Instituto Superior de Economia e Gestão
UNIVERSIDADE TÉCNICA DE LISBOA
DESDE 1911

MASTER
FINANCE

MASTER FINAL ASSIGNMENT
PROJECT

SPILLOVERS ACROSS PIIGS BONDS

SIMONE CRISTINA DE MACEDO FERREIRA

SEPTEMBER-2012

Instituto Superior de Economia e Gestão
UNIVERSIDADE TÉCNICA DE LISBOA
DESDE 1911

MASTER

FINANCE

MASTERS FINAL ASSIGNMENT

PROJECT

SPILLOVERS ACROSS PIIGS BONDS

SIMONE CRISTINA DE MACEDO FERREIRA

SUPERVISION:

RAQUEL M. GASPAR

SEPTEMBER-2012

Abstract

In this project we test for evidence of contagion between the bond financial markets of the so-called PIIGS countries: Portugal, Ireland, Italy, Greece and Spain, since 2005 till the end of 2011.

Despite the fact we look into all yield spread maturities, the focus will be on 5 year yield spread and credit-default-swap (CDS) spreads for 5 year senior debt. The reason why, is because 5 year CDS maturity is the most relevant and tradable (Wit, J. 2006), in the market and also to allow for comparison with yields.

We find return spillovers through both an event study and the Vector Autoregressive methodology (VAR). This first analysis is qualitative, and just allows to conclude about patterns or directions. The event study investigates whether sovereign yields spreads and CDS spreads in a given country, react significantly to rating announcements of other countries. The VAR, gives impulse response functions which trace the effect over 10 days of each variable (yields and CDS spreads) of each country, after a one-time unexpected shock in yields or CDS spreads of the remaining countries. Later, also in consonance with this latter methodology, Granger causality tests were performed.

Finally we construct a set of dummy variables and estimate some regressions, in order to make a quantitative approach of this study and to confirm the conclusions drawn previously.

Keywords: Contagion, PIIGS, Debt crisis, Sovereign Bond Yield, CDS spreads, Rating, Return Spillovers.

Resumo

Neste trabalho tentaremos testar se existe evidência de contágio no mercado obrigacionista dos já famosos, PIIGS: Portugal, Irlanda, Itália, Grécia e Espanha, de Janeiro de 2005 a Dezembro de 2011.

Apesar do facto de começarmos por abranger todas as maturidades das *yield spread*, focar-nos-emos na *yield spread* a 5 anos e nos *credit-default-swap* (CDS) *spreads* (também a 5 anos). O motivo subjacente, assenta no facto de que os CDS a 5 anos são a maturidade mais relevante e transacionada no mercado, além de que, permite a comparação com o comportamento das *yields spreads*.

Encontramos evidência de contágio ao nível dos retornos, através de um estudo de eventos e da metodologia do Vetor Auto Regressivo. Esta primeira análise é do tipo qualitativo e apenas permite aferir padrões de comportamento. O estudo de eventos testa se as *yields spreads* e CDS *spreads* dos países em estudo tendem a reagir significativamente a *downgrades* de rating de outros países. O Vetor autoregressivo, fornece as funções impulso-resposta que traçam a evolução ao longo de 10 dias de cada uma das variáveis (*yields* e CDS spreads) de cada um dos países, após um choque inesperado nas yields ou nos CDS dos restantes países em estudo. De seguida, também em consonância com esta última metodologia, foram realizados testes de causalidade de Granger.

Por último, definimos algumas variáveis *dummies* e estimamos algumas regressões, de forma a abordar o tema de forma quantitativa e confirmar as conclusões tiradas anteriormente.

Palavras-chave: Contágio, PIIGS, Crise de dívida, Yield das Obrigações Soberanas, CDS *spreads*, *Rating*, Contágio de Retornos.

Acknowledgments

I want to express my gratitude to some colleagues, friends and members of my family who have helped, both in a direct and indirect way. I want to give a special thanks to my boyfriend João Valério and two of my best friends: Tânia Dias and Raquel Figueira. Their help, own research, and comments have encouraged and enlightened me while writing this project.

I would like to acknowledge my supervisor Dra. Raquel M. Gaspar, she highlighted me for the importance of the current sovereign debt crisis and how countries are more interconnected than I expected. Thanks for her support, suggestions and perceptive advice.

I would like to thank all my master teachers, who have shared in their classroom knowledge and ideas with me over the master. Their commitment and enthusiasm motivated me to write this project.

While I believe that all of those mentioned have contributed to an improved final manuscript, none is, of course, responsible for remaining weaknesses. Without doubt there will be errors, omissions and over-simplifications, for which I take absolute responsibility, while hoping that the rest of the material will be enough to stimulate insights and new investigations into the notion of contagion.

Hoping that my thesis will prove to be useful, interesting, and enjoying for the readers and in the future, my effort may be acknowledged.

Acronyms and Abreviations

AR – Abnormal Returns

bp – Basis Points

CAAR – Cumulative Average Abnormal Returns

CAR – Cumulative Abnormal Returns

CDS – Credit Default Swaps

ECB – European Central Bank

IMF – European Monetary Fund

OLS – Ordinary Least Squares

NR – Normal Returns

PIIGS – Portugal, Ireland, Italy, Greece and Spain

VAR – Vector Autoregressive

General Index

Figures Index

Tables Index

1. Introduction

The fact that most of the countries in Europe are integrated in an economic region gave them opportunities to develop they probably never experienced before. More than their natural endowments, their workforce, their industry, now they have a new set of possibilities due to the lack of “frontiers”. But there is always the other side of the coin, everytime a country is hit by “bad news” all the others will be somehow affected. They are all interconnected by trade, investments, financial assets, through market psychology…but mainly through globalization.

These contagion effects tend to cause higher volatility in financial markets. Forbes and Rigobon (2002) alert for the fact that the definition of contagion is not consensual and may induce to different results.

In the present study, we focus on the sovereign bond markets of the so called PIIGS, and investigate the existence of return contagion, to measure its magnitude, pattern and direction. PIGS is the acronym used by some international bond analysts, academics, and the economic press that refer to Portugal, Ireland, Greece and Spain, and sometimes Italy (PIIGS), often related to their sovereign debt markets. Some economic organizations, like the Financial Times (FT) and Barclays Capital have banned or limited the use of the term due to the criticism regarding perceived offensive connotations.

Despite the fact we look into all yield spread maturities, the focus will be on 5 year yield spread and credit-default-swap (CDS) spreads for 5 year senior debt. The reason why, is because 5 year CDS maturity is the most relevant and tradable in the market (Wit, J. 2006), and also to allow for comparison with yields spreads. Despite the fact that yields and CDS may be considered substitute, because both measure default risk of the reference entity, they will be both considered and compared. First they do not react at the same time or with the same intensity to market news. First, according to Afonso et al (2011), rating downgrades seems to be preceded by CDS spreads and consequently the rating event itself has an higher impact on yield spreads.

So we consider that contagion exists whenever sovereign yield spreads or CDS spreads in a given country, show statistically significant reactions to rating announcements of other countries. Or whenever, an yield or CDS spread increase in some of the countries cause significant changes in other countries yields and CDS spreads. We measure those effects first through an event study, then from impulse response functions and Granger causality tests given from Vector Autoregressive methodology and last from a regression-based approach.

All the countries selected belong to the European Union and share the same currency since 2001 – the Euro. Other things that make these countries similar is that all of them faced/are facing a financial crisis that is causing a huge pressure on their bond yields and consequently on their public debt. On 2nd May 2010, the International Monetary Fund (IMF) and the Euro Zone countries agreed to a €110 billion loan for Greece, conditional on the implementation of austerity measures. The Greek bail-out was followed by a €85 billion rescue package for Ireland in November and a €78 billion loan for Portugal in May 2011[1]. Recently, on 9th June 2012, Spain also asked for a €100 billion loan to restructuring and recapitalization of Spanish banking system. Nowadays, all European zone is at stake and the European Commission and the IMF are trying to protect Italy (and other European countries) from contagion.

We are far from the first ones to study this theme. To the best of our knowledge, this study is the only one only focusing PIIGS, one of the few focusing on this time frame, and the fact that the remaining literature usually uses only one methodology, while here we use 4 different approaches which makes the analysis more robust.

The reminder of this text is organized as follows: in Chapter 2 there is a literature review, which defines the main concepts and discusses the general theoretical approach and main estimation methods applied in similar researches. Chapter 3 describes the full data set. Chapter 4 focuses on Methodology: an Event study for yields and CDS spread returns, impulse response functions and Granger causality tests given by the Vector Autoregressive method and a regression-based approach. Along with chapter 4, there is the outcome of the empirical research. Finally in Chapter 5 is the discussion of results and main conclusions.

[1] http://businesswatch.in/sovereign-debt-crisis-analysis-of-greece-fallout/

2. Literature Review

Several other authors have studied contagion among countries or regions. Hsin (2004) believe that there are co-movements that connect several countries. Booth, Martikainen, and Tse (1997), believe that volatility transmission is asymmetric and spillovers are more pronounced for bad than for good news. Wang, Rui, and Firth (2002) agree that spillovers exist but they are few in number and some markets are weakly related to each other. One conclusion seems consensual among authors, classical correlations between asset returns during a crisis period, may be misleading. They argue that there is no correlation, just interdependence, because correlation needs to be adjusted to overcome the problem that it is a positive function of volatility (Boyer, Gibson, and Loretan (1999), or Loretan and English (2000)).

The advantage of studying PIIGS markets is that, they have similar trading hours (Ireland and Portugal GMT; Spain and Italy GMT+1; Greece GMT +2) so, there is no problem with the non-synchronous trading, difficulty faced by King and Wadhwani (1990) and others. Or the shortcoming faced by those who have studied the stock market with dually traded stocks like Karolyi (1995) is no longer a problem.

Serra, A. (2002) and Fu, H. (2011) were used to apply the event study and Ahern, K. (2006) helped to define the estimation period, according to sample characteristics.

Event study examines the effect of some event (like stock splits, earning announcements, mergers or takeover announcements) on other assets' value or economic conditions. Fama et al (1969) pioneered the event study methodology to search the behavior of stock prices around stock splits. Turk (1992) studied managerial response to takeover bids, Worrell et.al (1986) measured the effect of key executives death on stock price, and so on.

Serra, A. (2002) and Fu, H. (2011) describe some of the main parametric and non-parametric tests used in other event studies. Fama et al (1969) use the event study analysis to find out around mergers and acquisitions time, if the actual stock return is equal to the normal return.

Afonso, et al (2011) suggested the use of CDS spreads and Rating notations. They carry an event study analysis about the reaction of 24 European government yields and CDS spreads before and after announcements from the 3 rating agencies (Standard & Poor's, Moody's, Fitch). Their data sample is from Jan1995 till Oct2010.

According to literature, there are various models to measure spillovers, and the most used for stock return spillovers are the GARCH family. We study contagion among bond markets so, like Baig and Goldfajn (1998) did, we use the Vector Autoregressive methodology and more specifically the impulse response functions. Baig and Goldfajn (1998) account for shocks in exchange rates originated by impulses in several countries. This methodology is a good measure of return spillovers through several periods. It calculates standard errors either by asymptotic or Montecarlo method, are useful to describe the dynamic behavior of economic and financial time series and for forecasting, and are well accepted in the literature despite its drawbacks. This methodology is also advantageous because, it is very difficult to isolate the magnitude of shocks that are transmitted from one market to another but the VAR recognizes the variables in the system. It also moves away from the usual focus on contemporaneous correlations, and allows for the impact of lagged values of the variables (Baig and Goldfajn (1998)).

The papers used as a reference were two from Diebold and Yilmaz (2009, 2010) and the paper from Baig and Goldfajn (1998) – a study performed by the IMF. Diebold and Yilmaz argue that VAR systems are easy to implement, the OLS estimator has the standard asymptotic properties and on large samples (which is the case), the OLS estimator is consistent and asymptotically normal. Baig and Goldfajn (1998) suggested the use of impulse response functions and its graphic analysis. Meanwhile, another two were used for methodology: Zivot, E. and Wang, J. (2005) and Pesaran, M., and Shin, Y. (1997). Beyond VAR they propose the generalized impulse response analysis, because unlike the traditional impulse response analysis, this approach does not require orthogonalization of shocks and it is invariant to the ordering of the variables in the VAR.

Finally, according to Baig and Goldfajn (1998) and Horen et al (2005), a regression based approach was pursued in order to quantify the impacts mentioned before. Both authors estimate OLS regressions to measure contagion among Asian exchange markets. They regress US stock index, yen / dollar exchange rate and dummy variables like good or bad news on nominal exchange rates from 5 Asian Countries.

3. Data

The dataset consists of government bond yields for all the available maturities (3 and 6 months, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 and 15 years ….) for Portugal, Ireland, Italy, Greece and Spain plus Germany. The German yields were used to compute yield spreads. In addition, we also collected 5 year credit-default-swap (CDS) spreads, for the countries under analysis.

Daily data was collected from Bloomberg and refers to the period from 1st January 2005 till 31st December 2011. We decided to study this time frame to include the pre-crisis and the crisis period. Later the sample is divided into two sub-periods [Jan2005-Jun2008] and [Jul2008-Dec2011] in order to see if conclusions change from one period to the other, because according to Hamao, Masulis, and Ng (1990) "correlations computed separately for ordinary and stressful market conditions differ considerably".

We could also have included a broader range sample, but before 2005 CDS were very illiquid instruments (Marra, M. 2012).

Daily data was used, because according to Hsin (2004), the increased information efficiency in international markets has prohibited the usage of low frequency data, because this might dilute co-movements that may only be observed with high frequency data.

Data for the credit rating developments is from Fitch (Table F), despite the fact that among rating agencies is the latest one to downgrade, it is one of the main credit rating agencies, it is the only agency that provides data online and mostly because their rating notations are used by ECB when estimating zero-coupon, forward and par yield curves for the euro area[2].

