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Credit rating impact on the financial market: the case of PIIGS countries coving European debt crisis period

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Credit rating impact on the Stock market:
the case of PIIGS countries coving European debt crisis period

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ABSTRACT

In this paper, I analyze the effect of sovereign debt rating to stock market under PIIGS (Portugal, Italy, Ireland, Greece and Spain) context coving European Debt Crisis. Through panel regression, I find that changes in one country's sovereign debt rating (country rating) and outlook have spillover effect on other PIIGS countries' stock market. Rating announcement has more significant spillover effect compared to outlook adjustment. And S&P is the most accurate and reliable among big three credit rating agencies. The result also shows an evolution of the CRAs' spillover effect throughout the crisis, with strongest effect observed in pre-crisis period and decreasing effects towards during crisis period and post-crisis period. Then I measure the effect of one country's rating events on its own stock market via event study, and abnormal returns have been observed around rating announcement date.

Key Words: Sovereign Credit Rating, Credit Rating Agencies, European Debt Crisis, PIIGS, Spillover Effect, Cumulative Abnormal Return

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Table of Contents

1.Introduction

In past few decades, there is abundant debate regarding the trustworthiness, objectiveness and efficiency of Big Three credit rating agencies (Standard & Poor's (S&P), Moody's, and Fitch Group). In retrospect, during the subprime crisis, the Big Three credit agencies showed excessively optimism bias. As such credit rating agencies underwent heavily criticisms after the financial crisis, particularly for its catastrophically misleading role (Casey, 2009) and disability to evaluate the situation of financial markets (The Financial Crisis Inquiry Commission, 2011). Following the criticisms, reasons behind have been well-discussed. Issuers pay ratings instead of investors has been addressed to contribute most to the misleading result (Partnoy, 2006; Hill & Faff, 2010)

Nevertheless, the importance of credit rating agencies in the financial market is undeniable. Firstly, credit rating changes are major news (Lehn, 1994). Moreover, credit rating agencies play crucial role in the fixed income market where investors rely on valuable and primary information provided by credit ratings to make informed decision (Darbellay & Partnoy, 2012). Furthermore, Darbellay and Partnoy (2012) raise the argument that government rescue efforts depend on credit ratings, regulators and other market participants use credit rating as mandated tools and credit rating can be used to determine bank's regulatory capital (Basel Committee on Banking Supervision, 2004).

Country rating, also known as long-term foreign currency credit ratings for sovereign bonds, is a forward-looking opinion about overall creditworthiness of government (S&P, 2016), and is a measurement of specific country's comprehensive risk level and summary of country-specific macro-fundamentals (e.g. Powell et al., 2008; Hilscher et al., 2010). In the last few years, there are intensive arguments regarding what was the role of credit rating agencies in the European Debt Crisis in 2012, were they delivered accurate rating on time and other related questions. Arbitrary country credit rating, the difference between real rating and estimated rating based on fundamentals, was observed in 2009 and 2010 (Gärtner et al., 2011), spillover effect from one country like Greece to other countries was detected (Santis, 2012), and spillover effect of credit rating announcement to other financial markets, such as fixed income market, was also observed (Afonso et al., 2012).

The main aim of my thesis is to answer the research question whether the sovereign credit rating announcements will affect the financial markets, to be more specific, the spillover effect of sovereign credit rating announcements to the stock market. My research is focus on 5 countries, including Portugal, Italy, Ireland, Greece and Spain (PIIGS) around European Debt Crisis period, ranging from 2006 to 2016 which covers pre-crisis period to post-crisis period. Since sovereign credit rating comprises macro-fundamental information, the change of credit rating reflects the change of environment in the financial market and therefore affects investors' decision, e.g. if one country's sovereign credit rating is downgraded (upgraded), the comprehensive risk level of which is increasing (decreasing). Stock market, the second largest market and one of the most important financial market, reacts swiftly to the change of macro-fundamentals and investors preference, and usually considered as one of the efficient financial market in reflecting new information. Stock index, in general, is an appropriate indicator to represent the performance of the stock market. Along the main research question, there are other related questions that are worth to be addressed. Such as whether credit rating agencies have been acting differently before, during and after European Debt Crisis, the spillover effect of one country's rating event on its own country's stock market and on other countries' stock market, how stock return been affected around rating announcement, whether upgrade and downgrade has the same spillover effect on stock market, and do countries within Europe react to credit rating announcements differently from those outside Europe. Due to limitation, in this paper, I will focus on the first three questions along the main research question.

To achieve the previous purpose, I decide to apply two methodology, including panel regression and event study. Panel regression is dedicated to see the spillover effect of one country's rating event on other countries' stock market, and event study is deployed to observe impact of one country's rating event on its own stock market. In panel regression, I apply top-down methodology. First, apply integrated quantified rating event as one explanatory variable to see if it is significant. And if yes, then apply second step, which includes two explanatory variables, quantified rating announcement and quantified outlook announcement. Last, to assess reliability and accuracy of different credit rating agencies' rating events, I further divide explanatory variable rating announcement in the second regression into S&P rating

announcement, Fitch rating announcement and Moody's rating announcement, and same apply to explanatory variables outlook announcement in the second regression. Moreover, to evaluate how European Debt Crisis (EBC) affect the credit rating agencies and stock market, time is divided to three fractions as follows: ex-EBC, EBC and post-EBC (details can be seen in session 4.1) and in each time periods, previous three top-down regressions will be performed. In the event study, to access the performance of stock market and whether it move differently when credit rating agencies release the announcement, cumulative abnormal return (CAR) will be calculated and different event window will be selected. Thus, we would be able to observe whether rating event has impact on own country's stock market. If yes, what is the impact and moreover, whether the impact changes in different PIIGS countries during European Debt Crisis.

The thesis is structured as follows: section I introduces the topic of related backgrounds of the paper; section II consists of literature review and separated in five categories: i) history of credit rating agencies (CRAs); ii) methodology of sovereign credit ratings and interpretation of investment-grade and speculative-grade iii) impacts of credit rating announcements and iv) European Debt Crisis; Section III describes dataset. Section IV consists of methodology and this paper consists two main methodologies: i) panel regression and ii) event study; Section V conducts the empirical analysis and presents the result which can be divided into three different categories: i) panel regression of all data ii) panel regression of different European Debt Crisis period iii) event study among PIIGS countries; while section VI concludes.

2.Literature review

2.1. Brief History of Credit Rating Agencies

In 1909, the first bond rating was published by John Moody. In the next 15 years, Poor's, Standard Statistic and Fitch joined the markets in chronological order. After decades of development, the credit rating market has been dominated by the Big Three credit rating agencies, S&P, Moody's and Fitch since 1990s. (White, 2010). According to European Securities and Market Authority (ESMA) (2016), S&P holds 45.00%, Moody's holds 31.29% while Fitch holds 16.56% which means the Big Three rating agencies in total holds 92.85% of European credit rating market share in 2015.

White (2002) claims the situation of few market players can be explained by less developed corporate bond market. While along with the development of credit rating market in the last decade, authority imposes more systematic and sophisticated regulations which create high barriers of the market. Bolton, Freixas and Shapiro (2012) argue that oligopoly status of credit rating market is due to high barriers to entry, and they further explain the designation from Nationally Recognized Statistical Rating Organization (NRSRO), which initially established by Security and Exchange Commission (SEC) in 1975 is a regulatory barrier. White (2002) considers designation as an "absolute barrier", Partnoy (1999 and 2001) claims NRSRO empowered recognized credit rating agencies as monopolists, Partnoy (2006) further deems NRSRO as "regulatory licenses" and benefits those by keeping their reputational capital, while Frost (2007) argues that NRSRO creates conflicts between credit rating agencies and investors by providing incentives which are not in the interest of investors. Li, Shin and Moore (2006) find out NRSRO recognized credit rating agencies deliver slightly lower rating than non-recognized credit rating agencies. The same result also found by Beaver, Shakespeare, and Soliman (2006) and Kisgen and Strahan (2010), despite Fairchild, Shin and Yan (2015) argues that NRSRO designation has no significant effect on their rating behaviors.

Another debatable argument is whether credit ratings are trustworthy. Since 1970s, credit rating agencies have been started charging fees from issuers instead of investors, about which many argues would cause conflicts of interest, e.g. White (2002), Partnoy (2006), Pagano et al. (2010) and Bolton et al. (2012). White (2002) claims it causes moral hazard and opportunistic behavior of credit rating agencies, such as inflating the rating. Partnoy (2006) indicates the real problem behind is that fees charging from issuers represent over 90% of CRAs revenue, and further concerns that no pressure has been exposed to CRAs to eliminate conflicts. Bolton et al. (2012) find that CRAs tend to inflate ratings when their reputation cost is low and investment decision is naive. Pagano et al. (2010) believe CRAs choose to behave in aligned with issuer's need. Cornaggia et al. (2013) find that Moody's provides less accurate ratings compare to investor-pay agencies, same result concluded by Milidonis (2013).

2.2 Sovereign Credit Rating methodology

According to S&P's principles, its credit ratings include both qualitative and quantitative method to deliver comprehensive assessment. Bulow (1992), Duffie et al. (2003) and Mellios et al. (2006) argues that sovereign credit rating market are different from corporate credit rating due to the absence of bankruptcy code. Researchers e.g. Eaton et al. (1986), Clark et al. (1999) and Mellios et al. (2006) have found out that the creditworthiness of sovereign issuers depends on both their ability and willingness. However, Mellios et al. (2006) claims that incented by government reputation, access to credit markets, including foreign debt market and possible sanctions, sovereign issuers will continue to pay their debt.

Both political and economic factors contribute to the sovereign credit rating Mellios et al. (2006). In the last decade, there are several studies trying to figure out determinants of sovereign credit rating. Cantor and Packer (1996) started with OLS model and followed by many researchers have concluded that the ordered probit model is more appropriate. Commonly agreed determinants from previous papers include GDP per capita, GDP growth rate, government budget balance, interest rate, inflation rate, external and public debt. (Bissoondoyal-Bheenick, 2005; Afonso et al, 2012; Zigman and Cota, 2011 and Reusens and Croux, 2017) Some other researchers find determinants relating to credit rating itself, including default history, previous outlook and rating, current rating, duration of rating (Al-Sakka, 2009; Hill, 2010 and Reusens and Croux, 2017).

The rating ranges from AAA to D (S&P and Fitch) and Aaa to C (Moody's), respectively, highest to lowest rating. Another important term is investment grade (AAA to BBB- for S&P and Fitch; Aaa to Baa3 for Moody's) and speculative grade or "high-yield" (BB to D; Ba1 to C). Frost et al. (2002) claim that downgrading from investment grade to speculative grade can cause consequences more than increase the cost of capital. This is the reason that Al-Sakka (2009) includes dummy variable "investment grade" to find determinants of sovereign credit rating.

2.3 Impacts of credit rating announcements

Arezki et al. (2011) conclude that downgrades dramatically increase the spillover effect to many financial markets as more regulations are implemented. Norden and Weber (2004) find that stock market and CDS market can anticipate downgrading event and observe significant abnormal return around downgrading event. Kaminsky

and Schmukler (2002) confirm that credit ratings contribute to the instability in financial markets by downgrade during recession, they further detect 1% decreasing in stock market when country is one notch downgraded. Another significant conclusion of their study is that spillover effect of sovereign credit rating is stronger when countries has lower rating as well as during crisis. Chiang et al. (2007) reject the previous conclusion that there is no contagion effect of sovereign credit rating during the Asian Financial Crisis (Ferri et al., 1999; Forbes and Rigobon, 2002; Bordo and Murshid, 2001) and claim that sovereign credit ratings play an important role in the Asian Financial Crisis as the contagion effect jeopardized the stock market. The contagion effect to stock market has also been found by other researchers. Christopher et al. (2012) conclude sovereign credit rating has positive spillover effect to not only local stock market but also neighboring countries, especially in the long-term. The same result found by Ferreira and Gama (2007) that nonevent countries' stock market decrease while event country experiences downgrading, yet no correlation found when event country upgraded.

Gande and Parsley (2005) raise the argument that the impact of sovereign credit rating to government bond spread is asymmetric, as one notch downgrade causes 12bp increase in government bond spread while one notch upgrade has no obvious impact. Sy et al. (2011) conduct series of analysis in between sovereign credit rating and financial market where the paper is applying CDS market during European debt crisis and conclude that downgrading has statistically significant effect across both countries and financial market. Moreover, Afonso et al. (2012) underline that impacts of rating announcement to government bond yield spread, especially negative ones, are more significant. Yet they also agree one notch upgrade slightly improves the government bond market. And they further underline that countries which experience downgrade in the last six months, has larger government bond yield spread than countries with same rate but without downgrading.

Apart from financial markets, fundamental economics also influenced by sovereign credit rating announcement. Quinn and Toyoda (2008) argue that change of sovereign credit rating will affect economic fundamentals, such as interest rate and capital flow balance. One notch downgrading will cause irregular capital outflow since investors tend to shift from risky assets to less-risky assets, according to Pavlova and Rigobon (2008) and political reason could be another consideration, according to

Lensink et al. (2000). It will also increase the interest rate, which directly affect financial markets since the cost of capital will increase. Thus, the economic situation of one country experienced downgrading will deteriorate.

2.4 European Debt Crisis

High level of Public debt to GDP triggered the European Debt Crisis. From early 2000s, most European countries applied loose fiscal policy, and most countries (e.g. Greece, Italy, Portugal, Spain, Ireland, France and Germany) no longer hold the 60% debt/GDP limit required by European Union in 2007, before the US subprime crisis. According to IMF Database, Greece and Italy have more than 100% Public debt to GDP in 2007. Lane (2013) argues that 2003-2007 is the most intense period where credit growth, he then underlines that not only government borrowing accumulated but also household borrowing rapidly increased. And after 2008, due to economic recession, distressed banking industry and loosing appetite from international investor, governments experienced difficulties to tighten fiscal policy, which Reinhart (2013) believes would be most efficient way to tackle the crisis. Candelon and Palm (2010) use empirical method and conclude negative correlation between stock market and Public Debt to GDP ratio during European financial crisis. De Bruyckere et al. (2013) acknowledge that there is risk spillover effect between banks and sovereigns during the European Debt crisis.

Many researchers have argued that the spillover effect of the US subprime Crisis is another cause for the European Debt Crisis. (Acharya et al., 2011 and Ureche-Rangau, 2013). Dieckmann and Plank (2012) further explain that increase government borrowing not only can't solve the distressed banking industry but even escalate the crisis. And internationally-active banks started to adjust their foreigner portfolio by shifting from distressed countries to Germany and United States, according to Caruana and Avdjev (2012). Ureche-Rangau and Burietz (2013) conduct quantitative study and conclude that European government interventions has negative impact on cost of sovereign debt, together with other reason such as capital injections among European governments right after subprime crisis jeopardize their ability for a second rescue 3 years later.

PIIGS (Portugal, Ireland, Italy, Greece and Spain) refers to five countries who experienced most intensive distress during the crisis. Most of them today is

recovered from European Crisis thanks to the bail-out fund from European Financial Stability Facility (EFSF) and the International Monetary Fund (IMF). Discussion about whether Italian economy can be fully recovery from the crisis has drawn attention. Indeed, Italy today still facing several challenges, partially due to inadequate help from EFSF financially, partially due to its own economy structure. But that's different research topic which I should not touch upon in this paper. In general, the aftermath of the crisis, including distressed banking industry and challenges from fiscal and monetary policy, is still worth to explore. Hence, in the following sections, I am going to study the spillover effect of sovereign credit rating announcements to stock markets. If we can learn the lessons from the past, it would be helpful to tackle with the next crisis or even prevent one.

3.Data

I choose PIIGS countries because these are most representative countries during the European Debt Crisis. To conduct an event study, it is important to determine the estimation window and event window. Given the peculiar fact that European Debt Crisis has spillover effect from the US Subprime Mortgage Crisis, I decide to date back the estimation window even before the US Subprime Mortgage Crisis. And to study how impact of credit rating evolves along development of European Debt Crisis, my data cover the period from 2006 to 2016, in total 11 years, coving pre-crisis, during-crisis and post-crisis period.

The main dataset has two parts, sovereign credit ratings and stock market indices. Other dataset includes U.S. interest rate.

3.1 Sovereign credit ratings

The big three credit rating agencies (S&P, Moody's and Fitch) together has more than 90% market share of credit rating industry. Hence, in my dataset, I use the sovereign credit rating data from the big three rating agencies, including outlooks & watch list and ratings. The reason to include outlooks & watch list is, usually, a change of outlooks & watch list will be followed by change of ratings, which makes it a proper indicator to predict the future sovereign credit ratings.

Country rating usually refers to foreign-currency sovereign credit rating, which additionally taking government transfer and convertibility risk into account compared to local-currency sovereign credit rating, thus makes it a better measurement in my study. Therefore, in the following study, all credit ratings refer to foreign-currency sovereign credit ratings.

All data is obtained from Trading Economics website. My study window is from 2006 to 2016. In order to observe the changes of rating/outlook within my study window, my sovereign credit rating data starts from last announcement in 2005 to the last rating/outlook announcement in 2016.

The detailed dataset includes the big three credit rating agencies (S&P, Moody's and Fitch), countries (PIIGS), credit ratings and dates of rating changes, outlooks and dates of outlook changes. All above inputs create a qualitative dataset.

To quantify the sovereign credit ratings, I apply *comprehensive credit ratings* (CCR) measurement, named by Ferreira and Gama (2007). And the change to CCR define my rating event. The CCR measurement has highest score of 20 to AAA (Aaa for Moody's) and lowest of 0 to SD, with each notch change counts for one score. Gande and Parsley (2005) assign positive and negative outlook one score, the same as one notch change. Chen et al. (2016) improve the CCR measurement by assign 0.5 score to negative and positive outlook and watch. The detailed CCR that I am applying for this paper is shown in Appendix 2.

