

FUNDAÇÃO GETÚLIO VARGAS  
ESCOLA DE ECONOMIA DE EMPRESAS DE SÃO PAULO

**Miguel de Campos Pinto Coelho**

**CREDIT RATINGS AND GOVERNMENT BONDS**

Evidence before, during and after the European debt crisis

**São Paulo  
2016**

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Campo do Conhecimento:  
International Master in Finance

Orientador Prof. Dr. João Mergulhão  
Prof. Dr. João Pedro Pereira

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## **Resumo**

Neste projeto, investigamos se as agências de rating e as taxas de juro de longo prazo da dívida soberana tiveram uma influência recíproca antes, durante e após a crise da dívida soberana Europeia. Esta análise é realizada, estimando a relação existente entre os ratings da dívida soberana ou taxas de juro e factores macroeconomicos e estruturais, através de uma diferente aplicação de metodologias utilizadas para este efeito. Os resultados obtidos demonstram que, no período da crise soberana, os ratings e as taxas de juros tiveram um mútuo impacto, sugerindo que as descidas dos ratings podem ter conduzido a profecias auto-realizáveis, levando países relativamente estáveis a um eventual incumprimento.

**Palavras-chave:** Europa, Crise dívida soberana, Rating soberano, Spreads taxas de juro.

## **Abstract**

This project investigates if there was any influence of credit rating agencies and long-term government bond yields on each other before, during and after Europe's sovereign debt crisis. This is addressed by estimating the relationship and causality between sovereign debt ratings or bond yields and macroeconomic and structural variables following a different procedure to explain ratings and bond yields. It is found evidence that, in distressed periods, ratings and yields do affect one another. This suggests that a rating downgrade might create a self-fulfilling prophecy, leading relatively stable countries to default.

**Key words:** Europe, Debt crisis, Credit rating, Sovereign spreads.

# Contents

<b>Acknowledgements</b>	<b>5</b>
<b>Resumo</b>	<b>6</b>
<b>Abstract</b>	<b>7</b>
<b>1 Purpose of Project - General Overview</b>	<b>11</b>
<b>2 Literature Review</b>	<b>13</b>
<b>3 Discussion of the Topic</b>	<b>16</b>
3.1 Data . . . . .	16
3.2 Methodology . . . . .	20
3.3 Empirical Analysis . . . . .	22
3.3.1 Correlation . . . . .	22
3.3.2 Models interpretation . . . . .	27
<b>4 Conclusion</b>	<b>36</b>
<b>Bibliography</b>	<b>39</b>
<b>Appendix A</b>	<b>48</b>



# List of Tables

1	Rating conversion . . . . .	42
2	Variables expected signal . . . . .	42
3	Explaining 10 year yield spreads with credit ratings . . . . .	43
4	Explaining 10 year yield spreads with and without Greece and dummies .	43
5	Explaining sovereign 10 year yield spreads for each period with dummies	44
6	Explaining ratings with 10 year yield spreads . . . . .	44
7	Explaining ratings with and without Greece and dummies . . . . .	45
8	Explaining ratings for each period with dummies . . . . .	46
9	Ordered probit model results for the determinants of credit ratings . . . .	47
A.1	Descriptive statistics for the entire sample period . . . . .	48
A.2	Descriptive statistics pre-crisis period . . . . .	48
A.3	Descriptive statistics crisis period . . . . .	48
A.4	Descriptive statistics post-crisis period . . . . .	49
A.5	Correlation matrix . . . . .	50
A.6	Correlation matrix pre-crisis . . . . .	50
A.7	Correlation matrix crisis . . . . .	51
A.8	Correlation matrix post-crisis . . . . .	51
A.9	Correlation matrix for the 10 year government bond spreads . . . . .	52
A.10	Correlation matrix for the 10 year government bond spreads pre-crisis . .	52
A.11	Correlation matrix for the 10 year government bond spreads crisis . . . .	53
A.12	Correlation matrix for the 10 year government bond spreads post-crisis . .	53
A.13	Correlation matrix for Moody's Ratings . . . . .	54
A.14	Correlation matrix for Standard & Poor's Ratings . . . . .	54
A.15	Correlation matrix for Fitch Ratings . . . . .	55
A.16	Correlation matrix for Moody's Ratings pre-crisis . . . . .	55
A.17	Correlation matrix for Moody's Ratings crisis . . . . .	56
A.18	Correlation matrix for Moody's Ratings post-crisis . . . . .	56

# List of Figures

3.1	Correlation heat maps of 10-year bond yields before, during and after crisis	23
3.2	Government 10 year bond yields before Euro introduction . . . . .	24
3.3	Government 10 year bond yields after Euro introduction . . . . .	24
3.4	Correlation heat maps of Moodys' ratings before, during and after crisis .	27
1	Rantings and yields evolution . . . . .	40
1 (Con	Rantings and yields evolution . . . . .	41

# Purpose of Project - General Overview

The global financial crisis of 2007 - 2010, which was once seen as an issue in the US sub-prime mortgage market and the bankruptcy of U.S. banks, evolved into a sovereign debt crisis in the Euro zone, with most European countries facing: (i) an abrupt increase in the government bond yields and spreads against the German Bund; together with (ii) successive downgrade of their credit ratings. In fact, until the end of 2009, Fitch Ratings, Inc. ("Fitch") would downgrade Greece's credit rating from A- to BBB+ with a negative outlook, being the first time in almost 10 years that Greece had a rating below an A grade by any of the three major credit rating agencies.<sup>1</sup> The Greece situation just intensified the possibility of the Euro area collapse and increased the cost of financing of several countries, where the ones most affected were those with fragile fiscal situation. At the end of 2014, almost five years after the first bailout program during the European sovereign debt crisis, and after the austerity plans introduced by the countries most affected by it, Europe was facing a slow and long recovery. The majority of these countries saw their government bond yields and spreads fall to levels lower than the ones before the crisis was installed, some of them registered minimum values of both long- and short-term bond yields in their history. Nevertheless, credit ratings did not follow the exponential decrease in the yields, being some, still, considered as a speculative investment.

This thesis intends to explain the impact of the three most well know credit rating agencies ("CRA"), Fitch, Moody's Investors Service, Inc. ("Moody's") and Standard & Poor's Financial Services LLC ("Standard & Poor's" or "S&P"), during the European sovereign debt crisis. In this context, it pretends to complement previous studies on the impact

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<sup>1</sup>In "*Tough words and hard budgets for eurozone*" (<http://www.ft.com/cms/s/0/0d5a6622-e4b4-11de-96a2-00144feab49a.html#axzz3vkmaNgws>)

of sovereign rating changes and sovereign bond yield spreads on one another by using updated data (until December 31<sup>st</sup>, 2014) and through an analysis that will be performed comparing the sovereign debt crisis period to the period before and after. In this sense, this paper pretends to assess how sovereign credit ratings influenced and were influenced by the bond yield spreads before, during and after the crisis.

The remainder of the thesis is organized as follows. In Chapter 2 it will be provided a review of related literature on the methodology behind sovereign debt ratings estimation and their role in the markets.

In Chapter 3, it will be given a description of the datasets used and reason of their application providing a methodological introduction.

Moreover, it will be described the empirical analysis and results of the impact of changes in the credit ratings issued by the CRA on the yield spread of sovereign bonds, vis-à-vis the German Bund, and vice-versa.

The final part, Chapter 4, concludes with a summary of the thesis's main findings and provides opportunities for future research.

# Literature Review

During the 1990s, the occurrence of several financial crises that affected the world financial markets led to an increase in popularity of the study of how CRA assessed the government's creditworthiness and how ratings influenced the markets. More recently, the last financial crisis increased the concern about Greece's, Portugal's and Ireland's capacity to pay their debts. This made investors turn to ratings as a measure of the creditworthiness of these countries and how the European Union was implementing measures to prevent a worldwide financial contagion.

In fact, the perception of sovereign risk of default published by Standard & Poor's, Moody's, and Fitch has a major role in the markets since it might ease the placement of sovereign debt in the primary markets. It also has a major impact for investors as the credit rating works as an "insurance" against the likelihood of default. Moreover, some institutional investors are obligated, either by law or their own statutes, to purchase and hold bonds with a certain minimum rating. Credit ratings are also used by regulators and market participants to establish the capital requirements and this could impact the portfolios since only highly rated assets are eligible as collateral to obtain credit. Under Basel II, countries, banks and corporations use the standardized approach to credit risk, which relies on credit ratings issued by external CRA to assess its own regulatory capital (*i.e.*, the amount of capital required by the financial regulator).

A downgrade can, therefore, lead to a change in the demand for certain sovereign bonds hence increasing these countries yields and spreads against a benchmark (in Europe, specially within the Euro area, it is usually used the German Bund as a benchmark).

In what regards the literature concerning sovereign ratings, we are going to focus on

two main categories. The first category concerns research that analyzes the determinants of sovereign credit ratings issued by CRA. Cantor and Packer (1996) analyzed a cross-section of 45 countries by applying OLS regressions to ratings and concluded that the rating is determined, mainly, by six economic factors - GDP per capita, GDP growth, inflation, external debt, level of economic development and default history - and that they are strongly correlated with market spreads. More recent studies by Bhatia (2002) and Afonso et al. (2007), the latter using a panel of 130 countries from 1970 to 2005, show similar conclusions with minor changes regarding the explanatory variables.

Other studies try to explain the impact of ratings on the yields and spreads of sovereign debt. Cantor and Packer (1996) realized that rating announcements directly affect the market although these often already anticipated the effects of this change (via the rise/decline of the spreads on the days before the announcement). Brooks et al. (2004) concluded, instead, that *“only Sovereign ratings downgrades convey information to the market”*.