3.1 Descriptive statistics

Figure 1 illustrates each country 5 year yield spread (left axis) and CDS spread evolution (also 5y) (right axis) with all bail-out events occurred in the period [2005-2011]. Bail-out dates were used instead of official aid request date, because the impact of rescue packages on economic variables were not studied. Figure D represents each country yield spread for all the maturities available for the period in analysis.

[2] http://www.ecb.int/stats/money/yc/html/technical_notes.pdf

Yield Spread and CDS spread evolution

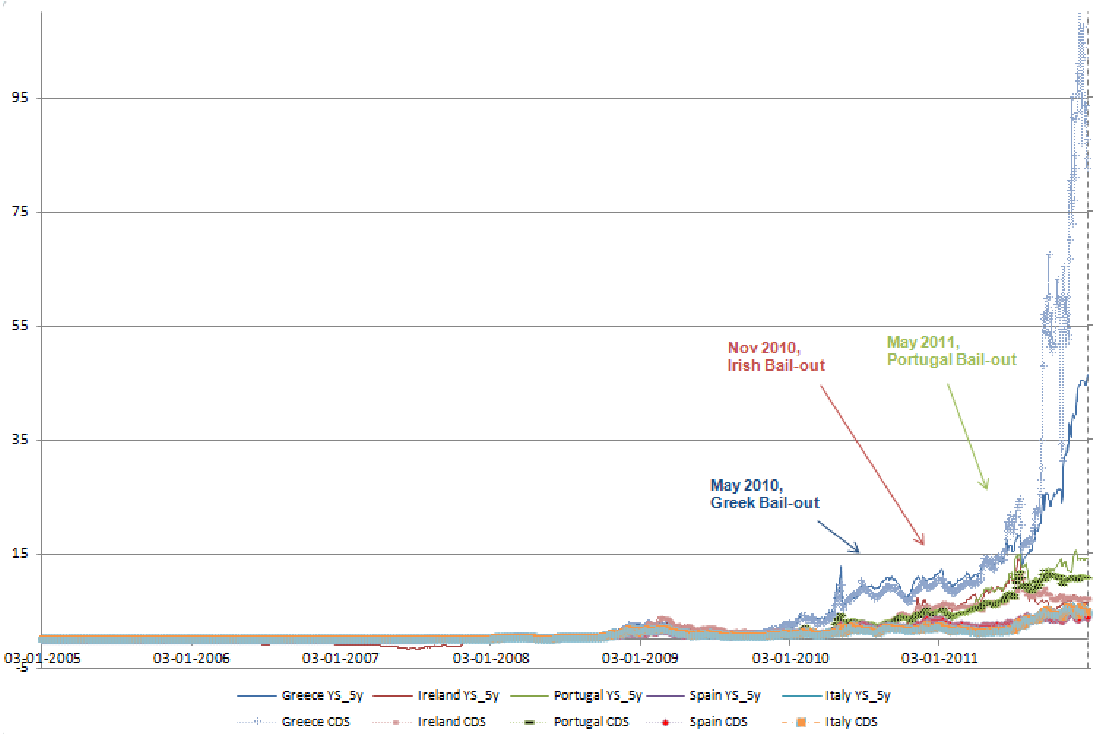


Figure 1: Yield and CDS spread 5y evolution since 2005 with bail-out events

Source: Bloomberg Units: Percentage

According to Table A, the studied countries show up average yield spread daily returns (annualized) that vary from -0,01% in Spain to 0,08% in Greece and Ireland, and mean CDS spreads that vary from 0,04% in Italy and Spain to 0,07% in Ireland. The majority are positively skewed and have excess Kurtosis (above 3), typical financial series characteristics'. Yield spread Skewness and Kurtosis is higher for Greece and Portugal, CDS spread Skewness is higher for Portugal and Kurtosis is higher for Spain.

Ireland has minus CDS spreads observations, because there were no quotes for Irish CDS before October 2007.

3.1.1 Unconditional Correlations across yield spreads and CDS spreads

Despite the fact that correlations between yield spreads were calculated for all maturities, here we just present, beyond the 5 year maturity (the more relevant in our analysis), one example of a short maturity (3 months) and one example of a long maturity (15 years). From this analysis, we found that classical correlations tend to increase with yield maturity. This may be explained by liquidity scarcity in the long run.

For the short maturity the lowest correlation happens between Greece and Ireland and the highest among Italy and Spain. For the longer maturity the lowest happens between Ireland and Italy and the highest among Greece and Portugal. In the medium term Greece and Italy are the most correlated countries (0,953), meanwhile Ireland and Italy the less correlated (0,78) [see Table B] .

If we look to Unconditional Correlations across PIIGS CDS spreads for 5y maturity, correlations vary from 0,66 (Ireland-Greece) to 0,937 (Ireland-Portugal) [see Table C].On average, correlations between each country CDS price are 0,86.

3.1.2 Unconditional Correlations before and during crisis

According to Table D, yield correlations just computed for the pre-crisis period [Jan2005-Jun2008], tend to be occasionally negative. When just the period that crisis actually occurred [Jul2008-Dec2011] is taken into account, all countries are positively correlated, and higher the maturity higher is the correlation coefficient.

When we look at evolution from one period to another, on short maturities negative correlations become positive. For longer maturities, the correlation coefficient increased, especially for the medium term, which is consistent with Corsetti et al (2005) argued on previous studies.

So we found that correlation coefficients need to be adjusted to overcome the problem that they are a positive function of volatility just like predicted by Forbes et al (2002) and others.

In the opposite are CDS correlations, that when computed only for stressful periods, tend to decrease relatively to calm periods [see Table E].

4. Methodology

Our methodology starts with an Event study based on what Ahern, K. (2009) and Fu, H. (2011) have done on previous studies. The event study is useful to investigate whether sovereign yields and CDS spreads in a given country, react significantly to rating announcements of other countries.

4.1. Event Study

Yield spreads

The purpose with the event study is, to find out around rating downgrades of one country, if the actual bond return spread of each country is equal to the "normal return".

The goal here is to investigate whether sovereign yields in a given country, react to rating announcements of other countries, setting a hypothesis that they are equal before and after the rating event. First, like (Fu, 2011), the event study is divided into 3 steps: We begin by identify the events (each rating downgrade), then calculate the normal bond returns, and finally calculate the abnormal returns around the downgrade date. These normal concepts will be defined bellow.

4.1.1. Identify the event

The first step is to define the data upon which the market would receive the news of the event. In this research, is the date when rating downgrades are announced. So if the event date is t=0, the estimation period lasts for 65 days, which starts from -70 days to -5 days before the event date (*[T1, T2] = [-70, -5]*).

The next step is to define the Event Window. In this research it lasts for 10 days: 5 days prior to the downgrade date and 5 days afterwards (*[t1, t2] = [-5, +5]*). This range was chosen because news frequently spread gradually to the public (Ahern, 2009) (Figure 2).

The choice of the estimation period is usually arbitrary. While Ahern (2009) used 238 days as the estimation period, Fu (2011) used 730 days. The estimation period may seem short relative to the literature, but due to the amount of downgrades occurred in the past few years, it had to be shortened because each rating downgrade should have its own estimation and event window. They still sometimes overlap therefore, in these cases [twice in Greece (B+ and BBB-), once in Ireland (A+) and once in Portugal (A-)], the earliest downgrade is the one taken into account to calculate the normal return of each bond:

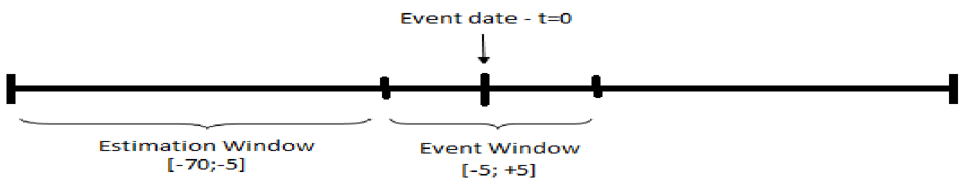


Figure 2: Identify Event date, Estimation Window and Event Window.

4.1.2. Calculate the normal returns

Normal return is the one if there had been no special events lately, or by other words, no rating downgrades occurred on sovereign bonds. On this sample, normal returns are the one occurred in the estimation period.

To calculate the normal return spread of a bond, the mean-adjusted return model (Eq.1) is used, which defines the normal return NR_i as the average return spread over the estimation period.

$$NR_i = \frac{1}{T} \sum_{s=T_1}^{T_2} R_{is} \quad (1)$$

where *i* is the sovereign bond index, $T=T2-T1+1$, equals the number of days during the estimation period and R_{is} is the historical daily bond yield spread (each country yield spread minus German bond yield).

The result of the normal returns is listed in Table G, of each sovereign yield spread and country CDS, for each downgrade occurred.

4.1.3. Calculate and analyze the abnormal returns

Abnormal return is defined as the difference between the actual return and the normal return (Eq. 2). By other words, is the excess return over the normal return defined previously:

$$AR_{i,t} = R_{i,t} - NR_{i,t} \quad (2)$$

Where $AR_{i,t}$ is the abnormal return spread of bond *i* on day *t*; $t = 0$ is defined as the event date; $R_{i,t}$ is the actual return spread of bond *i* on day *t* and $NR_{i,t}$ is the normal return spread of bond *i* on day *t*.

If there is more than one event happened on one country (several downgrades) they are treated separately. Given the fact that we are interested in the performance of an interval, the abnormal returns from period *[t1, t2]* are aggregated as the cumulative abnormal returns spread (CAR_i) of bond i.

$$CAR_i = \sum_{t=t_1}^{t=t_2} AR_{it} \quad (3)$$

Then cumulative average abnormal returns of all bonds, are calculated as:

$$CAAR_i = \frac{1}{N} \sum_{i=1}^{N} CAR_i \quad (4)$$

After the calculation, the next step is to perform a statistical test to evaluate if the downgrade events have a significant influence on yield spreads and CDS. Here the t-test method (Eq. 5), is adopted with a null hypothesis that is, the downgrade event has no influence on yield spread (or CDS). If the null hypothesis hold, means that the cumulative average abnormal returns of all bonds are zero.

$$H_0 = \overline{CAAR} = 0\,;H_1 = \overline{CAAR} \neq 0 \tag{5}$$

The standard t-test statistical formula is:

$$t = \frac{CAAR}{\sigma_{AR,i}} \tag{6}$$

The results of the Cumulative Abnormal Returns (CAR_i), Cumulative Average Abnormal Returns ($CAAR_i$) and CAR standard deviation (σ_{AR}) values are displayed on left side of Table G.

The degrees of freedom used in this test are t_1-t_2-2 (Serra, 2002), which is the number of days in the event period reduced by 2: 10-2=8. Looking into the t-test value table (double side, statistical significance *0.05*), $T_{8\ (\alpha=0,05)} = 2.306$. For each country and each downgrade the null hypothesis is rejected if $|t| > 2,306$. In those cases, the average cumulative abnormal returns are in fact different from zero and we would conclude that such event (rating downgrade) had a significant impact on yield spreads through returns.

CDS spreads

In order to apply the event study to CDS spreads, we begin by calculate CDS spread returns. Then the same formulas as for bond yield spreads were applied. The goal now is to draw conclusions about the effect of rating downgrades of one country on CDS returns of other countries (right side of Table G).

The next methodology to evaluate contagion among countries, is the Vector Autoregressive methodology, which is subdivided into Granger Causality tests and impulse response functions.

4.1.4 Results - Yield spread and CDS spread reactions'

		Significative yield spread reaction					Significative CDS spread reaction				
	Events	**Greece**	**Ireland**	**Portugal**	**Spain**	**Italy**	**Greece**	**Ireland**	**Portugal**	**Spain**	**Italy**
22-10-2009	Greece downgrade from A to A-		X	X	X	X					
09-04-2010	Greece downgrade from BBB+ to BBB-	X									
14-01-2011	Greece downgrade from BBB- to BB+										
13-07-2011	Greece downgrade from B+ to CCC	X	X	X	X	X					
08-04-2009	Ireland downgrade from AAA to AA+	X	X	X	X	X					
04-11-2009	Ireland downgrade from AA+ to AA-	X			X	X					
09-12-2010	Ireland downgrade from A+ to BBB+	X	X		X	X					
24-03-2010	Portugal downgrade from AA to AA-	X									
23-12-2010	Portugal downgrade from AA- to A+										
01-04-2011	Portugal downgrade from A- to BBB-	X	X		X	X					
24-11-2011	Portugal downgrade from BBB- to BB+		X		X	X					
28-05-2010	Spain downgrade from AAA to AA+	X	X	X	X	X					
07-10-2011	Spain downgrade from AA+ to AA-		X	X	X	X					
19-10-2006	Italy downgrade from AA to AA-	X			X	X					
07-10-2011	Italy downgrade from AA- to A+	X	X	X							

Table I: Event study with Yield and CDS spreads from Return Spillovers (X)

Each sign means that, the null hypothesis is rejected and that downgrade had a significant impact on those bond or CDS returns (Table I). By other words, it means that the abnormal returns for those countries during the event period, did not remained near 0. The blank table means that, CDS did not react significantly to rating announcements. The reason will be explained later.

4.2. Vector Autoregressive Methodology

This methodology is based on a system of k variables, being all coefficients simply estimated by applying ordinary least squares (OLS) to each equation individually. Let $Y_t = (Y_{1t}, Y_{2t}, \ldots, Y_n)$ denote an (n×1) vector of time series variables.