My data is summarized in the following table.

Table 1. Number of rating events of PIIGS countries

	S&P		Moody's		Fitch	
	Upgrade	Downgrade	Upgrade	Downgrade	Upgrade	Downgrade
Change in Rating						
Greece	5	13	2	9	4	11
Ireland	3	6	3	5	2	4
Italy	1	4	0	3	0	4
Portugal	1	5	2	5	0	5
Spain	2	6	1	5	1	4
Total Changes	**12**	**34**	**8**	**27**	**7**	**28**
Change in Outlook/Watchlist						
Greece	1	5	2	5	1	4
Ireland	3	2	2	3	3	2
Italy	0	2	1	2	1	3
Portugal	4	6	1	3	3	3
Spain	1	3	1	4	1	2
Total Changes	**9**	**18**	**7**	**17**	**9**	**14**

Source: Author's dataset

3.2 Stock Market Indices

Stock market index is an indicator to measure a group of stocks. There are different stock market indices based on different purposes, e.g. country-focus index, capitalization-focus index and industry-focus index. Since in the paper, I am exploring the impact on specific countries' equity market, I will use most comprehensive and representative stock market index to reflect specific country's stock market. Since PIIGS countries use Euro as local currency exclusively, there is no need for adjustment of exchange rate. I use the daily closing price exclusively to calculate the daily stock market return. The detailed stock market indices chosen are as follow:

- **Portugal: PSI 20,** a capitalization-weighted benchmark index, uses free float stocks listed on Euronext Lisbon.

- **Ireland: ISEQ Overall Index,** a capitalization-weighted index, tracks all stocks that listed on Irish Stock Exchange.

- **Italy: FTSE MIB,** a capitalization-weighted index, uses free floating method and tracks 40 leading stocks listed on Borsa Italiana.

- **Greece: Athens Composite Index,** a capitalization-weighted index, tracks stocks listed on the Athens Stock Exchange.

- **Spain: IBEX 35,** a capitalization-weighted index, uses free floating method and tracks 35 most liquid stocks listed on Bolsa de Madrid.

In second methodology of event study, market portfolio index is needed in order to calculate abnormal return via market model. Hence, Euro Stoxx 50 is selected, which is a stock index of Eurozone stocks designed by STOXX. Usually, market index is selected to calculate abnormal return of stock. However, in my study, index has been chosen as stock, thus, I can only apply continental stock market index in the market model. As one of the most commonplace and unbiased reference, index Euro Stoxx 50 is selected.

All stock market indices data are obtained from each country's stock exchange website and Stoxx 50 is obtained from Yahoo Finance. All market indices are obtained in daily form, of which I calculate daily simple stock market return using adjusted close price for later study.

The simple stock market index return is calculated as below,

$$R_1 = \frac{P_1 - P_0}{P_0}$$

Where P_1 is ending stock index, P_0 is initial stock index. All data are adjusted close index price.

3.3. U.S. Interest Rate

In this paper, U.S. interest rate refers to the one-month interbank offer rate. The interest rate data is derived from Yahoo Finance, dated from the beginning of 2006 to the end of 2016.

Kaminsky and Schmukler (2002) find stock return can be explained by changes of U.S. interest rate at significant level of 99%. One explanation of using U.S. interest rate is that the change of which reflects variation of financial market worldwide. Since rating event alone reflects certain country's fundamentals, adding U.S. interest rate as an explanatory variable to our regression means including measurement of economic fundamentals on a high-level. Moreover, U.S. market has no direct

influence of European Debt Crisis, therefore, its interest rate can be considered as a risk-adjusted factor. Hence, I include change of U.S. interest rate in my later regression studies.

3.4 Limitation of data selection

Parsley and Gande (2003) conduct data analysis based on two categories of the credit rating, upgrades/positive outlooks and downgrades/negative outlooks. They apply absolute value of CCR change in the model, to observe the spillover effect of upgrading and downgrading events to bond market. And they conclude that downgrades have larger spillover effect than downgrades. However, since in my study, I define the study period as during the crisis and post-crisis of European debt crisis and define the study countries as PIIGS which were affected the most among pan-European countries. Hence, in my data, downgrade or negative outlook is more likely to happen. As data presented before, the number of downgrading events are as much as three times of upgrading events.

This will be a limitation for me to study the spillover effect between upgrades and downgrades due to limited data points for positive events. However, it would be interesting to see whether stock market reacts asymmetrically to downgrading and upgrading events as bond market, this study is partially carried out via event study. Yet, economy recovery has been seen in European countries and pattern of upgrading in recent years has been detected in PIIGS countries. Hence, it would be interesting to do a follow-up study few years later where upgrading and downgrading events will be balanced during the period.

4.Methodology

To study the impact of rating event on stock return, I perform both panel regressions and event studies in this paper. The purpose of which is to see whether rating event has spillover effect on others' stock market and what is the impact on its own stock market respectively. In the following study, rating event is categorized as rating announcement and outlook announcement. To quantify rating event, comprehensive credit rating definition is framed.

4.1 Panel regression

The general idea of panel regressions is to analyze the daily stock return to changes of rating, outlook and U.S. interest. The reason I include U.S. interest rate as an explanatory factor is due to its strong reflection of financial market environment. And choosing U.S. interest rate over other PIIGS countries' interest rate is because U.S. is less affected by rating events of PIIGS countries. Since credit rating event is correlated with interest rate in the same country, using them as explanatory factors together in one regression model will cause high collinearity. I have also considered using German interest rate. However, during European debt crisis, all European countries were affected to different level. Hence, it is ideal to include U.S. interest rate instead of others.

To answer the question of whether rating event has spillover effect on stock return, what kind of rating event has highest spillover effect and which rating agency has the highest spillover effect, I conduct several panel regressions, using top-down approach.

In the first regression, I intend to answer the fundamental question that whether rating event has spillover effect on stock market, particularly one country's rating event on other countries' stock market within PIIGS countries. Based on this benchmark regression, I further develop and modify to answer other research questions.

$$R_{i,t} = \alpha + \delta Event_{j,t} + \gamma \Delta ir_t^{US} + \varepsilon_{i,t}, \forall i \neq j. \quad (1)$$

The sub-indexes i, j stands for country, $i, j = Greece, Protugal, Italy, Ireland \ \& \ Spain$. The sub-index t stands for time. Therefore, $R_{i,t}$ represents the stock return of country i at time t; $Event_{j,t}$ is the quantified result of rating event in country i at time t; Δir_t^{US} stands for change of U.S. interest rate at time t; and $\varepsilon_{i,t}$ is zero-mean disturbance term.

Since I am curious whether rating event has spillover effect on the stock market, I apply explanatory variable $Event$, which integrates all three rating agencies' event result by adding all three rating agencies' score in accordance to comprehensive rating definitions.

Then in my second regression, I want to see whether rating or outlook has more significant spillover effect on stock market. Therefore, based on the first regression, I divide explanatory variable $Event$ into two explanatory variables, $Rating$ and $Outlook$ respectively, and both of which are integrated result of the big three agencies' rating outcome. Hence, the second regression shows as below.

$$R_{i,t} = \alpha + \beta Rating_{j,t} + \theta Outlook_{j,t} + \gamma \Delta ir_t^{US} + \varepsilon_{i,t}, \forall i \neq j. \quad (2)$$

Until now, I conduct analysis without compare in between the big three agencies. In other words, I consider all rating events from the big three agencies are equally important by sum up the result of their rating event. However, Gande and Parsley (2005) apply only S&P rating data in their study due to three main reasons. First of all, S&P the most active one among the big three. The same pattern is also observed in my data, there are 31.4% more rating changes by S&P than by Moody or Fitch, as S&P has 46 rating changes while Moody and Fitch has only 35 each. Secondly, Fitch and Moody tend to follow S&P more often than S&P follow them (IFM, 2010). Same pattern is discovered by Gande and Parsley (2005), in their data, S&P ratings changes precede others' roughly two-thirds of the time. Last, S&P rating usually cannot be anticipated by market, according to Reisen and Maltzan (1999). In other words, S&P rating has less effect of market expectation.

Therefore, in my third regression, based on the second regression, I will separate the big three agencies' rating result, to observe which rating agency has the most significant spillover effect. Therefore, the $Rating_{j,t}$ from the second regression is divide into $Srating_{j,t}$, $Mrating_{j,t}$, and $Frating_{j,t}$ into third regression, which represent S&P rating, Moody's rating and Fitch rating respectively. Similarly, the $Outlook_{j,t}$ from the second regression is divide into $Soutlook_{j,t}$, $Moutlook_{j,t}$, and $Foutlook_{j,t}$ into third regression, which represent outlook result of S&P, Moody's and Fitch respectively. As a result, my third regression shows as below.

$$R_{i,t} = \alpha + \beta_1 Srating_{j,t} + \beta_2 Mrating_{j,t} + \beta_3 Frating_{j,t} + \theta_1 Soutlook_{j,t} + \theta_2 Moutlook_{j,t} + \theta_3 Foutlook_{j,t} + \gamma \Delta ir_t^{US} + \varepsilon_{i,t}, \forall i \neq j. \quad (3)$$

The purpose of previous regressions is to answer questions whether the rating event has spillover effect on stock market, whether rating or outlook has more significant

spillover effect and which rating agencies has the most significant spillover effect, within data collection period.

In the following study, I will conduct three groups of studies, each of which includes three regressions just like the aforementioned regressions (1) (2) and (3). The purpose is to see how spillover effect of rating event on stock market differs from pre-crisis, during-crisis and post-crisis period.

Given the study based on European Debt Crisis, I define the pre-crisis period from 2006.01.03 to 2009.10.09; crisis period ranges from 2009.10.09 to 2012.07.26 and post-crisis is from 2012.07.26 to 2016.12.30. In October 2009, a new Greek government was formed, together with dramatically increased long-term interest rate (See Appendix 3), which usually taken as a sign of the beginning of European Debt Crisis. And in 2012.07.26, Mario Draghi, president of European Central Bank (ECB) has pledged to do 'whatever it takes' to save Europe, following of which, several financial aids and advice have been provided. Therefore, I recognize 2012.07.26 as the end of crisis period, as afterwards, the economic fundamentals and financial markets have been interfered by ECB's act. Hence, after 2012.07.26, I define it as post-crisis period. And then conduct previous three regressions (1)(2) and (3) for each group.

The detailed study is summarized as below.

Group	**Period**	**Regressions**
Pre-Crisis	*2006.01.03 – 2009.10.09*	(1) $R_{i,t} = \alpha + \delta Event_{j,t} + \gamma \Delta ir_t^{US} + \varepsilon_{i,t}, \forall i \neq j.$ (2) $R_{i,t} = \alpha + \beta Rating_{j,t} + \theta Outlook_{j,t} + \gamma \Delta ir_t^{US} + \varepsilon_{i,t}, \forall i \neq j.$ (3) $R_{i,t} = \alpha + \beta_1 Srating_{j,t} + \beta_2 Mrating_{j,t} + \beta_3 Frating_{j,t} + \theta_1 Soutlook_{j,t} + \theta_2 Moutlook_{j,t} + \theta_3 Foutlook_{j,t} + \gamma \Delta ir_t^{US} + \varepsilon_{i,t}, \forall i \neq j.$
During-Crisis	*2009.10.09 – 2012.07.26*	
Post-Crisis	*2012.07.26 – 2016.12.30*	

From the above study, I can conclude whether there is spillover effect of rating event to stock market, and which type of rating event has more significant spillover effect, and most importantly, which rating agencies has the most significant spillover effect.

More specifically, how previous questions have been answered in different periods defined by European Debt Crisis.

However, to study how single rating event affects stock market within specific short period around the rating event, I need conduct other study using different methodology. Therefore, in the second part of this section, I elaborate event study, which can answer the previous questions in a better form and provide different aspects for my study.

4.2 Event Study

Second step, event study is carried out to analyze the impact of change of sovereign credit rating and outlook on stock return. The purpose of which is to detect if rating event produces any impact on its own country's stock market. Moreover, event study allows to observe the dynamic effect of rating even around the time of rating events, and gives the flexibility to identify how impact varies in different period by selecting different event window. They can also provide evidence whether rating events have sustained or just transient effect on financial markets.

4.2.1 Event definition and window selection

In this session, I will focus only on rating announcement due to more profound effect of rating announcement that observed in panel regression. Hence, in my event study, I define date that Credit Rating Agencies announce the change of rating as event, to be more specific, upgrade and downgrade respectively. And due to length of this paper, I will not perform event study with outlook adjustment as event. Given the less spillover effect that observed in panel regression study, I presume that less abnormal return will be captured by outlook announcement compared to rating announcement. But surely it would be interesting to conduct a follow-up research to confirm my assumption.

In my event study, two event windows will be chosen. First event window ranges from 5 days before and 4 days after a defined event, and second event window ranges from 2 days before and 1 days after an announcement of rating. The longer event window allows me to measure the anticipation effect of rating event and to confirm if the effect of rating event which estimated by abnormal return persist from before to after event. As for the short event window, it gives me the possibility to evaluate the

true effect on rating announcement day as well as the lag effect of the event right after the rating event.

4.2.2 Abnormal return under market model adjustment

In a standard event study methodology, it consists of observed deviations of some price-related measure from some benchmark following an event. In this paper, observed deviation refers to abnormality, price-related measure means stock returns, benchmark relates to normality and event is what I have defined previously. Hence, I need to capture the abnormal return and how it evolves over time of event, in order to conclude from event study.

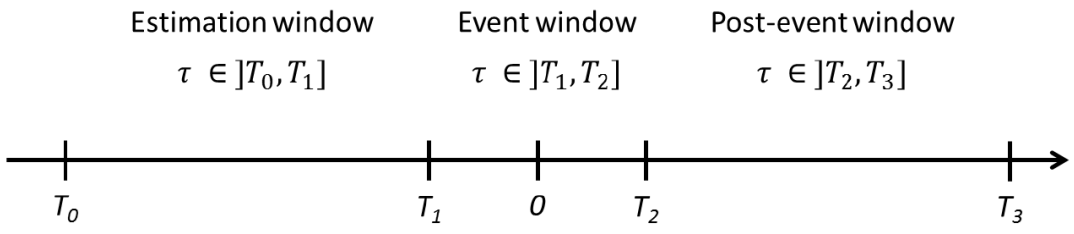
In this paper, market-model adjustment is chosen to calculate abnormal return (AR), which is illustrated in the following manner.

Abnormal return definition: $AR_{it} = R_{it} - E(R_{it}|X_t)$

Market-index adjustment: $AR_{it} = R_{it} - \alpha_i - \beta_i R_{mt}$

In previous model, AR_{it} is the abnormal return of stock index of country i on time t; R_{it} is the return of stock index of country i on time t; and R_{mt} is the return of market portfolio of country i on time t. α_i and β_i are parameters of the model, which can be estimated by applying market model with daily return and market portfolio index return, which is countries' indices and Euro Stoxx 50 is chosen respectively in this case.

The estimation window will be over 90 days prior to the start of event window. By now, two event window and estimation window have been well-defined as follows. Thus, in my first event window, from T_0 to T_1 is 90 days, T_1 to 0 is 5 days and 0 to T_2 is 4 days. And in the second event window, from T_0 to T_1 is still 90 days, but T_1 to 0 is 2 days and 0 to T_2 is 1 day.



And then Ordinary Least Squared (OLS) regression is used to calculate estimator α_i and β_i. The detailed calculation of α_i and β_i will be shown in the appendix 4.

After calculating the parameters of α_i and β_i, I apply $\widehat{\alpha_\iota}$ and $\widehat{\beta_\iota}$ to compute the abnormal return $\widehat{AR_{\iota t}}$ for the event window from $t = T_1 + 1$ to $t = T_2$, which is estimated as follows:

$$\widehat{AR_{\iota t}} = R_{it} - \widehat{\alpha_\iota} - \widehat{\beta_\iota} R_{mt}$$

And the abnormal return is assumed to be normally distributed with average of zero and variance as follows,

$$\sigma^2(\widehat{AR_{\iota t}}) = \sigma_{\epsilon i}^2 + \frac{1}{L_1}[1 + \frac{(R_{mt} - \widehat{u_m})^2}{\hat{\sigma}_m^2}]$$

$\sigma_{\epsilon i}^2$ is the variance (the detailed calculation is shown in Appendix), which considered to be the 'real' disturbance. The second part of the right-hand side formula is the 'estimation error' or 'additional variance', which occurs when there is sampling error in parameters α_i and β_i. In this part, L_1 is the length of estimation period, $\widehat{u_m}$ is the average market portfolio index return during estimation period and $\hat{\sigma}_m^2$ is the standard deviation of market portfolio index return during estimation period. Thus, the 'estimation error' part disappears with large estimation window, leaving 'real' disturbance matters which is independent over different estimation window.

