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Master's Thesis

Cross-border effects of sovereign rating changes on bond yields before and during the Eurozone crisis

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Declaration of Authorship

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Signature

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Abstract

This paper looks into the contagion dynamics of sovereign credit rating changes with regards to bond yields in the period before and during the sovereign debt crisis in Europe. Our sample included European Union member countries, as well as a Eurozone subsample and a subsample excluding highly indebted countries. Events and outlooks from all three major rating agencies were considered. Our findings for the pre-crisis period are consistent with existing research, indicating an increase in borrowing costs by approximately five basis points in the case of a one-notch negative event, and insignificant effects in the case of positive events. During the crisis period, we observed a reversal of this effect, associating negative ratings with lower spreads on the entire sample. However, the effect was no longer significant when highly indebted countries were excluded from the sample, indicating that this effect may be tied to overly negative expectations. Lastly, we investigated the persistence of results, with only full-sample crisis period data displaying persistent effects.

JEL Classification	F01, F34, F42
Keywords	credit rating, sovereign debt, default, debt crisis, European debt, sustainability

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Abstrakt

Práca sa zaoberá dynamikou ratingových zmien štátnych dlhopisov s ohľadom na výnosy dlhopisov ostatných krajín v období pred a počas dlhovej krízy v Európe. Skúmané vzorky zahŕňajú členské krajiny Európskej únie, eurozónu, a EU s výnimkou vysoko zadlžených krajín. Ratingové zmeny všetkých troch hlavných ratingových agentúr boli zohľadnené. Zistenia týkajúce sa predkrízového obdobia sú konzistentné s existujúcim výskumom a naznačujú zvýšenie nákladov na pôžičky o cca päť bázických bodov v prípade negatívnych ratingových udalostí, ako aj štatisticky nevýznamné dopady v prípade pozitívnych udalostí. V čase krízy bol pozorovaný zvrat v tejto dynamike, kde negatívne zmeny v ratingoch znížili spready. Tento efekt stratil štatistický význam po vylúčení vysoko zadlžených krajín, čo znamená, že tento efekt môže byť spojený s príliš negatívnymi očakávaniami. V neposlednom rade bola skúmaná perzistencia pozorovaných efektov, ktorá bola potvrdená len u pozorovaní v období krízy.

Klasifikace	F01, F34, F42
Klíčová slova	rating, štátny dlh, default, dlhová kríza, európsky dlh, udržateľnosť

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ACRONYMS

CDS: Credit default swap

IID: Independent and identically distributed random variable

PIIGS: Portugal, Italy, Ireland, Greece and Spain

S&P: Standard & Poor's Financial Services

SGP: Stability and Growth Pact

YTM: Yield to maturity

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MASTER'S THESIS PROPOSAL

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Proposed Topic:

Cross-border effects of sovereign rating changes on bond yields before and during the Eurozone crisis

Topic Characteristics:

This paper aims to investigate cross-border contagion effects of credit-rating changes within the Eurozone, comparing the observed effects before and during the Eurozone sovereign debt crisis of 2009-2013.
Alfonso, Furceri and Gomes (2011) investigated the effects of changes in sovereign ratings of European Union countries on respective bond yields and insurance costs as well as contagion effects, in a limited extent. Current research indicates a significant contagion effect to negative rating events, while insignificant contagion due to positive events. This thesis aims to extend the research by Alfonso, Furceri and Gomes (2011) by examining the effects rating changes in the Eurozone by the major rating agencies have on other member states' yields in the period leading up to and during the Eurozone crisis.
Insurance costs with regards to rating events have been investigated in Ismailescu and Hossein (2010). Lastly, we aim to attempt to look at the persistence effects of rating events have over longer time periods.

Hypotheses:

1. Relevant information is already efficiently priced into sovereign yields and rating changes do not influence yields and insurance premiums across borders.
2. The effect of cross-border rating changes on bond yields does not change during times of crisis.
3. Contagion effects are present only as temporary shock and do not persist in the long run.

Methodology:

This paper aims to be an event study that considers the isolated effects of rating events on cross-border sovereign bond yields in the Eurozone. To investigate immediate effects of rating changes, we will consider bond yields over a short period around the rating event. Data will be pooled and the changes in the yield will be regressed on factors that include the direction of the credit rating change, respective magnitude, and other control variables. Lastly, to investigate the persistence of the shocks, we will use wider time windows with further control variables.

INTRODUCTION

The Eurozone is unique in the sense that it applies a common monetary policy to many countries with independent fiscal policies. The fact that individual countries are not able to make changes to monetary policy has strong implications on fiscal policy, namely that only the latter can be used to steer individual economies and manage public debt levels. Contagion within the European Union, and especially the Eurozone is a much discussed topic. One potential transmission mechanism may be ratings of sovereign debt and their respective changes, which was indeed the scapegoat for some European politicians or policymaker such as Ewald Nowotny of the European Central Bank, who claimed that the financial crisis was exacerbated by rating agencies due to the destabilising nature of their rating announcements, and some even went on to call for a new rating agency that would be controlled by the EU (European Commission Memo of 16/01/2013). Indeed, this rhetoric is nothing new: "There are two superpowers in the world today in my opinion. There's the United States and there's Moody's Bond Rating Service. The United States can destroy you by dropping bombs, and Moody's can destroy you by downgrading your bonds. And believe me, it's not clear sometimes who's more powerful."[1] Furthermore, while not explicitly suggesting a European rating agency, Arezki, Candelon and Sy (2011) conclude that regulators should re-evaluate the use of ratings in regulation due to their potential to cause spillovers in financial market.

The claim that announcements by rating agencies concerning to government debt may worsen financial crises is an important one, however, there is little research pertaining to this specific topic.

In general, there is a relatively large amount of research concerning rating agencies and their announcements, as they play a large role in how risk levels of debt are perceived. Asset management schemes, such as pension funds, have explicit guidelines on asset quality that rely on ratings from the major agencies (S&P, Moody's, and Fitch). These effects may be used to explain the effects of rating changes on the prices of underlying sovereign bonds, while still being able to say that the markets behave efficiently. Nevertheless, these effects should be less pronounced

[1] FRIEDMAN, T. L. (1999): "From Supercharged Financial Markets to Osama Bin Laden: The Emerging Global Order Demands a New Enforcer, That's America's New Burden", *New York Times Magazine*, 40 (43), (March 28).

between countries, especially contingent on the fact that we control for all other countries rating changes.

The results of existing research on this topic are somewhat conflicting. Afonso, Furceri and Gomes (2011) found evidence for cross-border contagion within the European Union, while Aizenman, Binici and Hutchison (2013) did not, after controlling for all rating changes of member countries. When it comes to general research on the effects of rating changes on yields of assets other than the underlying, the majority points towards significant effects of negative rating events and insignificant effects of positive rating events.

Contagion is especially pertinent during times of economic turmoil. If contagion occurs during times of instability, it can have significantly more profound effects than if it occurs under stable market conditions. Recent years have been marked by exactly such instability. The crisis of confidence in European sovereign debt has led to spikes in interest rates, panic and even calls to question the viability of the Eurozone project. As will be shown in the literature review section, there is a significant amount of research on the effects of rating changes on sovereign debt in general. However, the crisis period in which such effects matter the most seems to be sparsely investigated.

The principal contribution of this paper is ascertaining the viability of sovereign credit ratings as transmission mechanism for crisis contagion and the investigation of factors that contribute and determine such linkages. If such contagion effects exist, we will investigate their dynamics during times of crisis. This will be done by considering the effects of rating events on surrounding countries' bond yields, comparing the effects before and during the Eurozone crisis of 2009-2013. Furthermore, this paper aims to investigate possible to what degree spill over reactions to rating events are symmetric. Lastly, it is our aim to investigate the persistence of any observed effects on a larger timeframe, again comparing pre-crisis dynamics to those observed during the crisis.

The following section contains summaries of key papers pertaining to credit rating effects on bond yields and insurance costs written over the past two decades. It is divided in the following manner: three subsections, one pertaining to credit ratings of sovereigns, one to credit ratings of corporate bonds and the third to other relevant research.

1. LITERATURE REVIEW

1.1 RATING EFFECTS ON SOVEREIGN BORROWING RATES, SOVEREIGN SPILLOVER EFFECTS

Ismailescu and Kazemi (2010) investigated spill over effects that credit rating events had on emerging economies. Using data from 2001 to 2009, the authors created an event study that investigated CDS spreads in 22 emerging economies with regards to S&P rating changes. The rationale for only using S&P changes is that they are more frequent and often precede rating changes of other agencies as seen in Gande and Parsley (2005). The results indicate that CDS spreads react in an asymmetric fashion to rating events. Rating upgrades appear to have a noticeable effect, while negative ones do not – this is in contrast to papers such as Afonso, Furceri and Gomes (2011) where negative effects are significantly more pronounced. This also extends into spill over dynamics, where positive news moves CDS spreads more than negative news. Finally, the paper identified factors contributing to spill over effects include common creditors and mutual trade competition. Indeed the common creditor thesis seems the most relevant, "Consistent with previous studies (Van Rijckeghem and Weder, 1999; Kaminsky and Reinhart, 2000), we find that the common creditor is a relevant transmission channel. CDS premiums of the non-event countries decline significantly in response to a positive event occurring in a country that shares the same lending bank … The common lender retains its significance when all variables are included"

Afonso, Furceri and Gomes (2011) investigate the effects credit rating announcements have on sovereign yields. The paper looked at the evolution of yields of 10-year bonds across the European Union from 1995 to 2010, with regards to credit rating changes by the three main rating agencies: Standard & Poor's, Moody's and Fitch. In order to investigate these dynamics, a standard event study methodology had been used. Factors that have been considered include the time window in which effects are most pronounced, whether the rating changes were anticipated or not, persistence of yield fluctuations and limited attention was paid to the contagion into sovereign bond yields of other countries in the sample. The paper concludes that rating changes have a significant effect on ratings, more so when they are unexpected. Furthermore, negative changes tend to have stronger effects than positive ones. Contagion analysis was limited and did not control for factors such as

bilateral trade and geographical distance, nevertheless, the authors note that contagion is especially visible from lower-rated countries to the higher rated ones. Lastly, the authors comment on the swiftness of yield reactions (1-2 days) and the persistence of these reactions (over 6 months), which according to them implies solid macroeconomic fundamentals.

Similarly, De Santis (2012) concludes that sovereign bond yields are highly affected by rating changes of the issuing countries. De Santis pointed out that this can be expected, as institutional bond holders, such as pension and mutual funds are obliged by laws to hold bonds with a certain standard of credit rating (or limit their holdings of lower-rated bonds). The paper looked at data from 2008 to 2011, a sub-period of the European sovereign crisis. The author showed that the factors that had the most influence on bond yields included regional risk, country specific risk and spillover effects coming from Greece. A panel model was employed for the analysis of the data, controlling for global volatility and bond market liquidity constraints. These constraints were proxied by the size of the bid-ask spread on the sovereign bonds.

