2010

The Value of the Sovereign Credit Default Market: Domestic Stock Market Interaction and Contagion Effects during Credit Crisis

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SUBMITTED TO

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FOR

SENIOR THESIS

FALL 2010

NOVEMBER 29, 2010

Acknowledgements

First, I would like to thank Professor Yu, preliminary discussions with him helped to spark my interest of the CDS market and the initial topic idea. His availability to answer my questions and help me circumvent road blocks that I came across during this process was invaluable. Secondly, I would like to thank the CMC community. This school, the professors, and the students have greatly prepared me for the world that waits upon graduation, and I am forever grateful to have called it home for four years of my life. Thirdly, I believe it is important to recognize Ms. Terri Van Eaton for her reassuring words and emotional support during this process. Finally I would like to thank my family and friends who have fueled my desire to succeed and whose support was pinnacle to the success of the paper.

Abstract

Credit Default Swaps have become a large part of financial markets and recently the center of debate between academics and regulators alike. Transferring the techniques to measure information flow between the CDS market and stock markets presented by Acharya and Johnson (2007), this paper looks at the relationship between a countries sovereign CDS spread level and its predominate stock exchange. Under the back drop of the Greek Credit Crisis in Spring of 2010 I measure contagion effects in the Euro Zone comparing the level of Granger causality significance between the stock and CDS market. I find that the greatest information flow from the CDS market to the stock market is during credit shocks or times of high credit distress. My results also point to the significance of the contagion effect in the CDS market but not in the stock market.

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1. Introduction

The credit derivative market has been vastly and rapidly evolving over the past decade. Credit Default Swaps, otherwise known as CDS, are the most common credit derivative traded and are powerful tools for investors looking to hedge out the credit risk in their portfolio. These Credit Default Swaps can be purchased on the debt of nations as well as companies. The underlying asset may be different, however the functionality of a CDS security is similar. An investor holding some level of a country's or company's debt can purchase a CDS in order to protect themselves from the chance that the underlining asset defaults. The purchase price is based off a spread above the asset and is usually paid once a year. In the chance of default the seller of the CDS must pay the entire principal of the bond, or an agreed upon compensation, to the buyer. In essence a Credit Default Swap acts as insurance on a debt instrument.

Since the financial crisis of 2008, the CDS market has been a focus point of debate between regulators and financial institutions. Often the CDS market is pointed to as the culprit that vastly exacerbated the financial crisis in 2008 as well as the most recent Greek Credit Crisis in April of 2010. Contrary to this belief there are some that say the CDS market has been unjustly vilified, rather we should look to the CDS market as the preliminary alert system pertaining to the financial health of a nation. This paper sets out to validate this statement.

To explore this argument I begin by analyzing the lead leg relationship between the sovereign CDS market and the respective stock exchanges. Using a similar model as Acharya and Johnson (2007) who looked at insider trading in the institutional CDS market, I initial create a CDS innovation variable to better isolate distinct spread movements in the CDS market. From there I analyze whether or not the lagged returns of this variable effect the current stock returns. The intuition being, that the information pertaining to the fiscal health of a nation will first be

priced in the CDS market and then will transfer into the nation's stock market in the following five days. This information flow will be most present when the CDS market is in a state of flux.

The hypothesis being that unconditionally the information flow between the CDS market and the Stock market is small and insignificant; however once the analysis is conditioned on credit shock or distress there will be significant and larger information flow from the CDS market to the stock market.

I define credit distress under the following two conditions. Condition A focuses on credit shocks that occur within one day of trading. I define a credit shock as an increase in a nations CDS spread by thirty-five bps or greater. Condition B takes into account credit distress over an average period of time. Looking at the different time blocks that lead up to and follow a crisis if a country has an average CDS spread of 150 bps or greater for ninety days then it is labeled as being in credit distress during that period.

In general my results confirmed my earlier hypothesis seeing the greatest amount of information flow from the CDS to the stock markets happening during times of credit shock or distress. These results are similar to the ones found by Acharya and Johnson (2007).

The time period used for collecting the data ranged from October 15th 2009 to October 14th 2010. The year encapsulated one of the most volatile times seen in the CDS market since its creation. As found in this paper, times of credit crisis seem to return the greatest amount of information flow between the markets. This paper expands off Acharya and Johnson (2007) to measure the levels of contagion effect present in the European Union during the Greek Credit Crisis of Spring 2010.

With austerity measures becoming the hot topic in Europe throughout 2010 I analyzed a sample of sixteen Euro Zone nations to better understand the market interdependence of the EU. Again I compared the CDS market to the stock market, this time in order to measure the level of contagion indication present in their returns. Using a vector auto regression and Granger causality wald tests I compared the levels between the two.

Due to the co-integration of sovereign economies inherent in a union of nations the contagion effect will most likely exist in a positively correlated direction in the CDS market but will not be as present or significant in the much more efficient stock markets.

To evaluate this hypothesis I looked at the interaction on a country by country basis, summing the coefficients in order to draw my final conclusion. From there I broke the countries into four groups ranging from greatest CDS average spread level to lowest. Here once again I confirmed that contagion effect in the stock market between Euro Zone nations to be insignificant.