The basic p-lag vector autoregressive (VAR(p)) model has the form

$$Y_t = C + \prod_1 Y_{t-1} + \prod_2 Y_{t-2} + \ldots \prod_p Y_{t-p} + \varepsilon_t, \quad t = 1, \ldots, T \qquad (7)$$

where $\prod_i$ are (n×n) coefficient matrices and ε_t is an (n×1) unobservable zero mean white noise vector process (serially uncorrelated or independent) with time invariant covariance matrix Σ . For example, a bivariate VAR (2) model equation has the form:

$$\begin{pmatrix} Y_{1t} \\ Y_{2t} \end{pmatrix} = \begin{pmatrix} C_1 \\ C_2 \end{pmatrix} + \begin{pmatrix} \pi_{11}^1 & \pi_{12}^1 \\ \pi_{21}^1 & \pi_{22}^1 \end{pmatrix} \begin{pmatrix} Y_{1t-1} \\ Y_{2t-1} \end{pmatrix} + \begin{pmatrix} \pi_{11}^2 & \pi_{12}^2 \\ \pi_{21}^2 & \pi_{22}^2 \end{pmatrix} \begin{pmatrix} Y_{1t-2} \\ Y_{2t-2} \end{pmatrix} + \begin{pmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{pmatrix} \qquad (8)$$

Or

$$\begin{cases} Y_{1t} = C1 + \pi_{11}^1 Y_{1t-1} + \pi_{12}^1 Y_{2t-1} + \pi_{11}^2 Y_{1t-2} + \pi_{12}^2 Y_{2t-2} + \varepsilon_{1t} \\ Y_{2t} = C2 + \pi_{21}^1 Y_{1t-1} + \pi_{22}^1 Y_{2t-1} + \pi_{21}^2 Y_{1t-1} + \pi_{22}^2 Y_{2t-1} + \varepsilon_{2t} \end{cases} \qquad (9)$$

where cov(ε_{1t},ε_{2s}) = σ_{12} for t = s; and 0 otherwise. Notice that each equation has the same regressors — lagged values ofy_{1t} and y_{2t}. Hence, the VAR (p) model is just a seemingly unrelated regression (SUR) model with lagged variables and deterministic terms as common regressors.

4.2.1 Granger Causality Tests

First in order to have stationary series the first differences are made to the original data, for all yield spreads (from each country under analysis), and an Augmented dickey Fuller test to confirm if the stationarity was achieved. Then a series of Granger causality tests are performed, given its relevance in the econometric field.

Correlation does not necessarily imply causation, and on econometrics there is a pool of magnificent correlations, which are simply spurious or meaningless, like positive correlation between teachers' salaries and the consumption of alcohol[3]. Granger (1969) approach of whether X causes Y is to see how much of the current Y can be explained by past values of Y, and then to see whether adding lagged values of X can improve the explanation. Y is said to be Granger-caused by X if X helps in the prediction of Y, or equivalently if the coefficients on the lagged X's are statistically significant. The two-way causation is frequently the case; X Granger causes Y and Y Granger causes X.

It is important to note that the statement "X Granger causes Y" does not imply that Y is the effect or the result of X. Granger causality measures precedence and information content but does not by itself indicate causality in the more common use of the term. E-views perform pairwise Granger causality tests between (all possible) pairs of the listed series or group of series, and runs bivariate regressions of the form:

$$\begin{cases} y_t = \alpha_0 + \alpha_1 y_{t-1} + \dots + \alpha_1 y_{t-l} + \beta_1 x_{t-1} + \dots + \beta_1 x_{t-l} + \varepsilon_t \\ x_t = \alpha_0 + \alpha_1 x_{t-1} + \dots + \alpha_1 x_{t-l} + \beta_1 y_{t-1} + \dots + \beta_1 y_{t-l} + \varepsilon_t \end{cases} \quad (10)$$

for all possible pairs of (x,y) series in the group.

The series of Granger causality tests were made with 2 lags and calculated between each country differentiated yield spreads and CDS spreads, from the 5 countries under analysis.

Results from each country yield spread

Yield spread Granger Causality Tests

From / To	Greece	Ireland	Italy	Portugal	Spain
Greece			X		X
Ireland	X		X	X	X
Italy	X	X		X	X
Portugal	X	X	X		X
Spain	X	X	X	X	

Table II: Yield spread Granger Causality Tests

From Granger Causality tests applied to 5 year yield spreads it can be concluded that almost all countries are affected or influence somehow other countries yield spreads. This conclusion is similar to what we found in the event study.

[3] Eviews 6 user's guide I

Results from each country CDS spread

CDS spread Granger Causality Tests

From / To	Greece	Ireland	Italy	Portugal	Spain
Greece		X	X	X	X
Ireland			X		
Italy	X				
Portugal	X		X		
Spain	X		X	X	

Table III: CDS spread Granger Causality Tests

According to CDS Granger causality test (5 year maturity) there are only 11 contagion effects between the countries studied. This lack of contagion effects is consistent with drawn conclusions from event study, where no causality was found. The more pronounced shocks begin in Greece and go towards Greece and Italy. This may be explained by the huge increase in Greek CDS spread during the period in analysis,

4.2.2 Impulse response functions

To evaluate how to achieve a good VAR model to our data series, the squared residuals autocorrelation function have to be examined, and test whether they are statistically different from zero or not (Ljung-Box test). It is also important to check whether the process is stationary (sum of the unit roots below 1) and test for cointegration. A definitive model just can be chosen after the data analysis and the study of the outputs from the E-Views.

After differentiating all PIIGS yields spreads and CDS spreads 5y for each country, 2 VAR's with 5 endogenous variables (all countries differentiated yield spread 5y and differentiated CDS spread 5y) and one exogenous variable (constant) each were estimated (Table N). The number of variables, were approved by Block Exogeneity Wald Tests, that evaluate whether an endogenous variable can be treated as exogenous, through a X^2 (Wald) statistics (Peña, 2005) (Table O).

Both VAR's were estimated with 12 lags (for the lack of space, in the appendix only the first and the last lag are shown), what seems appropriate given the results from AR Roots (the inverse roots of the characteristic AR polynomial lie inside the unit circle, which means VAR is stationary) (Figure A). We found no serial correlation between estimated residuals in each VAR (for the specified number of lags), Lag Exclusion tests (Chi-Square statistic for each Lag and for the joint significance of all endogenous variables in the VAR) also approve the 12 lags (Table M).

Each equation estimated from VAR, gives an impulse-response function. Here we adopted the generalized impulse response function suggested by Pesaran, M. et al (1997), that unlike the traditional one, it is invariant to the ordering of the variables in the VAR.

The impulse response function describes the response over time of each variable in the VAR, to a one-time shock in any of them, while keeping all others constant (E-views 6 user's guide II (2007)). Graphically, each estimated impulse response function show how shocks originated in a given country, influence the remaining four (Figure B and C). We choose a lag length of 10 days, and repeat this exercise for all five countries, giving us a total of 20 impulse response graphs. Then do the same for the CDS spread data.

Yield spread impulse response functions

The responses of Greek yield spread to each country unexpected orthogonal shocks are in the first line of Figure B. We may conclude that Greece is the country that is more influenced by the remaining under analysis. The influence is positive and similar from all of them and remains stable over the 10 lags, around 1,5 standard deviations.

The responses of Irish yield spread to each country unexpected orthogonal shocks are in the second line of Figure B. Now we may conclude that Ireland is more sensitive to shocks from Portugal and less sensitive to Italian shocks.

The responses of Portuguese yield spread to each country unexpected orthogonal shocks are in the fourth line of Figure B. Portugal is positively influenced by all countries at a similar degree as Ireland. And it is also Ireland the country that affects Portugal the most. It is clear that this methodology shows an interconnection between these two markets.

Italian and Spanish responses are in the third and fifth line respectively, and seem insensitive to other countries shocks.

CDS spread Impulse response Functions

The responses of Greek CDS spread to each country unexpected orthogonal shocks are in the first line of Figure C. We may conclude that again, Greece is the country that is more influenced by the remaining under analysis. But the pattern is different from what we found with yield spread impulse responses. Portuguese shocks are positive and have the highest influence over Greece and then are Spanish shocks that are negative but also significant. Italian shocks are positive but weaker and Irish shocks dissipate after a few lags.

The remaining countries seem insensitive to other countries CDS shocks, excluding the ones from Ireland to Portugal, that are positive and around 1,5 standard deviations. From this methodology we conclude that Greece is the most sensitive country especially regarding CDS spreads.

Yields Spreads

Responses of / to	Greece	Ireland	Italy	Portugal	Spain
Greece		+	+	+	+
Ireland	+			+	
Italy					
Portugal	+	+			
Spain					

CDS spreads

Responses of / to	Greece	Ireland	Italy	Portugal	Spain
Greece		+ / -	+	+	-
Ireland					
Italy					
Portugal		+			
Spain					

Table IV: Impulse response summary

Finally some regressions are estimated, in order to quantify those impacts. They are useful to test whether ratings tend to lead or instead cause changes in the yields spreads and CDS spreads, and examine whether downgrades, negative and positive outlooks influence more the market, than the rating notation itself.

4.3. Regression-based approach

First we begin by creating dummy variables, which take a value equal to 1 when the credit rating (or outlook) changes. Like Afonso et al (2011), the dummy variables created were *down*, standing for Fitch downgrades, *Neg* and *Pos* standing for negative and positive outlooks respectively:

$$\text{Down} = \begin{cases} 1, \text{if a downgrade occurs} \\ 0, \text{Otherwise} \end{cases}$$

$$\text{Neg} = \begin{cases} 1, \text{if a Negative Outlook occurs} \\ 0, \text{Otherwise} \end{cases} \qquad \text{Pos} = \begin{cases} 1, \text{if a Positive Outlook occurs} \\ 0, \text{Otherwise} \end{cases}$$

It would make sense to include an upgrade dummy but, throughout the sample chosen there is none. Later, even the positive outlook will not be considered because, they are rare and consequently become statistically not significant.

The sovereign credit rating information is transformed into a discrete variable by using a linear scale to group the ratings in 17 categories. To Triple-A is attributed the level 17, AA+ level 16, AA level 15 and so on [see Table I], a negative outlook reduces the level in 0,5 whereas a positive outlook increases it also by 0,5.

Rating Correspondence Table	
AAA	17
AA+	16
AA	15
AA-	14
A+	13
A	12
A-	11
BBB+	10
BBB	9
BBB-	8
BB+	7
BB	6
BB-	5
B+	4
B	3
B-	2
CCC	1
CC	1
C	1
RD/D	1
Rating Watching positive	+0,5
Rating Watching negative	-0,5

Table V: Rating Correspondence

This distinction is made because frequently a negative outlook brings more information to market than the downgrade itself. Often, outlooks also tend to anticipate movements in the rating notation, so they are important to explain yield movements.

The remaining estimated variables are:

- dif(country$_a$_r) –This variable represents each country differentiated rating;
- dif(country$_a$_r)^2 – Squared dif(country$_a$_r);
- country$_a$_CDS – Each country CDS spread 5y evolution in percentage;
- country$_a$_spread5y - Each country yield spread 5y evolution in percentage.

Finally, we analyze whether the reaction of sovereign markets (yields and CDS spreads) to rating announcements became stronger during the recent period of financial turbulence. To this purpose, the equation is re-estimated just for the period after mid-2008 (the beginning of financial crisis).

4.3.1 Regression results

Here we present the generic form of each equation, but all the regressions were estimated for each country individually.

First we regress each rating, yield spread, and the two dummy variables: downgrade and negative outlook in each country CDS spread, in order to see which variables seems to have an impact on CDS spread.

Regression 1:

$$country_a\_CDS = \beta_0 + \beta_1\, country_a\, \_r + \beta_2\, country_a\_spread5y + \beta_3\, down\_\, country_a + \beta_4\, neg\_\, country_a \quad (11)$$

Rating variable is always significant and has a negative impact on CDS prices, which is economically intuitive, higher for Greece and minor for Italy. Yield Spread coefficient is always positive and significant, with less impact of yield spreads on Irish CDS and higher on Greek CDS. Downgrades and Negative Outlooks are not significant in this model.

With the re-estimated equation for the period [July2008-Dec2011], the influence of rating decreased (except for Italy) (see Table H).

To view the impact of each variable on rating (discrete variable varying from 1 till 17) instead, rating is put has dependent variable:

Regression 2:

$$country_a\_r = \beta_0 + \beta_1\, country_a\_CDS \qquad (12)$$

Now CDS coefficient is always significant and negative but always smaller then 1, which means that CDS spread only causes smaller changes in rating notations. With the restricted sample [July2008-Dec2011], the impact of CDS increased only for Portugal and Spain (Table I).

Regression 3:

$$country_a\_spread5y = \beta_0 + \beta_1\, country_a\_r \qquad (13)$$

Rating coefficient is always significant with a negative impact on yield Spread, (higher impact on Greece and lower on Ireland). With the restricted sample no conclusions can be drawn (Table J). We also regressed yield spreads on rating, in order to assess if rating tends to cause, or is caused by yield spread changes, but coefficients were similar.

Then just like we did with CDS on the first regression, all the variables were regress on yield spreads:

Regression 4:

$$country_a\_spread\_5y = \beta_0 + \beta_1\, country_a\_r + \beta_2\ down\_c\ ountry_a + \beta_3\, neg\_country_a \qquad (14)$$

Rating coefficient is always negative and significant, its higher impact is on Greek yield spread and the notation itself has more influence on yield spread than negative outlooks. Downgrades and negative outlooks are only significant for Portugal and Spain, but have negative coefficients, which are not economically intuitive.

With the re-estimated equation for the period [July2008-Dec2011], the influence of rating remained equal for Greece, increased for Italy and decreased for Ireland, Portugal and Spain (Table K).

Finally for curiosity, regressions were made to conclude whether the relationship between rating and spread, despite negative, is linear or not. For 5 year maturity, a convex parabolic relationship was found, with a positive squared rating coefficient (except Spain), which means that, each additional upgrade/downgrade has a diminishing effect on yield Spread (Table L).

Regression 5:

$$country_a\_spread5y = \beta_0 + \beta_1\, country_a\_r + \beta_2\, country_a\_r^2 \qquad (15)$$

Then, because the main goal of this work is to study contagion among countries, a study of the relationship between each country 5 yield spread was pursued, again with OLS estimation, these are the main conclusions (Table VI):

Regression 6:

$$Country_A\_YS\_5y = \beta_0 + \beta_1\, country_B\_YS\_5y + \beta_2\, country_C\_YS\_5y + $$
$$+ \beta_3\, country_D\_YS\_5y + \beta_4\, country_E\_YS\_5y \qquad (16)$$

Greek yield Spread has a negative impact on Ireland, but a positive impact on Italy, Portugal and Spain. When the sample is restricted to [2008-2011], the impact of Greece on Ireland and Portugal decreased, but on Italy and Spain increased.