As in Ismailescu and Kazemi (2010), Gande and Parsley (2005) look into spill over effects that take place after rating changes. Controlling variables such as geographical distance and formal trade agreements do not seem to affect spill over (actual trade volume, however, does). The paper takes bond yields into consideration, as opposed to CDS spreads used by the aforementioned papers. The paper concludes that, on average, there is a 2% spill over effect upon a credit rating change. Transmission is higher for countries with capital linkages, and that negative rating changes have a more profound effect than positive ones. Lastly, the authors mention the relevance of the presence other rating events preceding a given rating event: "We also confirm the importance of cumulative events, as posited by Kaminsky and Reinhart (2000). In other words, ratings changes should not be viewed as isolated events, and it is appropriate to ask the context in which the change was announced: have there been other similar ratings changes in the past few days? Finally, we explicitly test whether our results stem from time-invariant historical, economic, institutional, cultural, or location-specific factors, or from time dependent crisis-specific factors. Our conclusions with regard to spill overs remain unaffected." This may be a factor that our paper will need to consider, as we are dealing with significantly interconnected countries and hence cumulative rating events may contain more information than if they were to be considered individually.

Effects of rating changes on sovereign bonds in Eurozone countries were considered in Aizenman, Binici and Hutchison (2013). The paper focuses primarily on differences in reactions of CDS spreads to rating events before and during the credit crisis. Using a dynamic panel model to investigate the data, the authors show that while there was a relatively standard level of responsiveness of CDS spreads to rating changes before the crisis, during the crisis PIIGS countries showed much greater responsiveness to rating events. However, the main idea of this paper pertains to the investigation of the effect of rating changes on bond yields based on the rating tranche of the event country. Lastly, the paper concludes that there is *no significant evidence* for cross-border contagion, once changes in the foreign country's ratings are controlled for. This presents conflicting evidence to Afonso, Furceri and Gomes (2011), where the opposite was observed (on an earlier timeframe, however, with the former using data from 2005 to 2012).

Similarly to the recent accusations of rating agencies and their negative effects on economic stability, agencies were criticised by some during the Asian crisis of 1997-1998. Kraussl (2005) attempted to quantify the effect rating changes had on emerging market bond yields. The author took an approach similar to the one we have seen in De Santis (2012). The paper was constructed as an event study and considered a two day time window around the rating event and also a twenty day period around the event. A stronger reaction has been observed with negative rating changes, "The results of the empirical study indicate that credit rating agencies have a substantial influence on the size and volatility of emerging markets lending." This is, again, consistent with the explanation that negative rating changes immediately affect the portfolios of institutional investors due to legislative constraints.

Arezki, Candelon and Sy (2011) looked into spillover effects in European financial markets during the recent financial crisis, thus dealt with a relatively short time period of three years. The authors investigated spillovers between countries and also between financial markets using CDS spreads. Downgrades, again, appear to have a more significant contagion impacts when compared to upgrades. The effects were pronounced across sovereign credit markets, as well as local financial markets, as evidenced by overall CDS spread levels. While downgrades affected markets in a significant manner, the markets that contagion spreads to depend on several factors, such as type of underlying announcement, financial situation of the country being rated and on the rating agency

that issued the rating. However, some events, such as those where a country was downgraded to or next to speculative grade had effects on all markets.

Baldacci and Kumar (2010) looked into different factors that influenced bond yields across both advanced and developing countries. The authors conclude that primary government deficits are a key driver of interest rates, along with total debt, which corresponds to the controversial paper Reinhart, Rogoff (2010). The paper is relevant because it provides a further spectrum of possible control variables that we may consider.

A case study of the impact of sovereign credit ratings on Indonesia's borrowing costs was performed by Novianti and Danarsari (2013). Reported results were consistent with other research, pointing to a diminished reaction to positive news, both within and outside the speculative rating range. Similarly to the conclusions of Longstaff et al. (2007), the authors showed that rather than news, rating events and local economic conditions, the yields were responsive to global macroeconomic trends.

Aizenman, Binici and Hutchison (2013) investigated if the claims that credit rating agencies affect borrowing costs has any merit. The authors consider data from 2005 to 2012, looking at CDS spreads during the sovereign debt crisis in the Eurozone and their relation to the issuing country's credit rating. The models considered global macroeconomic variables such as oil prices and overall volatility as control variables. Nevertheless, credit rating changes appeared to have a strong and statistically significant effect on bond insurance costs. Aizenman, Binici and Hutchison (2013) considered several different specifications of their model, including a rather innovative spline regression in which they attempted to look at price dynamics surrounding rating events depending on the rating categories of the home country as well as whether the event country is part of the riskier PIIGS group of Eurozone countries (Portugal, Italy, Ireland, Greece and Spain). It was found that events in PIIGS countries tend to have stronger effects on insurance costs. Furthermore, the paper also looked into contagion effects of credit events and found that highly indebted Eurozone member countries have the most significant contagion effects on other Eurozone members. All these results are in line with previous research, however, it is interesting to note that this paper did not consider positive and negative rating events separately, rather just as one 'change in ratings' variable. While somewhat similar to the research topic of our paper, Aizenman, Binici and Hutchison (2013) focus only on effects of rating events on the event country's borrowing costs.

The paper also touched upon contagion slightly, but did not extend their analysis to include data for the pre-crisis and crisis periods separately.

In Afonso, Arghyrou and Kontonikas (2012), the authors tried to relate European sovereign bond yield spreads (vis-à-vis Germany) to macroeconomic fundamentals. There were two periods considered, one before and one after global financial crisis. Variables considered included the VIX volatility index as a proxy for global risk, European bond market spreads and projected levels of sovereign indebtedness. The results indicate that these variables explain significant portions of the yield spread volatility for observations after the global financial crisis.

Havlicek (2013) investigated spillover effects in sovereign European bonds. With credit default swap and yield data ranging from 1999 to 2012 on most of the current member of the EU, the author measured the presence of an effect on borrowing costs, as well as contagion effects across borders. Rating events from all the three major rating agencies were considered. The paper first uses an event study methodology and then a panel regression. De-meaned spreads (i.e. daily spreads minus the mean spread for the country over the entire sample) are related to their past values and dummy variables indicating whether a positive or negative event had occurred. Interestingly, the model relates spreads on a given day to whether or not an event had occurred on that very day. Most studies tend to look at a multiple-day window around the event day. Nevertheless, results had been deemed conclusive, showing that negative events tend to affect the price more significantly than positive events. Furthermore, S&P events had the greatest significance. The paper also attempted to look at the persistence of these effects as well as whether information is already priced in at the time of the rating announcement. The paper concludes that price changes in the 20 days leading up to a rating event indicate that these events are, to an extent, already priced in.

A in a relatively recent paper, Baum et al. (2014) investigated effects of rating events on the euro exchange rate, as well as the borrowing costs of Italy, France, Spain and Germany. The authors employed a GARCH model based on a CAPM framework to estimate the outflows of capital as a result of rating events in the Eurozone. The premise of the paper was that, given the massive capital outflow following a negative rating event during the Asian crisis, does the same dynamic hold for Eurozone countries? The authors concluded that although negative events do increase borrowing costs for the countries mentioned (except Germany, whose rates decrease), rating events do not

automatically imply capital outflows from the Eurozone. Rather, it seems that a rebalancing occurs between higher and lower risk Eurozone countries, with the total remaining steady.

1.2 CORPORATE BONDS

The dynamics of the general bond market after a rating event was looked at by Hand, Holthausen and Leftwhich (1992). The authors considered bond returns after an S&P or Moody's rating event. What is important from our point of view is their system of classification of the rating events as expected or unexpected. The paper explains that the yield to maturity (YTM) of the bond in question was benchmarked towards the average YTM of bonds with the same ratings. The authors then argued that if the YTM of the bond is significantly higher than the benchmark average, investors consider the bond to be riskier and hence a downgrade is expected. While this methodology may require data that simply is not available for our sample, the paper illustrates a methodology around which one may base expectations modelling.

Hull, Predescu and White (2004) performed a similar analysis on the effects credit rating changes have on corporate bond yields and insurance premiums. Similarly to Hand, Holthausen and Leftwhich (1992), the author attempts to classify rating changes as expected or unexpected. Proxy variables used for expectations of upgrades and downgrades were created using CDS spreads. The paper was not able to find significant effects of rating changes on prices, with the positive changes being even less pronounced than the negative ones.

Corporate CDS spread reactions to credit rating events were further investigated by Norden and Weber (2004). The study considered a relatively short timeframe of two years and rating events from all three major rating agencies. The paper showed that corporate rating events did not contain new information that would influence their insurance costs. However, reviews for rating did affect the price when the reviews were negative. Furthermore, the magnitude of the abnormal price dynamics could be predicted by the average rating of the company by the three rating agencies.

Jorion and Zhang (2007) attempt to investigate contagion effects with regards to corporate debt and credit rating changes. The paper takes on a novel approach, in order to gauge the contagion

effect a rating event has, the authors looked into the correlation of CDS spreads of company bonds around a rating event. The authors concluded that there is significant correlation around important credit events, such as defaults, as well as large jumps in CDS spreads, pointing to contagion effects.

1.3 OTHER RESEARCH

Further research that examined the effects of rating changes include Gande and Parsley (2010), which looks at capital flows with regards to credit rating changes. Significant changes of equity flows were associated with negative downgrades, consistent with other research. Transparency was included as a control variable and it was shown that countries with lower levels of corruption experienced lower levels of capital outflows. Moreover, the paper noted a "flight to quality" phenomenon in which downgrades prompted capital outflows from downgraded countries flowed to less corrupt countries whose rating had not been changed. This is an interesting counterpoint to the hypothesis that downgrades should create contagion effects. However, the significance of transparency alone may be limited in the context of our research as Eurozone countries have much less variance in the levels of transparency than the wide sample of countries that was included in Gande and Parsley (2010).

Hilscher and Nosbusch (2010) considered the factors that could be used to predict credit risk. Sovereign credit ratings were determined to have predictive power with statistical significance, along with terms of trade and time since the last default. Attinasi, Checherita and Nickel (2009) also investigated the factors that played a role in EU sovereign spread increases with regards to the German baseline. The authors focused on the period of the recent financial crisis. The paper concludes that, "Higher expected budget deficits and/or higher expected government debt relative to Germany have contributed to higher government bond yield spreads in the euro area over the period end-July 2007 to end-March 2009. The results are robust if we restrict the period of analysis to after the crisis has intensified, i.e. the period from end-August 2008 to end-March 2009. The expected budget balance seems to be more robust than the expected debt across the various specifications. We interpret this result as pointing to a greater relevance of the fiscal deficit in shaping investors' expectations in periods of heightened uncertainty."

In a sense similarly to Jorion and Zhang (2007), Longstaff et al. (2007) investigate correlations of sovereign CDS spreads in order to ascertain whether they are driven by local conditions or rather global macroeconomic trends. The authors found that CDS spreads suffer from significant correlation, affecting more than half of total variation. What was surprising about this conclusion was how little local economic dynamics affected the spreads, compared to global fundamentals, "We find that the excess returns from investing in sovereign credit are largely compensation for bearing global risk, and that there is little or no country-specific credit risk premium."