The second category of research focused on the impact of CRA announcements during financial crisis. Ferri (1999) studied the impact during the East Asian financial crisis, at the end of the 1990s, and concluded that rating agencies' sovereign ratings may have aggravated it and that the CRA have failed to preventively warn the markets against the crisis. Mora (2006) then analyzed the *“tremendous power to influence market expectations on a country”* as pointed by Ferri (1999) and found out that ratings tend to be sticky (inertia of sovereign ratings) and that they remain over-conservative after a crisis but that the impact should be analyzed more carefully.

In recent years, and due to the European debt crisis, some researchers used these concept to assess the relationship between the crisis and the CRA's ratings. Gärtner et al. (2011) reformulated the analysis, adding the yield spread as an estimator of the country's rating and concluded that there is evidence that CRA may had a role during the crisis. Moreover, De Santis (2012) reached a similar result for the same period using the credit rating from each CRA as an estimator for the yields of the Euro area countries.

Another topic covered by some of these studies and by other researchers is the spillover effect of one country rating downgrade and its impact in other countries' ratings. Ismailescu and Kazemi (2010), addressed this matter by evaluating the impact of credit rating changes, positive and negative, on the CDS spread of both the event country and other emerging economies. They concluded that there is evidence of immediate reaction of CDS markets to credit rating events.

Arghyrou and Kontonikas (2011) and De Santis (2012) applied the same rationale for the European Monetary Union ("EMU") for the period up to the European sovereign debt crisis (roughly from 1999 to 2011, depending on the research) reaching a similar conclusion. They found that the early stage of the crisis was driven by the Greek debt crisis and that during the rest of the crisis period there is evidence for contagious from Greece, Portugal, Ireland and, on a lower scale, Spain and Italy (commonly referred as "PIGS" or "PIIGS").

This project contributes to the existent literature by explaining government bond yield spreads vis-à-vis the German Bund and sovereign credit ratings with a larger time period, covering the pre-European crisis, the crisis itself and post-crisis and using up to date data. This allows to capture how ratings and yields affect one another in different periods of a crisis and if there is, effectively, an impact.

Firstly, we will use in this study the linear regression approach following Cantor and Packer (1996) or Afonso et al. (2007) rationale and applying to panel data, regressions models for the ratings and yields.

Secondly, it will be used ordered models following Afonso et al. (2007) or Mora (2006) as ratings are a discrete variable and have different categories. The fact that the model used implies that the difference between two categories is the same for any two categories will not be addressed in this study.

Moreover, in this study we will not only study the impact of government ratings on government bond yields spreads but also the impact of the latter in the ratings. With this comparison we expect to assess the impact and what truly affects what throughout time.

# Discussion of the Topic

## 3.1 Data

As referred above, credit rating agencies are specialized in the assessment of the likelihood of default of sovereign and corporate issuers. Due to the expansion of the number of countries issuing securities, the globalization of the capital market and the implementation of laws and regulations as the Basel II, these agencies became protagonists in the financial markets.

This work project intends to study how far the CRA influenced or were influenced by the yield spreads of the countries during the crisis and what was this relation before and after this period.

For that purpose, we analyze quarterly 10-year yields and spreads, vis-à-vis the German Bund, from 12 economies: Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal, Spain and United Kingdom (U.K.)<sup>1</sup>. The choice of these countries is based on their differences namely, the size of the countries and the level of distress of these countries during the European sovereign debt crisis ("ESDC") making them the perfect fit for the analysis. The sample period runs from the first quarter of 2002 (introduction of the Euro) until the last quarter of 2014. It was not considered more updated data in order for the financial data not to be influenced by the quantitative easing ("QE") program launched in early 2015 by the European Central Bank ("ECB"). In this sense, it is used the value of the yields of the last available business day of each quarter.

Moreover, it is used the ratings issued by Moody's, Fitch and Standard & Poor's for all

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<sup>1</sup>Luxembourg is not considered in the sample due to the large amount of missing data.



these countries as they held together, in 2014, a global market share of roughly 90 percent<sup>2</sup>. Although the analysis is similar for each rating, CRA do not use the same credit rating notation therefore they were translated, based on previous literature (as used by Afonso et al. (2007)), into a numerical scale ranging from 22 to 1 respectively, AAA or Aaa to D.

In addition, a positive or negative credit watch announcement can foresee a rating change in the same direction in a near future. Taking this, it will also be analyzed the credit watch announcements from each CRA which will be translated to the numerical scale referred above and it will be valued  $\pm 0.5$  depending on it being a positive or negative credit watch.

Table 1 on page 37, depicts the numerical conversion of each rating scheme, which subsequently will be used for the empirical analysis.

Figure 1 (page 35 and 36) show the evolution of the countries' 10-year sovereign bond yield against the evolution of the ratings between the first quarter of 2002 and the last quarter of 2014. This figure shows a high correlation, during the crisis period, between rating changes and the increase on the yields, also revealing how ratings tend to have inertia (namely before and after this period).

Furthermore, the empirical analysis uses macroeconomic data as evidenced in the literature (from Cantor and Packer (1996) to Afonso et al. (2007)):

- *GDP Growth* - In theory, higher GDP growth increases the capacity for governments to repay their debt and thus it is expected a negative impact on the yields and positive on ratings. Quarterly data on real GDP growth is from Eurostat.
- *GDP per capita* - A larger income per capita, measured in thousand euro per capita, is anticipated in more developed (*i.e.*, stable, strong) countries and it is expected to have a negative impact on yields and a positive one on ratings. Quarterly data on GDP per capita is from Eurostat.
- *Government surplus (i.e., surplus or deficit)* - A higher deficit signals that the gov-

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<sup>2</sup>Table 1 in "Credit Rating Agencies' 2014 market share calculations for the purposes of Article 8d of the CRA Regulation" (2014) by European Securities and Markets Authority

ernment may not be able to repay its liabilities or that it will tax its population to cover its expenses. It is expected a negative effect on yields and positive on ratings. Quarterly data on government surplus as percentage of GDP is from Eurostat.

- *Inflation* - Inflation rate may point for structural stability since stronger economies have lower, but still positive, inflation in the medium term. A negative influence is expected for this on the rating and a positive for the yields. Quarterly data on inflation rate is from OECD.
- *Unemployment* - Distress periods usually lead to high unemployment rates and, consequently, an increase in the social and economical burden of fiscal policy and social benefits. A positive impact on the yields and negative on ratings is expected. Quarterly unemployment rate is from Eurostat.
- *Government debt* - A higher government debt represents a higher risk of default and thus it is expected to have a positive effect on the yields and a negative one on ratings. Quarterly data on government debt as percentage of GDP is from Eurostat.
- *Current account balance* - A higher current account balance (external balance) signals that the government and/or companies rely heavily on domestic funds and, therefore, the economy tendency to over-consume “in house”. It is expected a positive impact on ratings and negative on yields. Quarterly data measured as billions of euro is from Eurostat.

The descriptive statistics for each variable can be found in Table A.1 of Appendix A. It is worth noting the high values for the ratings which, considering the whole period, are equivalent to Aa2/Aa3 or an AA/AA- (respectively for Moody’s and S&P/Fitch). These results are clearly above what it would be expected taking such a severe crisis as the one lived in Europe and the fact that Greece defaulted in time being (which would give a numerical value of one or two depending on the rating scale). A simple explanation is the amount of AAA rating countries used for the purposes of this project (6 out of 12) that had triple-A rating for the majority, if not all period under analysis.

Moreover, the average of 4.20% for 10-year government bond yield and 1.15% for the 10-year government bond yield spread are also considerably low taking the crisis (again, the use of low-yield countries reduces considerably this value).

Such values could be more accurately analyzed if we split the all sample size in three periods: (i) before the crisis (from the first quarter of 2002 until the second quarter of 2008); (ii) crisis (from the third quarter of 2008 until the fourth quarter of 2012); and (iii) post-crisis (from the first quarter of 2013 until the last quarter of 2014). These sub-periods will be used throughout the text for further analysis.

Tables A.2, A.3 and A.4 of Appendix A show the descriptive statistics for each of the periods respectively, pre-, during and post-crisis.

From these it is perceived the gradual decline of the average ratings over time reflecting the situation lived in Europe. In what regards the average 10-year yields and spreads, it is possible to see a spike during the crisis and a decrease afterwards and, in the case of the yield, to levels below the ones before the crisis.

Notwithstanding the decrease of bond yields to minimum values from the first to the last period, the yield spreads did not follow this tendency, reflecting the change on the perception of the countries' credit risk from one period to the other. In fact, whereas in the pre-crisis period investors assumed a similar risk for all countries, in the post-crisis one, it becomes evident to investors the difference in the credit risk associated with less fiscally stable and more fiscally stable countries.

More interesting than only considering the average yield, is to check the standard deviation, as a simple measure for markets volatility (*i.e.*, risk) over time. The standard deviation of the yield was around 0.59% before the beginning of the crisis escalating to a value of approximately 3.99% during the crisis (decreasing to 2.26% after this period). This increase clearly shows, in a superficial analysis, the reaction of the markets to such a distress period. This instability led to maximum values of the yields in the PIGS, with Greece's yield achieving a value of approximately 35% for the 10-year bond (and

1,143% for the 1-year bond) before it was withdrawn of the market (a further analysis of the volatility will not be pursued during the current study).

## 3.2 Methodology

On a first section, the study of the relationship between ratings and yield spreads will partly follow the methodology used by Afonso et al. (2007).

The linear panel model used to estimate the yield spread  $Y_{i,t}$  (vis-à-vis the German Bund) of a country  $i$  ( $i = 1, \dots, N$ ), at time  $t$  ( $t = 1, \dots, T$ ), is described as follow:

$$Y_{i,t} = \alpha + \beta_R R_{i,t} + \gamma X_{i,t} + c_i + \epsilon_{i,t} \quad (3.1)$$

where  $R_{i,t}$  is the rating of the country  $i$  at time  $t$ ,  $X_{i,t}$  is a vector containing the time-varying variables previously mentioned, the macroeconomic series,  $c_i$  is an individual effect and  $\epsilon_{i,t}$  represents an error term.