In order to see at what time period during a crisis the contagion effect is most present I broke the year down into quarters, normal level, pre crisis level, crisis level, and post crisis level all equal to ninety days. The hypothesis being that the Euro Zone CDS market will be most vulnerable to the contagion effect during period three, “crisis level”. I ran the same regression as used above conditional to the periods. My results differ from my hypothesis with a significant positive correlation during period two “pre crisis level”, the ninety days leading up to a major sovereign credit event.

This paper is organized as follows. Section 2 will present a review of the relevant literature pertaining to CDS market integration and examples of contagion effects. Section 3 will

detail the data collection techniques used as well as defining the intricacies of such information. Section 4 reports and analyzes the regression results. The final Section 5 will conclude with a more general understanding of the findings.

2. Review of Relevant Literature

The recent development of the credit derivative market has greatly altered the way sophisticated investors manage credit risk. Since credit derivatives are not traded along with the underlining asset, their transaction costs as well as overall liquidity issues are significantly reduced when compared to other forms of credit protection. The CDS market has evolved to include a general index that allows investors to manage their market wide credit risk. In 2004 the Dow Jones iTrazz index was formed out of the combination of the iBoxx and Trac-x indicies. This has set a new precedent for liquidity and transparency in the CDS market, Bystrom (2005). With the development of the CDS market over the past decade, academics and investors alike have worked to analyze CDS fluctuations as it relates to other global markets.

The most recent recession has placed the CDS market at the center of negative attention stemming mainly from the debate over the Financial Reform Bill passed in July 2010. In a Reuters article released in April of 2010, Anthony Sanders a finance professor at George Mason University stated, "Credit Default saps are the current "villain du jour" in the Greek debt fiasco," continuing, "In, fact CDSs on Greek sovereign debt actually served a positive role: it alerted everyone around the globe that Greece was in a credit death spiral." Sanders disagrees with the movement by the United States to limit Credit Default Swaps, rather this "alarm" he speaks of raises the question as to whether or not one can look at sovereign CDS as a way to predict the future fiscal health of a country and the vitality of its major stock indices. A new school of investing strategy, Capital Structure Arbitrage, looks to do just that. The

intuition behind this form of arbitrage is to analyze discrepancies between the stock, CDS, and bond markets.

Literature pertaining to the lead lag relationship between equity and bond markets is extensive, however research of the CDS market as it relates to the others is much less developed. Alexander et al. (2000) investigate the relationship between high yield non convertible bonds and the common stock of the issuing firms from 1994 -1997. They find that a firm's high yield bond excess returns have a positive correlation with the excess returns of its stocks, Gordon J. Alexander (2000). Longstaff et al. (2005) became one of the first papers to analyze lead-lag relationship between the stock, bond and CDS markets. In a study of 67 single name CDS for March 2001- October 2002, they find strong evidence to conclude that the CDS market information flow precedes the bond market; however there was no significant evidence to conclude a directional flow in-between the stock and CDS markets, Longstaff, F. 2005. In an analysis of 58 firms over the years 2000-2002, Norden and Weber analyze the movement of the three markets on a monthly, weekly and daily basis. They find that stock returns lead CDS spreads as well as bonds spreads. The CDS market sensitivity to stock market fluctuations is correlated to the firm's credit quality as well as rating. Using a Granger causality test, the paper finds that CDS spread changes cause bond spread changes significantly more often than the opposite relation, Norden, L. (2009). In a paper titled Credit Default Swaps and Equity Prices: The iTraxx CDS Index Market, Bystrom (2005), utilizes the development of the Dow Jones iTraxx index, discussed earlier, to analyze the relationship between CDS and the stock market. The index is comprised of 125 firms that all have currently trading equity stocks. The paper reveals a close correlation between negative stock returns and positive CDS spread increases similar to the previous paper. In addition, the paper concludes that in relation to firm specific information the stock market is more relevant then the CDS market.

In order to better grasp the relationship between the two markets it is important to analyze the credit quality of the sovereign nations in questions as well as global market trends. In an article looking into Insider trading in the CDS market, Acharya and Johnson (2007) focus on 79 North American

corporations from the years 2001-2004. Their intuition behind why the CDS market provides a prime opportunity for insider trading is three fold: lower chance of detection, the CDS was created to provide an ideal hedge on debt exposure, and buying of this protection is easier than shorting the matching bond. They hypothesized that insider trader implies a greater flow of information from the CDS market to the stock market in times when credit distress is greatest as well as when there is a large number of informed investors, Acharya and Johnson (2007). They find that information flow between the CDS market to the stock market is greatest on days with negative credit related news and for those firms that already have high CDS spreads. In their conclusion they did not find any evidence to conclude that insider trading has any negative impact on the CDS market as a whole. This paper reveals key elements of the CDS stock market relationship that will be employed going forward in this paper.

