test for R_t										0.0462								
GC test for CDS_t		0.0081																
GC test for $Bond_t$																0.0462		
Optimal Legs	2						1						2					

Germany	Pre-Debt Crisis						During Debt Crisis						After Debt Crisis					
	Rt		CDSt		Bondt		Rt		CDSt		Bondt		Rt		CDSt		Bondt	
	Coeff	t-stats	Coeff	t-stats	Coeff	t-stats	Coeff	t-stats	Coeff	t-stats	Coeff	t-stats	Coeff	t-stats	Coeff	t-stats	Coeff	t-stats
R_{t-1}	-0.25585	[-1.40693]	2.533455	[0.25641]	0.391323	[0.67629]	-0.2038	[-1.18222]	-47.0489	[-1.32861]	0.488972	[0.61310]	-0.02233	[-0.22606]	-45.3222	**[-3.29194]**	-0.20442	[-0.36534]
R_{t-2}	0.362762	[2.02465]	-23.1799	**[-2.38110]**	0.497185	[0.87208]	0.153891	[0.88671]	-42.2666	[-1.18553]	2.542432	**[3.16642]**	0.056445	[0.54210]	-25.8412	[-1.78034]	-0.03009	[-0.05101]
ΔCDS_{t-1}	-0.00025	[-0.07458]	0.108217	[0.60398]	0.018195	[1.73404]	-0.00027	[-0.34869]	-0.33566	[-2.11944]	0.004307	[1.20738]	-0.00207	**[-2.85147]**	0.001883	[0.01857]	-0.00161	[-0.39062]
ΔCDS_{t-2}	0.004451	[1.33389]	-0.05634	[-0.31070]	-0.01184	[-1.11478]	-0.00072	[-0.95425]	-0.03476	[-0.22477]	0.000307	[0.08810]	0.001365	**[2.00457]**	-0.02179	[-0.22962]	0.008866	**[2.29853]**
$\Delta Bond_{t-1}$	0.039867	[1.11003]	-2.50125	[-1.28178]	0.007424	[0.06496]	-0.01326	[-0.43333]	10.48582	[1.66789]	-0.0564	[-0.39835]	0.017457	[1.05536]	-2.01208	[-0.87259]	-0.11702	[-1.24873]
$\Delta Bond_{t-2}$	-0.00479	[-0.13390]	1.558756	[0.80149]	-0.64878	[-5.69623]	-0.06267	[-1.97942]	12.01216	[1.84704]	-0.67532	[-4.61068]	-0.02869	[-1.75875]	-0.99514	[-0.43759]	-0.41309	[-4.46950]
	0.20158		0.184838		0.498679		0.151286		0.188508		0.354879		0.172293		0.152875		0.241086	
R^2		p val		p val		p val		p val		p val		p val		p val		p val		p val
GC test for R_t				0.0433								0.01				0.0008		
GC test for CDS_t														0.0026				
GC test for $Bond_t$																		
Optimal Legs	2						2						2					

Appendix F

Table 6: The Pairwise Correlation Coefficient between Stock and CDS by Sectors

	Pre-Debt Crisis	During Debt Crisis	After Debt Crisis
Consumer	-0.112	-0.2072	-0.2088
Energy	-0.2298	-0.3066	-0.2734
Financial	-0.3979	-0.6388	-0.3237

Appendix G

Figure 1 Weekly Time Series from Greece Sovereign CDS Spread vs. ASE Price

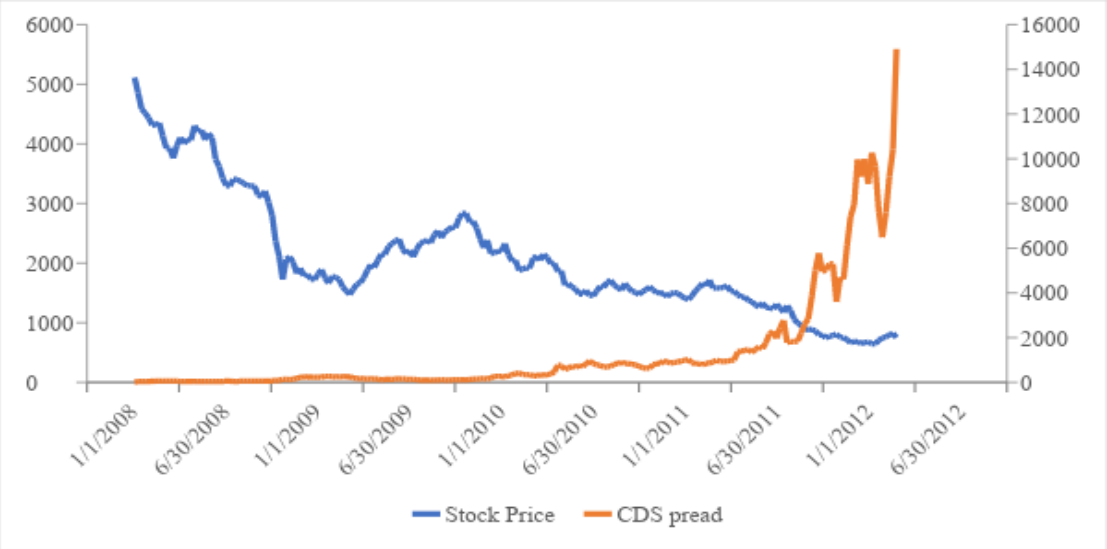

Figure 2 Weekly Time Series from Germany Sovereign CDS Spread vs. DAX Price