Irish yield Spread has a negative impact on Italy and a positive effect on Spain. When the sample is restricted to [July2008-Dec2011], the impact of Irish yields on Portugal and on Italy increased, but on Spain and Greece decreased.

Italian yield Spread has a positive impact in all countries yields' (except Irish ones), but the impact of Italy is higher on Spain, then on Portugal and less on Greece. When the sample is restricted to [July2008-Dec2011], the impact of Italy on Ireland and on Portugal increased, but the impact on Greece and Spain decreased.

Portuguese yield Spread has a negative impact on Spain and a positive effect on Italy (Greek coefficient is not significant). When the sample is restricted to [July2008-Dec2011], the impact of most countries on Ireland, Italy and Portugal increased.

$country\ A\_YS\_5y = \beta_0 + \beta_1\, country\ B\_YS\_5y + \beta_2\, country\ C\_YS\_5y + \beta_3\, country\ D\_YS\_5y + \beta_4\, country\ E\_YS\_5y$

	Jan 2005 - Dec 2011					July 2008 - Dec 2011				
	Greece	**Ireland**	**Italy**	**Portugal**	**Spain**	**Greece**	**Ireland**	**Italy**	**Portugal**	**Spain**
Greece		-0,607 [0,05]	2,801 [0,16]	1,151 [0,05]	1,972 [0,19]		-0,584 [0,09]	2,924 [0,25]	1,09 [0,08]	2,112 [0,26]
Ireland	-0,116 [-0,12]		-1,556 [-1,55]	0,689 [0,69]	2,616 [2,61]	-0,07 [0,01]		-1,841 [0,073]	0,756 [0,019]	2,065 [0,07]
Italy	0,049 [0,003]	-0,141 [0,006]		0,108 [0,007]	0,664 [0,02]	0,039 [0,003]	-0,206 [0,008]		0,169 [0,008]	0,604 [0,02]
Portugal	0,209 [0,009]	0,654 [0,02]	1,127 [0,07]		-1,039 [0,08]	0,14 [0,01]	0,806 [0,02]	1,612 [0,08]		-1,099 [0,09]
Spain	0,028 [0,003]	0,196 [0,004]	0,547 [0,017]	-0,082 [0,006]		0,028 [0,003]	0,228 [0,008]	0,597 [0,02]	-0,114 [0,009]	

Table VI: Regression coefficients

Now the same equation applied to CDS spreads:

<u>Regression 7:</u>

$$Country_A\_CDS\_5y = \beta_0 + \beta_1\, country_B\_CDS\_5y + \beta_2\, country_C\_CDS\_5y + \\ + \beta_3\, country_D\_CDS\_5y + \beta_4\, country_E\_CDS\_5y \qquad (17)$$

Greek CDS has a small influence on other countries CDS spreads. It shows a positive impact on Portugal and Italy, and a negative one in Ireland and Spain. Ireland has a strong negative impact on Greece, whereas the others have positive impacts or around 0. Italy has a positive impact on Greece and Spain and a negative one in Portugal and Ireland. Portugal just like Italy and Ireland also show a strong and positive impact on Greece, minor positive impacts on Ireland and Spain and then a negative impact on Italy. Finally, Spain shows the highest impact on Greece, a strong negative influence (-7.304), followed by smaller but positive impacts on Ireland, Italy and Portugal (Table VII).

When the sample is restricted, all countries are less sensitive to each other CDS spreads (excluding some exceptions).

$$country\ A\_CDS\_5y = \beta_0 + \beta_1\ country\ B\_CDS\_5y + \beta_2\ country\ C\_\ CDS\ \_5y + \\ + \beta_3\ country\ D\_\ CDS\ \_5y + \beta_4\ country\ E\_\ CDS\ \_5y$$

	Jan2005 - Dec2011					July2008 - Dec2011				
	Greece	**Ireland**	**Italy**	**Portugal**	**Spain**	**Greece**	**Ireland**	**Italy**	**Portugal**	**Spain**
Greece		-0,047 [0,0026]	0,029 [0,0013]	0,077 [0,0022]	-0,013 [0,0012]		-0,046 [0,0029]	0,024 [0,0014]	0,073 [0,0025]	-0,009 [0,0014]
Ireland	-4,750 [0,27]		-0,014 [0,0156]	0,756 [0,0229]	0,185 [0,0118]	-4,837 [0,294]		-0,009 [0,0173]	0,762 [0,0253]	0,187 [0,0131]
Italy	1,819 [0,49]	-0,053 [0,058]		-0,324 [0,0618]	0,638 [0,0164]	1,086 [0,534]	-0,033 [0,0637]		-0,333 [0,0678]	0,634 [0,0182]
Portugal	6,768 [0,2]	0,658 [0,02]	-0,075 [0,0144]		0,055 [0,0121]	6,751 [0,215]	0,655 [0,0217]	-0,077 [0,0158]		0,054 [0,0133]
Spain	-7,304 [0,67]	0,985 [0,063]	0,910 [0,0234]	0,336 [0,074]		-7,112 [0,729]	0,981 [0,0686]	0,901 [0,0259]	0,328 [0,0812]	

Table VII: Regression coefficients

5. Conclusions

From the event study it can be concluded that rating downgrades only have a significant impact on yield spreads but no significant influence on CDS returns (Table I), and that some changes in rating notations have higher impact than others (like downgrading to investment grade category or to bellow AAA).

The fact that CDS spreads have not experienced a statistically significant increase after a downgrade may be explained by the fact that, CDS premium by the time of Lehman Brothers collapse, was reflecting some of the high counterparty risk that CDS market was experiencing in that period. Banks were not lending to each other on generalized bankruptcy fears, lowering the CDS spreads, which could be not pricing well the default risk of the reference entities (De Wit, 2006). Other authors find that liquidity scarcity is the major issue driving the basis negative or factors like funding difficulties faced by investors, bonds traded above par value (the seller of a CDS contract who guarantees the par amount will settle for a correspondingly lower spread) or other technical issues played a significant role in this case. Afonso et al (2011), also found a weak evidence that CDS markets seem to anticipate rating downgrades, so it is likely that the downgrading itself has no impact on CDS spreads.

From yield spread impulse responses, it can be concluded that Greece is the country that is more influenced by the remaining under analysis, the influence is positive and similar from all of them and remains stable over the 10 lags, around 0,5 standard deviations. Portugal and Ireland influence each other, and Italy and Spain seem insensitive to other countries shocks. From CDS spread impulse responses, it can be concluded again, that Greece is the country that is more influenced by the others, and this influence is more pronounced with CDS spreads than with yield spreads. Those shocks are mostly Portuguese and positive, whereas Spanish shocks are negative.

From Granger Causality tests applied to 5 year yield spreads it can be concluded that, almost all countries are affected or influence somehow other countries yield spreads. This conclusion is similar to what we found in the event study. According to CDS spread Granger causality test (5 year maturity) there are only 11 contagion effects between the countries studied. This lack of contagion effects is more or less consistent with drawn conclusions from event study, where no causality was found. The more pronounced shocks begin in Greece and go towards Greece and Italy. This may be explained by the huge increase in Greek CDS spread during the period in analysis,

From the regression results it can be concluded that, Downgrades and negative outlooks are usually not statistically significant or, even when they are, have negative coefficients which are not economically intuitive, and that rating notation itself, has more influence on yield spread than negative outlooks. Rating variable is always significant, with a negative impact on yield and CDS spreads (usually higher for Greece and lower for Ireland). Also found a convex parabolic relationship between rating and most countries' yield spreads. This relationship exists due to a positive squared rating coefficient, which means that, each additional upgrade/downgrade has a diminishing effect on yield spread. There is also a positive relationship between yield spread and CDS spreads, and a negative one between yield spread and rating notation, which are economically intuitive.

Also from regression results, we found that, all countries yield spreads tend to influence positively other countries yield spreads, with Italy and Spain, being the ones that are most affected, and Greece and Ireland the ones that influence the others the most, during the period [2005-2011] (Table VI).

Finally, we may conclude that regarding contagion among each country CDS spread, Greece has a small influence on the other countries, and Spain is the country with the highest influence on Greece (Table VII).

So, despite the fact that this study focuses on different countries and time horizons than the remaining literature, the conclusions about return spillovers and the effect of rating downgrades on yields and CDS are analogous.

5.1 Limitations

This study focuses on yield spreads and CDS spreads from Jan-2005 till Dec-2011, but CDS (mainly from developed countries) had few liquidity before 2009, expressed by Fitch Liquidity score[4], the number of outstanding contracts and the spread bid-ask. In general, the more liquid a sovereign CDS is, stronger are the signs of financial stress, or a significant amount of outstanding national debt. This lack of liquidity can biase the results and therefore the conclusions drawn from the beginning of my sample.

The fact that conditional correlation tends to be a positive function of volatility, requires that classical correlation coefficients need to be adjusted to overcome the problem. The existence of Heteroskedaticity in data, biases coefficient standard errors and the existence of cointegrated variables did not allow the use of cholesky factor in the Vector autoregressive framework. Some of the shortcomings of VAR is that it cannot produce structural estimates, and requires the estimation of very large numbers of parameters causing some inefficiency.

Using the least squares regression is undoubtedly useful and an important technique, but has many defects like: lower performance when there are outliers, in reality most systems are not linear, leads to poor predictions if independent variables are significantly correlated to each other, the problem of selecting the wrong independent variables for a prediction problem will lead to spurious relationships between independent and dependent variables and when a substantial amount of noise in the independent variables is present, the total least squares technique may be more appropriate than ordinary least squares (Wooldridge; 2009).

[4] http://www.fitchpricingservices.com/liquidityscores.do

5.2 Future investigation

In the future we suggest the construction of a model that could predict or estimate, based on spillover measures, the evolution of economic variables like yields or CDS spreads. That could help countries in economic distress to implement earlier structural changes in the economy, and other healthier countries to protect themselves from contagion. That would be useful in case Portugal would have asked for IMF help earlier, the contagion effects and the austerity measures needed would be much less aggressive.

It would also be interesting to remake the same study several years later after the crisis peak (to evaluate whether contagion effects decrease), to include a broader period (to see the impact of upgrades or positive outlooks) or include countries like Germany or Netherlands, with lower risk premiums in order to see if results are similar.

6. References

<u>Database</u>

- Bloomberg

<u>Books</u>

- Eviews 6 user's guide II (2007); Quantitative Microsoftware, U.S.A.
- Peña, D (2005); "Análisis de series temporales"; Alianza Editorial, Madrid.
- Wooldridge, J. M. (2009); "Introductory Econometrics, A Modern Approach"; 4th ed., South-Western.
- Zivot, E.; Wang, J. (2005); "Modeling Financial Time Series with S-PLUS" Washington; pp 383-426.

<u>Papers</u>

- Afonso, A.; Furceri, D.; Gomes P. (2011); "Sovereign Credit Ratings and Financial markets linkages – application to European data"; Working paper series n.º 1347; European Central Bank.
- Ahern, K. (2006); "Sample selection and event study estimation"; Journal of Empirical Finance; Vol. 16; pp. 466–482.
- Baig, T; Goldfajr, I. (1998); Financial Market contagion in the Asian Crisis; IMF working paper; International Monetary Fund.
- Booth, G.; Martikainen, T.; Tse, Y. (1997); "Price and Volatility Spillovers in Scandinavian Stock Markets"; Journal of Banking and Finance; Vol. 21, n. 6; pp 811-23.
- Boyer, B.; Gibson, M.; Loretan, M. (1999); "Pitfalls in tests for changes in correlations"; Board of Governors of the Federal Reserve System (U.S.); International Finance Discussion; Paper n. 597.
- Corsetti, G.; Pericoli M.; Sbracia M. (2005); "Some contagion, some interdependence: More pitfalls in tests of financial contagion"; Journal of International Money and Finance 24; pp 1177–1199.
- De Wit, J. (2006); "Exploring the CDS-Bond Basis"; NBB Working Paper, No. 104, National; Bank of Belgium.

- Diebold, F.; Yilmaz, K. (2009); “Measuring Financial Asset Return and Volatility Spillovers, with Application to Global Equity Markets”; Economic Journal; Vol. 119 n.º 534; pp 158-71.
- Diebold, F.; Yilmaz K. (2010); “Better to give than to receive: predictive directional measurement of volatility spillovers”; International Journal of forecasting; University of Pennsylvania and Koç University, Istambul.
- Fama, E.; Fisher, L.; Jensen, M.; Roll, R. (1969); “The Adjustment of Stock Prices to New Information”; International Economic Review; Vol. 10, n. 1; pp. 1-21.
- Forbes, J.; Rigobon, R. (2002); “No Contagion, Only Interdependence: Measuring Stock Market Comovements”; Journal of Finance. Vol. 57 n.5; pp 2223-61.
- Fu, H. (2011); “Empirical Findings of Mergers and Acquisitions in the European Electricity and Gas Industry after the 5th Wave”; Master thesis; Tilburg University.
- Hamao, Y.; Masulis, R.; Ng, V. (1990); "Correlations in Price Changes and Volatility across International Stock Markets”; The review of financial studies, vol. 3; n. 3; pp. 281-307.
- Horen, V.; Jager H.; Klaassen, F. (2005); Foreign Exchange Market Contagion in the Asian Crisis: A Regression-based Approach; University of Amsterdam.
- Hsin, C. (2004); “A Multilateral Approach to Examining the Comovements among Major World Equity Markets”; International Review of Financial Analysis; Vol. 13; n. 4; pp 433-62.
- Karolyi, G. (1995); “Multivariate GARCH Model of International Transmissions of Stock Returns and Volatility: The Case of the United States and Canada”; Journal of Business and Economic Statistics; Vol. 13 n.1; pp 11-25.
- King, A.; Wadhwani, S. (1990); “Transmission of Volatility between Stock Markets”; National Bureau of Economic Research, Inc, NBER Working Papers.
- Loretan, M.; English, W. (2000); “Evaluating Changes in Correlations during Periods of High Market Volatility”; BIS Quarterly Review; pp 29-36.
- Marra, M. (2012); “Illiquidity Commonality across Equity and Credit Markets”; Warwick Business School.