Moreover, it will be used a similar model to estimate the rating  $R_{i,t}$  of the same country  $i$  ( $i = 1, \dots, N$ ), at time  $t$  ( $t = 1, \dots, T$ ):

$$R_{i,t} = \alpha + \beta_Y Y_{i,t} + \gamma X_{i,t} + c_i + \epsilon_{i,t} \quad (3.2)$$

where  $Y_{i,t}$  is the 10 year yield spread of country  $i$  at time  $t$  and  $X_{i,t}$  is a vector containing the macroeconomic series,  $c_i$  is an individual effect and  $\epsilon_{i,t}$  represents the error term.

Generally speaking, to estimate this equation one can use pooled Ordinary Least Squares ("OLS"), fixed effect or random effect. According to Wooldridge (2001), “*random effect is synonymous with zero correlation between the observed explanatory variables and the individual effect*” whereas “*the term fixed effect (...) means that one is allowing for arbitrary correlation between the unobserved effect  $c_i$  and the observed explanatory variables  $X_{i,t}$* ”. The pooled OLS regression method ignores the panel structure of the data

and purely estimates  $\alpha$ ,  $\beta$  and  $\gamma$  as a multiple linear regression.

If the individual effect is uncorrelated with the regressors,  $E[c_i|X_{i,t}, Y_{i,t}] = 0$ , then the random effect estimation is preferable. Nevertheless, if this condition is not verified, both pooled OLS and random effect provide inconsistent estimates and hence one should use fixed effects. In our study, it is expected for the individual effect to be correlated with the regressors hence it will be used the fixed effects estimation.

Moreover, heteroskedasticity is present in the model if the variance of the error terms changes. Consequently, we correct for heteroskedasticity by using robust standard errors.

The main purpose of the first section is to obtain robust indicators on how CRA can influence or are influenced by the yield spreads of the countries. For that we will use macroeconomic factors and credit ratings/spreads as a proxy for risk as it is commonly done in comparable studies. On the contrary, with the division of the analysis in subperiods it is expected to contribute to the literature by studying how this relation has changed over different economic periods.

On a second section, and taking the limited (*i.e.*, discrete) structure of the credit ratings, the ordered framework will be used. For this purpose, it will be computed a ordered probit model as follow:

$$R_{i,t}^* = \beta' X_{i,t} + \epsilon_{i,t} \quad (3.3)$$

where  $X_{i,t}$  is the vector of variables that explains the variation in ratings and  $\epsilon_{i,t}$  is the disturbance term that are assumed to be normally distributed.

Due to the limited structure of the credit ratings, several cut-off points will be computed to establish the boundaries for each rating level.  $R_{i,t}^*$ , which represents a continuous evaluation of the country's rating, will then result in the estimated discrete country's rating according to the cut-off points computed.

## 3.3 Empirical Analysis

### 3.3.1 Correlation

Before proceeding to the analysis of the estimation models, it is important to analyze the correlation between the variables as well as the correlations between the CRA and the 10-year yield spread, separately, within countries. Table A.5 through A.8 in Appendix A show the correlation matrices of the parameters for the four periods above mentioned (all sample period, pre-crisis, crisis and post-crisis).

From the first table we can realize the negative correlation between the CRA and the 10-year yield spreads confirming the intuition that an increase in the rating would result in a decrease in the spreads, and vice-versa. In addition, the majority of the macroeconomic variables' correlation with the 10-year yield spread meet the expected relation beforehand stated (with the exception of inflation).

Again, the values in this table do not fully explain the correlation over time between these variables. The level of correlation between the CRA and the 10-year yields spread changed as the crisis materialized. In fact, during this distress period the correlation between these two variables changed, from around 4% to  $-88\%$ . But not only did the correlation between these two variables changed but so did the correlation between the remaining variables and the spread with 8 out of 10 correlations with its sign changing from one period to the next, being the exceptions for this result the inflation and government surplus. Moreover, for all the variables, the absolute value of the correlation increased from the period before the crisis to the crisis one.

After the crisis period, correlations keep enhancing becoming, most of them, more negative and thus revealing an adjustment lag between financial and macroeconomic fundamentals. Another motive for this might be the recovery of the economic results of the countries after the crisis (increase of macroeconomic variables) and the generalized de-

crease of the spreads in recent years.

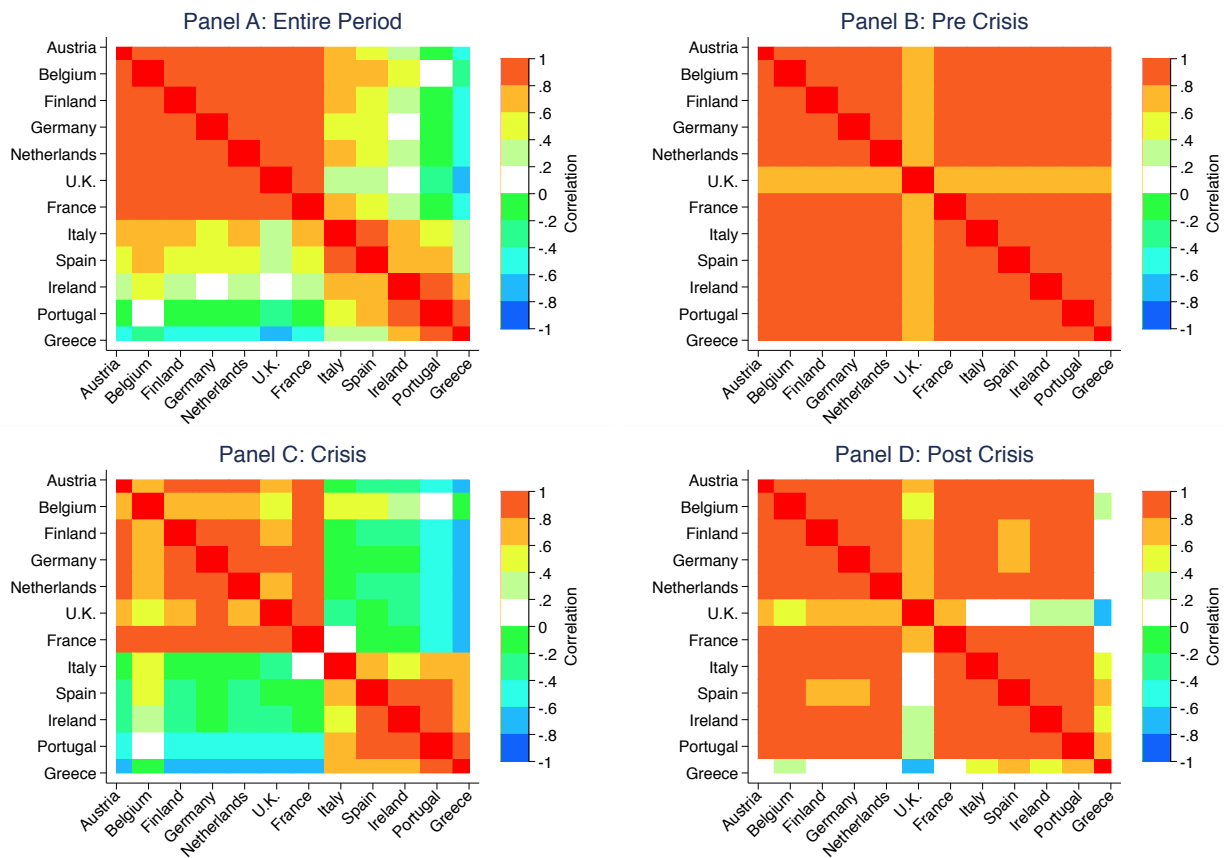


Figure 3.1: Correlation heat maps of 10-year bond yields before, during and after crisis

In addition, it can be used the same methodology to analyze the correlation of either the CRA or the yield spreads between countries during these periods. Figure 3.1 above depicts the correlation heatmaps of the yield for the entire period (Panel A) and each of the subperiods (Panel B through D) and is organized from non-PIIGS to PIIGS countries.

The first panel, which gives the correlation for the whole period, already signals the impact of the crisis in some peripheral countries like Greece and Portugal with the yield of these countries having a negative correlation with those fiscally stronger (non-PIIGS).

In the case of Ireland and Spain, even though they have a positive correlation with the remaining countries, this is much lower than the correlation within the PIIGS or within the non-PIIGS. On the contrary, the correlation between the PIIGS is considerably high especially between Greece-Portugal and Ireland-Portugal indicating a possible contagion effect between these countries.

With the creation of the European Monetary Union (“EMU”) the countries that adopted the Euro saw their yields decrease reflecting the elimination of exchange rate risk, the harmonization of the fiscal policies and a more integrated debt market (Figure 3.2).

Likewise, the European Central Bank’s practice of valuing all euro area countries’ bonds on the same terms as collateral for central bank credit to banks led investors to assume a similar risk for all countries.

Such convergence is observed in Panel B of Figure 3.1 (Table A.10 of Appendix A) where there is a high positive correlation

between all the countries that were in the process of entering the EMU in contrast with the correlation between these countries and the U.K.

The implosion of the crisis, the quickly deterioration of macroeconomic fundamentals for some countries and the rise of government debt to unbearable levels accentuated fiscal stimulus measures on some economies leading to increasing costs of financing in the markets and, ultimately, to divergences of the yields (Figure 3.3).

This reaction is clear in the negative correlation between the countries that were affected the most by the crisis and those with stronger fiscal fundamentals revealing a shift of the investors demand for countries’ debt from the first group to the latter (Figure 3.1, Panel C and Table A.11 of Appendix A).