The research done by Longstaff et al. (2007) was extended to Eurozone countries in Afonso, Arghyrou and Kontonikas (2012), which included data from 1999 to 2010. The paper looked into the determinants of bond yield spreads during the recent financial crisis as well as the period that preceded it. Conversely to Longstaff et al. (2007), the authors did not find significant support for the hypothesis that yield volatility was explained by global macroeconomic fundamentals in the time period before the financial crisis. However, this dynamic was observed during the course of the crisis, as well as further determinants that included European contagion risk as well as liquidity risks. The paper also touched on credit ratings and their relevance in explaining bond yields, concluding that their explanatory power was still significant, however less dominant than other factors.

Finally, Fanini (2005) also attempted to gauge the significance of increased budget deficits as well as total debt with regards to the standards outlined in the Stability and Growth Pact (SGP). This paper showed rather inconclusive results, stating that observed results indicate that "a one per cent increase in the deficit to GDP ratio leads to a rise in interest rates of not more than 10 basis points."

Sgherri and Zoli (2009) investigated the risk-premium differentials during the financial crisis. While many bond markets remained to have a constant differential vis-à-vis global risk sentiment, the authors observed a decoupling of several countries with higher indebtedness levels. Furthermore, an important explanatory factor for these risk premiums included the home country's bond market liquidity. The increasing skepticism for European countries carrying higher debt loads was evidently palpable in 2009 already, "Financial markets seem to have responded to the significant deterioration in fiscal positions by requiring higher sovereign default risk premiums for most countries, and differentiating across sovereign issuers much more than before. While global risk factors continue to play a significant role in explaining movements in euro area sovereign

interest rate differentials, country-specific developments—in particular rapidly rising projected debt levels as well as concerns about the solvency of national banking systems and their budgetary consequences are becoming increasingly more evident."

Reinhart and Rogoff (2011) investigated the dynamics between financial crisis and debt crisis. With a huge data sample of over two centuries covering 70 countries. Furthermore, the authors consider a myriad of factors that could influence borrowing costs and public debt levels – these control variables are especially pertinent to us given the probable need to control for similar factors in our study. The paper concluded that financial crises are usually preceded by growth of external debt. Next, financial crises usually precede sovereign debt crisis. Finally, public sector borrowing usually shoots up before a sovereign debt crisis.

Dasgupta, Laplante and Mamingi (1998) investigate the impacts of negative environmental news on the price of companies connected to this news. The paper deals with publicly traded companies in Argentina, Chile, Mexico and the Philippines. Conclusions include observable effects of positive versus negative news on publicly traded companies. This study is relevant because it provides a very solid foundation in terms of event-study methodology in financial markets. This is akin to the issue being address by our paper, as we are also dealing with semi-continuous prices and discreet events which are hypothesized to have effects on the prices. After presenting a deep theoretical model, the paper goes on to actual analysis. Normal returns are generated for days around the event dates. These generated returns are then subtracted from actual returns, pooled across events and tested for significance for each company. A test to pool results further across all companies was also presented.

2. BACKGROUND AND HYPOTHESES

The core issue we are attempting to investigate is whether sovereign credit rating events contain information for surrounding economies that has not been priced in by the market and how the dynamics of this mispricing changes during times of economic uncertainty. Price fluctuations can somewhat be expected in the bonds of the country whose rating is being changes, as outlined by De Santis (2012). The authors explained that some of these fluctuations may be attributed to legal constraints faced by institutional investors and their holding portfolios. However, this effect should not be present when we consider bond price dynamics with regards to rating events in neighbouring countries (both geographically and in terms of trade volume). The European Union is an ideal candidate for such an analysis due to the close proximity of countries in both the aforementioned aspects.

While it is true that a rating event mostly pertains to the country whose bonds are being revaluated, implications may exist for economic conditions for the broader region (in the geographical and trade volume sense). However, this information should be already priced in by the markets, if they are truly efficient in the sense of the Efficient Market Hypothesis as described in Fama (1970).

Nevertheless, if there is new, material information about a country or its bond, there are several theoretical transmission mechanisms through which contagion may occur. For instance, significant holdings of downgraded debt by a country's domestic banks may have broad implications that will resonate throughout the banking sector. Arazki, Candelok and Sy (2011) further explains, "Another example of channels through which sovereign rating news may spill over across countries and markets is when banks across countries hold claims on banks in other countries and are thus exposed to one another. This cross-holding feature is at the core of the European financial market convergence process in Europe. Sy (2010) provides a comprehensive discussion of the channels through which sovereign credit rating announcements may spillover to other markets including as a result of rating-based triggers such as those in banking regulation, ECB collateral rules, CDS contracts or investment mandates."

This paper aims to investigate the dynamics of spillover effects in European bond markets before and during the European sovereign debt crisis of 2009-2013. This crisis caused interest rates to

spike and exacerbated the already existing solvency issues many European countries faced. Figure 1 shows the dynamics of long term interest rates before and during the crisis period. For the purposes of this study, we will consider the crisis period to be from the beginning of 2009 to the end of 2013, with the pre-crisis period being defined as the period preceding the crisis period.

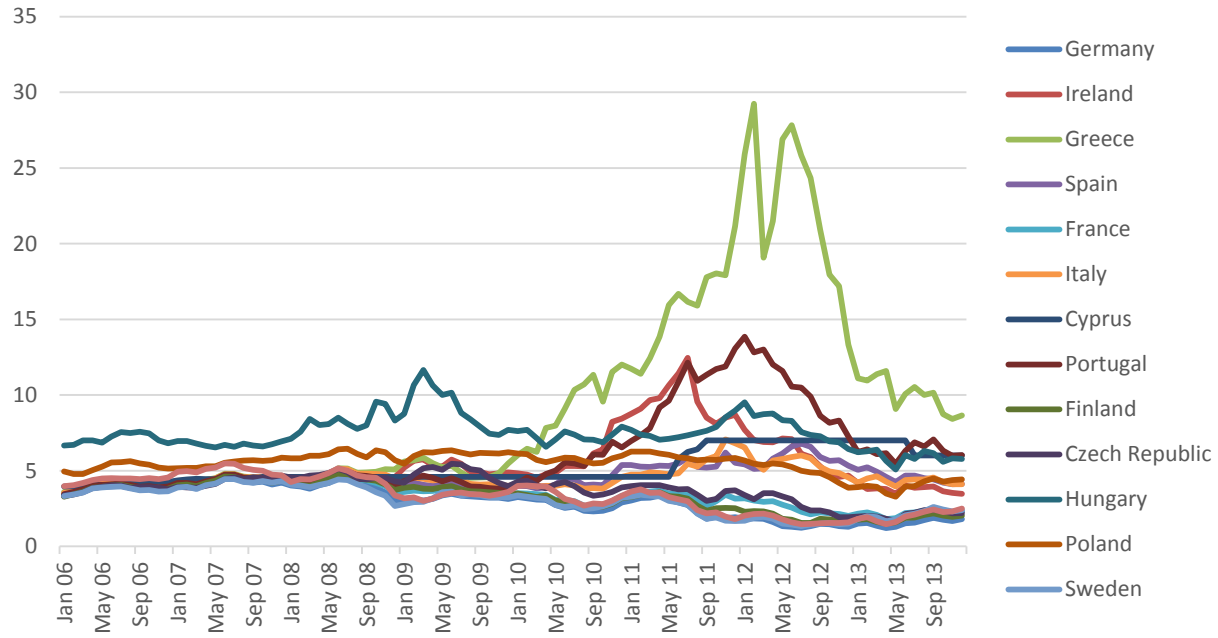

FIGURE 1 – EVOLUTION OF EU BOND YIELDS

Naturally, with worsening solvency prospects that were being decimated by rising borrowing costs came credit rating downgrades. These may or may not have contributed to the panic surrounding the crisis. It is the aim of this paper to look at the degree to which rating changes affected borrowing costs in countries other than the event country. We define the event country as the country whose comprehensive credit rating has been changed on a particular day, while non-event countries are those whose comprehensive credit ratings remain unchanged. A more precise definition of comprehensive credit rating is derived in section 3.1.1 Rating changes.

If we are able to identify spill over effects in sovereign rating events during or before the crisis period, it will also be interesting to consider the degree to which these effects are symmetric with

regards to upgrades and downgrades. In their research, Gande and Parsley (2005) were able to show that the effects were indeed asymmetric in their sample of countries. The authors went on to offer the following explanation: "…the existence of asymmetric spill overs is consistent with a view that rating agencies could be biased in evaluating sovereigns, e.g., through their reluctance to issue low credit ratings (at initiation) or to lower a credit rating in a timely manner. To explore this issue further, one must examine the incentives of the rating agencies in divulging ratings changes in a timely manner. In addition to the extent that large spill overs can be viewed as a precursor to a financial contagion, one can characterize (and possibly forecast) the vulnerability of an economic system to a financial contagion in terms of the aggregate spill overs."

The hypotheses of this paper are as follows:

H_1: *Relevant information is efficiently priced into sovereign yields and rating changes do not influence yields across borders.*

H_2: *The effect of cross border rating changes on bond yields does not change during times of crisis.*

H_3: *Contagion effects are present only as temporary shocks and do not persist in the long run.*

3. METHODOLOGY AND MODEL

Building on the models outlined in the literature review section, this study uses an event study methodology to gauge the impact of rating changes to bond yields across borders within the Eurozone. Our approach to testing the effects of rating changes will be twofold. First of all, we aim to investigate the general significance of rating events on yields depending on whether we the event is positive (an upgrade) or negative (a downgrade), as existing literature strongly hints to the existence of an asymmetry (Arezki, Candelon and Sy (2011); Gande and Parsley (2005); Afonso, Furceri and Gomes (2011)). This test will be done separately on data leading up to the crisis and on data during the crisis. Next, we will build on the methodology outlined by Afonso, Furceri and Gomes (2011) to quantify the observed effects and further dissect the variables that seem to be relevant in our two time periods. This methodology seems most appropriate due to the nature of the data, as we are dealing with daily yields on 10 year sovereign bond yields and sporadic rating events. Once again, all our investigations will be conducted separately on events before and during the Eurozone crisis in order to ascertain differences in reactions during the pre-crisis and crisis period.

3.1 DATA SELECTION

The main data components in our analysis will be rating changes and bond yields.

3.1.1 Rating changes

We will be dealing with the ratings of the three major rating companies, S&P, Moody's and Fitch. Afonso, Furceri and Gomes (2011) opted to use a linear scale for all three rating agencies' ratings with 17 discreet categories. Furthermore, dummy variables were used to signify whether a downgrade or upgrade was performed by any of the agencies as well as their positive or negative

outlooks. In this paper, we will also consider linear 17 point scales with a further addition or subtraction of half a point to indicate the outlook of any given agency. These scales will then be aggregated into two indicators, net positive rating changes and net negative rating changes for each day in our sample.

Taken from Afonso, Furceri and Gomes (2011), our scale (excluding outlook points) is described in Table 1.