- Pesaran, M.; Shin, Y. (1997); "Generalized Impulse Response Analysis in Linear Multivariate Models"; Trinity College, Cambridge and Department of Applied Economics, University of Cambridge.
- Serra, A. (2002); "Event Study tests – a brief survey"; FEP; Porto.
- Turk, T. (1992); "Takeover Resistance, Information Leakage, and Target Firm Value"; Journal of Management; vol. 18 pp. 503-522.
- Wang, S.; Rui, O.; Firth, M. (2002); "Return and Volatility Behavior of Dually-Traded Stocks: The Case of Hong Kong"; Journal of International Money and Finance; Vol. 21 n. 2; pp 265-93.
- Wit, Jan (2006);" Exploring the CDS-Bond Basis"; Working papers; National Bank of Belgium.
- Worrell, D.; Davidson W.; Chandy, P.; Garrison S. (1986); "Management Turnover through Deaths of Key Executives: Effects on Investor Wealth"; The Academy of Management Journal; Vol. 29, n. 4; pp. 674-694.

<u>Web sites:</u>

ECB Website available on (last update: 20-09-2012)

- http://www.ecb.int/stats/money/yc/html/technical_notes.pdf

Fitch Website available on (last update: 13-06-2012):

- http://www.fitchpricingservices.com/liquidityscores.do
- http://www.fitchratings.com

Business Watch Website available on (last update: 20-12-2011):

- http://businesswatch.in/sovereign-debt-crisis-analysis-of-greece-fallout/

7. Appendix

	5y Yield Spread					CDS Spread 5y				
	Greece	**Ireland**	Italy	**Portugal**	Spain	**Greece**	Ireland	**Italy**	Portugal	**Spain**
Mean	0,08	0,08	0,06	0,03	-0,01	0,06	0,07	0,04	0,05	0,04
Median	0,01	0,02	0,00	0,01	0,00	0,02	0,02	0,00	0,00	0,00
Maximum	50,00	53,00	28,00	25,00	58,00	9,40	5,96	6,78	7,05	11,95
Minimum	-15,67	-40,66	-22,00	-46,28	-48,00	-9,23	-9,89	-6,91	-7,49	-11,95
Std. Dev.	1,76	2,98	2,00	1,78	4,00	0,02	0,02	0,02	0,02	0,02
Skewness	15,34	3,20	2,72	-9,33	-1,00	0,12	-0,81	0,08	0,27	0,11
Kurtosis	430,29	133,81	75,48	288,22	79,00	18,20	32,26	12,87	10,66	36,82
Probability	0,08	0,14	0,08	0,08	0,18	0,05	0,00	0,00	0,00	0,04
Sum	138,00	144,00	117,00	62,00	-13,00	109,63	76,79	65,99	84,16	73,93
Obs.	1.824	1.824	1.824	1.824	1.824	1.824	1.100	1.824	1.824	1.824

Descriptive Statistics for daily returns (annualized)

Table A: Descriptive Statistics Source: Bloomberg; own calculations.

Correlation between yield spreads 3M

	GREECE_3M	IRELAND_3M	ITALY_3M	PORTUGAL_3M	SPAIN_3M
GREECE_3M	1	0,2841	0,7067	0,5384	0,6657
IRELAND_3M		1	0,4656	0,4716	0,6395
ITALY_3M			1	0,7626	0,9038
PORTUGAL_3M				1	0,7590
SPAIN_3M					1

Correlation between yield spreads 5y

	GREECE_5Y	IRELAND_5Y	ITALY_5Y	PORTUGAL_5Y	SPAIN_5Y
GREECE_5Y	1	0,7940	0,9531	0,9342	0,9198
IRELAND_5Y		1	0,7801	0,8929	0,8966
ITALY_5Y			1	0,9173	0,9344
PORTUGAL_5Y				1	0,9194
SPAIN_5Y					1

Correlation between yield spreads 15y

	GREECE_15Y	IRELAND_15Y	ITALY_15Y	PORTUGAL_15Y	SPAIN_15Y
GREECE_15Y	1	0,871407	0,962912	0,964558	0,940864
IRELAND_15Y		1	0,864683	0,918875	0,949477
ITALY_15Y			1	0,944853	0,945932
PORTUGAL_15Y				1	0,93988
SPAIN_15Y					1

Table B: Unconditional Correlations between yield spreads, 3 months, 5 and 15 years

Source: Bloomberg; own calculations.

Correlation between CDS spread 5y

	GREECE_CDS	IRELAND_CDS	ITALY_CDS	PORTUGAL_CDS	SPAIN_CDS
GREECE_CDS	1	0,661968	0,874361	0,826532	0,750183
IRELAND_CDS		1	0,825351	0,936741	0,928087
ITALY_CDS			1	0,903019	0,919864
PORTUGAL_CDS				1	0,934974
SPAIN_CDS					1

Table C: Unconditional Correlations between CDS spreads 5Y

Correlation between yield spreads

From January 2005 to June 2008

	GREECE 3M	IRELAND 3M	ITALY 3M	PORTUGAL 3M	SPAIN 3M
GREECE_YS	1	0,7575	-0,1458	0,5917	0,7479
IRELAND_YS		1	-0,0850	0,6849	0,8962
ITALY_YS			1	-0,1790	-0,1556
PORTUGAL_YS				1	0,7868
SPAIN_YS					1

From July 2008 to December 2011

	GREECE 3M	IRELAND 3M	ITALY 3M	PORTUGAL 3M	SPAIN 3M
GREECE_YS	1	0,1669	0,6886	0,4835	0,6364
IRELAND_YS		1	0,3831	0,2974	0,5040
ITALY_YS			1	0,7363	0,9185
PORTUGAL_YS				1	0,6931
SPAIN_YS					1

3 months yield spread

From January 2005 to June 2008

	GREECE 5Y	IRELAND 5Y	ITALY 5Y	PORTUGAL 5Y	SPAIN 5Y
GREECE_YS	1	-0,1203	0,4846	0,2962	0,5827
IRELAND_YS		1	-0,2364	-0,0886	-0,0849
ITALY_YS			1	0,7245	0,3195
PORTUGAL_YS				1	0,3642
SPAIN_YS					1

From July 2008 to December 2011

	GREECE 5Y	IRELAND 5Y	ITALY 5Y	PORTUGAL 5Y	SPAIN 5Y
GREECE_YS	1	0,7379	0,9437	0,9171	0,9050
IRELAND_YS		1	0,6874	0,8804	0,8498
ITALY_YS			1	0,8971	0,9072
PORTUGAL_YS				1	0,9062
SPAIN_YS					1

5 year yield spread

From January 2005 to June 2008

	GREECE 15Y	IRELAND 15Y	ITALY 15Y	PORTUGAL 15Y	SPAIN 15Y
GREECE_YS	1	0,9702	0,9215	0,9189	0,8960
IRELAND_YS		1	0,8682	0,8929	0,9226
ITALY_YS			1	0,9419	0,6968
PORTUGAL_YS				1	0,7508
SPAIN_YS					1

From July 2008 to December 2011

	GREECE 15Y	IRELAND 15Y	ITALY 15Y	PORTUGAL 15Y	SPAIN 15Y
GREECE_YS	1	0,8185	0,9518	0,9537	0,9334
IRELAND_YS		1	0,8077	0,8982	0,9241
ITALY_YS			1	0,9301	0,9362
PORTUGAL_YS				1	0,9448
SPAIN_YS					1

15 year yield spread

Table D: Unconditional Correlations between yield spreads before and during crisis

Source: Bloomberg; own calculations.

Correlation between CDS spreads

From January 2005 to June 2008

	GREECE	IRELAND	ITALY	PORTUGAL	SPAIN
GREECE CDS	1	0,8724	0,9097	0,9241	0,8448
IRELAND CDS		1	0,9699	0,9074	0,8753
ITALY CDS			1	0,9590	0,9201
PORTUGAL CDS				1	0,9660
SPAIN CDS					1

From July 2008 to December 2011

	GREECE	IRELAND	ITALY	PORTUGAL	SPAIN
GREECE CDS	1	0,6575	0,8795	0,8248	0,7522
IRELAND CDS		1	0,8131	0,9352	0,9230
ITALY CDS			1	0,9000	0,9138
PORTUGAL CDS				1	0,9353
SPAIN CDS					1

Table E: Unconditional Correlations between CDS spreads before and during crisis

Source: Bloomberg; own calculations

Fitch - Complete Sovereign Rating History			
Country	Date	Long-term	Outlook / Watch
Greece	13-Jul-11	CCC	- -
Greece	20-May-11	B +	Rating Watch negative
Greece	14-Jan-11	BB +	negative
Greece	21-Dec-10	BBB-	Rating Watch negative
Greece	9-Apr-10	BBB-	negative
Greece	12-May-09	A	negative
Greece	20-Oct-08	A	stable
Greece	5-Mar-07	A	positive
Greece	16-Dec-04	A	stable
Ireland	16-Dec-11	BBB +	Rating Watch negative
Ireland	14-Apr-11	BBB +	negative
Ireland	1-Apr-11	BBB +	Rating Watch negative
Ireland	9-Dec-10	BBB +	stable
Ireland	6-Oct-10	A +	negative
Ireland	4-Nov-09	AA-	stable
Ireland	8-Apr-09	AA +	negative
Ireland	6-Mar-09	AAA	Rating Watch negative
Ireland	21-Sep-00	AAA	stable
Italy	16-Dec-11	A +	Rating Watch negative
Italy	7-Oct-11	A +	negative
Italy	19-Oct-06	AA-	stable
Italy	25-May-06	AA	Rating Watch negative
Italy	29-Jun-05	AA	negative
Italy	17-Jun-02	AA	stable
Portugal	24-Nov-11	BB +	negative
Portugal	1-Apr-11	BBB-	Rating Watch negative
Portugal	24-Mar-11	A-	Rating Watch negative
Portugal	23-Dec-10	A +	negative
Portugal	24-Mar-10	AA-	negative
Portugal	3-Sep-09	AA	negative
Portugal	1-May-07	AA	stable
Portugal	29-Jun-05	AA	negative
Portugal	21-Sep-00	AA	stable

Country	Date	Long-term	Outlook / Watch
Spain	16-Dec-11	AA-	Rating Watch negative
Spain	7-Oct-11	AA-	negative
Spain	4-Mar-11	AA +	negative
Spain	28-May-10	AA +	stable
Spain	10-Dec-03	AAA	stable

Table F: Complete sovereign rating history from Fitch rating agency since 2005 till 2011

Source: Fitch Website

Date	Events	Data	Normal Returns - yield spread					Normal Returns - CDS spread				
			Greece	Ireland	Portugal	Spain	Italy	Greece	Ireland	Portugal	Spain	Italy
22-10-2009	Greece downgrade from A to A-	NR	0,96	0,96	0,40	0,40	0,51	-0,03	-0,10	-0,07	-0,04	-0,07
		SD (AR)	0,04	0,05	0,03	0,02	0,03	0,24	0,21	0,23	0,36	0,16
		CAR	-0,30	-2,75	-0,73	-1,23	-1,97	1,90	1,71	2,27	0,45	1,63
		CAAR	-0,03	-0,25	-0,07	-0,11	-0,18	0,17	0,16	0,21	0,04	0,15
		t-test	-0,78	-5,09	-2,37	-4,53	-6,66	0,72	0,73	0,91	0,11	0,94
09-04-2010	Greece downgrade from BBB+ to BBB-	NR	3,56	0,83	1,05	0,61	0,57	0,05	-0,02	0,11	0,00	0,01
		SD (AR)	0,41	0,07	0,09	0,04	0,03	1,18	0,60	0,89	0,62	0,52
		CAR	11,18	-1,66	1,63	0,64	-0,60	2,97	0,61	3,42	4,64	1,52
		CAAR	1,02	-0,15	0,15	0,06	-0,05	0,27	0,06	0,31	0,42	0,14
		t-test	2,46	-2,07	1,64	1,55	-1,66	0,23	0,09	0,35	0,68	0,27
14-01-2011	Greece downgrade from BBB- to BB+	NR	10,11	5,10	3,55	2,26	1,51	0,08	0,08	0,06	0,10	0,05
		SD (AR)	0,94	0,36	0,29	0,35	0,27	0,32	0,44	0,48	0,49	0,62
		CAR	2,80	3,81	2,03	3,44	2,12	-3,79	-1,48	-2,95	-5,39	-4,53
		CAAR	0,25	0,35	0,18	0,31	0,19	-0,34	-0,13	-0,27	-0,49	-0,41
		t-test	0,27	0,96	0,64	0,90	0,70	-1,08	-0,31	-0,56	-1,00	-0,66
13-07-2011	Greece downgrade from B+ to CCC	NR	14,03	8,73	9,08	2,18	1,55	0,16	0,06	0,07	0,05	0,08
		SD (AR)	0,63	1,02	0,48	0,35	0,48	0,70	0,98	1,14	0,87	1,30
		CAR	40,87	47,85	58,43	11,29	16,02	1,53	5,06	4,67	3,16	5,27
		CAAR	3,72	4,35	5,31	1,03	1,46	0,14	0,46	0,42	0,29	0,48
		t-test	5,86	4,28	11,14	2,92	3,06	0,20	0,47	0,37	0,33	0,37