The reduction of the possibility of the collapse of the Euro on the post-crisis period, associated with the introduction of the European Stability Mechanism (“ESM”) and the

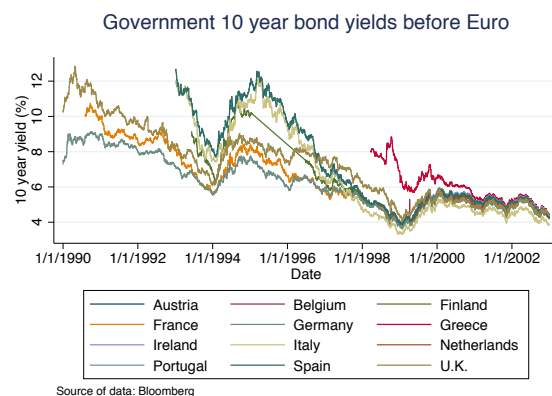


Figure 3.2: Government 10 year bond yields before Euro introduction

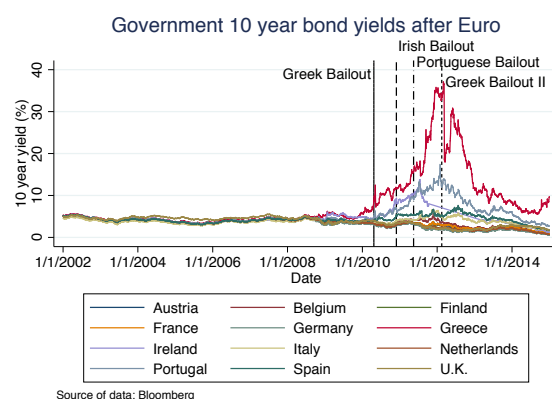


Figure 3.3: Government 10 year bond yields after Euro introduction



successful financial assistance programs of Ireland and Portugal relieved the markets and led to an overall decrease of the yields in the EMU and, consequently, to a positive correlation between the countries' yield spreads - Panel D of Figure 3.1 and Table A.12 of Appendix A.

Furthermore, Table A.13 through A.15 show the correlation matrices for each of the CRA. In this regard, it is only analyzed the correlation between the countries with more significant changes in ratings (countries that did not face a rating change over the period under analysis do not have a correlation defined hence are depicted in the tables with a ".").

During the crisis period, Moody's decreased "*Portugal's long-term government bond ratings to Ba2 from Baa1 and assigned a negative outlook*"<sup>3</sup>, not only on the basis of weak macroeconomic fundamentals but also as a reaction of the situation lived in Greece. As so, a high correlation level would be expected between these two countries. Furthermore, it is equally expected a high correlation between these two countries and Ireland, the third intervened country, as the situation in Greece also had an implication on Ireland's rating downgrades<sup>4</sup>.

In addition, one could also expect: (i) a contagion of the Portuguese situation to Spain, as this country is a major holder of Portuguese debt<sup>5</sup> and (ii) a higher correlation between France, Italy and Spain and the remaining major economies than between these and the intervened countries since a distress situation in France, Italy or Spain would have a higher impact on European economies than the impact of a less economically powerful country as Portugal, Greece or even Ireland.

All these relations can be seen the tables. It is shown the high correlation between Portugal, Ireland and Greece signaling a contagion effect between these economies. Spain

<sup>3</sup>In "*Moody's downgrades Portugal to Ba2 with a negative outlook from Baa1*" ([https://www.moody's.com/research/Moodys-downgradesPortugal-to-Ba2-with-a-negative-outlook-from?lang=en&cy=global&docid=PR\\_222043](https://www.moody's.com/research/Moodys-downgradesPortugal-to-Ba2-with-a-negative-outlook-from?lang=en&cy=global&docid=PR_222043))

<sup>4</sup>In "*Moody's downgrades Ireland to Ba1; outlook remains negative*" ([https://www.moody's.com/research/Moodys-downgrades-Ireland-to-Ba1-outlook-remains-negative--PR\\_222257](https://www.moody's.com/research/Moodys-downgrades-Ireland-to-Ba1-outlook-remains-negative--PR_222257))

<sup>5</sup>In "*Eurozone debt web: Who owes what to whom?*" (<http://www.bbc.com/news/business-15748696>)

is highly affected by rating changes in Portugal with the CRA clearly relating its level of risk with the amount of risky assets (Portuguese bonds) that it held.

Moreover, Spain, which had to intervene in the banking system with Madrid lending over €40 billion to Spanish banks and nationalizing of Bankia<sup>6</sup> (the country's fourth-largest bank by Tier 1 capital in 2014<sup>7</sup>) saw their yield spreads vis-à-vis the German Bund increase to levels around 6% in this period and several downgrades in the banking system and the country's ratings.

France, on the contrary, is the country with less impact in its ratings from the situation lived in other economies. Yet, a change in the rating of France is more related with changes in the ratings of Spain and Italy, as these are the major economies affected by the sovereign debt crisis, and that are highly correlated between them.

Table A.16 through A.18 are for Moody's ratings correlation before, during and after crisis. This is also depicted in Figure 3.4 below, from Panel B through D, respectively.

In the pre-crisis period, there are no material changes in ratings with most of the countries maintaining its ratings for the entire period. In the crisis period, it is possible to verify a high correlation between fiscally "weaker" countries and the absence of correlation between these countries and fiscally stronger ones. France has a low correlation with Portugal, Ireland or Greece and stronger one with other big economies as Spain or Italy. On the other hand, these last two countries have a high positive correlation between them and with the remaining PIIGS with the increase in stability of Italy leading to an absence of correlation with Spain, Portugal, Ireland or Greece after this period.

Spain, Portugal, Ireland and Greece, on the contrary, have, as expected, a high positive correlation both during and after the crisis with a persistence of high correlation between Ireland and Portugal from one period to another and a decrease of correlation between

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<sup>6</sup>In "Spain's Bankia-Led Bailout Won't Spell End of Bank Troubles" (<http://www.bloomberg.com/news/articles/2013-02-27/spain-s-bankia-led-bailout-won-t-spell-end-of-troubles-for-banks>)

<sup>7</sup>In "The top five Spanish banks" (<http://www.thebanker.com/Banker-Data/The-top-five-Spanish-banks>)

these countries and Greece. This result could be partially explained by the “end” of the financial assistance program in Ireland in December 2013 followed, only a few months later, by Portugal, leading to a regain of the market’s confidence and hence an increase in the ratings of these countries.

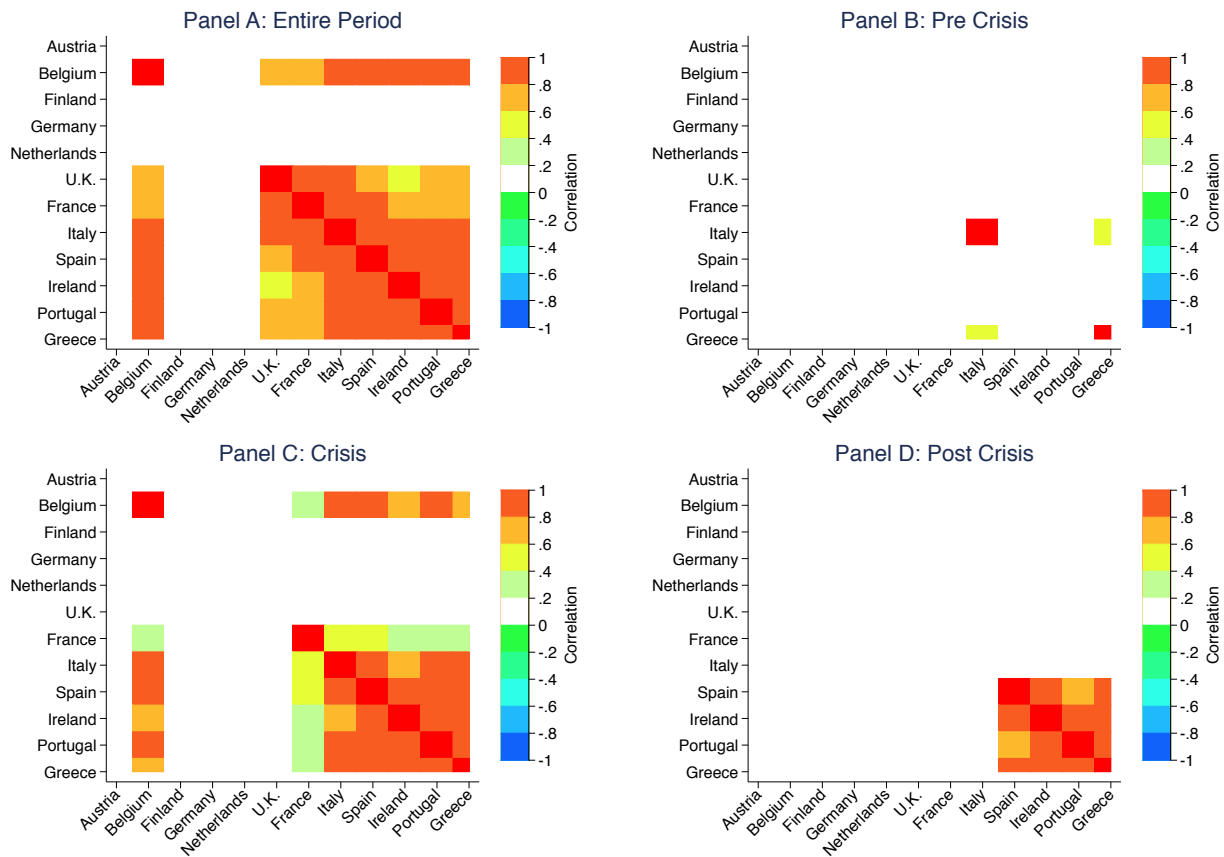


Figure 3.4: Correlation heat maps of Moodys' ratings before, during and after crisis

### 3.3.2 Models interpretation

#### Rating on yield

The initial model analyzed is the impact of CRA on the 10-year government bond yield spreads of the countries. Beforehand, Table 2 (page 37) recapitulates the expected signals of the impact of both different variables on the government bond yields and ratings.