Characterization of debt and issuer (source: Moody's)		Rating			Linear transformation
		S&P	Moody's	Fitch	
Highest quality	Investment grade	AAA	Aaa	AAA	17
High quality		AA+	Aa1	AA+	16
		AA	Aa2	AA	15
		AA-	Aa3	AA-	14
Strong payment capacity		A+	A1	A+	13
		A	A2	A	12
		A-	A3	A-	11
Adequate payment capacity		BBB+	Baa1	BBB+	10
		BBB	Baa2	BBB	9
		BBB-	Baa3	BBB-	8
Likely to fulfil obligations, ongoing uncertainty	Speculative grade	BB+	Ba1	BB+	7
		BB	Ba2	BB	6
		BB-	Ba3	BB-	5
High credit risk		B+	B1	B+	4
		B	B2	B	3
		B-	B3	B-	2
Very high credit risk		CCC+	Caa1	CCC+	1
		CCC	Caa2	CCC	
		CCC-	Caa3	CCC-	
Near default with possibility of recovery		CC	Ca	CC	
				C	
Default		SD	C	DDD	
		D		DD	
				D	

TABLE 1 – RATING CATEGORY CONVERSION TABLE

This conversion into a linear scale allows us to not only investigate the effects a rating upgrade or downgrade has on yields, but we are able to look at more nuanced effects of smaller and larger rating changes, as ratings do not necessarily change by only one order at each rating event.

Using this conversion scheme, we convert each rating change into the change in the linear scale. This is done for all rating events across all three rating agencies. Next, for each day in our sample, we pool the total rating change across all rating agencies. To this index, we add outlooks given by each agency. We categorize outlooks into three groups: positive, negative and neutral. These three groups are represented by either adding, subtracting half a point or leaving our aggregate index unchanged, respectively. This gives us a comprehensive index of rating change for any given day.

For the purpose of our analysis, we define a rating event for a country on a given day as change in the comprehensive index.

In our sample that ranges from 2006 to 2013, we have 192 rating events, in total. It is important to note that during this time period, negative rating changes were predominant, with 166 downgrades or negative outlooks and only 26 upgrades or positive outlooks. The exact distribution of positive and negative rating changes across agencies is presented in Figure 2 – Distribution of Rating Events by Rating Type. The distribution in time is shown in Figure 3.

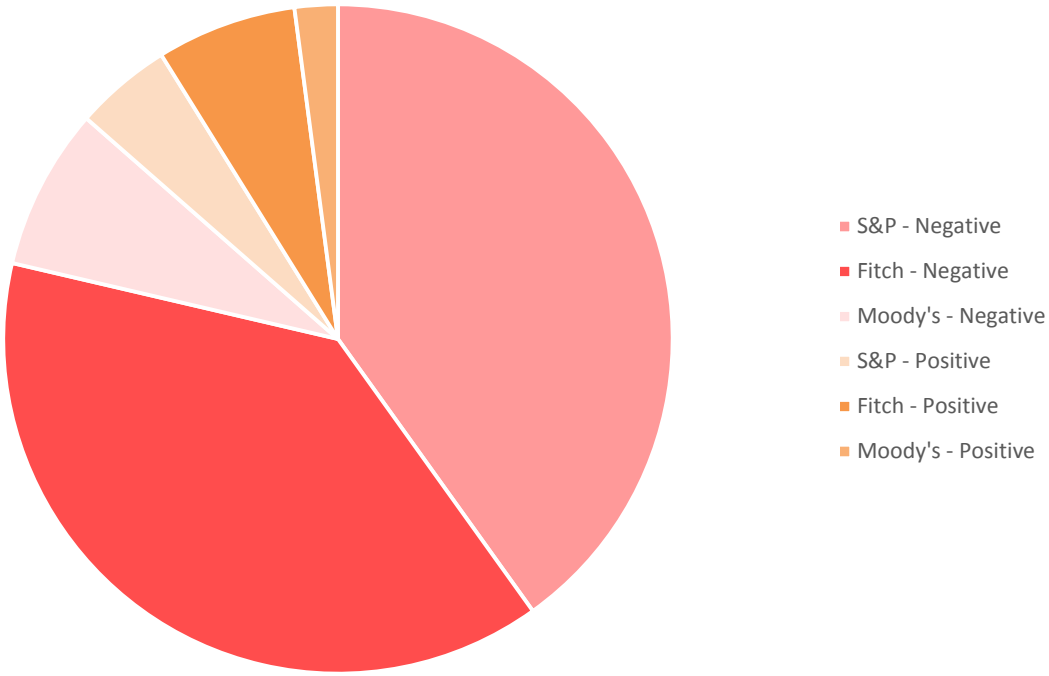

FIGURE 2 – DISTRIBUTION OF RATING EVENTS BY RATING TYPE

Given past research, we expect negative events to have a more profound effect on borrowing costs, however, it will be harder to gauge the significance of positive events, given their sparse distribution, especially in the time of the crisis.

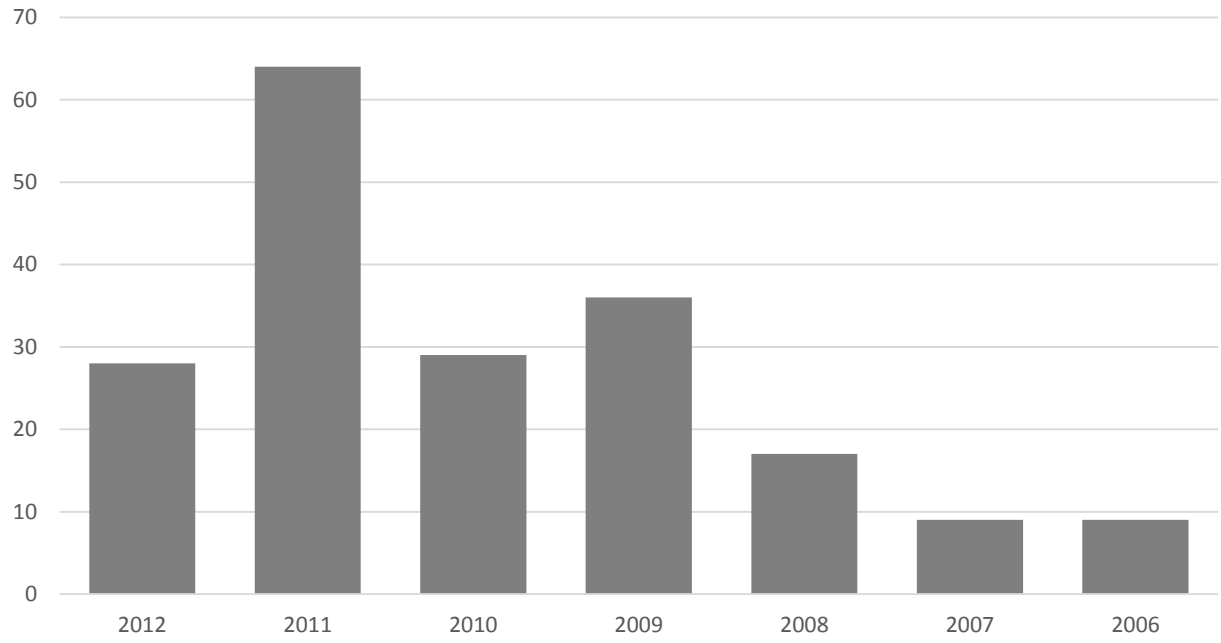

FIGURE 3 – DISTRIBUTION OF RATING EVENTS IN TIME

The distribution of rating events in time is also not exactly uniform. This is easily explained by the fact that during the crisis period of 2009-2012, many more rating events occurred due to the fact that the crisis was itself a sovereign crisis of solvency.

Over our sample period, some days are associated with more than one event. For instance, on 27/01/2012, S&P downgraded 16 countries in our sample, each by one point. This sort of 'batch' downgrading can be observed with all three rating agencies, and is most pronounced during the crisis period. Analysing such events may prove to be a major problem, as we will not be able to isolate the country with which the downgrade is associated with. After observing a change in yields following such days, we would have trouble with attributing this change to one specific country. Due to these considerations, we have decided to focus mainly on event days with at most one event. This will allow us to more clearly dissect the effects such changes have between specific countries. In our sample, more than one event occurs on 18 days, with a cumulative 50 events.

3.1.2 Yields

Our proxy for borrowing costs will be sovereign bonds from across the European Union with a 10-year maturity. The advantage of using these bonds is that the vast majority of countries issues them and that they create relatively liquid markets, providing us with a sufficient amount of data points.

The data on yields was sourced from Bloomberg. We will be dealing daily bond yields in the period from 2006 to 2013. Due to constraints such as unavailability of 10-year bonds, too recent European Union membership status and data unavailability, the following countries are not included in our sample: Bulgaria, Croatia, Cyprus, Estonia, Luxembourg, Malta, the Netherlands, Sweden and Slovakia. This leaves us with 19 countries for our analysis.

The period we are considering includes 1,920 trading days. Of this, 837 are classified as pre-crisis days while 1,083 are considered to be within the crisis period. In total, this yields 36,480 data points, of which 15,903 are pre-crisis observations and 20,577 are observations made during the sovereign crisis period.

The average yield on the bonds in our sample over the entire period is 5.02%. The pre-crisis and crisis periods average at 4.85% and 5.12%, respectively.

An interesting statistic shown in Afonso, Furceri and Gomes (2011) is the distribution of spreads according to rating category. In Table 2 we see the distribution of percentage spreads according to rating tranche over our entire sample. The percentage spread is calculated as the yield spread over the German yield, as a percentage of the German yield (further discussion concerning the use of the percentage spread over other spread measures can be found in section 3.1.1)

Rating	Average Percentage Spread		
	S&P	Fitch	Moody's
AAA	10.07	10.41	3.48
AA+	15.24	37.79	5.5
AA	61.41	40.91	13.13
AA-	48.80	49.38	60.69
A+	25.30	49.89	11.96
A	33.68	59.01	27.16
A-	137.85	45.55	115.74
BBB+	56.92	97.08	16.89
BBB	229.39	40.56	N/A
BBB-	444.06	130.19	75.43
<BB+	257.82	634.59	234.11

TABLE 2 – AVERAGE PERCENTAGE SPREAD BY RATING CATEGORY

In Table 3 we have the actual raw spreads for each rating tranche. Again, these are spreads over the German yield. The dynamics of the spreads are basically very straightforward, with a steady increase in borrowing costs along the rating scale.

Rating	Average Spread		
	S&P	Fitch	Moody's
AAA	0.3193	0.4332	0.3601
AA+	0.6659	1.0140	1.15173
AA	2.1092	1.5545	2.0951
AA-	1.1736	1.4378	2.4444
A+	1.8090	1.4123	2.3908
A	2.2599	1.3545	2.3255
A-	4.0169	3.3443	3.8266

BBB+	3.8851	3.8250	3.2825
BBB	7.5465	3.5998	N/A
BBB-	10.1030	4.8080	4.1201
<BB+	12.1311	16.7822	15.2040

TABLE 3 – AVERAGE SPREAD BY RATING CATEGORY

As the above table deals in raw spreads, we can see that a country with a BBB+ credit rating has a, on average, 3.51% higher borrowing cost than a typical AAA rated country, and a 3.89% higher borrowing cost than Germany.

Table 4 displays descriptive statistics for the entire bond yields sample.