Then Cumulative Abnormal Return (CAR) will be calculated. The development of which over event window (usually present in graph) is important for me to understand the research question that how rating announcement affect the stock market over event window. The formula of cumulative abnormal return calculation is shown as below,

$$\widehat{CAR_i}(t_1, t_2) = \sum_{t_1}^{t_2} \widehat{AR_{it}}$$

In this study, the estimation window is 90 days, while the larger event window is 9 days, which make the estimation window relatively large compared to event window. And for larger enough estimation window, the variance of cumulative abnormal return can be estimated as below,

$$Var\big(CAR_i(t_1,t_2)\big) = (t_2 - t_1 + 1)\sigma_{\epsilon i}^2$$

In this study, I have more than 1 event. To provide an average view on the study, I will average the result of CAR ($\widehat{CAR}_i(t_1,t_2)$) and the variance of which ($Var\big(CAR_i(t_1,t_2)\big)$) for all clean events N. The calculation is as follows,

$$\overline{CAR}(t_1,t_2) = \frac{1}{N}\sum_{i=1}^{N}\widehat{CAR}_i(t_1,t_2)$$

$$Var\big(\overline{CAR}_i(t_1,t_2)\big) = \frac{1}{N^2}\sum_{i=1}^{n}Var\big(CAR_i(t_1,t_2)\big)$$

Then,

$$\frac{\overline{CAR}(t_1,t_2)}{\sqrt{Var\big(\overline{CAR}_i(t_1,t_2)\big)}} \sim N(0,1)$$

In my study, overlapping between estimation window and even window is allowed. However, event window is not allowed to be overlapped. In other words, in this study, two rating announcements that happen closely to each other less than 5 days will not be selected as study event. The purpose of which is to minimize the influence of one rating event to another and measure unbiased impact of only one upgrade or downgrade in each event window. Thus, I only work on 'clean events', which means no overlapping with other rating events during 5 days of event window.

Below table is the 'clean' rating events by country that I applied in event study,

	Upgrade	Downgrade	Total
Greece	10	27	37
Ireland	7	15	22
Italy	0	11	11
Portugal	3	12	15
Spain	4	13	17
Total	**24**	**78**	

Due to the selection of the period, there are way much more downgrading events than upgrading events. But to see how stock market deal with upgrading and

downgrading events' signal, two type of event study based on upgrading and downgrading events need to be carried out.

5.Result

In this section, the result of previous study is presented. Whether credit rating events has spillover effect on stock market becomes clear in this section. The first part is about the result of panel regression, which answer the question whether spillover effect is exist or not, especially in different period of European debt crisis. While the second part is about event study, which gives us an idea about how announcements of credit rating events affect the stock market within specific event windows.

5.1 Panel Regression Result

In this section, the result of panel regression will be presented. It will give us a general idea about whether rating events have spillover effect on stock market, and during which period the spillover effect is most significant. The general result and explanations will be given under session 5.1.1 general study, and the different period study result, including pre-crisis, during-crisis and post-crisis results will be presented under session 5.1.2 different period study.

5.1.1 General Study

To start with, the table 2 below shows the results of data dated from 2006 to 2016, coving pre-, during- and post- crisis period. The results include three regressions as illustrated under section 4.1, where we can easily see if rating events have the spillover effect to stock market, which rating events has more significant spillover effect, and which rating agency has the most significant spillover effect.

	Regressions		
Explanatory variables	1	2	3
(Intercept)	-3.682 ** (0.00471)	-3.686 ** (0.00468)	-3.774 ** (0.003776)
US	5806.764*** (< 2e-16)	5806.642*** (< 2e-16)	5800.284*** (< 2e-16)
Tevent	6.525 * (0.04549)		
Trating		6.381 . (0.06343)	
Srating			18.265*** (0.000958)
Mrating			4.604 (0.452873)
Frating			-9.227 (0.164553)
Toutlook		8.318 (0.54897)	
Soutlook			27.664 (0.325733)
Moutlook			7.681 (0.735409)
Foutlook			-3.872 (0.862959)
Adjusted R-squared	0.1877	0.1877	0.1881

Notes:

1) The superscripts '***', '**', '*' and '.' indicat statistic significant at level 0.1%, 1%, 5% and 10%

2) All coefficients are expressed in basis point

Source: Author's calculations

According to the result of the first regression where rating event is captured by one explanatory variable, the rating event, regardless of announcement of rating or outlook, has significant spillover effect to stock market. This finding is coherent to the logic of country rating, since country rating reflects one country's economic and political environment; and PIIGS countries' economies, including stock market, were somehow influenced by each other due to both geographic and political reason. Therefore, this finding not only corroborates that through 2006 to 2016, one country' rating has spillover effect to rest PIIGS countries' stock market, but also demonstrates that country ratings were efficient during selected data period since

they did reflect true economic situation. And this result is the ground reason for the following studies – to further explore which variable causes the rating event significant, in other words, which is the real contributor of spillover effect of rating event to stock market.

In my second regression, I divide rating event into two explanatory variables, namely change of rating and change of outlook, to observe which rating event has more significant spillover effect to other PIIGS countries stock market. Before the regression, I was expected to find that rating announcements have better indication of current economic situation, therefore, have more significant spillover effect to other PIIGS countries' stock market.

The regression result confirms my hypothesis. There are several rationales behind. Usually, announcement of rating signals stronger change of current economic situation compare to announcement of outlook, regardless of upgrade or downgrade. Moreover, in some cases, change of rating outlook followed by one change of rating announcement. At the same time, economic situation is gradually changing at the beginning and then, either has some stronger indication or merely continuing deteriorate trend, will eventually cause credit agency to change the rating. In terms of stock market, it usually has some small fluctuations at the beginning and when the trend continues, investors start to lose (gain) confidence in the market, therefore the stock market will fall (rise). Therefore, matching the timeline of economic situation, credit rating and stock market, it is not difficult to understand that announcement of credit rating has more significant spillover effect to stock market. Finally, in my data sample, there are more changes of credit rating than changes of outlook since it covers European debt crisis period, and due to previous reason, the change of stock market are mostly explained by change of credit rating. However, if the data sample is not covering or related to European debt crisis, instead, without any severe event that has long-term influence, the data will have more change of outlook than change of rating, then the result might be different.

In my last regression that covers all data period, I separate rating event into rating announcement and rating outlook announcement, then further separate them by rating agencies, namely S&P, Moody and Fitch. The purpose of this regression is to observe which rating agency can provide most significant rating related to stock

market. I would argue that the one that provides most significant rating is the most accurate and reliable rating agency. The reasons are as follows. First of all, the stock market usually is the most accurate and agile index of the financial market, and the country rating should reflect own country's financial market. Since within PIIGS countries, county's financial market is tightly linked to each other, especially within the European Debt Crisis period. Therefore, the rating events should have some spillover effect to other country's stock market. If so, I would call it as an 'accurate' agency. Of course, you would disagree with me by saying that rating event always lag of stock market to reflect the true market situation. And this is exactly my point that a 'reliable' rating agency should foresee, or at least, adjust rating according to market environment in time. And in my third regression, if an agency's rating announcement or outlook announcement is significant, then it can be qualified as both 'accurate' and 'reliable' rating agency.

The result shows that only S&P rating announcement is significant under confidence interval of 99.9%. This is not a surprising finding, as S&P has always been considered as the leader among the big three agencies, not only because it alone has almost half of the market share, but also because the high-quality of the rating it provides. And Gande and Parsley (2005) have found that S&P tends to be followed by others instead of following others and cannot be predicted by market expectation. These findings, on the other hand, demonstrate that why S&P is 'accurate' and 'reliable', and of course why S&P rating announcement is significant in this case. From my regression results, I cannot identify the reason why Moody's and Fitch are not significant, whether is because of not 'accurate' or because of not 'reliable'. But maybe later in the event study, the finding can give us some flavor why they are not significant in this case.

As of why that none of agencies' outlook announcement is significant, the rationale is the same as in the second regression. Outlook announcement, compared to rating announcement, is a weaker signal and partially integrated in rating announcement. Especially during frequent rating announcements period, which usually refers to crisis, outlook announcements are followed immediately by rating announcement. Therefore, we can conclude that outlook announcements are integrated into rating announcements. Thus, the result that outlook announcements' variables are not significant in my third regression is understandable and align with expectation.

5.1.2 Different Period Study

In this session, I divide my data period into three, pre-crisis period, during-crisis and post-period, and conduct three regressions in previous general study within each period. The detailed period separations were described under Methodology, session 4.1 Panel Regression.

The purpose of this session is to detect how result of spillover effect of rating event and other research topics in previous study have changed from pre- European Debt Crisis to post- European Debt Crisis. Therefore, to conclude what is the influence of European Debt Crisis to rating announcements, whether spillover effect would change along the development of crisis and whether crisis event corrects or paralyzes the rating events. And results are presented in the table below.

	Regressions								
	Pre-Crisis regressions			Dur-Crisis regressions			Post-Crisis regressions		
Explanatory variables	1	2	3	1	2	3	1	2	3
(Intercept)	-2.600	-2.551	-2.368	-11.907 ***	-11.936 ***	-12.158 ***	-0.698	-0.6945	-0.6205
	(0.247)	(0.256)	(0.29036)	(6.52e-06)	(6.24e-06)	(4.18e-06)	(0.724)	(0.725)	(0.754)
US	4445.239 ***	4440.094 ***	4438.500 ***	7703.671 ***	7703.739 ***	7691.623 ***	8176.439 ***	8177.000 ***	8175.000 ***
	(< 2e-16)	(< 2e-16)	(< 2e-16)	(< 2e-16)	(< 2e-16)	(< 2e-16)	(< 2e-16)	(< 2e-16)	(< 2e-16)
Tevent	78.107 ***			3.382			-4.489		
	(6.62e-05)			(0.385)			(0.490)		
Trating		104.657 ***			2.763			-4.393	
		(8.4e-06)			(0.500)			(0.520)	
Srating			231.657 ***			12.029 .			2.149
			(4.56e-12)			(0.0986)			(0.804)
Mrating			99.187			6.013			-23.600
			(0.25191)			(0.3691)			(0.168)
Frating			-177.661 **			-12.797 .			-9.692
			(0.00191)			(0.0898)			(0.514)
Toutlook		18.265			12.599			-5.549	
		(0.604)			(0.519)			(0.812)	
Soutlook			30.573			83.497 *			-43.380
			(0.64388)			(0.0496)			(0.333)
Moutlook			-11.825			-1.932			35.990
			(0.87862)			(0.9502)			(0.332)
Foutlook			57.317			-12.017			-17.700
			(0.27175)			(0.6872)			(0.693)
Adjusted R-squared	0.1934	0.1940	0.1984	0.2621	0.2619	0.2631	0.1669	0.1668	0.1668

Notes:

1) The superscripts '***', '**', '*' and '.' indicat statistic significant at level 0.1%, 1%, 5% and 10%

2) All coefficients are expressed in basis point

3) The Pre-Crisis period is from 2006.01.03 to 2009.10.09; the crisis period is from 2009.10.09 to 2012.07.26; while the post-crisis period is from 2012.07.26 to 2016.12.30. The reasons of period definitions are given in the methodology session, under panel regression part

Source: Author's calculations

As we can see from the table, there are more significant variables during pre-crisis period than during-crisis period; and more significant variables within crisis period than post-crisis period. Therefore, I draw the conclusion that with the evolution of European Debt Crisis, from pre- to post- period, the spillover effect of rating event to stock market within PIIGS countries becomes less significant. Furthermore, I would argue that due to European Debt Crisis, the rating agencies' rating announcement get less effective compare to pre-crisis period, and there is post-effect on rating agencies' activities due to European Debt Crisis. In other words, European Debt Crisis paralyzes the rating agencies' ability to provide accurate and reliable ratings and outlooks. The above are high-level findings, in the following session, I will explain panel regression results of each period in details and will conclude findings on each period-level.

5.1.2.1 Pre-crisis period

During pre-crisis period, which ranges from 2006.01.03 to 2009.10.09, outlook downgrading is more common than rating downgrading. Credit rating agencies started to notice some abnormal performance of markets and economics, yet the signals were not strong enough for downgrading, therefore, outlook adjustment is more common during this period.

As we can see from the results of pre-crisis period, the results are similar as 5.1.1 panel data regression covers whole data period. Rating event, including rating adjustment and outlook adjustment, is significant under confidence interval of 99.9% and has spillover effect to stock market within PIIGS countries as the result shows in the first regression. And in the second regression, rating announcement is still significant under 99.9% confidence interval, while outlook announcement is not significant. The rationale behind is similar as 5.1.1 session; outlook adjustment often followed by rating announcement. Moreover, when an outlook announcement is not followed by rating adjustment, we can interpret that the market or economic situation is not volatile enough, or in other words, the trend of market performance is not obvious enough to adjust rating. Thus, we might not even be able to observe abnormal changes on stock market, which align to the result that spillover effect of outlook announcement on stock market is not significant.

In the last regression of pre-crisis period, S&P rating announcement and Fitch rating announcement are significant under 99.9% and 99% confidence interval respectively. However, Fitch rating event has negative parameter, which means negative spillover effect on stock market. Nevertheless, this result is contradicted to our hypothesis. The practical implication of this result is when Fitch decides to downgrade one country's country rating, which implies that this country's economic situation is deteriorated, the other PIIGS countries' stock market improves. However, PIIGS counties' markets are highly related to each other due to geographic, political and economic reason. My result is highly contradicted to reality. To find an explanation, I went to check the raw data, which including each countries' rating and date of rating announcement and have found that there are 7 S&P rating announcements during pre-crisis period, but only 2 Fitch rating announcements at the same period. More importantly, S&P downgraded all PIIGS countries' rating at pre-crisis period, at least once, some countries like Greece and Ireland have been downgraded twice; yet Fitch only downgraded Italy and Ireland once during this period, and Fitch's inaccurate and less frequent rating activities is the reason that caused negative parameter significant in my third regression which is not in accordance to reality.

5.1.2.2 During-Crisis period

And during crisis period, which ranges from 2009.10.09 – 2012.07.26, I find that rating event is not significant in the first regression; neither rating announcements nor outlook announcements is significant due to the result of second regression; and S&P rating announcement and Fitch rating announcement are significant under 90% confidence interval and S&P outlook adjustment is significant under 95% confidence interval. During crisis period, there are more frequent downgrading compared to pre-crisis period, for example, S&P has 15 downgrades during the crisis period, mainly due to rapid deterioration of economic situation within PIIGS countries started by Greek Debt Crisis. Credit rating agencies adjust their rating and outlook frequently during this period to truly reflect the economic and market situation to investors. However, rating events by CRAs, are most likely be influenced by market performance and lag the market. And during the crisis period, the market is volatile than before and the lag effect of rating/outlook announcement is more often to be observed during the crisis. To conclude, CRAs tend to provide less accurate and reliable rating activities during crisis period. It also explains why rating event in the

first regression and rating announcement and outlook announcement are not significant in the result.

As the result in the third regression, the S&P rating announcement is significant with positive parameter, therefore, we can conclude that S&P, even during crisis period, can provide relative reliable and accurate ratings compare to Moody's and Fitch and its rating announcement has spillover effect on other PIIGS countries' stock market. Fitch rating announcement is also significant, yet with negative parameter. The implied meaning of negative parameter is the same as the result of pre-crisis period, which is contradicted to our hypothesis and reality. The difference is during crisis period, Fitch has 13 times of downgrades, which is almost equal to 15 times of S&P. Therefore, the explanation in the pre-crisis is not applicable in the during-crisis period. Hence, I would like to conclude, Fitch rating announcement is inaccurate and unreliable during the crisis period.

Surprisingly, in the third regression result we see that S&P outlook announcement is significant under 95% confidence interval with positive parameter. This is the first time that variable of outlook announcement is significant. During crisis period, the outlook adjustment is less frequent to be seen compare to rating announcement, and usually a outlook adjustment happened in between two downgrades. Therefore, I would argue that during crisis period, all outlook adjustments that have been made are serious enough to cause another downgrade, which is different case in the pre-crisis period. Then the result makes sense since outlook adjustment is server enough to be followed by further downgrade during crisis period. Moreover, between 2009.10 to 2012.07 is the most intense period for EU economy and ECB was still on the stage of finding and trailing the remedy approach instead of providing the practical and efficient solution. Therefore, during my selection of crisis period, the market kept deteriorating rapidly without any signal of recovering. Therefore, since S&P rating agency is believed to be the most accurate and reliable rating agency, its rating activities, including adjustment of outlook should be able to mirror the real markets and economic environment. And the significant result of S&P outlook announcement demonstrates the S&P rating capability, not to mention S&P rating announcement is also significant during this period. To conclude, the result of significant outlook announcement and rating announcement is an evidence that S&P provides the most accurate and reliable ratings among the big three CRAs.

5.1.2.3 Post-crisis period

During post-crisis period, which ranges from 2012.07.26 – 2016.12.30, none of rating event-related variables is significant. The integrated rating event variable in the first regression is not significant; neither rating announcement nor outlook announcement is significant in the second regression; and not even S&P rating-related variables is significant in the third regression, not to mention Fitch and Moody's rating-related variables. There are several explanations might be able to clarify the result. First, we could claim this as a post-crisis effect, that the crisis paralyzes the accuracy and reliability of CRAs. That CRAs has difficulty to provide accurate and reliable rating activities. Moreover, during post-crisis period, ECB intervened the market with remedies and solution aimed to save EU from the crisis. When credit rating agencies adjust their rating or outlook, they are taking intervention of ECB into account; however, the market might not be able to include ECB's intervention into account if market expectation of remedies is different from ECB's intention. Thus, the following scenario might happen that CRAs already adjusted the rating by upgrading or adjusting outlook to ECB intervention, yet the stock market has not rebounded. To conclude, there is a post-crisis effect on CRAs that paralyzed their ability to provide accurate and reliable ratings and the intervention of third-party is processed differently by CRAs and markets. Therefore, none of rating-related variables is significant during post-crisis period. However, I believe the CRAs can eventually correct themselves from the post-crisis effect. To prove this hypothesis, it would be interesting to do a follow-up research in few years.

5.2 Event Study Result

In this session, I will present the result of session 4.2 event study. And explain how exactly the rating events like upgrading and downgrading affect own country's stock market performance. Moreover, based on the result of event study, I will be able to conclude whether CRAs behave procyclically, namely, upgrade the country when market behaves positively and downgrade when behaves negatively.