In a related study to Acharya and Johnson, Fung et Al. (2008) using their own index composed of 125 investment grade entities in North America studied the information flow between the CDS indices and the S&P 500. In an attempt to see whether or not credit quality affected this relationship, the paper analyzes the difference between investment grade and high yield CDS spreads and their relation to the S&P. Their findings confirm that the lead lag relationship is related to the credit quality of the firm and is only relevant during market down turns. In a surprising revelation the paper finds a strong feedback effect from the high yield CDS market which could signal that the stock market does not account entirely for all default risk of a firm. The paper concludes that the CDS market is the primary market for credit risk price discovery.

The first hypothesis that this paper will address is the lead lag relationship of sovereign CDS markets and global stock markets. To the best of my knowledge there has not been any literature on the topic of sovereign CDS spreads leading global stock markets.

H:1 - The deterioration of a countries credit quality during times of market crisis, ie. an increase in CDS spreads during the Greek credit crisis, precedes a decrease in the domestic stock market.

By specifically analyzing the Greek credit crisis of 2010 this paper will look to measure the contagion effects in other sovereign CDS markets that are closely linked to Greece. In a study that looks at credit contagion as it relates to Chapter 11 and Chapter 7 firm events Zhang (2005) attempts to provide empirical significance to credit contagion. In order to do this, the paper looks at the effects of credit events of a firm and to its most direct competitor. The argument being that Chapter 7 and 11 events affect firms differently. Similar to Acharya and Johnson (2007), the paper also looks at the characteristics of the specific firms. They find that credit quality, as well as the size of the firm, greatly impact the level of contagion exhibited by the firm. The study finds that contagion effects are much greater in the CDS market in comparison to the stock market.

My second hypothesis pertains to contagion effects in the sovereign CDS market as it relates to the domestic stock exchange of the respective countries.

H:2 – Particular to the Greek Credit Crisis of 2010, sovereign credit contagion effects are more apparent in the CDS market then in the complimentary stock markets.

3. Data

The Credit Default market utilizes CDS spreads to quote prices and initiate trades. The spread is equal to a fraction of the theoretical value of the underlying asset and is paid by the buyer in order to secure protection in the event of a default. In such an event the seller of the CDS must pay the buyer the difference between the face value and the actual market value of the underlining asset. Using the CDS spread one can judge to a certain extent the market perception

of the default probability on a specific asset. In this paper the underlining asset is sovereign debt, thus the sovereign CDS market gages the default probability of a nation.

The dataset used in this paper consists of CDS spreads and Stock returns from Bloomberg. The data contains the CDS spreads of a grouping of Euro Zone nations as well as their most valued respective stock market index returns. In order to compare both the Credit Default Market as well as the stock market returns, I used Euro Zone countries where a national stock exchange could be clearly identified as well as nations with an active credit default market. The sixteen countries used are as follows: Greece, Portugal, Spain, Ireland, Belgium, Germany, France, Denmark, Finland, Hungary, Netherlands, Norway, Poland, Russia, Sweden, and the United Kingdom. The Euro Zone nations selected allowed primarily for a diverse geographical and economical return structure that spanned the EU.

In order to encapsulate the Greek Sovereign debt crisis earlier this year the dates used ranged from October 15th 2009 to October14th 2010. This allowed for four periods: October 15th 2009 – January 14th 2010 level volatility, January 15th 2010 – April 14th 2010 pre crisis level, April 15th 2010 – July 14th crisis level, and July 15th 2010 – October 14th 2010 post crisis level. I used this quartile break down to highlight my regression analysis returns for different periods during the crisis.

Credit Default Swaps are most widely traded in five year contracts. In order to minimize issues with liquidity I used the US dollar denominated five year CDS contracts for the respective sixteen nations. Tradable CDS contracts can range between six months to thirty years in maturity, however the five year level is the benchmark in the industry (Hull, et al. 2004). The notional amount of these contracts is 10 million US dollars.

CDS prices are quoted as spreads. These spreads refer to the premium that must be paid annually as a percentage of the notional value of the underlining debt, more specifically in our case, the sovereign debt obligation in order to hold the CDS contract. Similarly to Acharya and Johnson (2007) I define CDS return as the log difference between the spread between time t and t-1.

Using Bloomberg I collected equity index stock prices for the corresponding Euro Zone countries adjusted for dividends paid. From this I generated daily stock returns in order to compare the CDS and equity returns. By analyzing trade volume and market capitalization I chose the following stock exchanges: ASE (Greece), PSI20 (Portugal), IBEX (Spain), ISEQ (Ireland), BEL20 (Belgium), DAX (Germany), CAC (France), KAX (Denmark), HEX25 (Finland), BUX (Hungary), AEX (Netherlands), OSEAX (Norway), WIG20 (Poland), RTSI$ (Russia), OMX30ASK (Sweden), and UKX (The United Kingdom).

4. Methodology

In the following section I will outline my empirical analysis used to measure information flow between the CDS and Stock market as well as the level of contagion effect seen in the Euro Zone markets. In order to effectively measure information flow I first must create a CDS innovation. From there I use this variable to measure the information flow from the CDS market to the stock market. In order to analyze the different levels of contagion between the two types of markets within the Euro Zone I use a Vector Auto Regression to measure such contagion effects.