	Mean	Median	SD	Minimum	Maximum	N
Euro Area						
Austria	3.34	3.58	0.9056	1.48	4.92	1985
Belgium	3.65	3.82	0.7673	1.94	5.83	1985
Finland	3.15	3.39	0.9813	1.32	4.87	1985
France	3.33	3.46	0.7875	1.66	4.84	1985
Germany	2.90	3.11	1.0263	1.1	4.69	1985
Greece	10.85	8.24	8.0578	3.91	39.85	1985
Ireland	5.47	4.72	2.0282	2.98	14.45	1985
Italy	4.58	4.43	0.6718	3.29	7.28	1985
Latvia	4.44	4.34	0.7637	3.09	6.70	1985
Portugal	6.57	5.36	2.8916	3.70	17.35	1984
Slovenia	5.88	6.13	1.3174	3.43	15.69	1985
Spain	4.60	4.37	0.7647	3.23	7.61	1985
Other EU, Non-Euro						
Czech Republic	3.71	3.89	0.9688	1.47	5.42	1985
Denmark	3.09	3.40	1.1706	0.97	4.99	1985
Hungary	7.47	7.34	1.2151	4.88	12.47	1985
Lithuania	5.92	5.10	2.7291	2.50	15.14	1985
Poland	5.47	5.67	0.7589	3.06	7.50	1985
Romania	6.62	6.71	1.4811	3.80	9.95	1985
United Kingdom	3.46	3.54	1.0984	1.43	5.54	1985

TABLE 4 – DESCRIPTIVE STATISTICS FOR BOND YIELDS

3.2 METHODOLOGY

This paper aims to be an event study that considers the isolated effects of rating events on cross-border sovereign bond yields in the Eurozone in two distinct time periods. To investigate immediate effects of rating changes, we will consider bond yields over a short period around the rating event.

Our approach to testing the significance of rating events on cross border bond yields will have two dimensions. First of all, we will use a standard event study methodology to estimate the degree to which returns on bonds are abnormal in the days around the rating event. This will allow us to

gauge the overall significance of these events and will provide direct information concerning the first hypothesis of this paper, namely that relevant information in already priced into bond yields. Secondly, if there is an observable effect on cross-border bond yields associated with rating events, we will attempt to quantify it and perhaps isolate the factors that contribute to this effect. To this end, data will be pooled and the changes in the yield will be regressed on factors that include the direction of the credit rating change, respective magnitude and control variables. We aim to control for factors such as country indebtedness and other links that may serve as transmission pathways for yield changes. Lastly, to investigate the persistence of the shocks, we will use wider time windows with further control variables.

3.2.1 General specification

The main time window selected for the purposes of this study is a three day to five day window centred on the event day. This is mainly in an attempt to isolate the effects of individual effects better and to avoid contamination. This event window is in line with existing research and general event study practices, however longer event windows may be considered to examine the persistence of effects. Indeed, in our secondary analysis we will attempt to quantify the persistence of observed effects using a wider range of event windows.

In this study, we will be considering yields on ten year sovereign bonds in all our analyses as specified in section 3.1.2 Yields. Furthermore, the German 10 year bond yield will serve as a general proxy for the market rate or baseline rate, in order to control for fluctuations in general lending condition in the bond market.

In all our subsequent analysis, we will *not* consider effects of events on the *event* country's yields, as we hope to focus solely on transmission dynamic.

We will attempt to use minimal event windows in order to avoid data contamination in the case of clustered events.

3.3 MODELS

3.3.1 Testing overall significance

In order to test the overall significance of rating events on bond yields, we will compare returns on bonds during a rating event window to normal returns which could have been expected in the absence of a rating event. As in Afonso, Furceri and Gomes (2011), we are using a five day event window around the rating event. We will consider individual returns as a function of German sovereign bonds of the same, ten year, duration.

This investigation will allow us to test our first hypothesis, that rating events do not effect bond prices across borders as the information they contain is already priced in when they are announced.

Dasgupta, Laplante and Mamingi (1998) provide a baseline model for testing the significance of abnormal returns in the context of an event study on which we have decided to build.

Our model will work with the assumption that bond yields tend to follow a linear relation with baseline or risk-free yields (in our case, equivalent German sovereign bonds). The relation for country i at time t can be described as follows:

$$Ret_{i,t} = \beta_{0,i} + \beta_{1,i} Ret_{Ger,t} + e_{i,t}$$

Where $E(e_{i,t}) = 0$, $Var(e_{i,t}) = {\sigma_i}^2$ and $Ret_{Ger,t}$ being the return on German bonds at time t.

We define abnormal returns as the differential between actual returns and returns that we could have expected without an event. Mathematically,

$$AbRet_{i,t} = Ret_{i,t} - \widehat{Ret}_{i,t}$$

Where

$$\widehat{Ret}_{i,t} = \hat{\beta}_{0,t} + \hat{\beta}_{1,t} Ret_{i,t}$$

Given we use a L-day window to estimate the normal returns around an event, under the null hypothesis that abnormal returns are zero, the abnormal returns follow a normal distribution with a conditional mean of zero and a conditional variance:

$$\sigma^2{}_{AbRet_{i,t}} = \sigma_i{}^2 + \frac{1}{L}\left(1 + \frac{\left(Ret_{Ger,t} - \overline{Ret}_{Ger}\right)}{\sigma_{Ger}{}^2}\right)$$

Note that

$$\lim_{L\to\infty} \sigma^2{}_{AbRet_{i,t}} = \sigma_i{}^2$$

Abnormal returns are essentially the difference between the returns we could have expected from the underlying asset conditional on the fact that no event had occurred and the actual observed returns. These expected returns are modelled by the assumed linear relationship described above.

As explained in Dasgupta, Laplante and Mamingi (1998), in order to gauge the general significance of abnormal returns, we want to test for their significance across all observed countries. Thus, we can define the aggregate abnormal returns at time t for n countries as follows:

$$AgAbRet_t = \frac{1}{n}\sum_{i=1}^{n} AbRet_{i,t}$$

$$\lim_{L\to\infty} \sigma^2{}_{AgAbRet_t} = \frac{1}{n^2}\sum_{i=1}^{n} \sigma_i{}^2$$

As we can divide our observed rating events into two types, positive and negative, it may be useful to consider each of these types separately. This is due to two facts. First of all, we expect the two types to possibly have opposite effects, which could cancel out in an aggregate indicator. Secondly, existing literature indicates that there is a strong possibility of asymmetric effects. This means positive events may have less pronounced effects than negative ones. Our indicators that aggregate abnormal returns across countries and time, which we will be able to test, will therefore have the following forms.

Positive events:

$$CumulARetPos = \frac{1}{n}\sum_{i=1}^{n}\sum_{t=t_1}^{t_2} AbRet_{i,t}$$

$$\lim_{L\to\infty} {\sigma^2}_{CumulAbRetPos_t} = \frac{1}{n^2}\sum_{i=1}^{n}(t_2 - t_1 + 1) * {\sigma_i}^2$$

Negative events:

$$CumulAbRetNeg = \frac{1}{n}\sum_{i=1}^{n}\sum_{t=t_1}^{t_2} AbRet_{i,t}$$

$$\lim_{L\to\infty} {\sigma^2}_{CumulAbRetNeg_t} = \frac{1}{n^2}\sum_{i=1}^{n}(t_2 - t_1 + 1) * {\sigma_i}^2$$

Where t_1 and t_2 define the length of the event window that we wish to investigate.

Our null hypothesis will be that abnormal returns are zero, which corresponds to H_1 of our paper, namely that information is already priced in and there are no abnormal returns associated with cross-border rating changes and their effects on sovereign yields.

The statistic that we will test will have the following form (MacKinlay, 1997) for both positive and negative events:

$$Z = \frac{CumulAbRet}{\sqrt[2]{{\sigma^2}_{CumulAbRet_t}}} = \frac{\frac{1}{n}\sum_{i=1}^{n}\sum_{t=t_1}^{t_2} AbRet_{i,t}}{\sqrt[2]{\frac{1}{n^2}\sum_{i=1}^{n}(t_2 - t_1 + 1) * {\sigma_i}^2}} \sim N(0,1)$$

Giving us an asymptotic distributions in the number of countries studied, n, and the normal performance estimation window length, L.

Cumulative abnormal returns are essentially the sum of abnormal returns across all events and countries, allowing us to look at the total deviation from the expected returns across our sample.

This model will serve to give us an overall view of the presence and significance of rating changes on cross-border sovereign yields. Moreover, our methodology will allow us to distinguish between positive and negative rating events. This distinction appears to be pivotal according to prior literature.

This model will be applied to both the pre-crisis and crisis period individually.

3.1.1 Quantifying effects

We will be investigating the changes of sovereign yields upon a credit rating event. However, we need to be able to control for macroeconomic fluctuations within the Eurozone that are reflected in individual bond yield changes but are not necessarily caused by the rating event itself. For purposes of controlling for such fluctuations, we will be using German sovereign yields as baseline rates. All bonds considered in this analysis will be ten year bonds.

Broadly speaking, our model will attempt to relate changes in the percentage spread to rating events. The percentage spread is essentially the yield differential over a German bond of comparable maturity, as a percentage of the German bond yield. This approach is similar to the one applied in Gande and Parsley (2005) and serves as both a standardisation mechanism for yields as well as to control for movements in the broader European sovereign bond market.

The advantages of considering the percentage spread are numerous. First of all, not all bond markets are equally liquid. The German sovereign bond is by far the most traded sovereign bond of our sample, with price changes practically every day. This gives us the sentiment of overall risk levels in Europe. It is our assumption that all other European bonds should carry similar risks plus some country specific risk, which is represented by the premium on bond yields. Next, by taking the percentage spread, rather than just basic spread, we put all countries on an equal footing, for if we used the former approach, countries with higher yields would have systematically higher spreads and would thereby pollute our data.

As in the previous section, we will apply our model to data leading up to the Eurozone crisis in order to investigate the presence of reactions to rating changes in the European debt market and to get a baseline response which we will compare to the crisis period.

Mathematically, our model can by generalized to the following equation, which will be estimated using fixed effects analysis:

$$\Delta PctSpread_{i,t} = \beta_0 + \beta_1 PosEvent_t + \beta_2 NegEvent_t + Control + a_i + u_{i,t}$$

With the percentage spread being defined as:

$$\Delta PctSpread_{i,t} = PctSpread_{i,t+t_1} - PctSpread_{i,t-t_2}$$

The variables t_1 and t_2 define the event window length. In our case we will use a 5-day symmetric window around the event. Further,

$$PctSpread_{i,t} = \frac{Yield_{i,t} - GermanYield_t}{GermanYield_t}$$

As mentioned in section 3.1.1, we constructed a generalized comprehensive index of rating changes for each day in our sample.

Our control variables will include global perceptions of risk. As mentioned above, we used the spread vis-à-vis the German 10 year bond to control for European risk levels and risk sentiment, however, we may want to further control for global risk and volatility. These risks will be proxied by the VIX volatility index and changes in the German DAX index. The VIX is constructed as an index of implied volatility of the broader S&P 500 index's options. This is a standard measure of global risk or risk aversion. The changes in the DAX index will provide a variable that follows the general economic sentiment in Europe.

Another control variable, the cumulative rating change over the past week (five trading days). This variable controls for possible interaction effects from previous rating changes, which may occur, especially in times of higher volatility.