5.2.1 Upgrading Event

Below graphs show the result of upgrade event, two difference event windows are applied, [-5, 3] and [-2, 1]. The x-axis is the timeline of event study, 0 is the date of upgrade announcement; while y-axis is the cumulative abnormal return. In upgrade

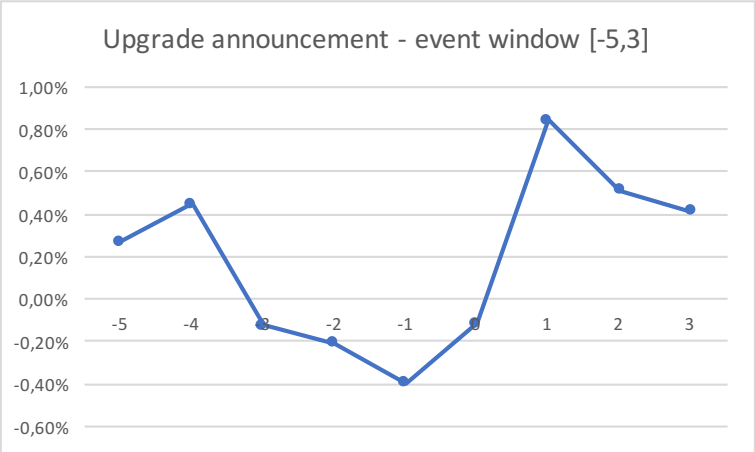
event study, there are only four countries in the poll, (Greece, Ireland, Portugal and Spain) as Italy has no clean event of upgrade during my event study period.

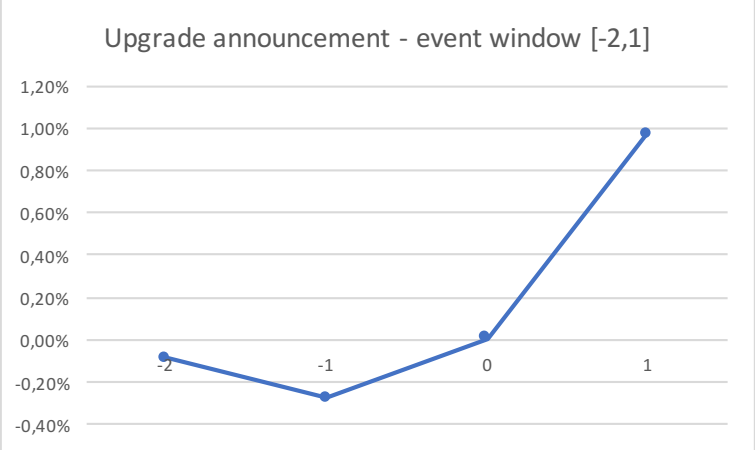
The previous findings of others conclude that when stock market is performing well, CRAs tends to upgrade the country. Yet in my event study, this finding is not significant, as between 4 days and 1 day before upgrading events, the stock market abnormal return is negative. Thus, there is decrease of CAR from 4 days to 1 day before rating event in the graph. Though one day before the rating event, the abnormal return tends positive, it is not reasonable to conclude that upgrading event happens when stock market outperforms in this case. However, my finding confirms that upgrading announcement has positive influence on stock market. As the graph shows that the day after the rating announcement, biggest abnormal return during the event window is observed. And overall, the CAR is positive in our event window, CAR of stock is almost 0.5% when event window of [-5, 3] is selected and CAR reaches almost 1% when event window is [-2, 1].

In event window of [-2, 1], the result is simpler and more straightforward. The upgrading event has significant impact on the stock market at day 1 after rating event. One possible interpretation is that investors will perceive the upgrading announcement as a strong positive signal, hence, they will become aggressive on stock market, which cause the return to increase. The investment enthusiasm will gradually cool off after the first day, which is the reason why we observe the slight decrease of CAR after the first day of upgrading event.

There are few possible explanations why my study does not give me the result of positive CAR right before upgrading event. Firstly, the selection of event window. Maybe the positive CAR occurs 5 days before the event day. And then the positive CAR period will be included in estimation window, this might cause the negative AR in my event window. Secondly, stock market is very volatile during my whole study period since aftermath of European Debt Crisis is severe and even today we cannot confidently conclude that PIIGS countries have fully recovered from the crisis. Thus, even during estimation window, the stock market is volatile and the estimated stock return, which used to compare with real return to calculate AR, is difficult to predict and lack of credibility. Finally, during my study period, the market cannot be considered as a totally free market. Especially after 2012, when EU decided to save

PIIGS from the crisis, the market has been interfered by local government and EU institutions afterwards. Take Greece as an example, the country accepted two bailouts from European Union, one in 2010 and 2012, which worth total amount of EUR 220 bn. And this is also the reason why Italy has less upgrading event compared to other PIIGS countries. Not because Italy cope or behave worse compared to others, but because it did not accept or receive any money from EU institutions. To conclude, the above explanations are reasons that I did not observe rally of stock return right before upgrade event.





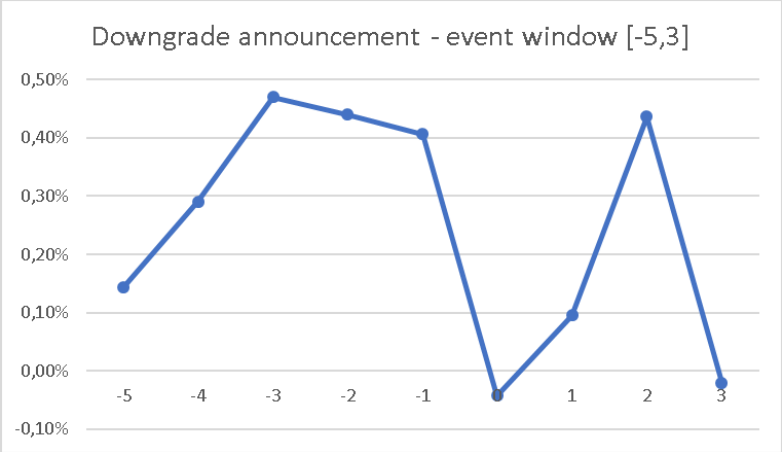
5.2.2 Downgrading Event

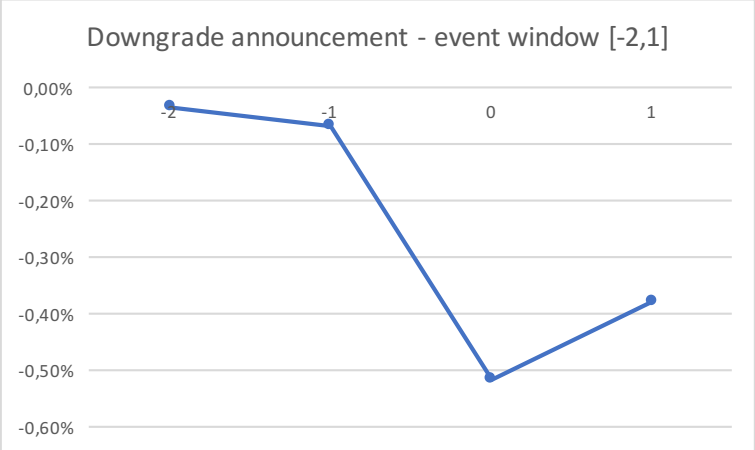
In this session, the result of downgrading announcement as event will be present and explained. The same estimation window and two event windows as upgrading event study have been adopted. The purpose of which is to see how exactly stock market behaves right before and after downgrading event.

Under event window of [-5, 3], I observe some interesting findings that are somehow different from previous studies of others. Up until 3 days before downgrading event, the abnormal return has been positive, indicating that market was performing better than expected from 5 days to 3 days before downgrading event. From 3 days before downgrading to the day of downgrading, the CAR decreases, which implies negative abnormal return during the same time. Hence, I can still draw a conclusion that downgrading event happens when market is underperforming than expected, which is aligned with other studies' findings. However, due to previous positive CAR, at the downgrading day, the CAR is only slightly lower than 0%, which is contradicted to other studies' findings. Yet if we look at the result of event window [-2, 1], only negative CAR can be found. This finding implies that though different event windows give us relatively similar result of how CAR develops along the time, the qualitative finding of whether give us positive or negative CAR varies.

After the day of downgrading, AR turns positive again for the next two days, giving us almost 0.5% cumulated AR. This finding is contradicted to other studies. One possible explanation is that during European Debt Crisis, the market is not totally free. Local government will try to interfere the market immediately after downgrading announcement to gain public confidence during sensitive period. However, in the third day after downgrading, biggest negative AR has been observed, which result an overall negative CAR during the event window. Hence, though AR occurs both positive and negative, downgrading event still cause overall negative CAR during the event window. The same conclusion holds also for the second event window [-2, 1], where only negative CAR has been observed. This indicates that though being interfered, market can still reflect the bad news of downgrading announcement.

The reason why AR is volatile during the event window is same as the explanations under previous upgrading event study session. First, the selection of event window and estimation window may result slightly different result. Second, stock market is particularly volatile during study period, which makes expected return even more difficult to predict. Last, free market assumption does not hold under interferences from government and institutions during the European Debt Crisis, which causes stock market behaves unexpectedly. Moreover, CRAs' rating activities are biased from financial market outlook under interferences. Thus, creditability and accuracy of CRAs activities are questionable under this condition.





From above discussion, I can conclude that rating events, both upgrading and downgrading announcements, deliver strong signal to the market and affect the performance of the market despite the interference from the third party. Moreover, at least one day before the rating events, the market has dramatic deviation from expected value, which indicates that CRAs process procyclical behavior, meaning they downgrade the country when market in bad condition and upgrade the country when in good condition.

6.Conclusion

Most of the previous studies regarding country sovereign rating during European debt crisis are measuring efficiency of Credit Rating Agencies (CRAs) through whether their ratings truly reflect one country's sovereign debt level. Hence, most studies are conducted via intensive research on debt market. In the meanwhile,

spillover effects of credit rating events are less focused and studied. Moreover, spillover effect of one country's credit rating to other countries' market are even less measured. In this paper, I focus on spillover effect of credit ratings not only to own country but also to other related countries under PIIGS context. And two methodologies, namely panel regression and event study, have been adopted to test whether credit rating spillover effect on stock market is significant and how does spillover effect evolve and develop around credit rating announcement period respectively. Panel regression focuses on spillover effect of one country's rating on other PIIGS countries stock market, while event study exams how one country's rating event affect own country's stock market.

There are four conclusions that we can draw from the panel regression study, which top-down methodology is applied and different regressions are carried out.

Firstly, one country's credit rating events have significant spillover effect on other countries' stock market under PIIGS context during whole study period coving pre-, during- and post- European debt crisis.

Secondly, after take a closer look of the nature of credit rating event, I conclude that credit rating announcement instead of credit outlook announcement is the reason of significant spillover effect on other countries' stock market, with average of 6 basis point change in the stock return in response to a rating announcement.

Thirdly, S&P is the most accurate and reliable rating agency among the big three CRAs (S&P, Moody's and Fitch), and this finding is aligned with previous studies in different period and under different context. In my study, S&P rating announcement is the only significant variable in the panel regression which includes different CRAs rating events. And the significant result shows that one country's S&P rating change can cause other countries' stock return changes about 18 basis point under PIIGS context. And during different period study, namely pre-crisis, during-crisis and post-crisis period study, S&P shows superior rating reliability and accuracy, as each of its rating announcement affects about 231 basis point changes of other PIIGS countries' stock return in pre-crisis period. Moreover, in during-crisis period, S&P related credit rating variables, including both rating announcement and outlook, are the only two

significant variables among big three CRAs' rating announcements and outlooks variables.

Finally, pre-crisis period is the only period where significant spillover effect can be detected, which contributed by rating announcement instead of outlook announcement, with 104 basis point changes in stock return per credit rating announcement. And in during-crisis period, only S&P related credit rating activities have spillover effect on other stock markets. While in post-crisis period, none of variables is significant which indicates that no spillover effect can be detected. In other words, European debt crisis exasperates the ability of CRAs' ability to provide accurate and reliable credit rating activities. The deteriorate effect becomes even worse after crisis, which I clarify as one negative post-effect of European debt crisis on CRAs.

And there are other three conclusions can be drawn from event study, where I observe how stock market return changes in response to its own country's rating announcement.

First, some positive (negative) cumulative abnormal return (CAR) has been observed in response to upgrading (downgrading) event, especially between the period of 2 days before and 1 day after the rating announcement, with almost -0.5% of abnormal return (AR) has been observed at the date of downgrading event and about 0.9% of AR has been measured one day after upgrading event.

Second, though effect of one country's rating event to own stock market has been detected, the effect is very time-limited. In other words, stock market will only be affected averagely around 3 days due to each rating event. As we can see from downgrading event, in between 5 days to 3 days before rating event, positive AR has been seen; while in upgrading event, negative AR has been observed until 2 days before rating event. Hence, I would draw a bold conclude that during European debt crisis, CRAs did not behave procyclically, namely, CRAs did not upgrade (downgrade) the country when market was improving (deteriorating).

Third, during event window of [-5, 3], overall effect of downgrading event on stock market is very limited, with CAR reaches merely -0.03% after three days of downgrading event. One explanation is that financial market was not fully free during

European debt crisis and was manipulated to some extent by third parties. European institution and government interfered the economy and market intensively, especially in PIIGS countries, in order to calm down the public and save themselves and Europe from the crisis. Hence, stock market returns might not truly reflect the nature of financial market and credit rating events might be biased and not reliable since they might include consideration of third parties' interference. To conclude, the result is not exactly as my expectation but it is reasonable considering the particularity of European debt crisis.

Several follow-up research would improve my understanding and might also strengthen the explanations of above conclusions. For instance, in the panel regression session, it would be better to separate downgrading event and upgrading event and see different result of these two rating events. Previous studies have concluded that upgrading event and downgrading event sometimes result different conclusion. The reason I did not apply in this paper is that not adequate upgrading events are available in my data, hence, the result might be biased.

Another extension research in event study session would be applying different estimation window and event window, especially would be interesting to see how CAR develops in the longer event window. Also, it would be helpful to also divide study period into pre-crisis, during crisis and post-crisis period, and observe if the results would change dramatically as the panel regression. This would shed light on how CRAs credit rating activities changed by European debt crisis.

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Appendix

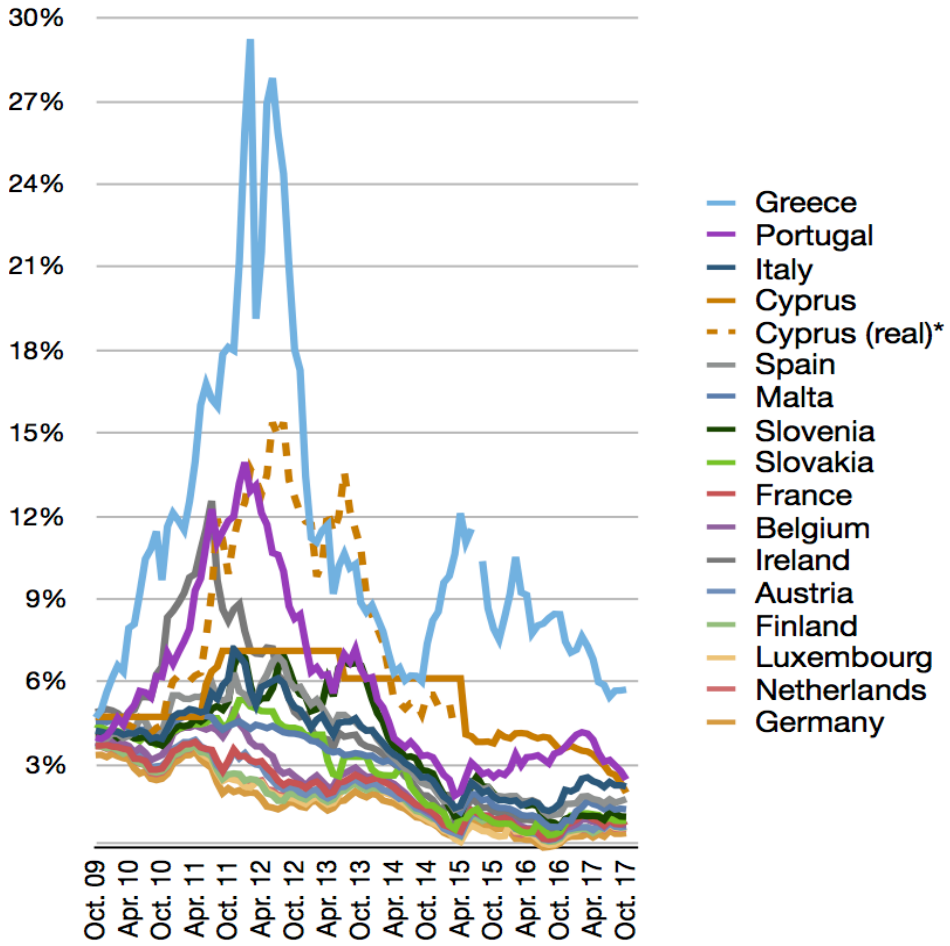
Appendix - 1 Credit Rating Scale per Agency

	S&P		Moody's		Fitch		
	Long-term	Short-term	Long-term	Short-term	Long-term	Short-term	
Investment	AAA	A-1+	Aaa	P-1	AAA	F1+	Prime
	AA+		Aa1		AA+		High Grade
	AA		Aa2		AA		
	AA-		Aa3		AA-		
	A+	A-1	A1		A+	F1	Upper Medium Grade
	A		A2		A		
	A-	A-2	A3	P-2	A-	F2	
	BBB+		Baa1		BBB+		Lower Medium Grade
	BBB	A-3	Baa2	P-3	BBB	F3	
	BBB-		Baa3		BBB-		
Speculative	BB+	B	Ba1	Not Prime	BB+	B	Non-Investment Grade (Speculative)
	BB		Ba2		BB		
	BB-		Ba3		BB-		
	B+		B1		B+		Highly Speculative
	B		B2		B		
	B-		B3		B-		
	CCC+	C	Caa1		CCC	C	Substantial Risk
	CCC		Caa2				Extremely Speculative
	CCC-		Caa3				In default with little prospect for recovery
	CC		Ca				
	C						
	D	/	C		DDD	/	In default