4.1 Cross-Correlation

As a preliminary test of the interaction between the two markets, I run a basic cross correlation regression. I regress CDS returns on stock market returns at time t, with a lead -5 and lag of 5. The lead lag relationship captures the information flow five days before to five days afterwards. For example stock market fluctuations at time t-5 would return a coefficient equal to the subsequent decrease or increase of returns in the CDS market. From my preliminary research I expect to see information flow from the CDS market to the stock market which would be signaled by negative significant lag coefficients. The interaction intuitively should be negative, as the stock exchange and CDS market are generally negatively correlated.

The results can be seen in the graphs of Figure 1 and differ in some regards from my initial theory however not from previous research. Looking at the significant coefficients there is information flow from the equity to CDS market at t-4 however there is also significant information into the stock market on days t+1 through t+4. What is intriguing is that the markets are positively correlated in lags t+2 to t+4 as well as t-4. At time t-4 for example, increased CDS spread was affected by increase in the countries respective stock index four days prior. This could signal that if investors anticipate an increase in a nation's economy they are more likely to purchase that countries debt, thus buy CDS protection in order to hedge their risk.

In order to further analyze the affects of the level of CDS spreads I selected the countries in the top quartile of average CDS spread level: Greece, Portugal, Ireland, and Hungary. From there I ran the same cross correlation regression. The results as to the positive correlation were similar as above, however there was greater significant information flow from the CDS market to the stock market, ie. a greater lag relationship, when compared with the unconditional regression.

This keeps with the hypothesis that firms under greater credit distress will affect the future returns of their stock market indices more than for those under average credit stress levels.

4.2 CDS Innovation

Since the stock and CDS markets are highly interdependent on one another I can not simply regress the two returns to draw conclusions pertaining to information flow. In order to separate the information solely present in the CDS market I must extract the residual from the changes in the CDS returns on the stock returns at time t. To generate this residual, I regress CDS returns on the contemporaneous stock returns, five lags of stock and CDS returns. With this new residual variable I am able to analyze variations arising in the CDS market place.

The CDS innovation model I used follows the same method of construction as Acharya and Johnson (2007). In order to validate their regression, Acharya and Johnson clarify that "the relation between [CDS] changes and stock returns should be inherently nonlinear." To account for this issue their model utilizes the inverse CDS level and its relation with stock returns lagged and at time t. Under the Merton (1974) model of risky debt Acharya and Johnson highlight the interaction between the inverse CDS level and the elasticity that relates the percent changes in stock price to the percent change in CDS spreads.

The regression is as follows: for each country *i*, I regress CDS returns on a constant, a contemporaneous stock return, five lags of CDS and stock returns, and the product of these stock returns and the inverse CDS level:

Equation #1

$$CDSreturn_{i,t} = \alpha_i + \sum_{k=0}^{5} [\beta_{i,t-k} + \delta_{i,t-k}(CDSlevel)_{i,t}] (Stockreturn)_{i,t-k} + \sum_{k=1}^{5} \varphi_{i,t-k} (CDSreturn)_{i,t-k} + \mu_{i,t}$$

The residual μ_i , that can be extracted from this regression accounts for the independent information flow found in the CDS market which is not priced in the stock market returns or not relevant in estimating index returns. Going forward I refer to μ_i, as the CDS innovation variable or CDS inn.

4.3 Information Flows Originating in the CDS Market to the Stock Market

The following section analyzes the information flow from the sovereign CDS market to the relevant stock markets. From my review of the relevant literature I expect that this information flow to be most significant for countries exhibiting credit distress. Looking specifically at the Greek Credit Crisis I expect the countries with the greatest average CDS spread, Greece, Spain, Portugal, Ireland, and Hungary to have the most CDS directional information flow. In order to statistically test this assumption I followed Acharya and Johnson (2007) by estimating panel data using two conditions to highlight credit distress.

Equation #2

$$Stockreturn_t = \alpha + \sum_{k=1}^{5} [b_k + b_k^C (CreditVar)_t](CDSInnovation)_{t-k} + \sum_{k=1}^{5} [d_k + d_k^C (CreditVar)_t](Stockreturn)_{t-k} + \epsilon_t$$

Condition A takes into consideration the four periods that I mentioned previously in the data section. The four quarters break down the CDS returns into average, pre crisis, crisis, and

then post crisis level. With this I generate a binary variable under the specifications that if a credit shock occurs during the period the variable is set to 1 until the date of the sudden increase in the CDS spread and 0 for the duration of the period. I define a credit shock as an increase in CDS spread by 35 bps or greater. Acharya and Johnson use a 50 bps level, however since sovereign CDS historically trades at a much lower average CDS spread compared to corporate CDS I decreased the credit shock threshold. The intuition behind this is to analyze how stock markets alone respond to such credit shocks.

Condition B takes a more broad approach to highlighting information flows by looking at average CDS spreads throughout each time period. In order to look at countries in the greatest credit distress, I set the dummy variable threshold to greater than 150 bps. Thus if a country has an average CDS spread greater than this level, they receive a one, any country with less than a 150 bps average is assigned a zero for that period. In a time when Greece's CDS spread reached a level greater than 1,000 bps, the 150 level covered the countries that were most closely affected by this increase.