With this information in mind, Table 3 (page 38) presents the results for the panel data for the whole period, from the first quarter of 2002 until the last quarter of 2014 using,

for that purpose, the formerly mentioned fixed effects. The models are divided by rating: (i) Moody's for 1 and 2; (ii) S&P for 3 and 4; and (iii) Fitch for 5 and 6. Moreover, odd number models represent the simple fixed effects model while even number models represent the simple fixed effect model but with heteroskedasticity-robust coefficients.

The most influential factors for the yield spreads of the countries are the ratings, inflation and external balance, which are robustly statistically significant at least at a 10% significance level over the three CRA. Credit ratings and inflation have the expected impact on yield spreads [an upgrade (increase) of the rating (inflation) decreases (increases) the spread] but, on the other hand, government debt has a contradictory impact as an increase of the indebtedness level decreases the yield spread. The minimum amount of government debt around 24% of gross domestic product ("GDP") and, specially a mean of 77% of GDP over the whole period, might undervalue the impact of debt in the yields.

Another explanation is, again, the lag between financial and macroeconomic fundamentals adjustments. After the crisis period (2013 onwards), and due to delivery of the assistance programs tranches to Greece, Portugal and Ireland, these countries saw their debt increase whereas the markets perception of risk eased and, consequently, the correspondent government yield spreads decreased, vis-à-vis the German Bund, in the secondary market.

The models obtained by this process point for similar results across the three CRA. As so, it will be used Moody's as a proxy for the impact of rating agencies in the yields spreads, and vice-versa.

Greece has faced from severe macroeconomic issues. A high level of debt much before the crisis (stabilized at a 100% of GDP during the 90's, versus the 70% average of the Euro area, and kept at this level until the crisis), the increase in the cost of refinancing, poor fiscal fundamentals, a high level of unemployment and political instability lead to a confidence crisis and consequently to outside intervention. Due to this, Greece's macroeconomic and rating values are over-pessimistic when compared with the remaining coun-

tries under analysis, even against Ireland and Portugal.

In this sense, and now that it has been covered the base model for the analysis of the yield spreads for comparison, the first step will be to reestimate the model, again as panel data, but without considering Greece. The robust results are in the first two columns (first with Greece and second without) of Table 4 (page 38).

The not inclusion of Greece in the estimation provides much clearer analysis of the economic situation lived in Europe. The first difference worth to emphasize is the decrease of the constant (base level of the 10-year yield spread) by 8% indicating the impact of Greece's high level of 10-year yield spread over the whole period (Greece, within the sample, reached a maximum value of 35% and had, more often than not, higher yields than its counterpart countries).

Furthermore, not accounting for the default of a country in the estimation allows for the CRA coefficient to decrease by almost one half, yet staying significant indicating that CRA do have a role in the yield level of a country.

The two last significant changes are: (i) government surplus is now robustly significant at a 10% significance level; and (ii) inflation, though its signal remains the same, becomes statistically insignificant.

To account for the specificities in the data and the robustness of the results we included several variables such as a dummy for the period with financial assistance (which depended on the country) or variables to account for specific rules of the EMU as the deficit above 3% or the debt level above 60%. These variables turned out statistically insignificant in the sample used.

Instead of a debt level above 60%, it was used a benchmark of 90% of GDP as a variable to distinguish between countries. The robust results, which do not include Greece again, are depicted in the third column of Table 4 [model (3)]. In this context, "Gov. Debt  $\geq$  90" is an interaction term which represents the additional variation on the yield spread, by a 1%

change of the government debt of a country which has a debt level as a percentage of GDP above 90%. Comparing model (2) and (3), Gov. Debt  $\geq 90$  is not statistically significant and the coefficient has a neutral value indicating that the increase of government debt level by 1% is the same for countries with a high or low government debt.

Some literature also uses dummies for the crisis period, Greece or the PIGS to estimate the impact of CRA on yields (see Gärtner et al. (2011) for comparative analysis). In light of this procedure it was computed series of models using a specific dummy the crisis period and an interaction term between Greece and the rating. The results are shown in the last two columns of Table 4 and include the interaction term for a debt level higher than 90% of GDP previously used.

Both these models give a similar result the one from the panel data analysis above. Moody's, government surplus and inflation are statistically significant and with identical signs but now external balance is no longer significant.

Furthermore, the interaction term between Moodys and Greece turned out to be statistically significant indicating that a downgrade of the Greek rating by one notch by Moody's has an impact on Greece's yield spread approximately 0.4% higher than a similar decrease on other countries' rating. The dummy for the crisis period is also statistically significant (at a 10% level) and indicates that in this period, the yield spread of the countries vis-à-vis the German Bund is, *ceteris paribus*, 1.46% higher than in the remaining periods.

From all the previous models it is possible to see that the rating variable is always statistically significant, but how does the rating impact changes over time? Table 5 on page 39 depicts four robust models, where model 1, 2, 3 and 4 are, respectively, for all sample period, pre-crisis period, during crisis period and post-crisis period.

In what regards these periods, the variables do change over time both in signal and/or significance. GDP growth, GDP per capita and government surplus are not significant in any of the periods or when considering the entire sample period.

An increase in the credit ratings has, as expected, a statistically significant negative impact of the on yield spreads during the crisis - *i.e.*, a downgrade of the rating leads to an increase of the yield spreads. Additionally, the impact intensified during the crisis, from -0.08% to -0.62%. Nevertheless, a high amount of downgrades during the crisis, even for fiscally stable countries which did not face a spike in their yield spreads, could have reduced the expected impact of the ratings on the yields.

During this period, not only the majority of the countries faced a rating change (either of credit watch or effective rating change), but the rating changes themselves were larger than in other periods. Thus, yield spreads are explained by a change in the rating but, more importantly, by the magnitude of this change (for Greece, the magnitude of the change on the rating was of 16 leading to a change in the yield spread, *ceteris paribus*, of 9.92%).

In the post-crisis period, and although it is not statistically significant, the impact of ratings on yields eases to -0.41% indicating that a rating upgrade, in this period, had a lower impact on the yield spreads than a similar downgrade during the crisis period. Moreover, this results partly reflects the inertia of the ratings when considering the fact that yield spreads decreased sharply to minimum historical values while ratings felt slight upgrades.

These results clearly indicate that the credit ratings do/did have an impact on the sovereign yield spreads of the countries and that, due to the high amount of downgrades, ended up aggravating the crisis in Europe.

### **Yield on rating**

Table 6 on page 39 depicts the results for the base model for equation 3.2, where the first and second column for each rating represents the non-robust and robust model, respectively. In all three models (for each CRA), government surplus, unemployment, government debt and the yield spread are robustly statistically significant. Moreover, GDP per capita, government surplus and external balance have the opposite signal to the one mentioned by the literature indicating that, the higher is the government surplus or GDP per

capita, the lower will be the credit rating, *ceteris paribus*.

Inflation, which is statistically insignificant to help explaining all the three ratings, also has the opposite signal indicating that a higher inflation leads to better ratings. The low variability of this variable, both considering all sample period or within each subperiod, may lead to such result. Focusing on the yield spread, in what regards all the CRA, an increase of 2% of the yield spread would lead to a reduction of the rating of, at least, 0.5 which is equivalent to a negative credit watch.

Again, for the remaining of the analysis, and considering the similarity of the results, it will be only used the Moody's rating as a proxy for the ratings.

Previously, the model with or without Greece provided a different insight about the yields estimation. A similar procedure is done for the ratings and the results are depicted in the first two columns Table 7 (model 1 and 2 with and without Greece, respectively) on page 40. Now, the non-inclusion of Greece slightly changes the previous results with an increase of 2% on the yield spread leading to a decrease by 1 notch of the rating. The inclusion of interaction term for debt higher than 90% of GDP, as presented in the third model of Table 7, reduces the impact of a change of yield spreads on ratings and it is, now, statistically significant. In this case, an increase in government debt of a country with a debt higher than 90% of GDP has, *ceteris paribus*, higher decrease of the rating than a similar change in a country with a more stable fiscal situation.

The last two columns present a model including a dummy for the crisis period and the interaction term for the debt as above mentioned, with (4) and without Greece (5). The results are fairly similar to the ones previously obtained with the dummy for the crisis period being statistically significant in both models and indicating that, during this period, the rating is higher, *ceteris paribus*. This unexpected value is offset by the increase, comparing to column four, of the absolute impact of a change of the yield spread on the rating. The average yield spread during this period is 2.40% against 0.11% and 1.75% of the pre- and post-crisis ones. Moreover, the highest value of the yield spread that was



verified in this is around 33% considering Greece, a much larger value than 1.14% and 11.15% for the other periods. In this sense, the value of the dummy is completely offset by a positive change on the yields of 2% which, during this period, was verified for the majority of the countries studied. The countries for which this dummy has a clear impact are the ones with a more stable fiscal situation as Austria, Finland or Netherlands.

Table 8 (page 41) decomposes the rating estimation for the 4 periods under analysis (all sample, pre-, during- and post-crisis) with and without Greece. The first different result is that, before the crisis, none of the variables had a statistically significant impact on the rating contradicting the results existing in the literature. Nevertheless, this period was a relatively stable one, a period which followed an effort by the countries to fulfill the euro convergence criteria introduced by the Maastricht Treaty: (i) price stability (via HCPI); (ii) sound public finances (government deficit not more than 3% of GDP); (iii) sustainable public finances (government deficit not more than 60% of GDP); (iv) durability of convergence (via long-term interest rates); and (v) exchange rate stability, which had to be met in order for the countries to be eligible to enter the EMU.