Date	Events	Data	Normal Returns - yield spread					Normal Returns - CDS price				
			Greece	Ireland	Portugal	Spain	Italy	Greece	Ireland	Portugal	Spain	Italy
08-04-2009	Ireland downgrade from AAA to AA+	NR	2,23	2,74	1,22	0,95	1,24	0,09	-0,06	0,02	0,03	-0,02
		CAR	-7,12	-3,96	-3,65	-2,87	-3,49	-4,55	-2,71	-5,48	-5,35	-4,25
		SD (AR)	0,11	0,10	0,07	0,06	0,04	0,70	0,73	0,92	0,92	0,70
		CAAR	-0,65	-0,36	-0,33	-0,26	-0,32	-0,41	-0,25	-0,50	-0,49	-0,39
		t-test	-5,95	-3,77	-4,69	-4,69	-8,04	-0,60	-0,34	-0,54	-0,53	-0,55
04-11-2009	Ireland downgrade from AA+ to AA-	NR	0,89	0,94	0,39	0,37	0,48	-0,04	0,03	0,01	0,02	0,01
		CAR	-2,67	0,23	-0,32	-0,93	-1,87	3,15	1,72	1,53	0,91	0,57
		SD (AR)	0,03	0,02	0,01	0,01	0,03	0,26	0,27	0,33	0,22	0,20
		CAAR	-0,24	0,02	-0,03	-0,08	-0,17	0,29	0,16	0,14	0,08	0,05
		t-test	-9,62	1,37	-2,01	-7,43	-4,87	1,08	0,57	0,42	0,37	0,26

09-12-2010	Ireland downgrade from A+ to BBB+	NR	4,36	9,62	3,49	1,82	1,35	0,13	0,01	0,10	0,08	0,01
		CAR	-60,88	10,13	-3,66	9,00	2,44	-1,53	0,00	-1,85	-0,48	-2,10
		SD (AR)	0,45	0,10	0,19	0,10	0,05	0,40	0,29	0,59	0,62	0,73
		CAAR	-5,53	0,92	-0,33	0,82	0,22	-0,14	0,00	-0,17	-0,04	-0,19
		t-test	-12,42	9,28	-1,72	8,55	4,37	-0,35	0,00	-0,28	-0,07	-0,26

			Normal Returns - yield spread					**Normal Returns - CDS spread**				
Date	**Events**	**Data**	**Greece**	**Ireland**	**Portugal**	**Spain**	**Italy**	**Greece**	**Ireland**	**Portugal**	**Spain**	**Italy**
24-03-2010	Portugal downgrade from AA to AA-	NR	0,96	3,38	0,86	0,59	0,54	0,11	0,05	-0,08	0,00	-0,01
		CAR	2,45	1,79	-0,87	0,71	0,35	2,43	2,02	4,61	3,58	3,85
		SD (AR)	0,08	0,20	0,07	0,04	0,04	0,44	0,69	0,41	0,83	0,42
		CAAR	0,26	0,25	-0,12	0,07	0,03	0,22	0,18	0,42	0,33	0,35
		t-test	3,29	1,23	-1,54	1,81	0,77	0,50	0,26	1,03	0,39	0,83
23-12-2010	Portugal downgrade from AA- to A+	NR	3,51	9,61	4,68	1,96	1,38	0,06	0,00	0,08	0,08	-0,01
		CAR	1,73	16,43	8,60	9,40	4,13	1,36	2,22	1,02	0,60	3,13
		SD (AR)	0,16	0,35	0,37	0,05	0,14	0,19	0,36	0,18	0,16	0,29
		CAAR	0,16	1,49	0,78	0,85	0,38	0,12	0,20	0,09	0,05	0,28
01-04-2011	Portugal downgrade from A- to BBB-	NR	4,31	10,54	5,97	2,11	1,46	0,03	-0,02	0,00	-0,11	-0,10
		CAR	25,70	8,05	14,16	-5,22	-3,79	-0,99	0,88	-2,78	-0,36	-2,32
		SD (AR)	0,50	0,25	0,61	0,05	0,06	0,38	0,20	0,54	0,79	0,42
		CAAR	2,34	0,73	1,29	-0,47	-0,34	-0,09	0,08	-0,25	-0,03	-0,21
		t-test	4,66	2,98	2,11	-9,22	-5,31	-0,24	0,40	-0,47	-0,04	-0,50
24-11-2011	Portugal downgrade from BBB- to BB+	NR	12,02	24,93	6,19	3,41	4,14	0,06	0,32	-0,01	0,09	0,13
		CAR	16,60	146,74	11,65	14,35	20,11	-1,06	-0,97	-0,76	-3,86	-4,75
		SD (AR)	1,63	1,42	0,53	0,25	0,36	0,30	1,61	0,35	0,67	0,53
		CAAR	1,51	13,34	1,06	1,30	1,83	-0,10	-0,09	-0,07	-0,35	-0,43
		t-test	0,93	9,43	2,01	5,23	5,12	-0,32	-0,05	-0,20	-0,52	-0,81

Date	Events	Data	Normal Returns - yield spread					Normal Returns - CDS spread				
			Greece	Ireland	Portugal	Spain	Italy	Greece	Ireland	Portugal	Spain	Italy
28-05-2010	Spain downgrade from AAA to AA+	NR	0,85	5,36	1,10	1,62	0,70	0,11	0,18	0,09	0,16	0,05
		CAR	9,80	15,31	8,27	7,16	7,72	2,26	-0,66	3,50	-0,61	6,55
		SD (AR)	0,24	0,22	0,11	0,16	0,18	1,15	0,57	0,84	0,79	1,14
		CAAR	0,89	1,39	0,75	0,65	0,70	0,21	-0,06	0,32	-0,06	0,60
		t-test	3,77	6,40	6,90	3,98	3,87	0,18	-0,11	0,38	-0,07	0,52
07-10-2011	Spain downgrade from AA+ to AA-	NR	3,20	18,60	8,46	11,83	3,29	0,08	0,24	-0,02	0,09	0,24
		CAR	-0,47	56,81	-19,19	4,45	5,45	-0,52	-0,50	1,57	-0,14	-2,83
		SD (AR)	0,17	0,67	0,58	0,17	0,11	0,46	0,91	0,43	0,35	0,50
		CAAR	-0,04	5,16	-1,74	0,40	0,50	-0,05	-0,05	0,14	-0,01	-0,26
		t-test	-0,26	7,69	-3,03	2,37	4,42	-0,10	-0,05	0,33	-0,04	-0,52

Date	Events	Data	Normal Returns - yield spread					Normal Returns - CDS spread				
			Greece	Ireland	Portugal	Spain	Italy	Greece	Ireland	Portugal	Spain	Italy
19-10-2006	Italy downgrade from AA to AA-	NR	0,11	0,15	-0,72	0,10	0,02	-0,074	-0,051	Not Available	-0,074	-0,019
		CAR	-0,13	-0,03	-0,79	-0,17	-0,08	0,669	-1,227		0,811	-1,405
		SD (AR)	0,00	0,00	0,04	0,00	0,00	0,296	0,279		0,146	0,488
		CAAR	-0,01	0,00	-0,07	-0,02	-0,01	0,061	-0,112		0,074	-0,128
		t-test	-4,04	-0,84	-1,97	-10,55	-6,03	0,205	-0,400		0,506	-0,262
07-10-2011	Italy downgrade from AA- to A+	NR	3,29	18,60	8,46	11,83	3,20	0,239	0,236	-0,022	0,091	0,078
		CAR	6,75	68,16	-38,37	5,28	-1,40	-2,829	-0,504	1,569	-0,137	-0,518
		SD (AR)	0,13	0,81	0,18	0,22	0,15	0,497	0,914	0,427	0,355	0,460
		CAAR	0,61	6,20	-3,49	0,48	-0,13	-0,257	-0,046	0,143	-0,012	-0,047
		t-test	4,59	7,60	-19,27	2,14	-0,84	-0,517	-0,050	0,334	-0,035	-0,102

Table G: Normal Returns (NR), Cumulative Abnormal Returns (CAR), Cumulative Average Abnormal Returns (CAAR), AR standard deviation [SD (AR)], t-test [CAAR / SD (AR)]. Source: Own calculations

$country_a\_CDS = \beta_0 + \beta_1\ country_a\_r + \beta_2\ country_a\_spread5y + \beta_3\ down\_\ country_a + \beta_4\ neg\_\ country_a$

	Jan2005-Dec2011					July2008-Dec2011				
	Greece	Ireland	Italy	Portugal	Spain	Greece	Ireland	Italy	Portugal	Spain
Rating	-2,23 [0,07]	-0,28 [0,015]	-0,08 [0,02]	-0,23 [0,02]	-0,19 [0,02]	-2,07 [0,09]	-0,27 [0,015]	-0,5 [0,04]	-0,13 [0,03]	-0,368 [1,86]
Yield Spread_5y	2,67 [0,028]	0,61 [0,014]	1,05 [0,01]	0,97 [0,01]	1,22 [0,01]	2,69 [0,04]	0,61 [0,01]	1,06 [0,01]	0,88 [0,02]	1,049 [1,39]
Downgrade	1,66 [1,57]	0,04 [0,33]	0,21 [0,19]	0,61 [0,25]	0,35 [0,14]	-1,99 [1,97]	0,029 [0,33]	1,03 [0,29]	0,49 [0,33]	0,2402 [0,154]
Negative Outlook	-3,78 [1,92]	0,35 [0,38]	-0,23 [0,19]	0,07 [0,28]	0,31 [0,14]	-2,26 [2,4]	0,34 [0,38]	0,19 [0,29]	-0,04 [0,43]	2,014 [1,55]
R^2	0,9	0,94	0,95	0,97	0,97	0,9	0,94	0,94	0,97	0,97

Table H: Regression 1 coefficients

$country_a\_r = \beta_0 + \beta_1\ country_a\ \_CDS$

	Jan2005-Dec2011					July2008-Dec2011				
	Greece	Ireland	Italy	Portugal	Spain	Greece	Ireland	Italy	Portugal	Spain
CDS	-0,17 [0,003]	-0,99 [0,013]	-0,24 [0,006]	-0,75 [0,006]	-0,52 [0,007]	-0,15 [0,004]	-0,99 [0,01]	-0,2 [0,006]	-0,82 [0,008]	-0,64 [0,01]
R^2	0,63	0,84	0,46	0,89	0,77	0,59	0,83	0,48	0,9	0,78

Table I: Regression 2 coefficients

$country_a\_spread5y = \beta_0 + \beta_1\ country_a\_r$

	Jan2005-Dec2011					July2008-Dec2011				
	Greece	Ireland	Italy	Portugal	Spain	Greece	Ireland	Italy	Portugal	Spain
Rating	-2,2 [0,02]	-0,99 [0,01]	-1,89 [0,04]	-1,46 [0,01]	-1,36 [0,01]	-2,2 [0,03]	-0,92 [0,01]	-2,74 [0,07]	-1,4 [0,01]	-1,2 [0,02]
R^2	0,84	0,84	0,51	0,94	0,82	0,80	0,78	0,59	0,94	0,82

Table J: Regression 3 coefficients

$country_a\_spread\_5y = \beta_0 + \beta_1\ country_a\_r + \beta_2\ down\_\ country_a + \beta_3\ neg\_country_a$

	Jan2005-Dec2011					July2008-Dec2011				
	Greece	Ireland	Italy	Portugal	Spain	Greece	Ireland	Italy	Portugal	Spain
Rating	-2,21 [0,02]	-1 [0,01]	-1,9 [0,04]	-1,46 [0,01]	-1,37 [0,01]	-2,21 [0,03]	-0,92 [0,01]	-2,75 [0,07]	-1,4 [0,01]	-1,21 [0,02]
Downgrade	-4,62 [1,31]	-0,82 [0,57]	-0,47 [0,56]	-0,79 [0,44]	-0,7 [0,31]	-4,64 [1,72]	-0,94 [0,70]	-1,41 [0,80]	-0,81 [0,51]	-0,67 [0,34]
Negative Outlook	0,57 [1,60]	0,84 [0,65]	0,83 [0,56]	-1,16 [0,49]	-0,98 [0,31]	0,57 [2,10]	0,8 [0,80]	0,21 [0,80]	-1,5 [0,66]	-0,87 [0,34]
R^2	0,84	0,84	0,51	0,94	0,83	0,80	0,78	0,59	0,95	0,82

Table K: Regression 4 coefficients

$country_a\_spread5y = \beta_0 + \beta_1\ dif(country_a\_r) + \beta_2\ country_a\_r^2$

	Jan2005-Dec2011					July2008-Dec2011				
	Greece	Ireland	Italy	Portugal	Spain	Greece	Ireland	Italy	Portugal	Spain
Rating	-3,78 [0,10]	-2,76 [0,14]	-24,6 [1]	-1,52 [0,11]	7,73 [0,41]	-3,85 [0,13]	-3,88 [0,17]	-21,6 [1,82]	-1,44 [0,13]	5,66 [0,47]
$Rating^2$	0,11 [0,01]	0,07 [0,00]	0,82 [0,04]	0,003 [0,005]	-0,29 [0,01]	0,12 [0,01]	0,11 [0,01]	0,7 [0,07]	0,002 [0,006]	-0,22 [0,01]
R^2	0,86	0,86	0,62	0,94	0,86	0,83	0,83	0,59	0,94	0,85