Appendix - 2 Comprehensive credit rating definitions

S&P		Moody's		Fitch		Credit outlook	
Rating	Numerical Node	Rating	Numerical Node	Rating	Numerical Node	Outlook	Numerical Node
AAA	20	Aaa	20	AAA	20	Positive	1.00
AA+	19	Aa1	19	AA+	19	Positive watch	0.50
AA	18	Aa2	18	AA	18	Stable	0.00
AA-	17	Aa3	17	AA-	17	Negative watch	-0.50
A+	16	A1	16	A+	16	Negative	-1.00
A	15	A2	15	A	15		
A-	14	A3	14	A-	14		
BBB+	13	Baa1	13	BBB+	13		
BBB	12	Baa2	12	BBB	12		
BBB-	11	Baa3	11	BBB-	11		
BB+	10	Ba1	10	BB+	10		
BB	9	Ba2	9	BB	9		
BB-	8	Ba3	8	BB-	8		
B+	7	B1	7	B+	7		
B	6	B2	6	B	6		
B-	5	B3	5	B-	5		
CCC+	4	Caa1	4	CCC+	4		
CCC	3	Caa2	3	CCC	3		
CCC-	2	Caa3	2	CCC-	2		
CC/C	1	Ca	1	CC/C	1		
SD	0	C	0	RD	0		

Appendix - 3 Long-term interest rate of European countries from 2009 to 2017



* actual market trade values without cut-off yield for Cyprus government bond maturing 3 February 2020

Source: European Central Bank

Appendix - 4 Estimation of parameters α_i and β_i in market model (Event study)

In this part, I will explain how to calculate parameters of α_i and β_i in the market model from event study in session *4.2.2. Abnormal return under market model adjustment.* The estimation window is 90 days before T_1, the first day of event window. Thus length L_1 is 90 days. T_0 is the first day of the estimation window and T_1 is the last day. For any country i in the study, the parameters α_i and β_i can be estimated in the following manners,

$$\widehat{\beta_\iota} = \frac{\sum_{t=T_0}^{T_1}(R_{it} - \widehat{u_\iota})(R_{mt} - \widehat{u_m})}{\sum_{t=T_0}^{T_1}(R_{mt} - \widehat{u_m})^2}$$

$$\widehat{\alpha_\iota} = \widehat{u_\iota} - \widehat{\beta_\iota}\widehat{u_m}$$

where,

$$\widehat{u_\iota} = \frac{1}{L_1}\sum_{t=T_0}^{T_1} R_{it}$$

$$\widehat{u_m} = \frac{1}{L_1}\sum_{t=T_0}^{T_1} R_{mt}$$

And the estimated variance can be calculated as follows,

$$\widehat{\sigma_{\epsilon\iota}}^2 = \frac{1}{L_2 - 2}\sum_{t=T_0}^{T_1} \widehat{u_{it}}^2 = \frac{1}{L_2 - 2}\sum_{t=T_0}^{T_1}(R_{it} - \widehat{\alpha_\iota} - \widehat{\beta_\iota}R_{mt})^2$$

R_{it} is the index return of country i in time t, and R_{mt} is the market portfolio index return which is Euro Stoxx 50 in the same time t. And $\widehat{u_\iota}$ is the average return of country i over estimation period, which is from T_0 to T_1. And L_1 is the length of the estimation period, which is 90 days in this case. $\widehat{\sigma_{\epsilon\iota}}^2$ is the estimated variance.

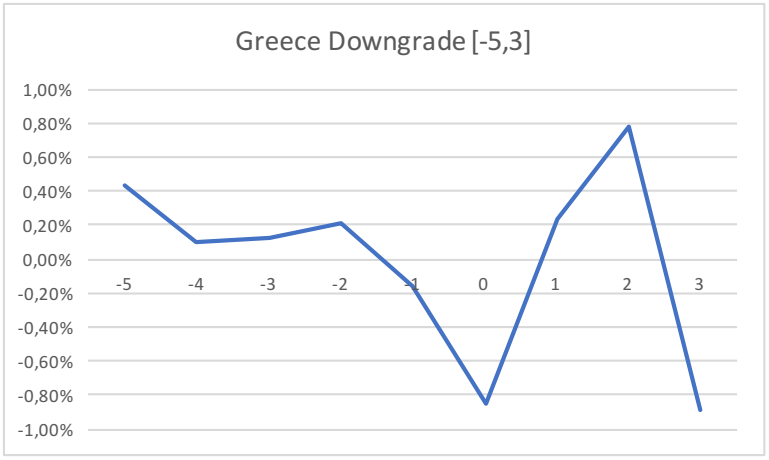
Appendix - 5 Event study of specific PIIGS country

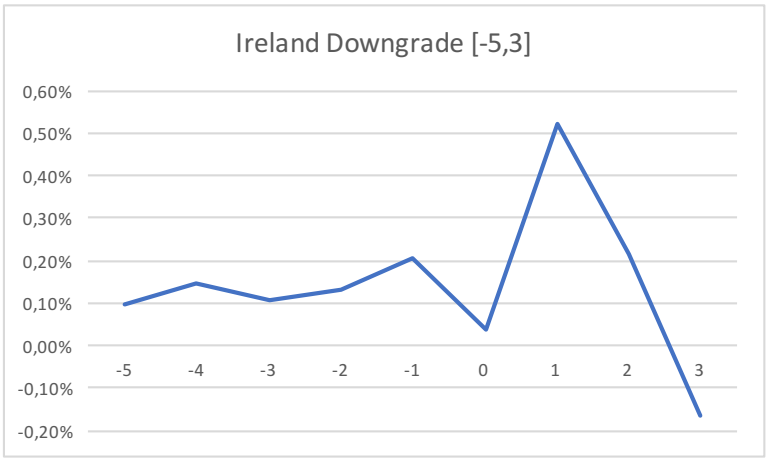
In this session, result of event study on each PIIGS will be present. I select event window of [-5,3] and same estimation window of [-90, -5] as session 4.2.1.

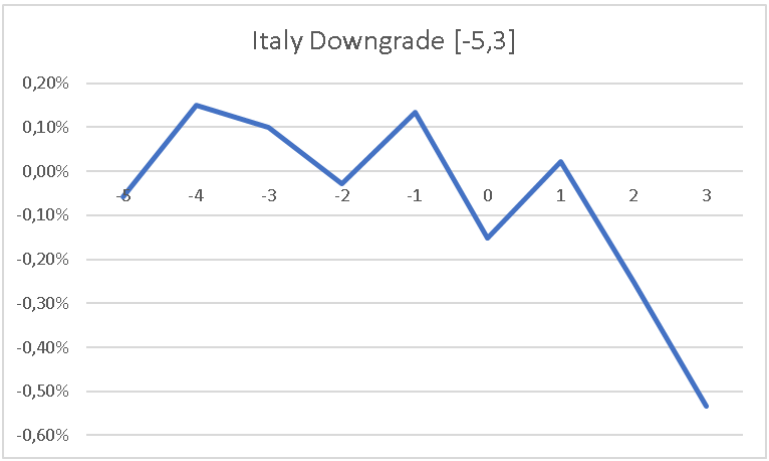
The original purpose of which is to see if any country has different result compared to other countries, which might cause extreme or abnormal result in the aggregate analysis on PIIGS countries. But since the result didn't give us breakthrough finding or contradicted result, I decide to put them in the appendix.

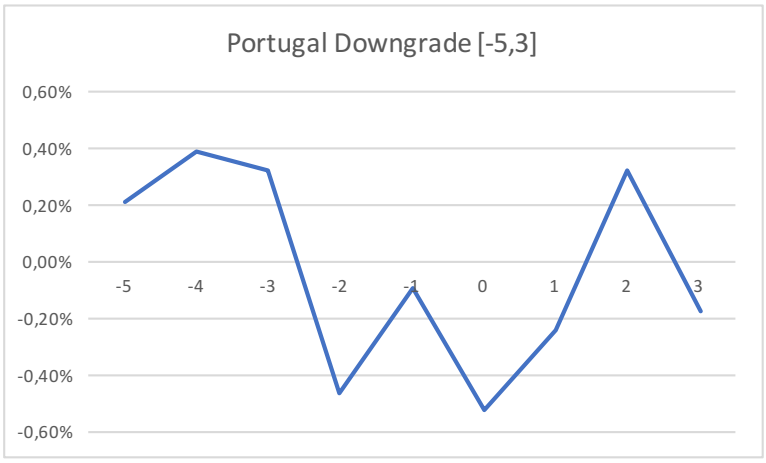
Note: for event study on upgrade, result of Italy is not applicable since there isn't any upgrading event during my study period.

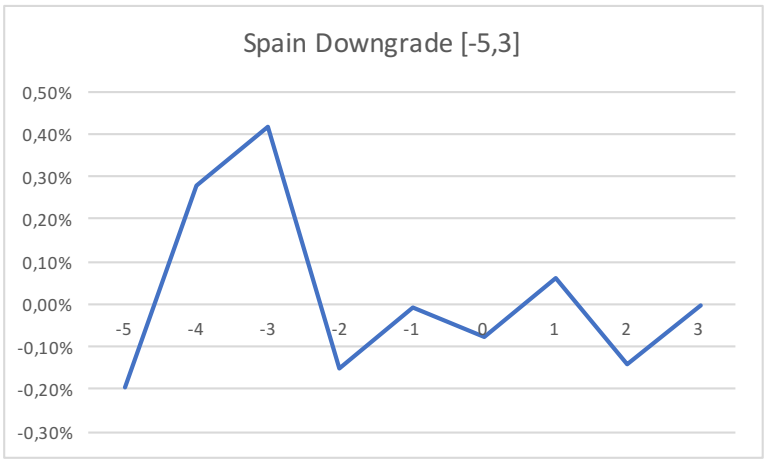
Downgrading event:



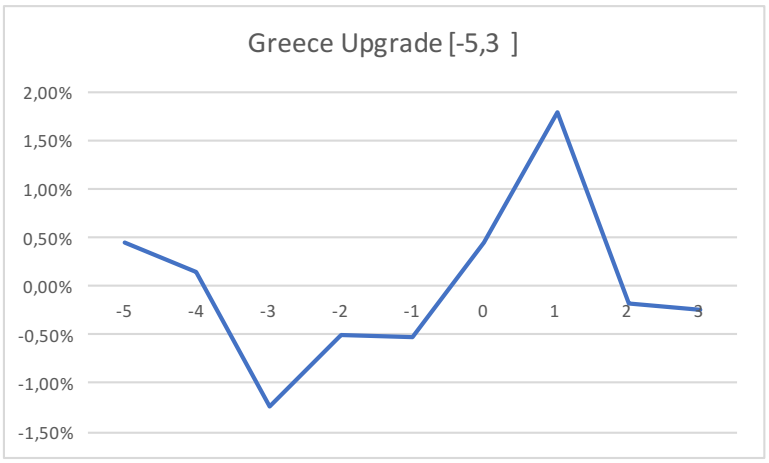


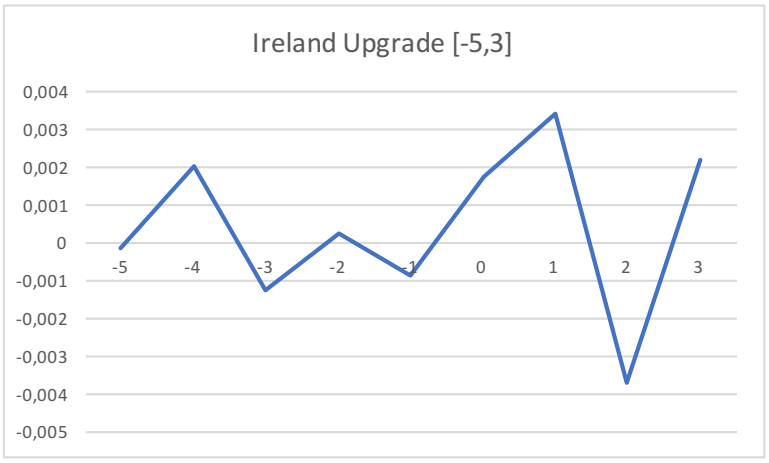


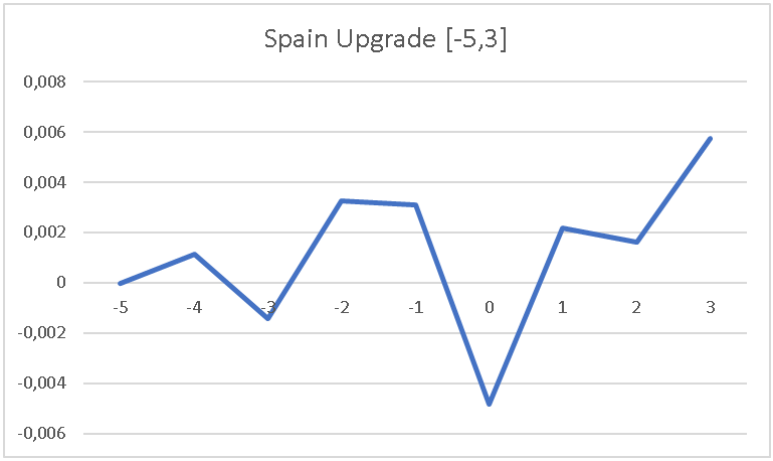




Upgrading event:




Ireland Upgrade [-5,3]
0,004
0,003
0,002
0,001
0
-0,001
-0,002
-0,003
-0,004
-0,005
-5
-4
-3
-2
-1
0
1
2
3


Spain Upgrade [-5,3]
0,008
0,006
0,004
0,002
0
-0,002
-0,004
-0,006
-5
-4
-2
-1
0
1
2
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Stockholm School of Economics

Credit rating impact on the CDS market: the case of PIIGS countries coving European debt crisis period

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Abstract:

In this paper, I analyze the impact of sovereign debt rating to CDS market under PIIGS (Portugal, Italy, Ireland, Greece and Spain) context during the European Debt Crisis. Via panel regression, I find country's sovereign rating and outlook have significant impact on the CDS market during the pre-crisis period. Rating announcements have a less significant effect compared to outlook adjustments. S&P is the most accurate and reliable one among the big three credit rating agencies. Furthermore, we conclude that crisis has paralyzed the credit rating agencies' ability to provide rating accurately and promptly. Then through event study, we observe a negative impact on the CDS market from the rating announcement in both upgrading and downgrading events. Downgrading events tend to have bigger impact on the CDS market compared to the upgrading events, in terms of the cumulative abnormal return that captured in the event window and the lasting effect on the market after the event date.

Key Words: Sovereign Credit Rating, Credit Rating Agencies, CDS market, Sovereign CDS spread, European Debt Crisis, PIIGS

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Table of Contents

1. Introduction

The role of credit rating agencies (CRAs) has been well-discussed and criticized in the last decades. Although by function, CRAs provide creditworthiness of entities and their financial obligations. Thereby, CRAs usually considered as the trustworthy players who provide a reliable credit-related reference to investors in order to help them make a decision. In reality, however, CRAs are behaving like a 'rating shops' (Baker & Mansi, 2003), because the favourable rating system is well-liked by issuers who pay for the ratings. Although several studies have criticized on this mechanism of CRAs and its catastrophic results, change the business model back to 'investor-pay' seems to be a blind alley. During the subprime crisis, credit rating agencies showed excessive optimism bias, disabled to evaluate the situation and eventually misled the market (Casey, 2009). In 2017, Moody's has paid USD 864 million penalty for inflated ratings during the subprime financial crisis.

Nevertheless, CRAs are still playing an important role in the financial market. Credit rating is universal recognized indicator for credit risk. Also, change of credit rating is a major news (Lehn, 1994) and can be used to make a vital decision, i.e. bank's regulatory capital (Basel committee, 2004). Credit rating also plays a central role in the financial market and imposes significant spillover effect to different financial markets, among which, stock (Barron et al, 1997; Pacheco, 2012), bond (Darbellay & Partnoy, 2012) and credit default swap (CDS) market (Hull et al., 2004; Norden and Weber, 2004; Cesare, 2006) are the main markets that have been well-studied.

Among aforementioned matters, the relationship between the CDS market and credit rating is an interesting and relative contemporary research topic. CDS, invented in early 1990s, is one of the most popular derivatives on the market. It provides protection against default risk, closes the gap between the demand and supplies of less liquid corporate debt market and builds opportunity for hedging and arbitrage. By nature, both CDS and credit rating are driven by the quality of credit. Although the asymmetric information may lead to the diverge of the two, under efficient market hypothesis, there should be a significant relationship in between CDS and credit rating.

The main objective of this paper is to answer the research question that how sovereign credit risk is affected by sovereign credit rating announcement, and sovereign CDS spread is used as the indicator of the credit risk. To be more specific, through this

paper, I want to understand if there is a link in between sovereign credit rating announcement and CDS market, i.e. whether credit rating announcement provides insightful information to credit risk which is measured by CDS spread. My research is focus on European Debt Crisis period, ranging from 2006 to 2016, with most representative countries during the crisis which are Portugal, Italy, Ireland, Greece and Spain (PIIGS). Apart from the main research question, I also want to examine other matters in order to build a comprehensive understanding regarding the topic, such as whether CRAs have been acting differently before and during the European debt crisis, how CDS spreads react to the changes of credit ratings, and whether upgrades and downgrades both present significant relationship with CDS spreads.