Lastly, if we do observe significant effects on yields associated with rating events, we will want to investigate their persistence in time. This means we will attempt to analyse whether these observed effects dissipate over a longer time period. The approach that we aim to utilize includes the standard panel analysis described in this section with longer event windows. While this may appear to be a straightforward procedure, it is important to understand the caveat that a longer time window will distort our observed data more, as we are not able to consider the effects of rating changes in isolation. Furthermore, if we deal with rating event changes that are clustered in a certain time period, percentage spread changes may be influenced by several events if our window is too large. To address these concerns, it is essential to select an appropriate window. While some papers that are mentioned in our literature review consider windows of up to 30 days long, we opt for a more prudent, 12 trading day window. This includes one day before the event day, the event day, and ten trading days past the event day. Compared to the baseline analysis, our window asymmetrically expands by eight days after the rating event.

The results of this persistence analysis will indicate whether observed rating event effects on the percentage spread are merely temporary shocks or persist in the week after the event. It is important to note that a 12 day window is still a relatively short period, however the nature of our data sample does not lend itself to a more long-term analysis due to issues such as data contamination, which are outlined above. Again, a variable indicating the cumulative number of events that occurred in the past two weeks will be included in the analysis to control for clustering of events, however, due to the nature of this data, analysis on extended event windows will necessarily be imprecise and therefore lend to only limited implications.

4. INVESTIGATION OF DATA

4.1 DATA OVERVIEW

Our models will be dealing with panel data on 18 countries within the European Union. As was mentioned before, German yields will serve as a baseline and therefore cannot be included in the analysis. Rating events from all three major rating agencies will be consider, as well as control variables in order to account for global risk sentiment and Europe-specific risk. For more details please refer to section 3.1 – Data Selection.

4.2 REGRESSION ANALYSIS

4.2.1 Testing overall significance

As described in section 3.3.1, we first aimed to test the overall significance of rating events on cross-border sovereign yield changes. Due to the fact that positive and negative rating events are expected to have opposite and perhaps differently significant effects, we opted to examine positive and negative events separately.

After estimating expected returns in the absence of rating events, we examined the differences between observed values in our data set and estimated values during the event window (in our case a five day window centred on the event date). Next, we aggregated these abnormal returns across countries and tested the null hypothesis that across events, these abnormal returns are zero (The test statistic, distribution and assumptions are explained in section 3.3.1). If these indicators were zero, we would not have evidence of any abnormal returns of bonds around the event window, and therefore not have sufficient evidence to reject this thesis' first hypothesis, that rating event changes are already totally priced in. These analyses were performed on data pertaining to the pre-crisis and crisis period separately in order to ascertain the statistical significance in both periods.

The results of this first analysis are presented in Table 5.

	Pre-Crisis		Crisis	
	Coefficient	p-value	Coefficient	p-value
Positive	-3.1752	0.000	5.2462	0.000
Negative	5.0056	0.000	19.5790	0.000

TABLE 5 – REGRESSION RESULTS (FULL SAMPLE)

The pre-crisis period is marked by effects that correspond to existing research. Both positive and negative rating events have statistically significant effects on yields in a five day window around the event date. Positive events are associated with *lower* than expected yields, while negative events tend to *increase* yields and therefore borrowing costs. Negative events during the crisis period are basically in-line with expectations, also having significant effects. Positive events appear to be associated with higher costs in the crisis period, but this may be explained by the severe lack of positive rating events during the crisis and the consequent low sample size.

We also applied the above analysis to only Eurozone member countries, the results are summarized in Table 6.

	Pre-Crisis		Crisis	
	Coefficient	p-value	Coefficient	p-value
Positive	-1.7744	0.000	8.9891	0.000
Negative	1.9120	0.000	33.9752	0.000

TABLE 6 – REGRESSION RESULTS (EUROZONE SUBSAMPLE)

These are basically consistent with the results for the entire sample. Given that in the wider sample and in the Eurozone subsample we are dealing with the same number of days and events, it is possible to compare the coefficients of the aggregate abnormal returns. We observe that the

aggregate abnormal returns are estimated to be higher in the Eurozone subsample, which is consistent with the fact that we were dealing with a Eurozone-centric crisis.

In order to control for heteroskedasticity, we consider a robust standard errors. The p-value associated with each observation tests the hypothesis that the sum of abnormal returns over events and countries is zero. The coefficient measured, however, does not lend to a deeper interpretation due to the facts that these abnormal returns are summed over different numbers of events in all the four categories. We can therefore limited to only judging the sign of the individual coefficients, rather than comparing them between each other. Therefore, the fact that the post-crisis coefficient for negative events is significantly higher than that of the pre-crisis events does not signify anything by itself.

Both these results are statistically significant, this allows us to reject H_1 which claims that sovereign bond rating changes are already efficiently priced in on the announcement day. Furthermore, the signs on both the estimated coefficients are consistent with existing literature and theory, that positive events should have a net effect of lower yields, while negative events should increase yields.

4.2.2 Quantifying effects – Standard event windows

Following the methodology in section 3.1.1, we first estimated a baseline model with control variables that proxied global risk. Our event window will be include five days and will be centred on the event day. The results of this analysis are presented in Table 7. The Positive and Negative coefficients indicate the change in the percentage spread over the event window around positive and negative rating events. Cumulative represents the total rating change that had occurred in the past five trading days before an event. Lastly, DAX represents the *change* in the Xetra DAX index over the event window and VIX is the S&P 500 volatility index for a given day.

	Pre-Crisis		Crisis	
	Coefficient[2]	Std. Err.	Coefficient	Std. Err.
Positive	1.2664	0.9074	-2.3915**	1.2147
Negative	1.2391*	0.6613	-2.2984***	0.4659
Cumulative	-0.2093	0.1395	-0.6818*	0.3370
DAX	0.0227**	0.0114	0.0123	0.0102
VIX	0.0552***	0.0084	0.0885***	0.0250

TABLE 7 – REGRESSION RESULTS (FULL SAMPLE)

We can see in the table above that the pre-crisis data follows existing research. Negative events increase the percentage spread, on average, by over 1% for each change in the level of the comprehensive rating index. While negative events have a statistically significant effect on yields, positive ones do not. The sign on the cumulative variable indicates that the higher the number of events in the past days, the lower the effect on yields is. Control variables DAX and VIX are also significant in predicting yield changes, as can be expected due to their representativeness of global risk sentiment.

On the other hand, data from the crisis period paints a somewhat different picture. While positive events gained some significance, we observe a very significant ($p<0.01$) effect of negative events. However, the direction of this effect has reversed, and negative events appear to be associated with an over 2% decrease in percentage spread per rating level. One of the possible explanations for this dynamic are is the fact that we included highly indebted countries in our analysis at the time of crisis, indeed without including them in the sample, the results are rather different, as can be seen below. Further discussion regarding the causes and possible explanations of this effect are presented in section 5. As far as the control variables are concerned, they reflect a similar dynamic to the one in the pre-crisis period. The volatility index is still significant when it comes to explaining change in the percentage spread, the change in the DAX index less so. Cumulative

[2] The ***, ** and * symbols indicate statistical significance at the 1%, 5% and 10% levels, respectively.

lagged five-day change is more significant, but that may be attributed to the fact that negative events vastly outnumber positive events in this time period, and therefore the cumulative variable is not distorted by the fact that there may be asymmetries in its interactions with positive and negative rating changes.

	Pre-Crisis		Crisis	
	Coefficient[3]	Std. Err.	Coefficient	Std. Err.
Positive	-	-	-0.4710	1.1372
Negative	-	-	-0.8626	0.6706
Cumulative	-	-	-0.7026*	0.3512
DAX	-	-	0.0124	0.0102
VIX	-	-	0.1105***	0.0270

TABLE 8 – REGRESSION RESULTS (CRISIS – NO PIIGS)

Again, we also applied the above analysis to a subsample including Eurozone countries only. The results are summarized in Table 9.

	Pre-Crisis		Crisis	
	Coefficient	Std. Err.	Coefficient	Std. Err.
Positive	1.6619***	0.8300	-2.7971	1.9547
Negative	0.7173	0.6071	-2.6476***	0.7022
Cumulative	-0.1863	0.1279	-1.0616	0.7048
DAX	0.000839	0.0104	0.2225	0.0145
VIX	0.0366***	0.0076	0.0585***	0.0243

[3] The ***, ** and * symbols indicate statistical significance at the 1%, 5% and 10% levels, respectively.

TABLE 9 – REGRESSION RESULTS (EUROZONE SUBSAMPLE)

Overall, we observe a significantly less clear picture of transmission dynamics. In the pre-crisis period, we do not see statistically significant evidence of transmission. However, during the crisis period we observe a similar dynamic to that of the broader sample. It appears that even negative events are again associated with somewhat lower percentage spreads. In this case, positive events are again not sufficiently statistically significant, however this may be attributable to the low number of positive events during the crisis period, and the fact that we are currently considering an even smaller subsample of the dataset analysed above. To account for the anomaly of negative rating events having a positive effect on spreads (lowering them), we again performed the analysis without PIIGS countries. As can be seen below, the effects were no longer observable.

	Pre-Crisis		Crisis	
	Coefficient[4]	Std. Err.	Coefficient	Std. Err.
Positive	-	-	-0.6433	1.8667
Negative	-	-	-0.9637	1.1536
Cumulative	-	-	-1.1260	0.7413
DAX	-	-	0.0224	0.0145
VIX	-	-	0.0811**	0.0283

TABLE 10 – REGRESSION RESULTS (CRISIS; EUROZONE – NO PIIGS)

According to these results, we can reject H_2 which stipulates that the effects of rating changes is the same during the pre-crisis and crisis periods. While the positive rating change effect is insignificant in both periods, the response to negative rating changes is dramatically different.

[4] The ***, ** and * symbols indicate statistical significance at the 1%, 5% and 10% levels, respectively.

4.2.3 Quantifying effects – Extended event windows

In this section we look at the persistence of the effects that we observed in the previous subsection. We will be using an expanded 13 trading day event window to look at the evolution of percentage spreads in the week after a rating change event took place. The variable notation is the same as in the previous section. The regression results are presented in Table 11.

	Pre-Crisis		Crisis	
	Coefficient[5]	Std. Err.	Coefficient	Std. Err.
Positive	-	-	-	-
Negative	-3.5146**	1.5306	-2.1363***	0.4413
Cumulative	-1.1961***	0.3726	-0.5390	0.6150
DAX	0.0321*	0.0165	0.0858***	0.0256
VIX	0.1568***	0.0447	-0.0791	0.0993

TABLE 11 – REGRESSION RESULTS (FULL SAMPLE)

In the pre-crisis timeframe we observe a clear reversal of the increased borrowing rates that we observed on the shorter timeframe. However, during the crisis period, no such reversal occurs and *negative* events are still associated with *lower* spreads in non-event countries. Further discussion on the possible causes of this counterintuitive effect can be found in Section 5. As in the previous subsection, we repeated out analysis on the crisis subsample without including PIIGS observations. The persistent decrease of yields again quickly dissipates.

[5] The ***, ** and * symbols indicate statistical significance at the 1%, 5% and 10% levels, respectively.