Using the results from the conditional regressions, $\sum_{k=1}^{5} b_k^C$ I compare the result coefficients with the unconditional coefficients, $\sum_{k=1}^{5} b_k$. My intuition is that in the sovereign sphere the conditional information flow will be more negative and significant than the unconditional flow. If this is the case the summation of the conditional coefficients I expect to be large and negative. $\sum_{k=1}^{5} b_k + b_k^C$

The results, which can be found in Figure 2 Table A, confirm the previous assumptions. Unconditionally there is very little information flow from the CDS innovation to the stock returns, however when I implement the conditional dummy variables the results vary drastically.

Under Condition A there is significant negative information flow from the CDS innovation to stock returns. The results show an 8% information transmission flow from the CDS innovation to stock returns for the five days following a large increase in CDS spread. This confirms the hypothesis that during a spike in CDS level the CDS market will affect stock returns in the coming days. Implementation of Condition B returns similar results. There is a large negative information flow from the CDS innovation variable to the stock market, with the transmission flow equal to 12%. Condition B reveals that for countries who experience average CDS levels greater than 150 bps for a given period will have greater and more significant information flow from the CDS market to the stock market. When the regression is unconditional, the coefficients are minimal and insignificant however when adding restrictions based on CDS level the results become significant and substantial highlighting information flow from the CDS innovation to future stock returns for CDS level shocks and high average levels of credit distress.

Considering that the differences between nations is so vast in the way they conduct their business, organize their markets, and structure their government it is very difficult to compare the countries as a single entity. The next step in my analysis will attempt to minimize the country by country differences by regressing stock returns on the lags of both the CDS innovation and stock returns for each of the sixteen countries in my sample. Similar to Acharya and Johnson (2007) I use the replicate the regression from Hou and Moskowitz (2005):

Equation #3

$$(Stockreturn)_{i,t} = \rho_i + \sum_{k=1}^{5} \omega_{i,k} \, (CDSInnovation)_{i,t-k} + \sum_{k=1}^{5} \sigma_{i,k} \, (Stockreturn)_{i,t-k} + \epsilon_t$$

From the summation of the beta coefficients for each county under the specific lag I am able to quantify the amount of information flow that can be termed permanent from the CDS market to the stock market. This method I replicate from my previous regression,

.

Theta represents the level of CDS market information flow and the sustainability of such flow in the respective stock markets. If the average theta is large and negative, one can draw the conclusion that there is a strong and permanent level of information flow from the CDS market to the stock markets. I expect this result for the firms with the highest average CDS spread.

In order to better illustrate the relationship between credit stress and information flow I broke the sixteen firms into four different categories ranging from lowest average CDS spread to greatest. From there I looked at the average theta return. It is expected that under this condition, the mean theta level should be most negative for the countries with the greatest CDS spread levels.

The regression confirms my expectations. As can be seen in Figure 3, there is significant information flow from the CDS innovation to stock returns for the respective countries. With the established separate quarters I calculated the average CDS spread for each group. Again the results reaffirm my hypothesis, in countries that experience significant credit distress there is greater information flow from the CDS market to the stock market. For Q4, the quartile with the highest average CDS spread, the sum of θ is equal to -.190395. The results indicate that as average CDS spreads decrease so does the level of significant information flow.

4.4 Contagion Level Comparison

The level of market interdependence of Euro Zone nations has been argued as one of the greatest risks of the European Union. The Greek Sovereign crisis highlighted the risks of such market linkage. The consequence translated into stock market loses as well as large increases in respective CDS Spreads. The level to which each market was affected has never been measured for this crisis. The following section evaluates the hypothesis that there is a greater contagion effect in the CDS market. My reasoning behind this hypothesis is due to the lack of liquidity in the CDS market it is inherently less efficient than the stock markets. Thus a change in the CDS market for a country may not be immediately be priced into the CDS market of a complimentary country until five days in the future.

In order to test this hypothesis I utilized a Vector Auto Regression. A VAR compares the levels of interaction between two or more variables as they relate to each other. In my example I use Greece as my bench mark nation as it was the source of the credit crisis. From there I compare each of the other fifteen countries CDS markets with Greece's market; as well as run a similar VAR evaluating the interaction between each respective countries stock exchange. Using the following equations I evaluate the interactions by country.

1) $CDSreturn_{gr,t} = \alpha^*_{gr} + \sum_{k=1}^{5} \beta_{gr.k}(CDSreturn)_{gr,t-k} + \sum_{k=1}^{5} C_{i.k}(CDSreturn)_{i,t-k}$

$$CDSreturn_{i,t} = \alpha^*_{gr} + \sum_{k=1}^{5} \tau_{i.k}(CDSreturn)_{i,t-k} + \sum_{k=1}^{5} \mu_{gr.k}(CDSreturn)_{gr,t-k}$$

2) $Stockreturn_{gr,t} = \alpha^q_{gr} + \sum_{k=1}^{5} \beta^q_{gr.k}(Stockreturn)_{gr,t-k} + \sum_{k=1}^{5} C^q_{i.k}(Stockreturn)_{i,t-k}$

$$Stockreturn_{i,t} = \alpha^q_{gr} + \sum_{k=1}^{5} \tau^q_{i.k}(Stockreturn)_{i,t-k} + \sum_{k=1}^{5} \mu^q_{gr.k}(Stockreturn)_{gr,t-k}$$

I expect that the sum of the lagged coefficients for Greece vs. $Country_i$ CDS Spread interaction will be greater than that of the Athens Stock Exchange vs. $Country_i$ Exchange. Keeping with my hypothesis I anticipate there to be higher significance in my coefficients of the CDS market. If the sum of the lagged coefficients is large and positive, this signals a contagion effect such that an increase in the CDS spread in Greece causes an increase in CDS spread in $Country_i$ in the future.