This work is a complementary study of Part A study which investigates the relationship between stock market and credit rating announcement of PIIGS countries during the European debt crisis. The two studies share several similarities. Fundamentally, the impact of CRAs' credit rating is being measured in both cases. And the role of CRAs is well-examined. By nature of CRAs and hypothesis of efficient market, the credit ratings show high quality when there is a significant link in between them and the financial markets. Besides, even though two studies examine different financial markets, they both focus on PIIGS countries during the European debt crisis period. Notably, the datasets range from 2006 to 2016 in both cases. Obviously, stock market and CDS market are different, as CDS market mainly measuring credit risk, yet both markets represent similar fundamentals and a strong relationship is presence in between the two. Hence, I consider this thesis as a complementary work of the Part A study instead of standalone study. It provides a more comprehensive understanding about the impact of credit ratings on the financial markets, as well as the role of credit rating agencies.

The paper is structured as follows: section I introduces the topic of related backgrounds of the thesis. Section II consists of literature review which includes following categories: i) recall of credit rating agencies from Part A study; ii) overview of CDS market; iii) impacts of credit rating announcements, particular on CDS market and finally iv) recall of European debt crisis from Part A study. Section III describes the dataset, including both sovereign credit ratings and CDS spreads. Section IV explains the methodologies of this paper, including i) panel regression and ii) event study. Panel regression is to test whether there is a significant link in between CDS spread and sovereign credit

rating, while event study is carried out to quantify the impact of sovereign credit rating on the CDS spread. Section V presents the results of both panel regression and event study; while section VI concludes.

2. Literature Review

2.1 Recall credit rating agencies and their sovereign credit rating

Since the1990s, the credit rating market has been dominated by the big three credit rating agencies, S&P, Moody's and Fitch (White, 2010). Together the big three CRAs has over 95% of the total market share, according to European Securities and Market Authority (ESMA) (2016). The oligopoly status of credit rating market is mainly due to high barriers to entry, especially regulatory barriers (Bolton et al., 2012; Partnoy, 2001; Li et al., 2006; Frost, 2007).

Are CRAs trustworthy? Credit rating agencies charge fees from issuers instead of investors, and this methodology has argued by many that would cause conflict of interest, e.g. White (2002), Partnoy (2006), Pagano et al. (2010) and Bolton et al. (2012). White (2002) claims it causes moral hazard and opportunistic behaviour of credit rating agencies, such as inflation of the rating. Partnoy (2006) concerns that no pressure has been exposed to CRAs to eliminate conflicts. Pagano et al. (2010) believe CRAs choose to behave in aligned with issuer's need. Cornaggia et al. (2013) find that Moody's provides less accurate ratings compare to investor-pay agencies, same result has also been concluded by Milidonis (2013).

In this study, I focus on the impact of the sovereign credit rating. Thus, it is important to understand its determinants. Mellios et al. (2006) claim that both political and economic factors contribute to the sovereign credit rating. Several empirical studies have been carried out in order to figure out determinants of sovereign credit rating. Cantor and Packer (1996) started with the OLS model which followed by many researchers who have concluded that the ordered probit model is more appropriate. Commonly agreed determinants from previous studies include GDP per capita, GDP growth rate, government budget balance, interest rate, inflation rate, external and public debt (Bissoondoyal-Bheenick, 2005; Afonso et al, 2012; Zigman and Cota, 2011 and Reusens and Croux, 2017). Some other researchers believe determinants relating to credit rating itself, including default history, previous outlook and rating, current

rating, duration of rating (Al-Sakka, 2009; Hill, 2010 and Reusens and Croux, 2017). In addition, downgrading from investment grade to speculative grade can cause consequences more than increase the cost of capital. Hence, Al-Sakka (2009) includes dummy variable “investment grade” to find determinants of sovereign credit rating. One thing worth to notice is that sovereign issuers are free from default. As Mellios et al. (2006) claim that incented by government reputation, access to credit markets, including foreign debt market and possible sanctions, sovereign issuers will continue to pay their debt.

2.2 Overview of CDS market

Credit default swap, commonly known as CDS, is a financial swap agreement that seller will compensate the buyer in the event of the credit event (usually default). In return, the buyer will make series of payments to the seller. To some extent, CDS is very similar to insurance. CDS was first invented in the market in 1990s and considered to be a relatively new financial instrument. Nevertheless, CDS has gained popularity and increased dramatically in early 2000s. By the end of 2007, the whole CDS market was at the highest level of about USD 62.2 trillion. In fact, the rapid growth of CDS increased leverage and decreased transparency in the market, which eventually led to the subprime crisis in 2008 (Fostel and Geanakoplos, 2012) and the European debt crisis (Portes 2010). Following the crisis, the European Parliament has banned naked sovereign CDS trading. As today, the outstanding notional amount of CDS market is only USD 9.4 trillion.

CDS has gained lots of criticisms in the past decade. First of all, the CDS is unregulated since it is traded over-the-counter instead of via exchange. Each CDS contract is negotiated by the two counterparties privately, without disclosure of the transaction price. Soros (2009) points out that buying the CDS carries a limited risk but has unlimited revenue potential. Yet selling the CDS means exactly the opposed situation, which means unlimited risk with limited revenue. Moreover, CDS provides investors an opportunity to a large risk exposure at the cost of mere minimal up-front capital. Such high leveraged trading needs a better-formed regulation to keep in order (Simkovic M., 2008). The asymmetry and leverage in the CDS market could lead to massive default, especially during the market downturn, i.e. the subprime crisis.

Second, CDS is very risk-oriented and difficult to be priced. CDS is recognized as one of the efficient credit risk transfer (CRT) instruments which helps bank to reduce the cost by transferring the credit risk (Pausch, 2012). Parlour and Plantin (2007) find out that it is likely to lead to moral hazard problem if bank is monitoring their borrowers. Similar conclusion has been claimed by Chakraborty et al. (2015) that moral hazard can be found in CDS lenders. Besides, is very difficult to value the CDS, given the fact that different factors need to be taken into consideration, such as default probability, recovery rate and timing of default. Any asymmetric information of aforementioned factors should be concerned (Archarya and Johnson, 2007) since it can lead to insider trading. For instance, if bank A knows company X will go into default, then bank A can purchase CDS from less informed counterparty to profit itself against the default. In consequences, the asymmetric information may also result to illiquidity in the CDS market. Archarya and Johnson (2007) argue that asymmetric information will lead to a widen bid-ask gap and therefore increased the liquidity cost. Parlour and Plantin (2007) confirm that asymmetric information in the CDS market will eventually decrease the liquidity of the CDS market, due to the low quality of information and lack of transparency in the market.

Last but not least, usually, high degree of speculation is involved in CDS trading. Although CDS was designed to hedge the risk when introduced, many investors use it for speculations. ‘Naked CDS’ refers to purchasing CDS without holding underlying securities, and it is deemed as a speculative investment. Take playing card (see movie The Big Short) as an example, the first CDS buyer A may hedge the risk of player 1 lose to player 2. The second CDS buyer B, instead of betting on the game itself, may bet on whether buyer A will win or lose. CDS buyer C can bet on B’s position and so on. One card game can generate infinite number of CDSs, thanks to this rolling betting system. Apart from buyer A who actually bets on the game, the rest buyers are all ‘naked CDS’ buyers. In real world, the naked CDS can cause short-selling bonds in the market downturn. The consequence of which forced EU to ban naked CDS trading on sovereign bonds (Barley, 2010), which is finalized in October 2011. The speculation in the sovereign CDS market was blamed as a cause for the European debt crisis. Even though Duffie (2010) suggests that restrict speculative CDS trade would actually reduce the market liquidity and raising cost for all investors.

2.3 Impacts of credit rating announcements, particular on CDS market

Recall from Part A, sovereign credit rating announcement has significant impact on the financial markets. In the past decade, researchers have studied the relationships in between sovereign credit rating and stock market, bond market as well as CDS market under the context of financial crisis, such as the Asian financial crisis, the subprime crisis and the European debt crisis.

Concerning the stock market, a significant impact of the credit rating events, especially downgrading events has been found during both the Asian financial crisis and the subprime crisis. (Kaminsky and Schmukler, 2002; Chiang et al. 2007; Christopher et al., 2012). In Part A, I also concluded that credit rating events' impact on the stock market is significant, particularly the credit events from S&P. Besides, spillover effect of one country's credit rating events to other countries' stock market has also been found during the subprime crisis and the European debt crisis (Ferreira and Gama, 2007; Christopher et al. 2012). Through Part A, I also validated the spillover effect of credit rating events on the stock market among PIIGS countries during the European debt crisis.

The significant impact of sovereign credit rating events on the bond market has also been found. Reisen and von Maltzan (1998) found significant relationship in between spread volatility of sovereign bond and rating events, with volatility increasing (decreasing) as rating downgrading (upgrading). Afonso et al. (2014) conclude that rating events have asymmetric effect on the bond volatility, where downgrades tend to have more significant impact both instantly and with two lags. Similar results have been addressed by Böninghausen and Zabel (2015), who have applied sample from 74 countries ranging from 1994 to 2011.

Even though in theory, CDS spreads should have equal movement as the bond yield spreads since they are both proxies of credit risk, yet this usually doesn't hold in the real world. Longstaff et al. (2005) have found the difference in between bond yield spreads and CDS spreads. Hence, it is valuable to treat the CDS market as a separate market from the bond market and study the link in between the CDS market and sovereign credit ratings. In the last decade, researchers have carried out several studies on CDS market and credit rating events. Although, the conclusions are

diverged. Micu et al. (2006) conclude significant impact of all credit rating events on CDS spreads, including upgrades, downgrades and outlooks. While other researcher such as Weber (2004) and Sy et al. (2011) find that only downgrading events have significant impact on the CDS spreads. Moreover, Sy et al. also observe spillover effect of one country's sovereign credit ratings to other countries' CDS market among European countries during the European debt crisis. On contrary, Callen et al. (2009) and Jacobs et al. (2010) suggest that there is no significant impact of sovereign credit rating events on the CDS spreads. Jacobs et al. explain that the CDS market acts quicker to the risk than rating agencies. Furthermore, CDS spreads mirror a higher risk level than credit ratings.

2.4 Recall European debt crisis

European debt crisis, also refers to European sovereign debt crisis, is one of the catastrophic economic crises that has been taking place in the European Union since the end of 2009. There are lots of impacts and consequences of this crisis, not only limited to economics and financial markets, but also extended to the politics. Since our study is focusing on European debt crisis period, from pre-crisis period to post-crisis period, it is worth to take a comprehensive look into the crisis and its implications.

In early 2000s, most European countries applied loose fiscal policy, and most countries (e.g. Greece, Italy, Portugal, Spain, Ireland, France and Germany) no longer hold the 60% debt/GDP ratio limit required by European Union in 2007, before the US subprime crisis. The failure to tight the fiscal policy of several European governments after 2008 has led to the European debt crisis (Reinhart, 2013). Candelon and Palm (2010) also conclude that negative correlation between the stock market and the Public debt to GDP ratio via their empirical study on the Euro zone. The U.S. subprime crisis also contributes to the European debt crisis indirectly. First of all, the whole world banking industry is under pressure after 2008. Dieckmann and Plank (2012) confirm that the increasing government borrowing cannot solve the distressed banking industry, rather escalate the crisis. Moreover, Ureche-Rangau and Burietz (2013) argue that capital injections among European governments right after the subprime crisis has jeopardized their ability for a second rescue three years later.

The reason I choose to focus on PIIGS countries in both parts is because they are the most representative countries during the crisis, in other words, they have experienced most intensive distress situation. Most of them have recovered from the crisis thanks to bail-out fund from European Financial Stability Facility (EFSF) and International Monetary Fund (IMF), though Italy is still struggling with its economy. Yet as one of the largest economic crises in the history, it is worth to spend some time and study its implications. If we can learn the lessons from the past, it would be helpful to tackle with the next crisis or even prevent one.

3. Data

This section describes how the data are selected and obtained. Same as the Part A, I choose PIIGS countries (Portugal, Italy, Ireland, Greece and Spain) because of the representativeness of these countries during the European debt crisis. Since my intention of this paper is to observe what is the impact of sovereign credit rating on the debt market, the time span of the dataset should cover the whole European Debt Crisis. Moreover, in order to compare how impact of credit rating announcements on the CDS market has changed before, during and after the crisis, the data in this paper will be covering 2006 to 2016, which will further be classified as pre-, during and post-crisis period.

The main dataset has two parts, countries' CDS spreads and sovereign credit ratings.

3.1 CDS Spread

Credit Default Swap (CDS) spread, usually denominated in basis points, is the price of CDS, which is the agreement to protest CDS buyer from CDS seller, in case of the credit event, such as default. Similar to insurance, the buyer of CDS is insured by the seller of CDS.

Concerning the sovereign CDS, unlike corporate CDS, bankruptcy is unlikely to happen. The three main credit events to trigger sovereign CDS are 1) Failure to pay a coupon or principal on a bond, 2) Moratorium and 3) Restructuring.

With sovereign CDS spread, we can then estimate the market sovereign default rate given the recovery rate.

$$Default\ rate\ for\ one\ year = \frac{CDS\ spread}{1 - recovery\ rate}$$

Assume we use 5-year CDS spread in the above equation, then the cumulative default rate for 5 years is,

$$Cumulative\ default\ rate = 5\ years \times Default\ rate\ for\ one\ year$$

Based on the previous calculation, we can confirm O'Kane and Sen (Lehman Brothers, 2004) statement that CDS spread represents sovereign credit risk. In the meantime, CDS spread reflects the macroeconomic fundamentals, which has been concluded by Amato (2005), Tang and Yan (2010), Aizenman et al. (2013) and etc.

In this paper, I use PIIGS countries' 5-year sovereign CDS spread denominated in EUR to conduct empirical study of panel regression and event study. The exchange risk is not our concern in this study, since all PIIGS countries use Euro as national currency. The index is in daily form, and an average of bid-ask spread is being used. 5-year sovereign CDS spread is usually considered to be perfectly priced, as stated by Longstaff et al. (2010). The data is obtained from DataStream and starts from October 2006.

3.2 Sovereign credit rating

Recall from the Part A, the big three credit rating agencies (S&P, Moody's and Fitch) together has more than 90% market share of credit rating industry. Same as the Part A, I will use sovereign credit rating data from the big three agencies, including both outlooks and ratings. All ratings are referring to foreign-currency sovereign credit rating due to additional consideration of government transfer and convertibility risk compared to local-currency rating. Furthermore, all ratings and outlooks are obtained from the Trading Economics website, ranging from October 2006 to the end of 2016.

Yet all ratings & outlooks data are qualitative, in order to quantify them, I apply comprehensive credit ratings (CCR) measurement, named by Ferreira and Gama (2007). CCR measurement assigns scores to ratings, with highest rating received highest score. For instance, AAA rating (Aaa for Moody's) is equal to 20 while SD is equal to 0. How to assign scores to outlooks, however, is divergent and debatable. Gande and Parsley (2005) assign positive and negative outlook one score, the same

as one notch change. Chen et al. (2016) improve the CCR measurement by assign 0.5 score to negative and positive outlook and watch. In part A, I assign 1 score to change of outlook and 0.5 score to change of outlook watch. Also, this part will continue to use the same measurement. The detailed CCR that I am applying is shown in the Appendix 1.

The rating data of my dataset is summarized in the following table. The data covers rating events from October 2006 to the last trading day of 2016.

Table 1. Number of rating events of PIIGS countries

	S&P		Moody's		Fitch	
	Upgrade	**Downgrade**	**Upgrade**	**Downgrade**	**Upgrade**	**Downgrade**
Change in Rating						
Greece	5	13	2	9	4	11
Ireland	3	6	3	5	2	4
Italy	1	4	0	3	0	3
Portugal	1	5	2	5	0	5
Spain	2	6	1	5	1	4
Total Changes	**12**	**34**	**8**	**27**	**7**	**27**
Change in Outlook/Watchlist						
Greece	1	5	2	5	1	4
Ireland	3	2	2	3	3	2
Italy	0	2	1	2	1	2
Portugal	4	6	1	3	3	3
Spain	1	3	1	4	1	2
Total Changes	**9**	**18**	**7**	**17**	**9**	**13**

Source: Author's dataset

3.3 U.S. interest rate

The U.S. interest rate in this study refers to the one-month interbank offer rate, same as the study in the Part A. The data is from Yahoo Finance.

U.S. interest rate somehow reflects the variation of financial market worldwide, hence adding U.S. interest rate as an explanatory variable to our regression means including measurement of economic fundamentals on a high-level, as well as exchange risk. Besides, U.S. market has no direct influence from the European Debt Crisis, therefore, U.S. interest rate can be considered as a risk-adjusted factor. Hence, it is included in the panel regression studies.

4. Methodology

Among works that studied about the relationships in between sovereign credit rating events and the financial markets, two main methodologies are well-used and developed, namely, panel regression and event study. In Part A, I also performed both methodologies in order to understand the link in between the credit rating events and the stock market during the European debt crisis. Also, the same methodologies will be adopted in this part. The purpose of which is to see whether rating events have impact on the CDS market and whether lag effect of the impact on the CDS market exists. In the following study, rating events are categorized as rating announcements and outlook announcements, and they are quantified by aforementioned comprehensive credit rating measurement.

4.1 Panel regression

The aim of the panel regression study is to understand whether there is significant relationship in between the CDS spreads and the credit rating events, especially under PIIGS countries context during the European debt crisis.

The methodology is very similar to Part A. I will perform several panel regressions, using top-down approach. In the first regression (shown in the below equation), I zoom out on a bigger picture and intend to answer the fundamental question that whether one country's rating events overall has impact on its own CDS market, taking PIIGS countries as example. The pooled OLS panel regression method will be applied.

$$C_{i,t} = \alpha + \delta Event_{i,t} + \gamma \Delta ir_t^{US} + \varepsilon_{i,t} \qquad (1)$$

In the above model, the sub-indexes i stands for country, where i = $Greece$, $Protugal$, $Italy$, $Ireland$ & $Spain$. The sub-index t represents time. Therefore, $C_{i,t}$ means the CDS spread of country i at time t; $Event_{i,t}$ is the quantified rating event in country i at time t; Δir_t^{US} stands for the change of U.S. interest rate at time t; and $\varepsilon_{i,t}$ is zero-mean disturbance term. α is the intercept in the pooled OLS panel regression.