Furthermore, the European Central Bank's practice of valuing all euro area countries' bonds on the same terms as collateral for central bank credit to banks led investors to assume a similar risk for all countries. As so, these countries faced a period where they were considered fiscally stable and their creditworthiness similar with all having investment grade ratings (mean of Aa1/AA+) with very low variability, explaining the results.

For the subsequent period, and considering Greece, four variables (GDP growth, unemployment, the interaction term for government debt higher than 90% of GDP and external balance) are now statistically significant with the external balance having an opposite sign to the one expected and mentioned in the literature. Moreover, the 10-year yield spread is not statistically significant and has a negative impact on the rating. Keeping the remaining values constant, a 5% increase in the yield spread during this period would lead a downgrade by one notch of the rating. Considering the high spread increases verified

during this period, this results provides information about why ratings of “weaker” countries were downgrade by such a large amount (a 15% increase on the yield spread, as the one in Greece, would lead to downgrade of three notches).

The exclusion of Greece from the sample makes the yield spread statistically significant though GDP growth and unemployment are no longer significant. Now, the 10% increase in the spread of Portugal during the crisis period would traduce into a downgrade of seven notches of Moody’s rating.

The post-crisis period provides a different insight and, with the inclusion of Greece, no variables are statistically significant indicating, again, the existence of ratings inertia after a crisis period as mentioned by Mora (2006). The exclusion of Greece from the sample makes government debt and the yield spread statistically significant variables and a 3% decrease in the Portuguese spread would lead to a an upgrade of the rating by one notch and a positive credit watch (a numerical value of 1.5), *ceteris paribus*. During this period, Portugal did face indeed an upgrade by two notches of the Moody’s rating yet, high levels of government debt and lower decreases of the spread than the increase verified during the crisis could help explain the inertia of the ratings in this last period.

So far, it has been shown that, during the crisis, ratings had an impact on spreads (and spreads on ratings if Greece is excluded from the sample) helping a self-fulfilling prophecy on the countries instability at a structural and markets level. For the remaining periods, and if Greece is included, the two variables revealed not to be statistically significant. Moreover, before the crisis, none of the variables here studied had an impact either on the ratings or on yield spreads.

As mentioned before, a different approach to analyze what determines the ratings is to use an ordered probit model as in equation 3.3. Table 9 on page 42 depicts the ordered probit model to determine the Moody’s rating for all the sample period, the pre-crisis period, the crisis period and the post-crisis period.

Contrary to previous results, in which no variables were statistically significant, with the

inclusion of Greece, in the pre-crisis period, GDP per capita, unemployment and government debt are statistically significant in all four periods. External balance is statistically significant in every period with the exception of the post-crisis one and GDP growth and 10-year yield spreads are only statistically significant in this last period.

In the pre-crisis period, an increase in the GDP per capita, government debt or external balance would result in the expected change in the rating. Unemployment, on the contrary, has an unexpected impact, with an increase in the unemployment level of a country, leading to an upgrade of the rating.

With the exception of Greece, GDP per capita has a positive trend throughout time in all the countries yet the stagnation on the last two periods for some countries and the decrease of this variable in Greece, Italy or Portugal to levels similar to late 2003/early 2004 together with the downgrade during the crisis and then the slight improvement of the ratings in the post-crisis period might explain why this variable has slight positive impact during the crisis and negative in post-crisis model, respectively.

Furthermore, the impact of the yield spread more than doubles from the crisis period to the post-crisis one which could be due, as previously mentioned, to a larger change of the yield spread relative to the change in the ratings after the crisis than during it reflecting the fact that, after the crisis, yield spreads dropped to levels closer to the ones before the crisis but the ratings were not upgraded to the levels before the crisis or similar.

The case which better exemplifies this situation is the Greek one where yield spread decreased, from a peak during the crisis of 33% to a value around 4% (before the crisis the yield was around 0.5%) yet the rating only faced an upgrade from a default level of C (a numerical value of 2) to Caa1 (6) - the rating before the crisis was A1 (18) with Ireland, Portugal or Spain having similar situations.

# Conclusion

The objective of this study was to assess the extent of influence of credit rating announcements on sovereign bond yield and the influence of a change on the yields to credit rating focusing on the European market.

For this purpose it was used 10-year sovereign bond yield spreads, vis-à-vis the German Bund, and macroeconomic data from 12 European economies for a period between 2002 and 2014 and divided into three major periods: (i) the period before the crisis (from the first quarter of 2002 until the second quarter of 2008); (ii) the financial crisis and the sovereign debt crisis period (third quarter of 2008 until the last quarter of 2012); and (iii) the period after the crisis (first quarter of 2013 until the last quarter of 2014).

We estimated the impact of credit rating announcements (*i.e.*, changes in rating grades and credit watch), made by Moody's (as a benchmark) throughout these periods, focusing the study on two models: (i) panel data regression models including dummy variables for different situations; and (ii) ordered models. The main contribution is providing an updated study on the impact of credit rating agencies and spreads on one another not limiting the study to selected periods (such as the crisis) and extending previous analysis to a period after a crisis.

The findings from the empirical parts of this study confirm that ratings changes did have a negative impact on the yield spreads when considering the whole sample period. These results confirms expectations that ratings have an impact on the yields and do confirm some of the outcomes indicated literature. Furthermore, some macroeconomic fundamentals estimators revealed to be statistically insignificant (either for the full sample period and/or some subperiods) and presented a sign contrary to those expected and previously

studied by the majority of the references above.

Regarding the analysis per sub-period, the results vary for the different periods. For the first methodology (*i.e.*, panel regressions), confirm that ratings had an impact on the yield spreads during the crisis though, both in the pre- and post-crisis period, this impact is not statistically significant. Moreover, the inclusion of different dummy variables and interaction terms turned out to be statistically insignificant and inconclusive regarding its impact on yield spreads including the interaction term for government debt higher than 90% of GDP. Other variables as the interaction term of Moody's and Greece and a dummy for the crisis period turned out to be statistically significant indicating that yield spreads tend to be higher during a crisis and that a change in Moody's rating had a higher impact on Greece than a similar one for the remaining countries.

The study of the impact of the yield on the credit ratings provided similar results in both methodologies when considering the 12 years under analysis. Both models indicate that yield spreads had an impact on the ratings. Moreover, the majority of the variables had an impact on the ratings which goes according to what one might expect considering that credit ratings provide information about present and future state of the economy.

The division in subperiods provide a different insight. The first methodology indicates that, before the crisis, none of the variables had a statistically significant impact on the rating and only during and after the crisis some variables, including the sovereign yield spread (if Greece is excluded), had a significant impact on the ratings. The second methodology shows that variables provide information on rating changes in all the three subperiods. Yield spreads contribute to the determination of credit ratings before and during the crisis, if Greece is not considered though, in the last period, spreads provide information both with and without Greece in the sample. The differences obtained with and without Greece are due to the values of Greece's spreads and ratings during the period under analysis which could be considered as outliers comparing to other countries'. In this sense, its removal from the sample leads to more precise results.

In light of the above, it is possible to assume that, during the crisis, ratings announcements (either credit watch or rating changes) and the information that it provides to the markets had a direct impact on sovereign yields. However, during the remaining periods analyzed, the results do not show that, these same announcements provide enough information to significantly change yields on the secondary markets. The results with Greece, on the contrary, do not provide clear information about the effect of the increase of spreads during the crisis and the decrease after, on ratings.

The possible extensions of this study are diverse. Given the methodology and the results, it is suggested to apply it to often forgotten bond markets of emerging countries. Moreover, it would be interesting to apply these model to more countries and for a broader period or even different crisis (as the Asian crisis) and compare for the same different subperiods (before, during and after a crisis).

Finally, there are several suggested adjustments that could improve the informative value of this study. An increased of the number of countries could reflect better the reality in the European market in each of the three periods though different time periods might have to be considered. Furthermore, some of the analysis in this study revealed to be inconclusive unless Greece was excluded from the sample. As so, the introduction of correction instruments for extreme values could improve the models. This paper focused only on the reaction of yields and ratings to one another however, it could be interesting to analyze how other variables affect themselves in the different periods for macroeconomics purposes. Moreover, it would be interesting to test the causality effect of these variables with the introduction of a panel VAR model analysis.