Table L: Regression 5 coefficients

VAR Lag Exclusion Wald Tests
Chi-squared test statistics for lag exclusion

Numbers in [ ] are p-values
Sample: 3/01/2005 12/30/2011

	GREEK_YS	IRISH_YS	ITALIAN_YS	PORTUG_YS	SPAIN_YS	**Joint**
Lag 1	2.069,219 [0,000000]	2.364,634 [0,000000]	2.381,309 [0,000000]	2.847,218 [0,000000]	2.679,588 [0,000000]	11.021,010 [0,000000]
Lag 2	122,581 [0,000000]	42,939 [3,80e-08]	101,800 [0,000000]	102,598 [0,000000]	117,598 [0,000000]	298,132 [0,000000]
Lag 3	32,561 [4,60e-06]	22,708 [0,000384]	8,533 [0,129187]	13,608 [0,018302]	7,290 [0,199973]	127,832 [8,88e-16]
Lag 4	24,337 [0,000187]	24,632 [0,000164]	51,836 [5,83e-10]	21,672 [0,000604]	35,675 [1,10e-06]	111,640 [6,42e-13]
Lag 5	38,684 [2,75e-07]	34,497 [1,90e-06]	32,571 [4,58e-06]	31,467 [7,57e-06]	23,188 [0,000311]	122,104 [9,44e-15]
Lag 6	11,302 [0,045702]	32,833 [4,06e-06]	35,602 [1,14e-06]	10,020 [0,074666]	28,809 [2,53e-05]	127,849 [8,88e-16]
Lag 7	48,179 [3,27e-09]	6,270 [0,280807]	56,892 [5,32e-11]	17,714 [0,003327]	54,044 [2,05e-10]	164,593 [0,000000]
Lag 8	25,437 [0,000115]	9,841 [0,079859]	19,992 [0,001254]	24,286 [0,000191]	11,717 [0,038880]	128,478 [6,66e-16]
Lag 9	13,198 [0,021589]	39,166 [0,561492]	28,605 [2,77e-05]	17,666 [0,003395]	37,211 [5,43e-07]	129,464 [4,44e-16]
Lag 10	6,407 [0,268603]	11,811 [0,037476]	55,692 [9,41e-11]	14,077 [0,015126]	51,614 [6,47e-10]	138,731 [0,000000]
Lag 11	1,703 [0,888565]	19,994 [0,001253]	35,402 [1,25e-06]	25,414 [0,000116]	27,355 [4,86e-05]	88,223 [5,57e-09]
Lag 12	6,007 [0,305562]	15,884 [0,007184]	17,793 [0,003218]	9,991 [0,075504]	16,202 [0,006290]	76,713 [3,70e-07]
df	5	5	5	5	5	25

Included observations: 1772

	GREEK_CDS	IRISH_CDS	ITALIAN_CDS	PORTUG_CDS	SPAIN_CDS	**Joint**
Lag 1	1.429,213 [0,000000]	1.661,261 [0,000000]	1.497,564 [0,000000]	1.645,474 [0,000000]	1.319,399 [0,000000]	6.681,086 [0,000000]
Lag 2	43,964 [2,36e-08]	41,895 [6,19e-08]	60,338 [1,03e-11]	54,916 [1,36e-10]	28,922 [2,40e-05]	171,671 [0,000000]
Lag 3	23,531 [0,000267]	11,555 [0,041416]	6,677 [0,245814]	34,280 [2,09e-06]	4,216 [0,518716]	89,997 [2,86e-09]
Lag 4	49,110 [2,11e-09]	10,049 [0,073857]	39,784 [1,65e-07]	21,206 [0,000741]	16,273 [0,006105]	108,396 [2,33e-12]
Lag 5	4,175 [0,524552]	23,287 [0,000297]	35,095 [1,44e-06]	23,948 [0,000222]	31,926 [6,15e-06]	70,300 [3,47e-06]
Lag 6	13,495 [0,019158]	23,191 [0,000310]	9,008 [0,108764]	11,321 [0,045373]	20,430 [0,001038]	69,177 [5,09e-06]
Lag 7	6,053 [0,301076]	30,829 [1,01e-05]	20,349 [0,001075]	17,077 [0,004356]	22,714 [0,000383]	70,523 [3,22e-06]
Lag 8	24,328 [0,000188]	3,148 [0,677163]	16,459 [0,005649]	8,624 [0,125044]	21,239 [0,000730]	89,710 [3,19e-09]
Lag 9	35,631 [1,13e-06]	8,287 [0,141125]	28,641 [2,73e-05]	21,857 [0,000557]	25,728 [0,000101]	86,651 [9,99e-09]
Lag 10	53,517 [2,63e-10]	13,340 [0,020391]	20,911 [0,000842]	30,747 [1,05e-05]	22,647 [0,000394]	122,195 [9,10e-15]
Lag 11	39,204 [2,16e-07]	81,412 [0,148624]	38,042 [0,577942]	12,036 [0,034302]	17,374 [0,003843]	113,946 [2,55e-13]
Lag 12	20,122 [0,001186]	6,590 [0,252959]	14,714 [0,011655]	9,406 [0,093935]	22,007 [0,000522]	82,218 [5,10e-08]
df	5	5	5	5	5	25

Included observations: 1089

Table M: Lag Exclusion Wald Tests for Yield and CDS Spreads

Vector Autoregression Estimates - Standard errors in ( ) & t-statistics in [ ]

	GREECE_YS	IRELAND_YS	ITALY_YS	PORTUGAL_YS	SPAIN_YS
GREECE_YS(-1)	0,984296	-0,008379	-0,025862	-0,032006	-0,020638
	-0,02753	-0,01308	-0,00683	-0,01298	-0,00624
	[35,7574]	[-0,64070]	[-3,78920]	[-2,46543]	[-3,30510]
GREECE_YS(-12)	0,050089	0,021961	0,015786	-0,016581	0,002479
	-0,02691	-0,01278	-0,00667	-0,01269	-0,0061
	[1,86143]	[1,71787]	[2,36600]	[-1,30657]	[0,40616]
IRELAND_YS(-1)	0,109573	1.049.336	0,04525	0,075441	0,035217
	-0,0635	-0,03017	-0,01574	-0,02995	-0,0144
	[1,72558]	[34,7842]	[2,87404]	[2,51914]	[2,44494]
IRELAND_YS(-12)	-0,01208	0,076637	3,27E-05	0,021674	-0,016009
	-0,06329	-0,03007	-0,01569	-0,02985	-0,01436
	[-0,19086]	[2,54883]	[0,00209]	[0,72615]	[-1,11510]
ITALY_YS(-1)	0,821089	0,044264	1.014.440	-0,214683	-0,1187
	-0,1719	-0,08167	-0,04262	-0,08107	-0,03899
	[4,77657]	[0,54201]	[23,8009]	[-2,64812]	[-3,04411]
ITALY_YS(-12)	-0,11467	-0,174572	-0,069313	-0,247095	-0,089958
	-0,18238	-0,08664	-0,04522	-0,08601	-0,04137
	[-0,62876]	[-2,01485]	[-1,53282]	[-2,87285]	[-2,17451]
PORTUGAL_YS(-1)	-0,031405	0,065075	-0,019745	1.167.726	-0,026851
	-0,07073	-0,0336	-0,01754	-0,03336	-0,01604
	[-0,44401]	[1,93661]	[-1,12586]	[35,0063]	[-1,67355]
PORTUGAL_YS(-12)	0,011288	-0,020168	0,037387	0,021497	0,052402
	-0,06964	-0,03308	-0,01727	-0,03284	-0,0158
	[0,16210]	[-0,60960]	[2,16521]	[0,65454]	[3,31723]
SPAIN_YS(-1)	0,231209	0,326448	0,218518	0,568235	1.379.132
	-0,19906	-0,09457	-0,04936	-0,09388	-0,04516
	[1,16148]	[3,45189]	[4,42725]	[6,05271]	[30,5420]
SPAIN_YS(-12)	-0,130743	0,047997	0,005746	0,19579	0,033393
	-0,20182	-0,09588	-0,05004	-0,09518	-0,04578
	[-0,64781]	[0,50059]	[0,11483]	[2,05702]	[0,72941]
C	-0,01568	0,011871	0,001869	0,008083	0,005257
	-0,01021	-0,00485	-0,00253	-0,00481	-0,00232
	[-1,53597]	[2,44768]	[0,73823]	[1,67886]	[2,27018]
R-squared	0,998589	0,997586	0,995703	0,998458	0,996014

Included observations: 1772 after adjustments

	GREECE_CDS	IRELAND_CDS	ITALY_CDS	PORTUGAL_CDS	SPAIN_CDS
GREECE_CDS(-1)	1,145654	-0,007735	-0,00499	-0,010228	-0,00472
	-0,03273	-0,00271	-0,00175	-0,00319	-0,00186
	[35,0009]	[-2,85844]	[-2,85841]	[-3,20631]	[-2,53883]
GREECE_CDS(-12)	0,065922	0,003568	0,005091	0,002988	0,005425
	-0,03599	-0,00298	-0,00192	-0,00351	-0,00204
	[1,83194]	[1,19923]	[2,65234]	[0,85199]	[2,65427]
IRELAND_CDS(-1)	-1.301.437	1.181.807	0,002368	0,08886	0,012155
	-0,64803	-0,05358	-0,03456	-0,06316	-0,0368
	[-2,00829]	[22,0585]	[0,06851]	[1,40696]	[0,33026]
IRELAND_CDS(-12)	0,429799	0,012339	-0,050225	0,023275	-0,103945
	-0,6412	-0,05301	-0,0342	-0,06249	-0,03642
	[0,67031]	[0,23276]	[-1,46863]	[0,37246]	[-2,85442]
ITALY_CDS(-1)	-0,003061	-0,192502	0,980159	-0,198904	0,044186
	-0,94849	-0,07842	-0,05059	-0,09244	-0,05387
	[-0,00323]	[-2,45488]	[19,3753]	[-2,15171]	[0,82028]
ITALY_CDS(-12)	1.668.007	-0,094732	-0,049295	-0,149441	0,018298
	-0,93761	-0,07752	-0,05001	-0,09138	-0,05325
	[1,77899]	[-1,22208]	[-0,98574]	[-1,63538]	[0,34362]
PORTUGAL_CDS(-1)	1.608.622	0,127238	0,027471	1.234.428	0,041619
	-0,59745	-0,04939	-0,03186	-0,05823	-0,03393
	[2,69250]	[2,57601]	[0,86212]	[21,2002]	[1,22658]
PORTUGAL_CDS(-12)	0,865582	-0,050112	0,063661	-0,038178	0,054897
	-0,61841	-0,05113	-0,03298	-0,06027	-0,03512
	[1,39968]	[-0,98016]	[1,93011]	[-0,63345]	[1,56308]
SPAIN_CDS(-1)	0,074123	0,134603	0,249501	0,154734	1.051.933
	-0,9088	-0,07513	-0,04847	-0,08857	-0,05161
	[0,08156]	[1,79149]	[5,14743]	[1,74699]	[20,3811]
SPAIN_CDS(-12)	-3.086.182	0,165902	0,030914	0,244644	0,066758
	-0,92332	-0,07634	-0,04925	-0,08999	-0,05244
	[-3,34247]	[2,17333]	[0,62774]	[2,71866]	[1,27307]
C	-0,161356	0,011656	0,009596	0,013648	0,01124
	-0,10589	-0,00875	-0,00565	-0,01032	-0,00601
	[-1,52378]	[1,33138]	[1,69913]	[1,32245]	[1,86906]
R-squared	0,992788	0,997599	0,995388	0,997899	0,994455

Included observations: 1089 after adjustments

Table N: Vector autoregressive estimates from 5y Yield Spreads and 5y CDS spreads

Block Exogeneity Wald Tests
Sample: 3/01/2005 12/30/2011

Dependent variable: GREECE_YS	Chi-sq	df	Prob.
IRELAND_YS	25,02	12	0,0147
ITALY_YS	151,85	12	0
PORTUGAL_YS	39,38	12	0,0001
SPAIN_YS	41,94	12	0
All	449,04	48	0

Dependent variable: GREECE_CDS	Chi-sq	df	Prob.
IRELAND_CDS_sp	18,27	12	0,1077
ITALY_CDS_sp	36,68	12	0,0003
PORTUGAL_CDS_sp	42,65	12	0
SPAIN_CDS_sp	40,19	12	0,0001
All	148,57	48	0

Dependent variable: IRELAND_YS	Chi-sq	df	Prob.
GREECE_YS	30,84	12	0,0021
ITALY_YS	42,15	12	0
PORTUGAL_YS	42,92	12	0
SPAIN_YS	22,62	12	0,0312
All	261,20	48	0

Dependent variable: IRELAND_CDS	Chi-sq	df	Prob.
GREECE_CDS_sp	36,25	12	0,0003
ITALY_CDS_sp	39,86	12	0,0001
PORTUGAL_CDS_sp	48,47	12	0
SPAIN_CDS_sp	47,23	12	0
All	158,47	48	0

Dependent variable: ITALY_YS	Chi-sq	df	Prob.
GREECE_YS	76,08	12	0,00E+00
IRELAND_YS	51,69	12	0,00E+00
PORTUGAL_YS	112,19	12	0
SPAIN_YS	62,50	12	0,00E+00
All	309,20	48	0

Dependent variable: ITALY_CDS	Chi-sq	df	Prob.
GREECE_CDS_sp	94,66	12	0
IRELAND_CDS_sp	40,75	12	0,0001
PORTUGAL_CDS_sp	54,09	12	0
SPAIN_CDS_sp	50,11	12	0
All	283,77	48	0

Dependent variable: PORTUGAL_YS	Chi-sq	df	Prob.
GREECE_YS	38,70	12	0,0001
IRELAND_YS	30,14	12	0,0027
ITALY_YS	84,47	12	0,00E+00
SPAIN_YS	69,80	12	0,00E+00
All	260,21	48	0

Dependent variable: PORTUGAL_CDS	Chi-sq	df	Prob.
GREECE_CDS_sp	51,07	12	0
IRELAND_CDS_sp	46,01	12	0
ITALY_CDS_sp	47,34	12	0
SPAIN_CDS_sp	40,25	12	0,0001
All	190,41	48	0

Dependent variable: SPAIN_YS	Chi-sq	df	Prob.
GREECE_YS	51,19	12	0,00E+00
IRELAND_YS	65,65	12	0,00E+00
ITALY_YS	54,51	12	0,00E+00
PORTUGAL_YS	87,27	12	0,00E+00
All	300,58	48	0

Included observations: 1772

Dependent variable: SPAIN_CDS	Chi-sq	df	Prob.
GREECE_CDS_sp	67,56	12	0
IRELAND_CDS_sp	49,09	12	0
ITALY_CDS_sp	24,20	12	0,0191
PORTUGAL_CDS_sp	61,69	12	0
All	187,82	48	0

Included observations: 1089

Table O: Block Exogeneity Wald Tests applied to Yield spreads and CDS spreads.