The explanatory variable $Event_{i,t}$ includes all rating events. In other words, it is the combination of ratings and outlooks from all three rating agencies. In order to understand different impact on the CDS spread from rating and outlook changes, I

further divide all rating events ($Event_{i,t}$) into rating events ($Rating_{i,t}$) and outlook events ($Outlook_{i,t}$) in the second regression.

$$C_{i,t} = \alpha + \beta Rating_{i,t} + \theta Outlook_{i,t} + \gamma \Delta ir_t^{US} + \varepsilon_{i,t} \qquad (2)$$

From Part A and other research papers, I have observed different impacts from different rating agencies, with S&P being the most significant among the three. Therefore, in the third panel regression, I will further break down the changes of rating event into three explanatory variables based on the rating agencies, same as the changes of outlook event. Therefore, the $Rating_{i,t}$ from the second regression is divide into $Srating_{i,t}$, $Mrating_{i,t}$ and $Frating_{i,t}$ in the third regression, which represent S&P rating, Moody's rating and Fitch rating respectively. Similarly, the $Outlook_{i,t}$ is divided in the same way into $Soutlook_{i,t}$, $Moutlook_{i,t}$ and $Foutlook_{i,t}$. As result, the third regression is shown as below.

$$C_{i,t} = \alpha + \beta_1 Srating_{i,t} + \beta_2 Mrating_{i,t} + \beta_3 Frating_{i,t} + \theta_1 Soutlook_{i,t} + \theta_2 Moutlook_{i,t} + \theta_3 Foutlook_{i,t} + \gamma \Delta ir_t^{US} + \varepsilon_{i,t} \qquad (3)$$

Until now, all regressions are performed on the whole database, which time span is from year 2006 to 2010. In the following studies, I will further break the time period into three groups, pre-crisis, crisis and post-crisis period. In each time period group, three aforementioned regressions will be carried out. The purpose of which is to observe whether the impact of credit rating events on the CDS market deviate before, during and after the crisis.

Similar to Part A, the pre-crisis period ends at 2009.10.09 as the new Greek government was formed and long-term interest rate increased dramatically; crisis period last until 2012.07.26 when president of European Central Bank (ECB) Mario Draghi pledged to do 'whatever it takes to save Europe' and several financial aids and advices have been provided following his statement. While, the post-crisis ends at the 2016.10.28.

The detailed data periods selection is shown below.

Table 2. Sample periods breakdown

Group	Period	Regressions
Pre-crisis	2006.10.01 - 2009.10.09	1) $C_{i,t} = \alpha + \delta Event_{i,t} + \gamma \Delta ir_t^{US} + \varepsilon_{i,t}$ 2) $C_{i,t} = \alpha + \beta Rating_{i,t} + \theta Outlook_{i,t} + \gamma \Delta ir_t^{US} + \varepsilon_{i,t}$ 3) $C_{i,t} = \alpha + \beta_1 Srating_{i,t} + \beta_2 Mrating_{i,t} + \beta_3 Frating_{i,t} + \theta_1 Soutlook_{i,t} + \theta_2 Moutlook_{i,t} + \theta_3 Foutlook_{i,t} + \gamma \Delta ir_t^{US} + \varepsilon_{i,t}$
Crisis	2009.10.09 - 2012.07.26	
Post-crisis	2012.07.26 - 2016.10.28	

In the panel regression study, I am hoping to answer questions which are 1) whether there is a significant impact of credit rating events on the sovereign CDS market; 2) which kind of credit rating events has more significant impact, ratings or outlooks? 3) which credit rating agency has more significant influence on the CDS market? 4) whether the result of previous three questions would be answered differently before, during and after the crisis?

Furthermore, to study how single rating event can affect the CDS market within specific short period around the rating event, event study methodology will be applied. Event study can conclude if there is a lead of lag effect of credit rating events on the CDS market. This methodology will provide another angle to my research.

4.2 Event study

Event study is carried out in order to measure the impact of rating announcements on the CDS market. Moreover, comparing to the panel regression, event study provides a more dynamic view of the effect of rating announcements on the CDS market, especially around the rating announcement date. Moreover, event study give us an opportunity to observe the impact of upgrading event and downgrading event separately. Similar studies have been done in the last decade. Ismailescu and Hossein (2010) found that upgrading events tend to have greater impact to the CDS spread

compared to downgrading impact under event window of two days. Afonso et al. (2012) have applied European data of 24 countries in between 2003 to 2010 to study the link in between the CDS spreads and sovereign credit ratings and concluded that bi-directional causality exists in between sovereign ratings and CDS spreads in a 1–2 week window.

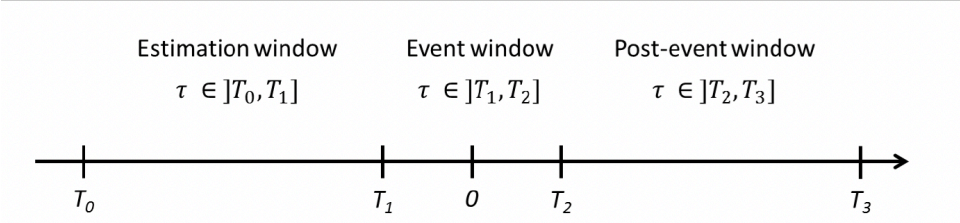
4.2.1. Event definition and window selection

Similar to Part A, I define the announcement of rating change as event. In this case, there will be only two types of events, namely upgrading event and downgrading event. The date which the announcement is made is denoted as T=0. Then, I design two types of event windows in order to have more comprehensive understanding about how credit rating events affect the CDS market, particularly before the rating is announced. We want to observe a longer period before the event date since rating events tend to have lag effect compared to the financial market. Hence we construct the second event window which has a longer period before the event date.

First event window is from 5 days before to 4 days after the event date, which means the event window is from T_1=-5 to T_2=4. Second event window is from 10 days before to 4 days after the event date, which means the event window is from T_1=-10 to T_2=4.

In order to estimate the normal CDS spread without the effect from the rating announcement, I select estimation window of 90 trading days, ranging from T_0=-95 to T_1=-6 (or T_0=-100 to T_1=-9). The detailed window selection of the event study presents as below.

Graph 1. Window selection of event study



4.2.2 Abnormal return of the CDS market

In order to examine the deviation from normality, CDS abnormal return (AR) will be calculated in this context. First step, I need to measure the return of CDS, using CDS

spread. The calculation of the CDS return is complicated because the CDS price depends on uncertain stream of premia. The formula of calculation of CDS return is shown as below:

$$R_t = \frac{P_t}{P_{t-1}} - 1 = \frac{S_t \cdot RPV01_t}{S_{t-1} \cdot RPV01_{t-1}} - 1$$

Where P_t is the market value of a CDS contract at time *t*

S_t is the CDS spread at time *t*

$RPV01_t$ is the the present value of one basis point stream of premia at time *t*

To further simplify the calculation of CDS return, we assume that $RPV01_t$ = $RPV01_{t-1}$. This means we assume the probability of not default prior to a certain payment date is the same at time *t* and time *t-1.* Although this is very controversial assumption, it seems reasonable for a one day horizon. For further elaboration on the assumption and simplification, please refer to Micu et al. (2006).

Hence, the simplified formula of CDS return on time *t* is:

$$R_t = \frac{S_t}{S_{t-1}} - 1$$

Second step is to calculate the abnormal return of CDS. In this paper, market-index adjustment methodology is chosen, and the CDS abnormal return is estimated as in the following formula:

$$AR_{it} = R_{it} - \alpha_i - \beta_i R_{mt}$$

Where AR_{it} is CDS abnormal return of country *i* at time *t;*

R_{it} is CDS return of country *i* at time *t*;

R_{mt} is return of CDS market index at time *t*;

α_i and β_i are parameters of the model.

In order to estimate α_i and β_i, which are estimated by applying market model with daily return and market index return, I need a CDS market index that are applicable under

this context. Due to the fact that no sovereign CDS index has been constructed globally, we decide to build a market index ourselves. We want the index to be related to the PIIGS countries, yet there shouldn't be any spillover effect of PIIGS countries' ratings to the index. Therefore, we use Nordic countries' (Sweden, Finland, Denmark and Norway) sovereign CDS spread to frame the index. The reason we choose Nordic countries is 1) their presence in the EU which reflects the relationship with other EU economies and 2) they have experienced less during the European debt crisis which means hardly no spillover effect from PIIGS countries' rating adjustments.

Then, OLS (ordinary least squared) regression is used to determine α_i and β_i. The detailed calculation will be shown in Appendix 2.

Next step is to calculate the cumulative abnormal return (CAR) of CDS, which is employed to understand how rating announcements affect the CDS market over the event window. The formula of which is shown as below;

$$\widehat{CAR_\iota}(t_1, t_2) = \sum_{t_1}^{t_2} \widehat{AR_{\iota t}}$$

In this study, I only work with strictly 'clean event', which means event windows and estimation windows are not allowed to be overlapped. If two rating are announced within less than 100 days, only the first rating event will be taken into consideration. Second one will be excluded because the CDS return in the beginning of its estimation window might be affected by the first rating event, which makes the estimation less accurate. The purpose of deploying only 'clean event' is to minimize the impact of one rating announcement to another and to make sure that unbiased impact of single upgrading or downgrading event to the CDS market is measured.

There is downside of applying only 'clean events' in the study, mainly due to the fact that lots of downgrading events were clustered. Hence, the number of events in the sample for event study are less than number of upgrading and downgrading events that happened during the period.

5. Result

In this session, I present the results of aforementioned studies. The first part is about the result of the panel regressions, which answers the questions whether impact of

changes of sovereign credit rating on the CDS market exists, and whether the impact changes before, during and after the crisis. The second part presents event study result, which answers the question of how announcements of credit rating events affect the CDS market around the announcement date.

5.1 Panel regression

5.1.1 General study

To start with, the table below shows the result of panel regressions on whole data sample, ranging from 2006 to 2016. The pooled OLS method has been applied here.

Table 3. Results of panel regressions on the whole data sample

Panel Regression			
Explanatory variables	**1**	**2**	**3**
(Intercept)	1664.536 ***	1664.583 ***	1663.576 ***
	(< 2e-16)	(< 2e-16)	(< 2e-16)
US	1977.544	1979.932	1993.825
	(0.498)	(0.498)	(0.495)
Rating and Outlook	195.343		
	(0.324)		
Rating		202.369	
		(0.325)	
S&P Rating			532.844
			(0.116)
Moody Rating			279.846
			(0.432)
Fitch Rating			-415.737
			(0.299)
Outlook		94.457	
		(0.908)	
S&P Outlook			-1831.811
			(0.274)
Moody Outlook			1139.074
			(0.396)
Fitch Outlook			-120.444
			(0.930)
Adjusted R-squared	-0.00004	-0.00012	-0.00002

Notes: The superscripts '***', '**', '*' and '.' indicates statistic significant at level 0.1%, 1%, 5% and 10%

Source: Author's Calculation

In the first regression, all rating events, including both rating and outlook, are captured by one explanatory variable. And it doesn't show a significant impact on the CDS market even under 90% confidence interval. This could due to the rating events and outlook events carry different impact, different CRAs rating events have different impact, due to the selection of different time period or simply due to the rating events have no impact on the CDS market. From the result in the first regression, we can conclude that overall rating events have no impact on the CDS market during 2006 to 2016 under PIIGS countries context. This somehow confirms the critics on the credit ratings that the information carried by them are not effective and prompt during the time period of 2006 to 2016.

In the second regression, rating and outlook are separated. The result shows that neither rating events nor outlook events has significant impact (even under 90% confidence interval) on the CDS market. Hence, we know the insignificant variable in the first regression is not due to the different impact from rating events and outlooks events.

In the third regression, I further divide rating events and outlook events into three variables, by different CRAs. The purpose of which is to see whether the big three CRAs have different impact on the CDS market and which CRA has the most accurate rating. Yet the result shows that none of the CRAs' ratings or outlooks is significant. This rules out the insignificant variable in the first regression is due to the different impact from different CRAs.

In the next section, we will carry out the regressions on different period. By then, we will be able to answer the question of insignificant variable in the first regression is due to different period selection or simply due to the non-existence of the relationship in between the CDS market and rating events, which reflects the untrustworthy role of the credit rating agencies. Intuitively, the credit rating events should have negative impact on the CDS spread. When credit risk gathers in the market, the CDS spread tends to go up and the ratings will go down. Thus, we tend to see downgrading and increasing CDS spread during the crisis. Although, previous studies have found out that rating events often have lag effect. In other words, the financial market, including the CDS market, tends to react faster to the market information compared to the credit

rating agencies. Thus, further event study is necessary in order to understand whether lag or lead effect exists or not.

5.1.2 Different periods study

In this session, the result of panel regression on three different periods will be present. Each group will apply the aforementioned regressions on its sample data, and the result will be present separately. The purpose of this session is to understand whether CRAs behave differently before, during and after the European debt crisis. Moreover, the result will answer the question whether the insignificant variable in the first regression in the previous session is due to the inconsistent behavior of CRAs during different period selections.

The result is shown as below.

Table 4. Results of panel regressions on different data periods

Panel Regression									
	Pre-crisis			Crisis			Post-crisis		
Explanatory variables	1	2	3	1	2	3	1	2	3
(Intercept)	55.197 ***	55.199 ***	55.175 ***	1124.269 ***	1124.062 ***	1122.763 ***	3098.576 ***	3100.416 ***	3099.282 ***
	(< 2e-16)	(< 2e-16)	(< 2e-16)	(< 2e-16)	(< 2e-16)	(< 2e-16)	(< 2e-16)	(< 2e-16)	(< 2e-16)
US	56.578	56.743	56.907	-892.136	-901.951	-979.024	385.333	450.120	579.664
	(0.3117)	(0.310)	(0.340)	(0.819)	(0.817)	(0.802)	(0.969)	(0.963)	(0.953)
Rating and Outlook	-129.659 ***			-46.473			-22.204		
	(6.31e-13)			(0.760)			(0.966)		
Rating		-114.262 ***			-67.401			138.321	
		(4.65e-06)			(0.667)			(0.799)	
S&P Rating			-137.732 ***			493.531			229.145
			(2.03E-06)			(0.103)			(0.739)
Moody Rating			-41.347			44.360			240.280
			(0.568)			(0.858)			(0.861)
Fitch Rating			-63.746			-766.124 **			-232.614
			(0.362)			(0.091)			(0.846)
Outlook		-154.290 ***			360.646			-1969.418	
		(2.92E-06)			(0.621)			(0.298)	
S&P Outlook			-197.204 **			550.875			-7160.171 *
			(0.002)			(0.733)			(0.045)
Moody Outlook			-160.274 *			333.934			1590.579
			(0.013)			(0.777)			(0.606)
Fitch Outlook			-160.818 **			-345.556			-1741.180
			(0.002)			(0.771)			(0.631)
Adjusted R-squared	0.01328	0.01323	0.01292	-0.00053	-0.00072	0.00072	-0.00036	-0.00033	0.00045

Notes: the superscripts '***', '**', '*' and '.' indicat statistic significant at level 0.1%, 1%, 5%, 10%.

Source: Author's calculation

5.1.2.1 Pre-crisis period

In the first group of regressions which studied pre-crisis period, the result shows significant variables with negative coefficients, which is in line with the market logic. First of all, the variable of overall credit rating event is significant with negative coefficient under confidence interval of 99.9%. This means when CDS market spread is going up (down), the credit rating event is going down (up) either by rating adjustment or outlook adjustment. The coefficient also means that the CDS spread will increase (decrease) about 130 basis point with the quantified credit rating measurement going down (up) 1 point, which equals to one notch change of rating or notch change of outlook.

After we further separate the rating event variable into rating variable and outlook variable, both variables show negative coefficients under significant level of 99.9%, as result shown in the second regression. We observe that the impact of outlook is slightly higher than rating adjustment, with one notch outlook adjustment causing roughly 154 basis points change in the CDS spread, yet about 114 basis points change for one notch of rating adjustment.

Furthermore, the result of the third regression not only indicates the different behavior among the big three CRAs and but also concludes who provides more refined ratings or outlooks before the crisis. S&P rating variable is the only rating variable that shows significance under 99.9% confidence interval. While all three outlook variables are significant in the result, S&P and Fitch outlook are under 99% confidence interval while Moody's is under 95%. Moreover, S&P outlook has the biggest absolute coefficient, in other words, with the same adjustment being made, the impact of S&P outlook on the CDS market is the biggest compared to Moody's and Fitch outlook. One notch change of S&P outlook causes roughly 200 basis points change in the CDS spread. The same change of outlook in Moody's or Fitch results about 160 basis points change in the CDS spread. Hence S&P provides more accurate and prompt ratings and outlooks in the pre-crisis period under PIIGS context.

To conclude, in the period before the European debt crisis, credit rating events in general shows negative impact on the CDS spread, which is align with the market logic. Also, it means that the CRAs are reacting to the market promptly without lag effect.

Furthermore, outlook events tend to have stronger and more significant impact compared to rating events to the CDS spread. Among the three CRAs, S&P has the most significant impact on the CDS spread, with both rating and outlook event variables being significant under 95% confidence interval. Thus, S&P has the most refined ratings and outlooks compared to others in the pre-crisis period. We can also boldly conclude that the insignificant variable in the previous section is due to the different period selection. Also, credit rating agencies were functioning well by providing creditworthy ratings during the pre-crisis period.