	Pre-Crisis		Crisis	
	Coefficient[6]	Std. Err.	Coefficient	Std. Err.
Positive	-	-	-	-
Negative	-	-	3.4169	2.0100
Cumulative	-	-	-0.5800	0.6519
DAX	-	-	0.0867***	0.0257
VIX	-	-	-0.1085	0.1078

TABLE 12 – REGRESSION RESULTS (LONG EVENT WINDOW; CRISIS– NO PIIGS)

In Table 13 are the results for the extended-window analysis for Eurozone countries.

	Pre-Crisis		Crisis	
	Coefficient	Std. Err.	Coefficient	Std. Err.
Positive	-	-	-	-
Negative	-1.7961	1.1153	-2.3645***	0.6719
Cumulative	-0.8762**	0.3596	-1.0648	1.3375
DAX	0.0132***	0.0038	0.1009**	0.0402
VIX	0.1005***	0.0195	-0.1609	0.1553

TABLE 13 – REGRESSION RESULTS (EUROZONE SUBSAMPLE)

[6] The ***, ** and * symbols indicate statistical significance at the 1%, 5% and 10% levels, respectively.

	Pre-Crisis		Crisis	
	Coefficient[7]	Std. Err.	Coefficient	Std. Err.
Positive	-	-	-	-
Negative	-	-	3.7692	3.4121
Cumulative	-	-	-1.1719*	1.4361
DAX	-	-	0.1016**	0.0402
VIX	-	-	-0.1975	0.1687

TABLE 14 – REGRESSION RESULTS (LONG EVENT WINDOW; EUROZONE; CRISIS– NO PIIGS)

The evidence from Eurozone countries is basically consistent with the results for the wider sample. In the pre-crisis period, effects on yields from negative rating events tended to dissipate over the course of one or two weeks (5-10 trading days). On the other hand, during the crisis period we again observe persistence of the negative event on yields, with significance diminishing in the non-PIIGS subsample.

From these results we do not have sufficient evidence to reject H_3, which stipulates that cross-border responses to rating events are merely temporary shocks and do not persist over longer time periods. While it is true that we did not observe persistence in the pre-crisis period, the results of the crisis period data is consistent with persistent contagion effects. As mentioned in Section 3.1.1, according to both past research and the nature of our data, we believe that our model would face too much data contamination if it were applied to longer event windows.

[7] The ***, ** and * symbols indicate statistical significance at the 1%, 5% and 10% levels, respectively.

5. DISCUSSION

5.1 SUMMARY OF KEY POINTS

Broadly speaking, our analysis can be divided into three distinct parts. First of all, we looked into the overall significance of rating events on bond yields across borders in the time periods before and during the crisis. An event study methodology was employed to test for deviations from expected returns in the time periods around rating events. Secondly, we attempted to quantify the effect these rating events have on yields across borders. Lastly, we extended the secondary analysis to test the observed effects' persistence in time. All analyses were conducted on the pre-crisis and crisis time periods separately, as well as on a Eurozone subsample of countries.

The results can be summarized as follows:

- Rating events do have a statistically significant effect on bond yields across borders.
- In the pre-crisis period, results are consistent with existing research, negative rating events increase yields and are statistically significant, while positive events are associated with insignificant effects.
- In the crisis period, all rating announcements are counterintuitively associated with lower yields, negative events are again significant.
- When PIIGS observations were not included, these counterintuitive effects were no longer observed.
- While effects in the pre-crisis period do not show persistence, those events that were observed during the crisis do show persistence in the ten day extended window.
- Analysis that was extended to the Eurozone subsample shows results that are basically in line with the results from the larger sample.

This section will follow with a more detailed discussion of the procedures employed in each stage of our analysis. Finding and estimates will be also discussed and of findings. Lastly, the limitations of this study will be illustrated, as well as possibilities for further research with regards to the topic of contagion effects of rating events.

5.2 Discussion of the Results of Regression Analysis

5.2.1 Testing overall significance

We investigated cross-border effects of sovereign credit rating events on bond yields in the time periods before and during the European sovereign crisis. Firstly, we assessed the overall presence of contagion effects in Section 4.2.1. This involved estimating the expected returns in a window around each rating event and then testing if the actual returns were systematically and significantly different from the expected ones. Expected returns (yields) were calculated based on past performance with regards to German yields. The analysis was performed on four distinct subsets of our larger data set. The data was divided by time period (pre-crisis and crisis periods) and sign of event (positive or negative rating event). A five day event window centred on the event day was used.

Our findings indicate statistically significant abnormal returns associated with each of the four categories. Our tests were performed on the cumulative abnormal returns in a given time period, meaning that the overall coefficients that have been estimated cannot be compared with each other due to the fact that each period has different numbers of events. However, we can look at the signs of the cumulative abnormal returns coefficients to get an idea which way a certain type of events may influence yields. From the results in Table 5 we can see that in the pre-crisis time period positive events are associated with negative cumulative abnormal returns. What this essentially means is that expected yields are higher than those observed. Conversely, negative events are associated with lower expected yields. These observations are in line with most of existing research (Gande and Parsley (2005), Afonso, Furceri and Gomes (2011)) and basic intuition. When a negative event occurs, the prospects of bond repayment worsen and hence borrowing costs increase. What we see here are the transmission effects of this dynamic.

Data from the crisis period is less easy to interpret. The coefficient on positive events has a positive sign, going against what we might expect. However, given that there are only a handful of observations pertaining to positive events in the European Union in the crisis period, we cannot ascribe much importance to this result. On the other hand, negative events are again associated with

higher yields during this time period. The coefficient on negative events during the crisis is observed to be four times as large as the one in the pre-crisis period, but it is important to note that this carries absolutely no information regarding the scale of responses to individual rating events during these two time periods, as these coefficients are cumulative and each period has different numbers of events. More precise quantification of effects is performed in section 4.2.2.

Overall, the result of this section's analysis indicates that there are transmission dynamics present in European Union countries. The analysis on the Eurozone member counties subsample basically reflects the same information as the broader analysis. This section's analysis hinges on the assumption that we can predict expected yields in the absence of events by simply considering the past yields and market (German) yields. Despite the fact that our event window is relatively short, this remains a rather bold assumption and should therefore be kept in mind when considering the results.

5.2.2 Quantifying effects – Standard event windows

In section 4.2.2 we attempted to gauge the exact effects a one-notch upgrade or downgrade has on yields throughout the European Union. This was done by means of a panel analysis, taking the percentage spread vis-à-vis the German yield as the dependent variable. The dependent variables consisted of the amount of levels upgraded on a particular day, the amount of levels downgraded and control variables such as the cumulative change in ratings throughout the sample in the past five trading days. Further control variables included the change in the Xetra DAX index and the VIX volatility index, as proxies for global risk sentiment. Again, analysis was performed for the pre-crisis and crisis period separately, as well as on the Eurozone subsample.

The analysis of the entire sample in the pre-crisis period is consistent with past research. As in Gande and Parsley (2005), positive events do not tend to have statistically significant effects on

yields. Furthermore, negative events are associated with an approximately 5 basis point[8] increase in yield – Gande and Parsley (2005) reported an approximately 13 basis point increase when they were investigating similar effects on US trading partners. The control variables including the cumulative change in ratings for the past five trading days, the change in the DAX and the VIX index have all statistically significant effects. We may speculate that the reason why the cumulative change in ratings has a negative effect is that when markets have observed several negative events in a given timespan, a marginal negative effect has diminished potential.

On the other hand, the analysis of the entire sample in the crisis period is less straightforward to analyse. While the coefficient on positive events is still statistically insignificant, the coefficient s on the cumulative rating change and other control variables are basically in line with the pre-crisis estimates. The cumulative rating change is somewhat more significant in the crisis time period, but we may attribute this to the fact that events tended to be more clustered in this period and therefore when several announcements were made in a row, the later ones carries less significant effects with regards to yields. Furthermore, it is also possible that since there were predominantly negative events during the crisis period, the cumulative variable reflects the effect of negative events, while in the pre-crisis period if also took into consideration positive events with a greater importance. This is due to the asymmetry of positive and negative event responses. Two control variables for cumulative changes could be included in future analyses in order to control for this problem. Lastly, the negative coefficient switched signs and is associated with an over 7 basis point *decrease* in yields. While this may seem counterintuitive, we may speculate about the possible causes of such an effect. What we observe may be connected to expectations. During the crisis, sovereign default was a realistic prospect that loomed in the not-so-distant future of several European countries (the acronym PIIGS comes to mind, which refers to Portugal, Italy, Ireland, Greece and Spain). It is conceivable that given such a negative climate, a mere one or two notch downgrade may have actually been more positive news than markets anticipated. This would explain why we observe an inverse effect. Indeed 89 of the 157 rating events that took place during the crisis period are associated with a highly indebted countries such as Portugal, Italy, Hungary, Ireland, Greece or

[8] Assuming constant German yield of 3%, a change of 1.2391 in percentage spread corresponds to approximately 5 basis point change in yield.

Spain. Therefore, a in this period, it seems that markets could have already priced in such negative expectations that a smaller debt rating downgrade actually constituted positive news. A very interesting and prospective area for further research could involve testing the sentiment of the market and its anticipation of a significant negative rating event.

When we performed this analysis without including the PIIGS countries, these counterintuitive effects were no longer observed, thus supporting the theory that anticipations with regards to the problematic European countries were the driving causes of the dynamics we observed.

This analysis has also been performed on a Eurozone member countries subsample. However, we did not observe significantly different results. The contagion effect in the pre-crisis period is less pronounced, both in the shorter and longer event windows. The dynamic in the crisis period mirrors that of the wider sample.

5.2.3 Quantifying effects – Extended event windows

In section 4.2.3 we extended the analysis from the previous subsection on to longer event windows in order to investigate the extent of persistence of the effects that we observed on the shorter windows. For this persistence analysis, we opted for a 13-day window, with two days before the event day and ten days after. Ten trading days correspond to a two week period. Longer event windows could be interesting, however, they are not feasible due to the clustered nature of our events. The problem is that the longer our event window is, the higher the probability that another rating event takes place in that window, thereby contaminating our results.

Our findings for both the wider sample and the Eurozone subsample reflect different dynamics in the pre-crisis and crisis periods. While in the pre-crisis period we observe a clear reversal of the effect of the rating event on yields, in the crisis period the observed effect persists in full force. In the crisis period, the short time window indicated a decrease of approximately 6 basis points per rating tranche, as did the extended event window. This means that the effects observed during the shorter event window persist for over two weeks after the event. Again we may only speculate about the fact that rates actually decrease following a downgrade. In such turbulent times, a small

downgrade may be one of the more *optimistic* scenarios that markets priced into the yield, due to very negative expectations, especially in the case of PIIGS countries, and the looming threat of their outright default. Therefore, when a rating agency confirms that a country's rating slid by only one tranche level, it constitutes positive news for markets.

5.2.4 Crisis Period Dynamics

As described in the sections above, the most significant results are observed on negative events during the period of the sovereign debt crisis. A one notch downgrade in debt results in a decrease in borrowing rates of, on average, 6 basis point. This contrasts starkly to the observation in the pre-crisis period, which is more in line with common sense expectations, that negative events have a detrimental effect on borrowing rates. Nevertheless, not only is the observed crisis effect significant, it is also persistent, in the sense that it does not diminish even after two weeks.