In order to test for significance I utilize a Granger causality wald test. In Figure 4, Table C, I display the results of this test. To better interpret the significance results I will explain Table C in greater detail. Focusing on the relationship between Spain and Greece, the Granger causality test sets Greece's coefficients to zero and evaluates null hypothesis which states that this will have no affect on Ireland's CDS spread levels. Setting Greece's coefficients to zero, as Greece is the excluded variable in this example, we can reject the null hypothesis as its p-value is equal to 8.3%. Meaning that Greece Granger causes Spain's CDS level over a five day lagged period.

To better highlight the differences in CDS spread levels and contagion, I separate the countries into four groups ranging from lowest average CDS spread to highest. I expect the results to show greater Granger causality significance for the CDS market versus the stock market, with the greatest CDS spread level being the most significant pairing. Similar to the previous section, due to the lower liquidity levels of the CDS market, there is more of an opportunity to witness spillover effects than in the highly efficient global stock exchanges. Countries with greater average CDS spreads represent sovereign economies who are more vulnerable to the fluctuating health of the country experiencing extreme credit distress. If

Greece's CDS spreads are increasing one should see a greater contagion effect in countries who are also experiencing some level of credit distress.

The results in Table D are in line with my first assumption, however they do not show an increase in significance with an increase in average CDS spread level. First looking at the difference in level of Granger significance, it is apparent that there is more contagion in the CDS market than the stock market with three of the four CDS Levels returning significant Granger causality values. In comparison only one level out of the four is statistically significant when determining causality in the stock market. One can not confirm the assumption that countries with greater CDS spreads see more of a contagion effect in the CDS market when compared to countries with lower spread levels. The greatest level of causality is seen for the Level 3 countries, with a significance level of .000; however one can draw the conclusion that there are other factors affecting the contagion in the CDS market then the general level of CDS spreads.

After analyzing the entire sample period I focus now on the period ranges I have pre-defined earlier. This is in order to highlight the interaction between the markets during times of crisis. I expect that during times of greatest credit distress, there will be the largest correlation and contagion in the CDS market. To explore this idea, I run the same regression as above specifically for each of the four periods. In order to be able to measure the actual impacts of the contagion per period I run the regression country by country adjusting solely the period parameters. I expect the results on average to be of a greater positive magnitude during period three which is when the credit crisis met its absolute climax.

The results, which can be seen in Table E, differ from my initial assumptions. It is seen that an increase in Greece CDS spreads causes movements in $Country_i$ CDS market ranging from

-.144 to 1.182 for at least one period over the five day lag. What is surprising is that for every country besides Poland there is significant positive contagion affect during Period 2, in the ninety days prior to the crisis climax. One possible conclusion is that in the months preceding the crisis time, investors where relying mainly on Greece's CDS level when making decisions in the CDS market. Once the debate about the possibility of a European Union bailout process began investors based their decisions more on the probability of the bailout being agreed upon. It was during Period 3 where it became apparent that the Greek crisis had become a European Union crisis. Thus the CDS market in Greece ceased to be the driving force of the CDS markets around Europe, rather the EU member states CDS markets became linked to their ability to remedy this situation at the collective level.

The Granger causality tests and result coefficients provide information on the relation between countries either in the CDS market or stock market. These results provide us with the ability to find level of significance and highlight patterns for countries. This broken down further one can draw conclusions on market timing during certain periods of a credit crisis. To expand off these pattern interactions one could structure an event study as to the release of news of bailout proceedings or EU austerity measures. The VAR model used in this paper can not effectively be used as a trading basis because the interactions between nations are constantly in flux. For example debt levels and location of this debt changes on a daily basis. If Portugal buys a significant amount of Spanish bonds, then the countries co-interaction in the markets will inherently increase. This paper does not explore such interaction.

5. Conclusion

Presented in this paper is an analysis of market interaction between the sovereign CDS market and the respective stock exchanges, as well as a measure of the contagion effect present within the Euro Zone pertaining to these two markets. Initial I use the model and analysis techniques found in Acharya and Johnson (2007). Where my methodology differs is that I focus on the sovereign Credit Default Swap market and the respective stock exchanges of the countries in the data set. I build on their findings of information flows by utilizing a Vector Auto Regression to measure the contagion effect between nations within the Euro Zone.