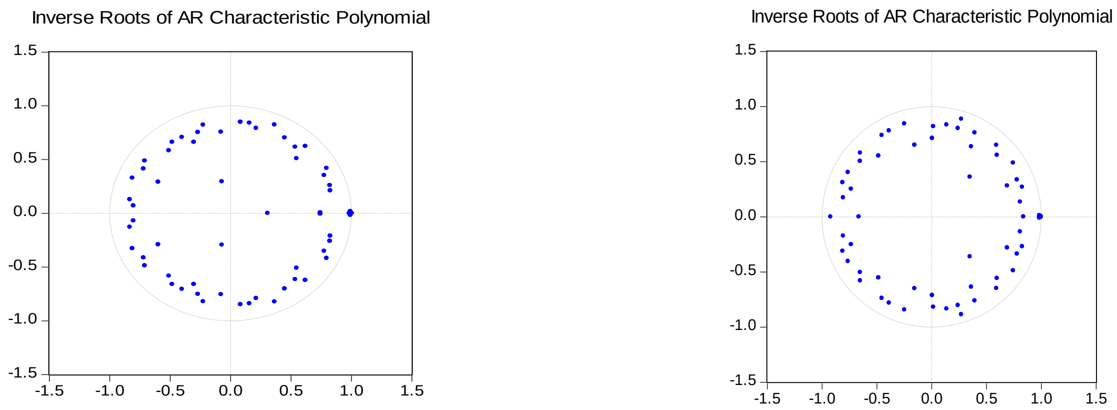


Figure A: Unit Root Tests applied to yield spreads (left graph) and CDS spreads (right graph).

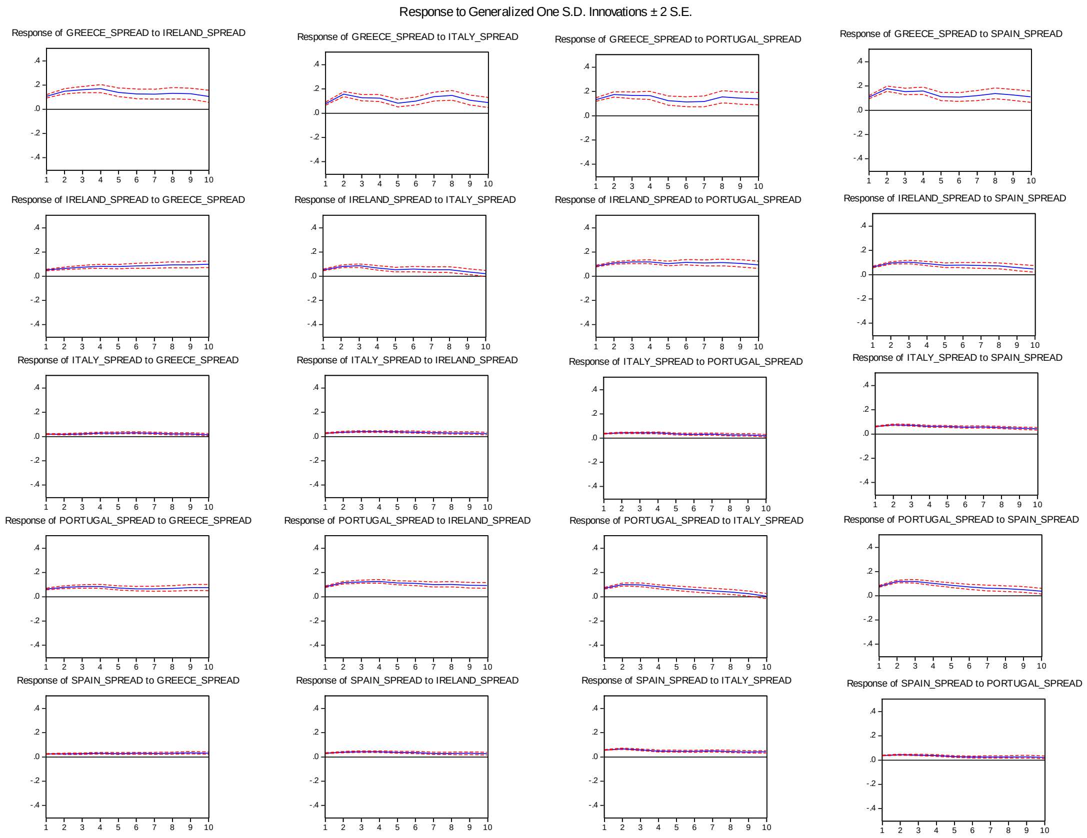


Figure B: Yield Spread Impulse Responses

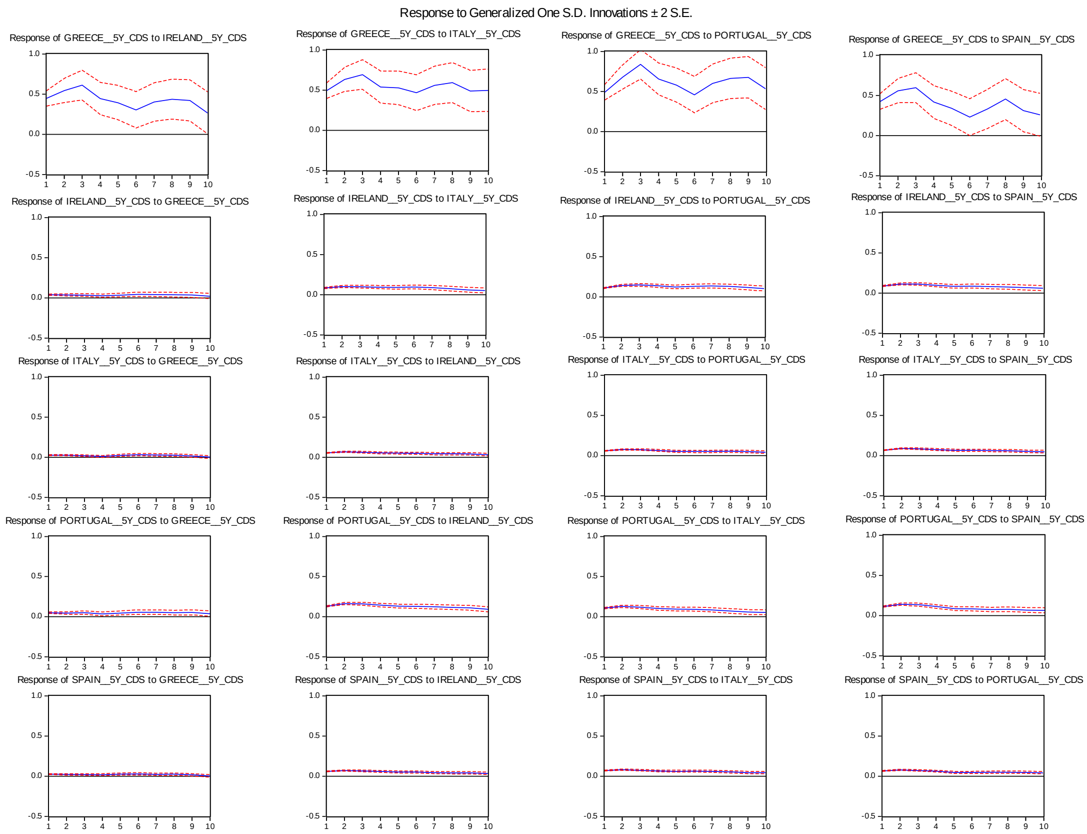
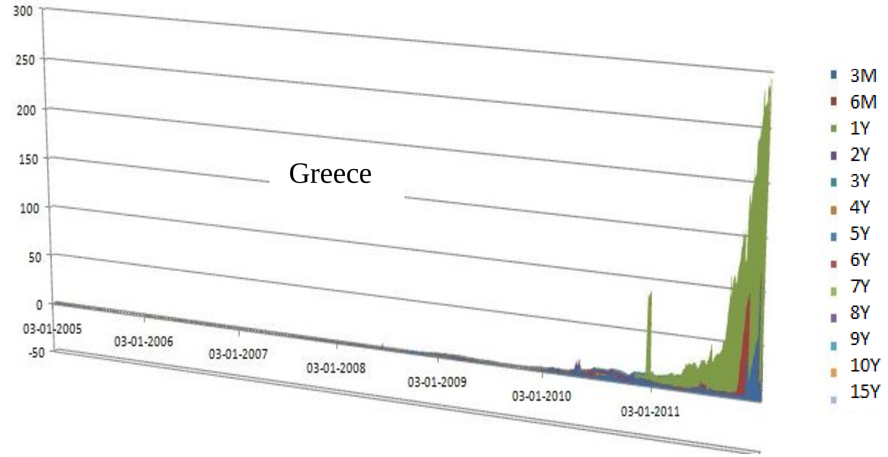
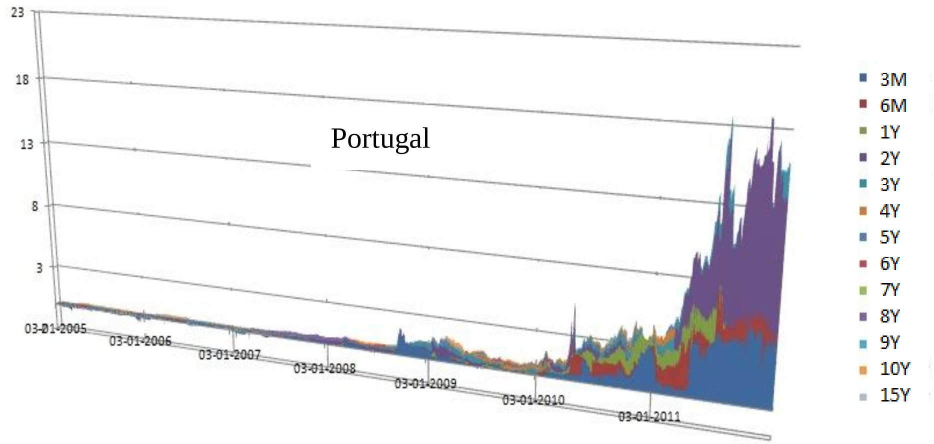
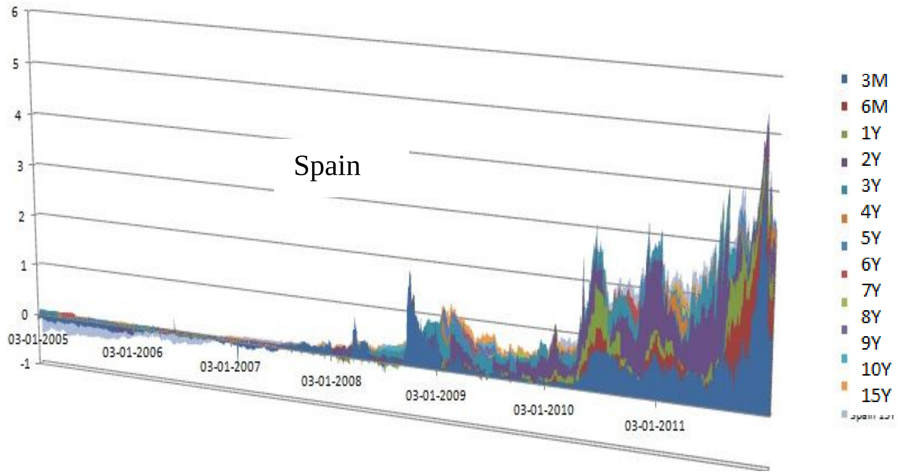
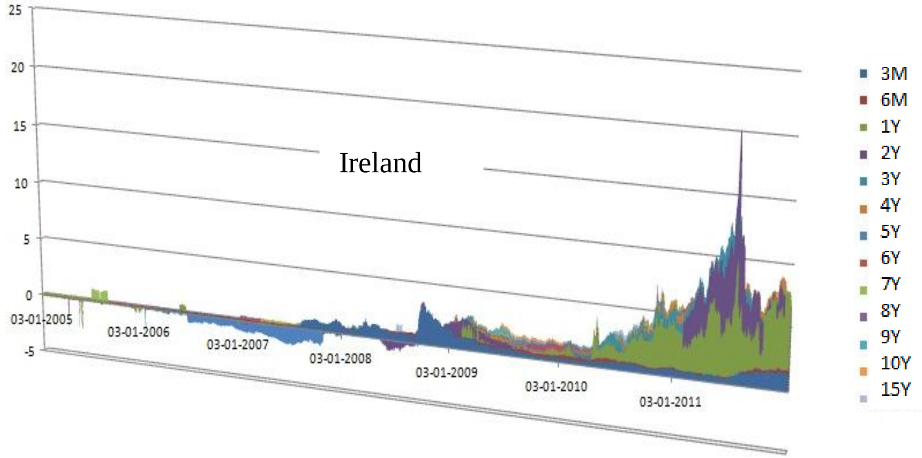


Figure C: CDS Spread Impulse responses









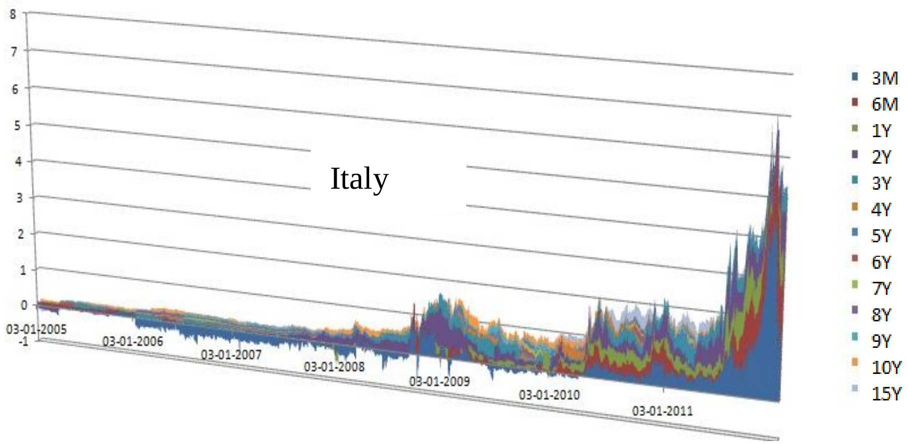


Figure D: Yield Spreads from each PIIGS countries

Source: Bloomberg Units: Percentage