5.1.2.2 During crisis period

The result of sample during the crisis is very different from the pre-crisis period. During the crisis period, only the sub variable of Fitch rating in the third regression shows significance under 99% confidence interval with a negative coefficient. Interestingly, the impact of Fitch rating during the crisis is much higher than any significant ratings/outlooks impact in the pre-crisis period. One notch downgrade can cause more than 700 basis points increase in the CDS spread. This also reflects the distressed situation of the CDS market during the European debt crisis.

Furthermore, compared to the significant result of regressions in the pre-crisis period, CRAs are proved to have less accurate rating activities during the crisis period than before. One could also speculate that the rapid deterioration and volatile market situation during the financial crisis make accurate and prompt ratings very difficult for CRAs. To conclude, CRAs tend to provide less accurate and reliable rating activities during the crisis period.

5.1.2.3 Post-crisis period

In the post-crisis period, the results are relatively similar to the crisis period. S&P outlook variable is the only significant variable (under 95% confidence interval) in all three regressions, and the negative coefficient of which means the link in between the outlook variable and the CDS spread is align with the market logic. The other non-significant variables may suggest that CRAs were not providing accurate and refined credit rating in the post-crisis period.

Comparing the three groups of studies, we can conclude that CRAs were behaving promptly and accurately in the pre-crisis period yet became less reliable during the crisis, and continue to perform less in the post-crisis period. There are several possible explanations behind. First of all, the volatile environment during the crisis period might paralyzed the CRAs' ability to adjust their rating in time. Frequent intervenes from other parties such as ECB on the financial market during the financial crisis further increased the difficulty for CRAs to provide an accurate and unbiased rating, solely based on the market performance. Furthermore, the ban of naked CDS trading in 2011 could also play a role, since it made the CDS spread before 2011 and after 2011 became fundamentally different. Thus, understanding the link in between the CDS market and the credit rating events became even more difficult in the post-crisis period. However, I believe CRAs will eventually correct themselves from this post-crisis effect and go back on track to the pre-crisis period where they were providing refined and timely credit rating activities.

5.2. Event study

In this session, the result of event study about how CDS return evolves around the date of credit rating announcements will be present. This study focuses on two rating events, namely rating upgrades and rating downgrades. The outlook and watchlist events are not included in this event study. The event study will help me to complete the understanding about the impact of the credit ratings on the CDS market, especially the puzzle about whether there is a lead or lag effect of the rating events on the CDS market.

5.2.1 Upgrading events

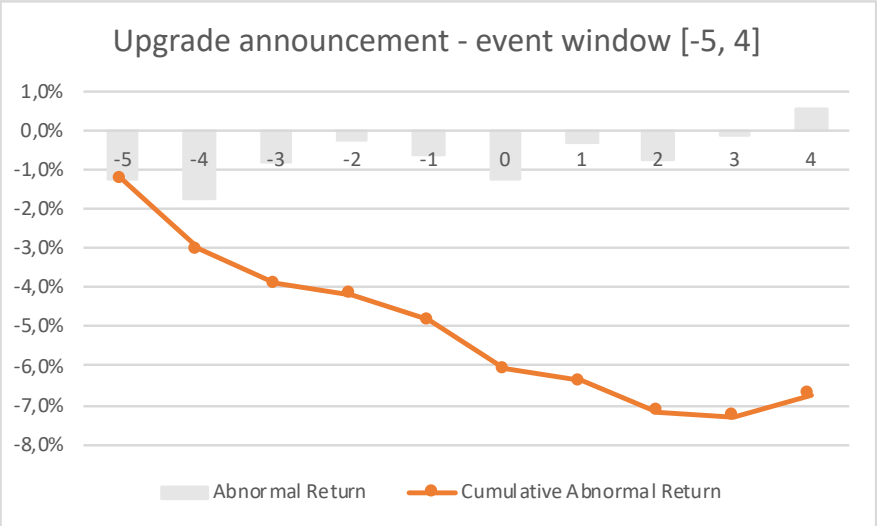
In this session, result of event study on the upgrading announcements is present. The estimation window is of 90 days length, and two event windows are selected, [-5, 4] and [-10, 4]. The x-axis is the timeline of the event, 0 is the date of upgrade announcements; while y-axis is the cumulative abnormal return. Since I only work with strict 'clean event' in this study, only 13 upgrading events are included in the sample.

Following our logic, upgrading events and decreasing CDS spread should happen at the same time. Also, decreasing CDS spread implies the decreasing CDS return. And the results shown in Graph 1 and Graph 2 confirm our logic. In the short event window

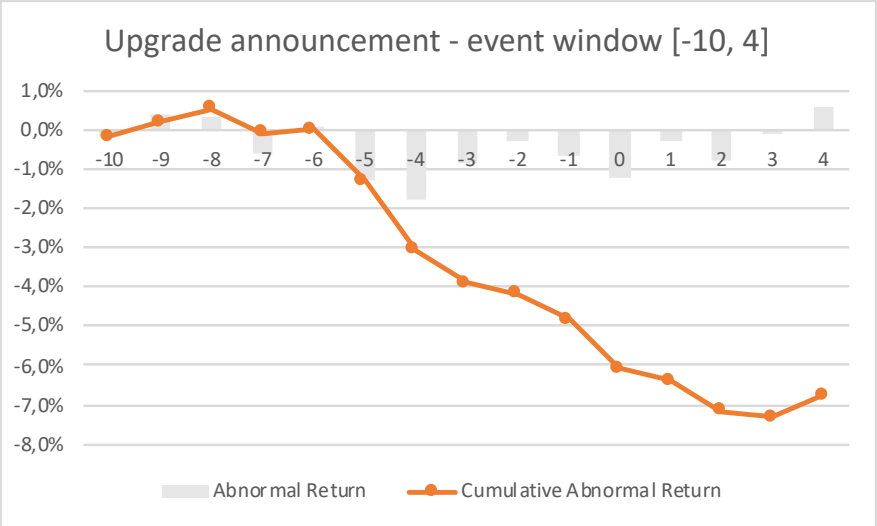
of [-5, 4], the cumulative abnormal return start to be decrease from 5 days before the upgrade announcement and last 8 days until 3 days after the announcement. This also means 8 consecutive days of negative abnormal return and they cause about -6% cumulative abnormal return around the upgrading announcement date. The biggest abnormal return (in absolute term) occurs at 4 day before the upgrading announcement, at about -1.8%. And in the event window of [-10, 4], we also observe a 9 days consecutive negative abnormal return in the period of [-6, 3] which result in a cumulative abnormal return of more than -7%.

The results suggest the negative relationship of upgrading events on the CDS return. With cumulative abnormal return of CDS reach to up -7% around the short period of time around the announcement date. Moreover, the CDS market react earlier than the credit rating events, as the negative abnormal return starting from 8 trading days before the announcement date. And the upgrade will continue to have negative impact on the CDS market for 3 days after the announcement date. Then the CDS market start to bounce back slowly. Furthermore, cumulative abnormal return can reach to almost 6% before the rating announcements, while only 1% after the rating announcements. Hence, we can conclude that there is indeed a lag effect of credit rating events on the CDS market. In other words, the CDS market tends to react faster to the market information compared to CRAs on their rating adjustments. From other perspective, we could argue that CDS return has the predictability of the upgrading events, since the biggest abnormal return of almost -2% and 6 consecutive days of negative abnormal returns happen before the announcements of the upgrading events.

Graph 1. Event study of upgrades with event window of [-5, 4]



Graph 2. Event study of upgrades with event window of [-10, 4]



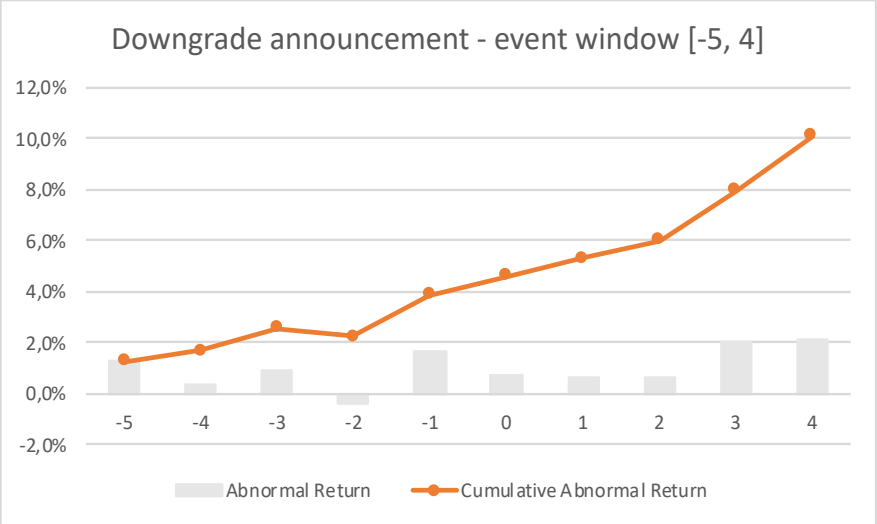
5.2.2 Downgrading events

In this session, we elaborate on the result about event study on the downgrading events. The same estimation window and event windows as aforementioned upgrading event study are chosen. There are 28 strictly 'clean event' of downgrading events in our sample.

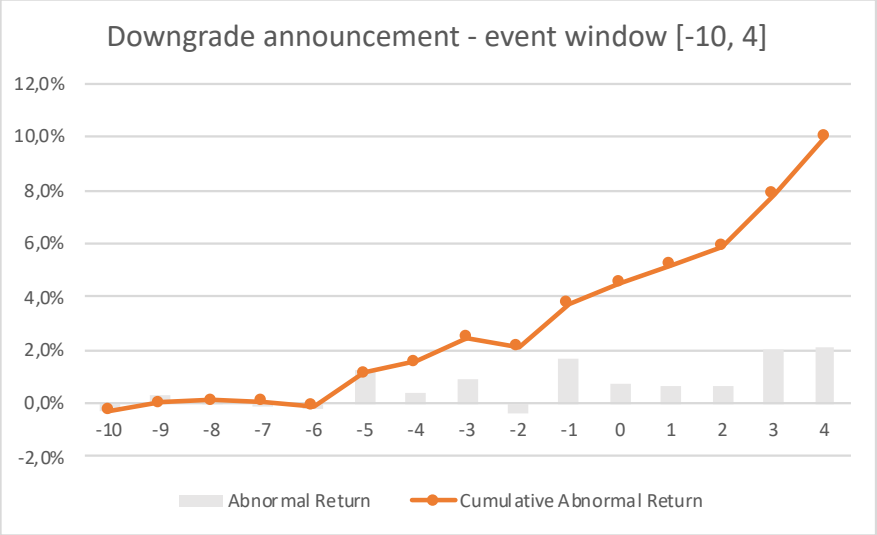
In theory, the downgrading events are announced when the market risk is increasing. The market risk and CDS spread are positively corrected, which means the CDS spread will go up as market risk increases. According to the formula of CDS return, increasing CDS spread implies rising CDS return. The result has confirmed our theory, we have observed more than 10% cumulative abnormal return in the event window of [-5, 4]. The biggest abnormal return of about 2.1% happens 4 days after the events.

In the longer event window, almost 10 consecutive days of positive abnormal returns have been recorded in between [-6, 4], with only one negligible negative abnormal return at 3 days before the downgrading events. Similar to the upgrading events, the CDS market reacts prior to the downgrades. Surprisingly, we found a relative bigger cumulative abnormal return after the rating events compared to before the events, which means that the downgrading events have lasting effect on the CDS market. The CDS market continues to deteriorate after the announcements of the downgrades.

Graph 3. Event study of downgrades with event window of [-5, 4]



Graph 4. Event study of downgrades with event window of [-10, 4]



6. Conclusion

Our results confirm the impact of sovereign credit rating event on the sovereign CDS market of PIIGS countries during the European debt crisis. Yet the implications suggested by panel regression and event study differ. Event study has shown stronger link in between the CDS market and the sovereign credit ratings compared to the panel regression on the whole dataset. There are some possible explanations behind the difference of the results. First of all, in my event study, I only work with strictly 'clean event', which eliminated more than half of the rating events in my sample. In particular, the sample of downgrading events dropped more than 2/3, because rating adjustments usually happened in cluster during the crisis period. While in the panel regression, all rating events in the sample are included. Hence, the impact on the CDS market that captured in the panel regression may be the result of several rating events instead of one. Secondly, in the event study, downgrading and upgrading are separated from each other. I study the impact of them on the CDS market independently. Yet in the panel regression, downgrading and upgrading events are treated equally and jointly. Therefore, the differences in between the results of two methodologies are nothing abnormal.

Even though we didn't observe any significant relationship in between the CDS spread and sovereign credit ratings on the whole data period through the panel regression, we found significant negative impact of credit ratings, including both rating announcements and outlook adjustments, on the CDS market in the pre-crisis period. This suggests that CRAs are behaving promptly before the crisis. Besides, the outlook adjustments tend to have slightly bigger impact compared to rating adjustments. The reason of which could be that the rating adjustment usually follows the outlook change. Hence, after the CDS market already reacted to the outlook adjustment, further rating change will has less impact on the market. Among the three CRAs, S&P is the only credit rating agency whose ratings and outlooks both show significant impact on the CDS market in the pre-crisis period This confirms the market theory that S&P is the most accurate compared to the other two.

Yet in the period of crisis and post-crisis, we didn't observe so significant link in between the CDS market and sovereign credit ratings. In crisis period, only Fitch's rating is significant; while in the post-crisis period, only S&P's outlook is significant. I

believe that European debt crisis has hampered the CRAs' ability to provide accurate and refined rating. Also, this paralyzing effect on CRAs last longer than the actual crisis period. It would be interesting to conduct another group of panel regression 5 years later to see if CRAs have fully recovered from the crisis and regained their creditability.

In event study, the results are in line with our logic. CDS return decreases around the upgrading events while it increases around the downgrading events. Upgrading events can cause 6 consecutive days of negative abnormal returns, which add up to more than 7% cumulative abnormal return. Downgrading events tend to have bigger impact on the CDS return compared to upgrading events. The cumulative abnormal return reaches to more than 10% and positive abnormal returns last for almost 10 consecutive days in the event of downgrades.

In both upgrading and downgrading events, the CDS market is reacting prior to the announcements of events. The cumulative abnormal return before the event date in upgrades reaches to 6%; while the cumulative abnormal return adds to 4% in the case of downgrades. The findings not only conclude that there is a lag effect of the sovereign rating events but also suggest that the CDS return has the predictability on the rating events.

Interestingly, downgrading events continue to have impact on the CDS market after the announcement date. The cumulative abnormal return from event date to day 4 can reach to 6%, which is even bigger compared to the CAR before the event date. Hence, in the case of downgrades, 60% of all cumulative abnormal return that observed in the event window is captured after the event date. Differently, only less than 15% of all cumulative abnormal return is recorded after the event date in the study of upgrading events.

Overall, our study confirms the significant impact of credit rating events on the CDS market during the pre-crisis period, as well as a negative relationship in between upgrading events and the CDS return among the PIIGS countries coving from 2006 to 2016.

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Appendix

Appendix - 1 Definition of comprehensive credit rating

S&P		Moody's		Fitch		Credit outlook	
Rating	Numerical Node	Rating	Numerical Node	Rating	Numerical Node	Outlook	Numerical Node
AAA	20	Aaa	20	AAA	20	Positive	1.00
AA+	19	Aa1	19	AA+	19	Positive watch	0.50
AA	18	Aa2	18	AA	18	Stable	0.00
AA-	17	Aa3	17	AA-	17	Negative watch	-0.50
A+	16	A1	16	A+	16	Negative	-1.00
A	15	A2	15	A	15		
A-	14	A3	14	A-	14		
BBB+	13	Baa1	13	BBB+	13		
BBB	12	Baa2	12	BBB	12		
BBB-	11	Baa3	11	BBB-	11		
BB+	10	Ba1	10	BB+	10		
BB	9	Ba2	9	BB	9		
BB-	8	Ba3	8	BB-	8		
B+	7	B1	7	B+	7		
B	6	B2	6	B	6		
B-	5	B3	5	B-	5		
CCC+	4	Caa1	4	CCC+	4		
CCC	3	Caa2	3	CCC	3		
CCC-	2	Caa3	2	CCC-	2		
CC/C	1	Ca	1	CC/C	1		
SD	0	C	0	RD	0		

Appendix – 2 Estimation of parameters α_i and β_i in market model (Event study)

In this part, I will explain how to calculate parameters of α_i and β_i in the market model from event study in session 4.2.2. Calculation of abnormal return under market model adjustment. The estimation window is 90 days before T_1 the first day of event window. Thus length of estimation window is 90 days. T_0 is the first day of the estimation window and T_1 is the last day. For any country i in the study, the parameters α_i and β_i can be estimated in the following equation.

$$\widehat{\beta_\iota} = \frac{\sum_{t=T_0}^{T_1}(R_{it} - \widehat{u_\iota})(R_{mt} - \widehat{u_m})}{\sum_{t=T_0}^{T_1}(R_{mt} - \widehat{u_m})^2}$$

$$\widehat{\alpha_\iota} = \widehat{u_\iota} - \widehat{\beta_\iota}\widehat{u_m}$$

Where,

$$\widehat{u_\iota} = \frac{1}{L_1}\sum_{t=T_0}^{T_1} R_{it}$$

$$\widehat{u_m} = \frac{1}{L_1}\sum_{t=T_0}^{T_1} R_{mt}$$

R_{it} is the CDS return of country i in time t, and R_{mt} is the CDS return of market portfolio which is calculated by average weighted CDS return of PIIGS country. And u_i is the average return of country i over estimation period, which is from T_0 to T_1. And L_1 is the length of the estimation period, which is 90 days in this case.