The findings of this paper leave room for advancement in future research. The data is comprised of daily end of the day quotes of the CDS market, unfortunately this does not fully capture all fluctuations in the market. Yes, not as liquid as the stock exchange, the CDS market does experience intraday movements especially during crisis periods which was not fully calculated in my regression. Using intraday quotes would enhance the depth of the findings.

Another option to improve the future research in this topic is by varying the credit conditions I used to define a credit shock and credit distress. Using Acharya and Johnson as my primary reference I chose these levels in order to better estimate the sovereign CDS market. In the future these levels can be varied to affect the regression returns.

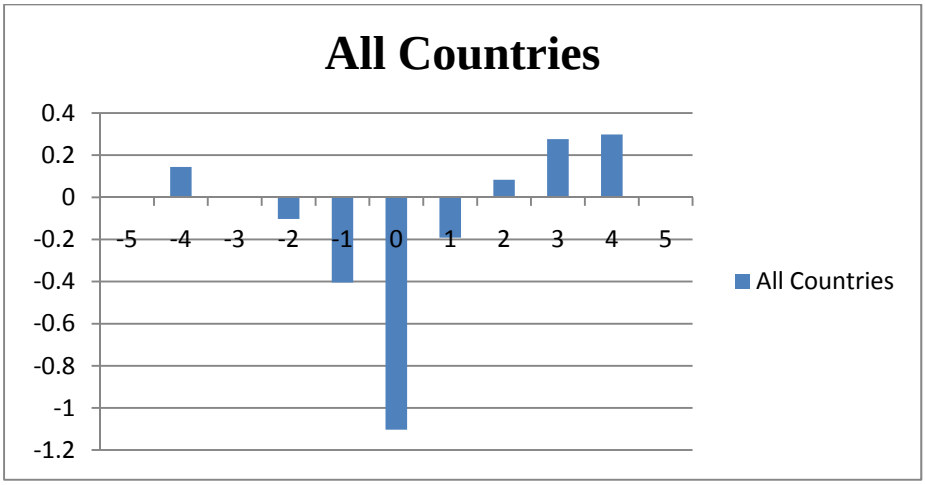
The results confirm the initial hypothesis that there is information flow from the sovereign CDS market into the stock market of the measured nations. This had never been proven in the sovereign sphere before and thus provides a base to continue research into this interaction. The paper also finds that CDS contagion is greatest in the period immediately preceding a crisis. As mentioned earlier one can not effectively use this as a trading strategy

however this is can be furthered analyzed using an event study. This technique would help to pin point what causes such level of contagion effect in the CDS market during the ninety days leading up to a major sovereign credit crisis. In response to the question as to whether or not CDS markets can be looked at as an early warning system for credit stress of nations, my paper agrees with this statement as the results show that the sovereign CDS market can be a good indicator of credit distress and the countries that are most vulnerable to the contagion effect during a crisis.

6. Tables

Figure 1

Graph A



Graph B

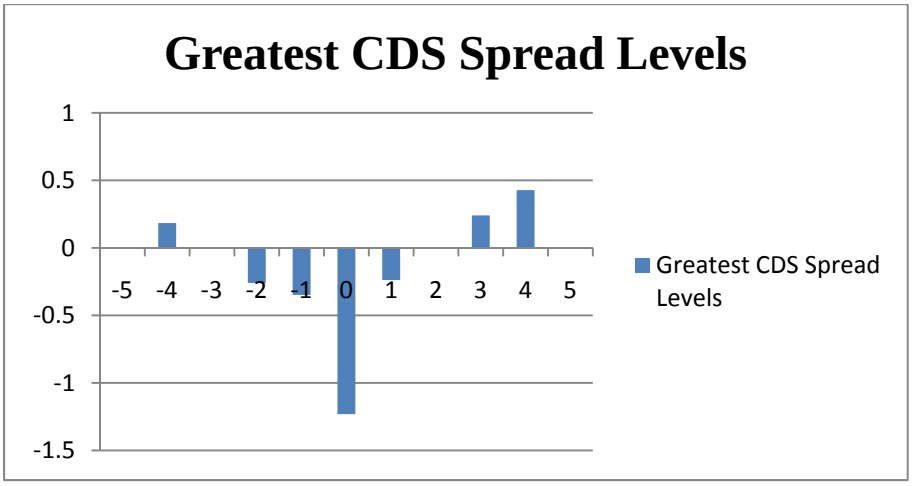


Figure 1 - The graphs above display the cross correlation regression results from section 4.1. In order to capture the preliminary relationship I regressed CDS market returns on the lead (t-5) and lagged (t+5) stock market returns for the respective countries. Graph B highlights the same regression relationship conditional to the four countries in the top quarter of the sample for CDS spread level (Greece, Portugal, Ireland, and Hungary).

Figure 2

Table A

	Condition A	**Condition B**
C	.00526 .027	.00544 .023
$\sum_{k=1}^{5} b_k$	-.02325 .346	-.0245502 .158
$\sum_{k=1}^{5} b_k^C$	-.07900 .000	-.11951 .000
$\sum_{k=1}^{5} s_k$	-.34854 .000	-.10587 .0343
$\sum_{k=1}^{5} s_k^C$	-.043368 .3074	-.17150 .001
Total number of Countries = 16		

Table A - The table above uses two different credit dummies to display the information flow between a countries CDS market and its respective stock exchange. The coefficients are summed to include the entire data set of sixteen Euro Zone countries. See Equation #2. Below the summed coefficients are the respective p-values.