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# Figures



Figure 1: Rantings and yields evolution



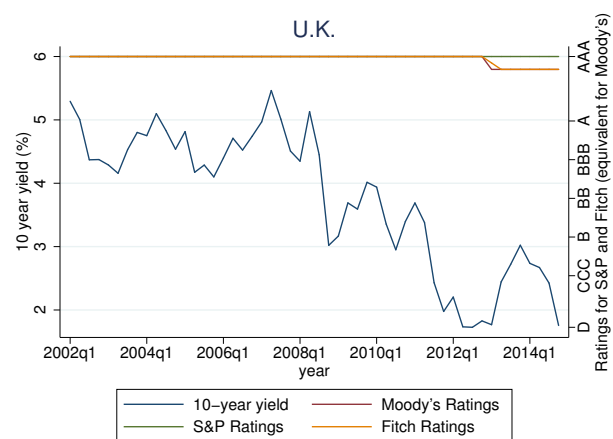
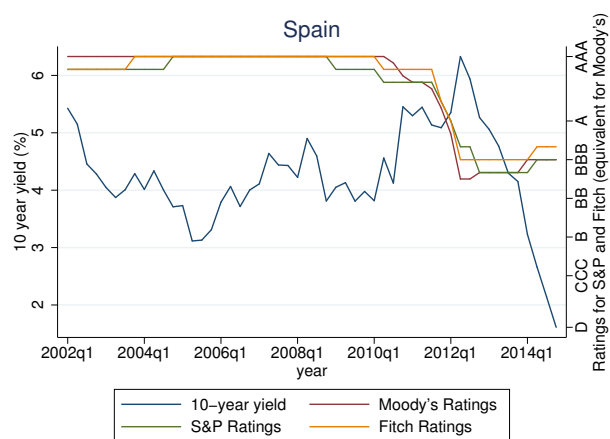
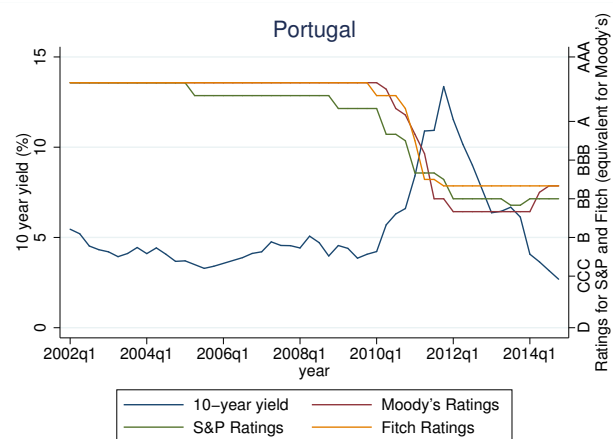
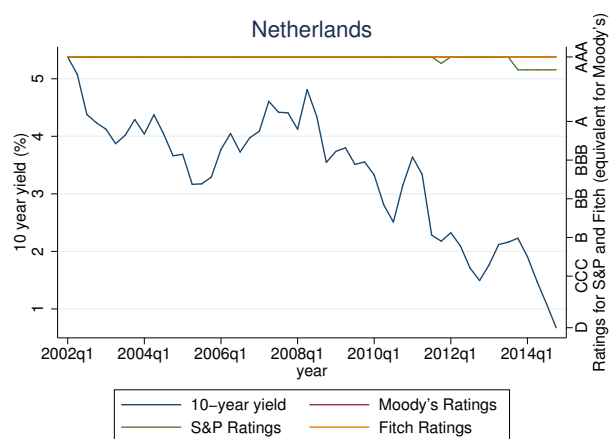
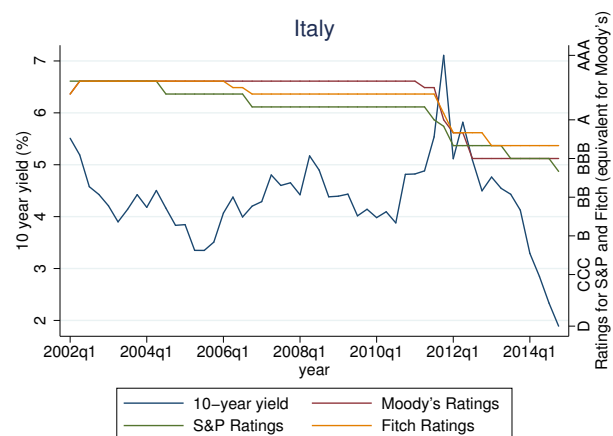
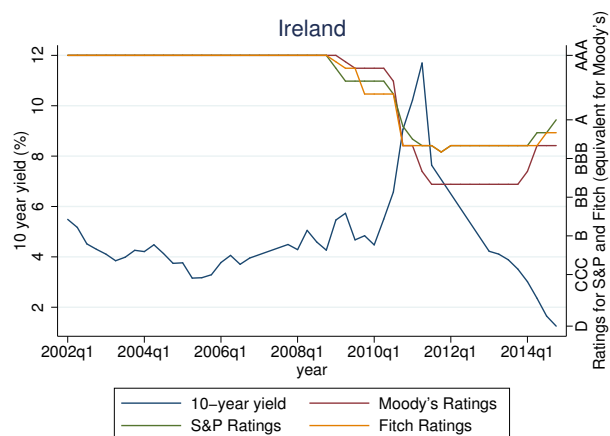


Figure 1 (Cont.): Ratings and yields evolution

# Tables

Table 1: Rating conversion

Credit Rating	Moody's	S&P/Fitch	Numerical Value
Investment grade	Aaa	AAA	22
	Aa1	AA+	21
	Aa2	AA	20
	Aa3	AA-	19
	A1	A+	18
	A2	A	17
	A3	A-	16
	Baa1	BBB+	15
	Baa2	BBB	14
	Baa3	BBB-	13
Speculative grade	Ba1	BB+	12
	Ba2	BB	11
	Ba3	BB-	10
	B1	B+	9
	B2	B	8
	B3	B-	7
	Caa1	CCC+	6
	Caa2	CCC	5
	Caa3	CCC-	4
	Ca	CC	3
	C	C	2
		D	1
Credit watch			
Positive			0.5
Negative			-0.5

Table 2: Variables expected signal

Dependent variable	Expected signal	
	10-year yield spread	Rating
GDP growth	-	+
GDP per capita	-	+
Gov. Surplus	-	+
Inflation	+	-
Unemployment	+	-
Gov. Debt	+	-
External balance	-	+
Moody's Ratings	-	
S&P Ratings	-	
Fitch Ratings	-	
10 yr. yield spread		-

Table 3: Explaining 10 year yield spreads with credit ratings

	Moody's		Standard & Poor's		Fitch	
	(1)	(2)	(3)	(4)	(5)	(6)
GDP growth	-0.38*** (-5.60)	-0.38 (-1.49)	-0.30*** (-5.07)	-0.30 (-1.75)	-0.43*** (-6.29)	-0.43 (-1.48)
GDP per capita	0.07 (0.70)	0.07 (0.55)	-0.12 (-1.25)	-0.12 (-0.98)	0.15 (1.40)	0.15 (1.22)
Gov. Surplus	-0.04** (-2.80)	-0.04 (-2.13)	-0.04** (-3.03)	-0.04 (-2.10)	-0.03 (-1.70)	-0.03 (-1.63)
Inflation	0.19* (2.26)	0.19* (2.70)	0.20** (2.69)	0.20** (3.41)	0.21* (2.45)	0.21* (2.74)
Unemployment	0.02 (0.53)	0.02 (0.16)	-0.03 (-0.82)	-0.03 (-0.27)	0.05 (1.13)	0.05 (0.43)
Gov. Debt	-0.02*** (-3.73)	-0.02 (-1.75)	-0.04*** (-6.30)	-0.04 (-1.55)	-0.02*** (-3.36)	-0.02 (-1.70)
External balance	-0.08*** (-4.35)	-0.08** (-3.25)	-0.09*** (-5.25)	-0.09* (-2.78)	-0.09*** (-4.41)	-0.09* (-3.12)
Moody's Ratings	-0.75*** (-14.20)	-0.75** (-3.38)				
Standard & Poor's Ratings			-1.13*** (-20.07)	-1.13* (-2.92)		
Fitch Ratings					-0.92*** (-12.66)	-0.92* (-2.90)
Constant	17.03*** (10.13)	17.03* (3.03)	27.18*** (15.93)	27.18* (2.65)	19.51*** (9.61)	19.51* (2.67)
R-squared	0.60	0.60	0.68	0.68	0.57	0.57
F-Statistic	101.67	309.46	147.22	195.21	92.30	269.27
p-Value	0.00	0.00	0.00	0.00	0.00	0.00
Akaike's info criterion	2184.44	2182.44	2049.21	2047.21	2216.71	2214.71
Schwarz info criterion	2223.58	2217.23	2088.35	2082.00	2255.85	2249.50
Observations	572	572	572	572	572	572

The *t*-statistics are in parentheses. \*, \*\*, \*\*\* denotes significance at the 10%, 5% and 1% level

Table 4: Explaining 10 year yield spreads with and without Greece and dummies

	Expected signal	(1)	(2)	(3)	(4)	(5)
GDP growth	-	-0.38 (-1.49)	-0.11 (-1.11)	-0.11 (-1.08)	-0.33 (-1.51)	-0.16 (-1.05)
GDP per capita	-	0.07 (0.55)	0.05 (0.58)	0.05 (0.54)	0.13 (1.37)	-0.09 (-0.71)
Gov. Surplus	-	-0.04 (-2.13)	-0.03* (-2.60)	-0.03* (-2.32)	-0.06* (-2.50)	-0.02 (-1.57)
Inflation	+	0.19* (2.70)	0.15 (1.81)	0.15 (1.67)	0.19* (2.63)	0.18* (2.69)
Unemployment	+	0.02 (0.16)	0.12 (1.67)	0.12 (1.63)	-0.08 (-0.48)	-0.13 (-0.79)
Gov. Debt	+	-0.02 (-1.75)	-0.01 (-0.95)	-0.01 (-0.72)	-0.00 (-0.14)	-0.01 (-1.30)
External balance	-	-0.08** (-3.25)	-0.07* (-2.60)	-0.07* (-2.77)	-0.03 (-0.98)	-0.01 (-0.25)
Moody's Ratings	-	-0.75** (-3.38)	-0.44** (-4.47)	-0.44*** (-7.17)	-0.55** (-4.46)	-0.59*** (-5.01)
Gov. Debt $\geq 90$	+			-0.00 (-0.17)	-0.00 (-0.41)	0.00 (0.60)
Greece x Moody's	-				-0.41*** (-6.90)	-0.42*** (-8.15)
Crisis	+					1.46* (2.56)
Constant		17.03* (3.03)	8.90** (3.92)	9.06*** (5.59)	12.40** (3.89)	15.51** (4.37)
R-squared		0.60	0.64	0.64	0.64	0.69
F-Statistic		309.46	502.44	5720.54	.	.
p-Value		0.00	0.00	0.00	.	.
Akaike's info criterion		2182.44	1296.94	1298.76	2118.89	2039.57
Schwarz info criterion		2217.23	1330.97	1337.04	2158.04	2083.07
Observations		572	520	520	572	572

The *t*-statistics are in parentheses. \*, \*\*, \*\*\* denotes significance at the 10%, 5% and 1% level.