We may only speculate about the causes of this dynamic, as investigation of market expectations is beyond the scope of this study. As mentioned above, during the direst times in the crisis period, unmanaged sovereign default was on the table. This could have disastrous consequences and implications for the entire European sovereign debt market. It is therefore conceivable that in light of such negative possibilities, a mere one notch downgrade can be considered a positive news event.

On the other hand, we may consider a scenario in which markets have reasonable expectations and rating agencies are downplaying the risks. While again purely speculative, it could be conceivable that in the light of allegations that they are exacerbating the crisis and calls for a new, European rating agency, the major rating agencies are reluctant to downgrade European debt and hence are less strict about rating events than markets expected them to be.

This explanation is further supported by our results of analyses which excluded PIIGS observations from the crisis sample. The anomalous effects were no longer observable, and therefore were related to the PIIGS observations.

Looking back at Aizenman, Binici and Hutchison (2013), a paper that considered credit rating dynamics during the Eurozone crisis, it seems that our results are compatible. As a secondary

analysis, the paper looked into contagion effects in the European Union, unfortunately not only during the crisis. However, they did not use to distinct variables for the two types of rating event – positive and negative. Instead, they opted to only use the change in credit rating. On the surface this analysis may seem very similar to the one employed by us, however, their construction presupposes that positive and negative events have inverse effects, and does not allow for the effects to have a common direction. The results Aizenman, Binici and Hutchison (2013) show a statistically insignificant effect of rating events on credit default swap rates across borders on their full sample – an observation which runs contrary to other papers. One explanation for this is that their results are contaminated by observations during the crisis, when the sign on the negative events flips and therefore cannot be represented[9] by one regression variable.

5.3 Limitations of This Study

While this study did reach some conclusions regarding sovereign rating dynamics, it is important to note several caveats that are associated with our analysis. These are mainly related to data availability, as well as the generally sporadic nature of rating events.

The main shortcoming of this study, and basically most studies dealing with the topic of sovereign rating events, is the relatively low sample size of rating events. As mentioned in section 3.1.1, we were analysing a cumulative 192 events over our seven year sample. This in itself is a relatively small number, and considering the fact that these events are further subdivided into positive and negative ones, the number of observations for each category dwindles even more. Indeed, this may be a factor in why positive events do not have observed significant effects, even during the crisis period. The splitting of our time period into two distinct periods compounds these problems.

[9] If a one notch downgrade is represented as -1 in the "Change in Credit Rating" variable, and an upgrade is represented by 1, an estimated coefficient of value A will automatically imply an effect of 1*A on the dependent variable for positive events, and -1*A for negative events, hence presupposing that the two event types have inverse effects.

Furthermore, as can be expected during a sovereign debt crisis, there are little to no positive rating events during the crisis period, hence analysis need to be focused mainly on negative events.

Next, due to the unavailability of 10 year bonds for several European countries, only 18 out of the current 28 are included. Some of these are accounted for by the fact that during significant portions of the sample, they were not member states and would therefore distort our analysis. Others could not be included simply because they do not issue 10 year bonds, or due to data unavailability. A more comprehensive analysis could include data on credit data swaps and other instruments in order to proxy for the missing data and ameliorate the study.

As far as the distribution of rating events goes, the very nature of these events is very sporadic and perhaps clustered. As mentioned above, in case several events occur in succession, it becomes difficult to attribute effects to a specific event. This becomes an even bigger problem with wider event windows, which is why the baseline window for our analysis is a very small, five day one. The extended event window is a thirteen day one, and should therefore be considered with more scepticism. Efforts were made to control for such contamination by using the rolling five day cumulative sum of rating events in the regression analysis, but that cannot fully control for all the dynamics associated with several rating events occurring in succession. Another possible solution to this problem is not considering those observations which are clustered in such a way, but given the already minimal sample we are working with, this would prove to be counterproductive.

Another data limitation is the decisions of rating agencies to announce several rating changes in one day, which significantly diminishes our ability to identify the dynamics between individual rating events and changes in borrowing costs. For instance, on the 5th of December 2011, we observed 16 rating events (albeit only placement on credit watch, not actual downgrades), while on 13th of January 2012 there were 15 distinct events (actual downgrades). As described in the data preparation section, these events were not included in the analysis due to the fact that there was no realistic way of isolating the effects of individual downgrades. Therefore, significant amounts of information relevant to our analysis had to be discarded.

Lastly, when dealing with the crisis period, we need to consider the extent to which the events which transpired around Greece were a typical scenario, and how likely this dynamic is to repeat. It would be interesting to observe different crisis scenarios and compare their dynamics among

each other. Indeed, the observation that markets apparently had significantly worse expectations for event countries than did the rating agencies is something that would be very interesting to test. This dynamic essentially goes against all 'theories' that rating agencies raise borrowing costs of countries by downgrading them and therefore have a pro-cyclical effect, prolonging the crisis.

5.4 Space for Further Research

The dynamics of borrowing costs and rating events offer a wide range of possibilities for further research.

It might be worthwhile to look into specific linkages between individual countries. Past papers have attempted to analyse the different regional dynamics (think PIIGS countries), however, a comprehensive analysis of specific linkages has not been done. Such analysis would allow for substantially more control variable and hence more precise models.

Our analysis could be expanded to further regions, giving us a wider range of rating event observations. However, with such analysis one should keep in mind the very real possibility of different dynamics across different regions, as mentioned by De Santis (2012). This type of analysis could shed more light on transmission mechanisms (for instance bilateral trade volume or common indebtedness levels). Further extension could also be done in the direction of other sovereign debt crises. It would indeed be interesting to see if similar dynamics are observed in crises in other parts of the world.

The fact that we observed significantly negative expectations during the crisis provides another interesting research topic. It seems that the likelihood of a more severe downgrade was already priced in. This anomaly is interesting from several different perspectives – how long before the downgrade were the expectations so negative, were these expectations substantiated and were the rating agencies being excessively positive in their 'less negative' downgrades? This could be analysed by a more thorough look at the events during the crisis on a case by case basis. Gande and Parsley (2005) hinted at the possibility that rating agencies are biased with regards to giving lower ratings – could this be exacerbated during the crisis, because of the destabilizing effects significant

downgrades could bring, as well as the backlash from politicians? It would be very interesting to attempt to quantify the extent to which a rating change (mostly downgrades, upgrades do not face such issues) is different from what markets expected. On the other hand, it may have been the markets that were overly negative and that negativity was reflected in the prices, only to be corrected by rating agency announcements. In any case, this dynamic provides for an exciting prospect for further research.

6. CONCLUSION

This paper looked into the cross-border effects of sovereign rating changes on bond yields in the periods before and during the European sovereign debt crisis. This topic was motivated by the fact that while some research into cross-border yield dynamics with regards to rating events, many of the results are inconsistent. Furthermore, given that rating agencies received negative by European policymakers due to claims that their rating changes intensify the crisis. On the other hand, such rating events are not regarded so negatively in normal market conditions. We therefore wanted to inspect the dynamics of rating events in a period of crisis and compare them to a period when markets are calm. For this, the recent European sovereign debt crisis seems ideal. With the European market ripe with trade and other linkages, as well as a significant portion sharing one monetary policy, one may expect to observe linkages (if they exist) more easily than in other, less connected groups of countries.

The data that we used to analyse these dynamics consisted of daily yields of the 10-year bonds of 18 European countries in the period from 2006 to 2013. These were taken as direct proxies of the borrowing costs of the respective countries. As for the rating events, we considered rating upgrades and downgrades by S&P, Moody's and Fitch, as well as their respective rating outlooks.

Our analysis is broken down below. All analyses have been conducted on the pre-crisis and crisis periods separately, as well as on the Eurozone subsample.

1. Testing overall significance of rating changes effects on yields across borders.
   In order to ascertain the presents of abnormal returns associated with rating events, we estimated normal returns of the bonds in the period around the rating events, then aggregated them and tested their significance. These tests were employed to get a general overview of the dynamics in the two time periods.

2. Quantifying effects – Short event window
   Our secondary analysis involved estimating the effect a one notch change in rating had on yields. This was done using a basic panel data model. We used a standardized measure of borrowing costs, referred to as the percentage spread, to relate changes in borrowing costs

to rating events. Variables that controlled for both, European and global risk sentiment had been included. The time period over which we attempted to observe these effects was purposefully kept short in order to avoid inadvertently including multiple events in the event window.

3. Quantifying effects – Longer event window – Testing for persistence
   In order to investigate the persistence of the effects observed over the shorter event window, we employed a longer event window with similar techniques of analysis. Some measures were employed to account for the possibility of several events occurring during the event window. However, due to the clustered nature of the rating events, it is not possible to fully isolate the effects of one event.

The key takeaways from our results are as follows:

- Rating events are associated with abnormal returns across the entire sample, significance is observed mainly with negative events.
- In the pre-crisis period, negative events were observed to be associated with an approximately five basis point increase in borrowing costs, on average. Positive events did not show statistical significance. The Eurozone subsample analysis did not reveal different dynamics.
- In the crisis period, all events were associated with lower borrowing costs. Negative events again carried statistical significance, averaging a drop of six to seven basis points. We believe this effect was caused by extremely negative market sentiment, coupled with the reluctance of rating agencies to, proverbially, add fuel to the fire. In depth discussion of these causes is in section 5.2.4. When PIIGS countries were excluded from the sample, these effects were no longer significant.
- The pre-crisis results were not observed to be persistent over the longer event window. On the other hand, the events during the crisis were fully persistent.

In conclusion, we observed that negative events have significant effect in both the pre-crisis and crisis periods. The effects in these respective periods are reversed and persistence is only observed in the latter. The implications of our analysis point to the fact that rating agencies do not necessarily have a destabilizing effect on borrowing costs in times of crisis, despite the fact that in pre-crisis times negative events are associated with higher borrowing costs across borders. In the crisis period, we have seen that markets had significantly more negative expectations than were actually reflected by rating announcements. This effect is associated with observations from PIIGS countries, about which there was talk of possibilities of outright defaults. Nevertheless, this disagreement between market sentiment and rating changes could be an exciting area for further research – Why are markets overly negative? Is risk being downplayed by the rating agencies?

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APPENDIX

Variable	Description	Source
Yield	Yield on a 10-year European sovereign bond, covering the period from 2006 to 2013.	Bloomberg
Percentage Spread	Differential between a country's yield and Germany's yield on a 10-year sovereign bond, as a percentage of the German bond's yield.	Bloomberg; Author's calculations
Event (Positive / Negative)	The total change in rating (number of notches plus outlook) by all three rating agencies, converted into numerical equivalents.	Standard and Poor's, Moody's, Fitch; Author's calculations
Cumulative Events	Cumulative events over the past ten trading days.	Standard and Poor's, Moody's, Fitch; Author's calculations
VIX	Chicago Board Options Exchange Market Volatility Index, implied volatility of S&P 500 index options. Daily rates.	Bloomberg
DAX	Index performance for Deutsche Boerse Ag German Stock Index. Daily rates.	Bloomberg

TABLE 15 – DATA DESCRIPTIONS AND SOURCES