The two credit conditions are as follows:

Condition A – Conditions for a credit shock greater than 35 bps during a period. If a country experiences an increase of their CDS spread equal to or greater than 35 bps then they receive a 1 from the beginning of the period to the date of the credit shock and a zero until the end of the period.

Condition B – The dummy variable conditions for high average CDS levels. If a country experiences an average CDS level greater than or equal to 150 then they receive a one for the entire period.

Figure 3

Table B

	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Average θ	.019535	.04245	-.05476	-.19354
Mean CDS Spread	43.769	134.538	163.304	181.008
Total Number of Countries = 16 Countries Per Period = 4				

Table B – Using Equation #3, the regression returned results for each country over a five lagged period. Using $\theta_i = \sum_{k=1}^{5} \omega_{i,k}$ I summed the lagged results in order to obtain a measure of comparison. The results are broken down into quarters ranging from the most positive summed θ to the most negative. From there the average CDS spread is calculated for the respective quarters. Each quarter has a total of four countries. See below for the breakdown of the quarters:

1st Quarter Netherlands, Norway, Sweden, and the UK

2nd Quarter Spain, Ireland, Denmark, Poland

3rd Quarter Greece, Germany, France, Finland

4th Quarter Portugal, Belgium, Hungary, Russia

Figure 4

Table C – Country by Country Granger Causality Test Results

$Country_i$	Independent Variable	$Prob_{Stock} > Chi^2$	$Prob_{CDS} > Chi^2$
Portugal	Greece	.242	.904
Spain	Greece	.654	.083
Ireland	Greece	.638	.040
Belgium	Greece	.557	.136
Germany	Greece	.768	.001
France	Greece	.660	.000
Denmark	Greece	.454	.140
Finland	Greece	.923	.000
Hungary	Greece	.837	.288
Netherlands	Greece	.973	.000
Norway	Greece	.904	.054
Poland	Greece	.424	.169
Russia	Greece	.019	.107
Sweden	Greece	.973	.000
United Kingdom	Greece	.880	.848
Average Lagged Coefficients =		.0729	.1616

Table C – Using Equation #4, presented are the results from the Granger Causality Wald Test. Using Greece as the universal independent variable, the table shows the Granger causality level of the interaction between $Country_i$ and Greece first in the stock market and then in the CDS market. For example in the CDS market Greece is said to Granger cause Spain but not in the stock market.

Table D – Granger Causality Results Grouped by CDS Level

CDS Level	Independent Variable	$Prob_{Stock} > Chi^2$	$Prob_{CDS} > Chi^2$
Level 1	Greece	.343	.007
Level 2	Greece	.030	.143
Level 3	Greece	.654	.000
Level 4	Greece	.577	.009

Level 1	Germany, Finland, Denmark, Norway
Level 2	France, Netherlands, United Kingdom, Sweden
Level 3	Spain, Belgium, Poland, Russia
Level 4	Portugal, Ireland, Hungary

Table D – Utilizing Equation #4 the table presents the results of the Granger Causality test . The different levels are based upon average CDS Spread over the entire sample period, ranging from smallest to largest. Again using Greece as the universal independent variable the causality significance is reported for both the Stock Market as well as the CDS market.

Table E – Country by Country Summed Coefficients of $Country_i$ and Greece Conditional on 90 Day Periods

$Country_i$	Period 1	Period 2	Period 3	Period 4
Portugal	-0.1701	**0.4746**	0.0295	0.4007
Spain	**0.2989**	**1.1817**	0.4666	0.8177
Ireland	**-0.1441**	**0.3451**	**0.0218**	**0.5914**
Belgium	-0.3113	**0.4087**	0.0617	0.5080
Germany	**0.2874**	**0.5396**	0.1397	0.6367
France	**0.3862**	**0.3708**	-0.1038	**0.6678**
Denmark	-0.0482	**0.2946**	**0.2590**	0.3580
Finland	**0.3926**	**0.5332**	**0.2077**	0.2624
Hungary	**0.4745**	**0.1334**	0.1402	0.3535
Netherlands	-0.0429	**0.2783**	**0.4885**	0.2506
Norway	**0.1401**	**0.4832**	**0.4174**	0.1670
Poland	**0.8594**	0.1713	0.0643	0.6208
Russia	**0.0699**	**0.2238**	0.2760	0.4547
Sweden	**0.0500**	**0.4185**	**0.2595**	0.2915
United Kingdom	0.0559	**0.2013**	0.2480	0.3610
Average	.15322	.40387	.1984	.44945

Table E – Running the same regression as Table A using Equation #4 I analyze the difference between periods. The results are the summed coefficients of the lagged interaction between $Country_i$ as the dependent variable and Greece as the universal independent variable. The summed results "**Bolded"** and **"**Underlined**"** ie. the results for Portugal in Period 2, **.4746** are significant.

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