Table 5: Explaining sovereign 10 year yield spreads for each period with dummies

	All sample (1)	Pre-Crisis (2)	Crisis (3)	Post-Crisis (4)
GDP growth	-0.36 (-1.50)	-0.01 (-1.42)	-0.24 (-1.14)	-0.28 (-1.23)
GDP per capita	0.06 (0.47)	0.01 (0.18)	-0.20 (-0.56)	0.25 (0.74)
Gov. Surplus	-0.04 (-2.09)	-0.00 (-0.32)	0.03 (0.86)	-0.04 (-1.50)
Inflation	0.18* (2.42)	0.01 (0.83)	0.13 (1.60)	-0.01 (-0.12)
Unemployment	-0.01 (-0.09)	-0.04* (-2.60)	0.33** (3.31)	0.15 (0.89)
Gov. Debt	-0.01 (-0.76)	0.01 (1.77)	-0.00 (-0.09)	-0.07* (-2.30)
Gov. Debt $\geq$ 90	-0.01 (-1.51)	-0.00* (-2.35)	-0.00 (-0.00)	-0.01* (-2.86)
External balance	-0.09** (-3.50)	-0.00 (-1.11)	-0.10* (-3.17)	-0.03 (-1.85)
Moody's Ratings	-0.82** (-3.41)	-0.08 (-1.13)	-0.62*** (-7.64)	-0.42 (-1.62)
Constant	18.27** (3.18)	1.65 (1.13)	12.78*** (5.66)	12.93 (1.80)
R-squared	0.60	0.09	0.65	0.53
F-Statistic	647.25	2039.51	2579.59	3931.07
p-Value	0.00	0.00	0.00	0.00
Akaike's info criterion	2172.48	-263.18	818.25	175.42
Schwarz info criterion	2211.62	-230.27	847.84	197.71
Observations	572	286	198	88

The *t*-statistics are in parentheses. \*, \*\*, \*\*\* denotes significance at the 10%, 5% and 1% level.

Table 6: Explaining ratings with 10 year yield spreads

	Moody's		Standard & Poor's		Fitch	
	(1)	(2)	(3)	(4)	(5)	(6)
GDP growth	-0.01 (-0.26)	-0.01 (-0.43)	-0.01 (-0.36)	-0.01 (-0.65)	-0.05 (-1.30)	-0.05 (-1.63)
GDP per capita	0.08 (1.07)	0.08 (0.44)	-0.12* (-2.13)	-0.12 (-1.09)	0.15** (2.65)	0.15 (1.27)
Gov. Surplus	-0.10*** (-9.47)	-0.10** (-4.49)	-0.06*** (-7.45)	-0.06** (-4.56)	-0.06*** (-7.88)	-0.06** (-4.25)
Inflation	0.00 (0.03)	0.00 (0.02)	0.05 (1.07)	0.05 (0.77)	0.01 (0.29)	0.01 (0.20)
Unemployment	-0.36*** (-13.39)	-0.36* (-2.66)	-0.23*** (-11.72)	-0.23*** (-4.62)	-0.28*** (-13.59)	-0.28* (-3.06)
Gov. Debt	-0.05*** (-13.30)	-0.05* (-2.91)	-0.04*** (-14.65)	-0.04* (-2.97)	-0.04*** (-13.88)	-0.04* (-3.01)
External balance	-0.03 (-1.96)	-0.03 (-0.63)	-0.03*** (-3.49)	-0.03 (-1.77)	-0.02* (-2.05)	-0.02 (-0.86)
10-year yield spread	-0.35*** (-14.20)	-0.35** (-4.24)	-0.37*** (-20.07)	-0.37*** (-13.04)	-0.25*** (-12.66)	-0.25** (-3.77)
Constant	26.53*** (48.13)	26.53*** (20.30)	26.15*** (63.66)	26.15*** (27.13)	24.73*** (57.79)	24.73*** (31.39)
R-squared	0.86	0.86	0.88	0.88	0.86	0.86
F-Statistic	425.34	1622.12	530.09	2602.05	422.99	513.82
p-Value	0.00	0.00	0.00	0.00	0.00	0.00
Akaike's info criterion	1752.80	1750.80	1416.67	1414.67	1463.40	1461.40
Schwarz info criterion	1791.94	1785.59	1455.81	1449.47	1502.54	1496.19
Observations	572	572	572	572	572	572

The *t*-statistics are in parentheses. \*, \*\*, \*\*\* denotes significance at the 10%, 5% and 1% level.

Table 7: Explaining ratings with and without Greece and dummies

	Expected signal	(1)	(2)	(3)	(4)	(5)
GDP growth	+	−0.01 (−0.43)	−0.01 (−0.24)	0.01 (0.31)	0.06 (2.09)	0.08* (2.40)
GDP per capita	+	0.08 (0.44)	0.04 (0.22)	−0.01 (−0.07)	−0.07 (−0.42)	−0.12 (−0.70)
Gov. Surplus	+	−0.10** (−4.49)	−0.08** (−3.85)	−0.05** (−3.80)	−0.05** (−4.16)	−0.04** (−3.31)
Inflation	−	0.00 (0.02)	0.06 (0.51)	0.02 (0.21)	−0.01 (−0.14)	0.03 (0.38)
Unemployment	−	−0.36* (−2.66)	−0.15 (−1.93)	−0.16* (−2.69)	−0.36* (−2.87)	−0.16* (−2.72)
Gov. Debt	−	−0.05* (−2.91)	−0.06* (−2.88)	−0.03 (−1.82)	−0.03 (−1.64)	−0.03 (−2.12)
External balance	+	−0.03 (−0.63)	−0.07 (−2.25)	−0.08* (−2.86)	−0.02 (−0.57)	−0.06* (−2.80)
10-year yield spread	−	−0.35** (−4.24)	−0.60*** (−5.36)	−0.50** (−3.98)	−0.38** (−4.56)	−0.62*** (−4.84)
Gov. Debt $\geq$ 90	−			−0.02* (−2.69)	−0.02* (−2.27)	−0.02 (−1.93)
Crisis	−				0.75* (2.85)	0.83* (2.92)
Constant		26.53*** (20.30)	25.81*** (16.11)	24.92*** (18.20)	26.38*** (19.82)	25.76*** (16.68)
R-squared		0.86	0.83	0.86	0.89	0.87
F-Statistic		1622.12	16782.08	266.20	564571.24	.
p-Value		0.00	0.00	0.00	0.00	.
Akaike's info criterion		1750.80	1464.83	1360.11	1625.07	1298.89
Schwarz info criterion		1785.59	1498.86	1398.39	1668.56	1337.18
Observations		572	520	520	572	520

The  $t$ -statistics are in parentheses. \*, \*\*, \*\*\* denotes significance at the 10%, 5% and 1% level.

Table 8: Explaining ratings for each period with dummies

	All sample			Pre-Crisis			Crisis		Post-Crisis	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)		
GDP growth	0.00 (0.08)	0.01 (0.31)	-0.00 (-0.69)	-0.00 (-0.33)	0.18* (2.72)	0.19 (1.90)	0.03 (0.30)	-0.04 (-0.82)		
GDP per capita	0.05 (0.27)	-0.01 (-0.07)	0.03 (1.29)	0.01 (0.96)	-0.15 (-0.65)	-0.08 (-0.46)	-0.01 (-0.05)	0.14 (0.99)		
Gov. Surplus	-0.07** (-4.34)	-0.05** (-3.80)	-0.00 (-0.71)	0.00 (0.92)	-0.04 (-1.65)	-0.03 (-1.74)	0.03 (1.18)	-0.01 (-0.50)		
Inflation	-0.01 (-0.19)	0.02 (0.21)	0.00 (1.44)	0.00 (1.28)	0.06 (0.73)	0.13 (1.59)	0.04 (0.98)	0.06 (1.30)		
Unemployment	-0.37* (-2.73)	-0.16* (-2.69)	-0.02 (-1.83)	-0.01 (-1.16)	-0.55* (-2.88)	-0.21 (-1.81)	-0.36 (-1.95)	-0.14 (-0.99)		
Gov. Debt	-0.02 (-1.33)	-0.03 (-1.82)	0.00 (1.46)	0.00 (1.00)	-0.03 (-1.12)	-0.05 (-1.92)	-0.03 (-0.41)	-0.09* (-3.00)		
Gov. Debt $\geq 90$	-0.02* (-2.90)	-0.02* (-2.69)	-0.00 (-0.16)	0.00 (0.13)	-0.02* (-2.57)	-0.01 (-1.07)	-0.00* (-2.51)	-0.00* (-2.85)		
External balance	-0.03 (-0.73)	-0.08* (-2.86)	0.00 (0.87)	0.00 (1.17)	-0.10* (-3.04)	-0.10** (-4.26)	-0.03 (-1.49)	-0.02 (-1.26)		
10-year yield spread	-0.34*** (-4.86)	-0.50** (-3.98)	-0.05 (-0.72)	0.01 (0.80)	-0.22 (-1.86)	-0.70** (-4.41)	-0.30 (-1.38)	-0.55** (-4.75)		
Constant	25.48*** (20.00)	24.92*** (18.20)	20.81*** (73.20)	21.48*** (721.53)	29.61*** (13.38)	27.97*** (13.49)	25.16*** (5.06)	28.33*** (10.58)		
R-squared	0.88	0.86	0.06	0.02	0.86	0.86	0.49	0.72		
F-Statistic	8037.00	266.20	63.17	2.49	12413.69	5943.61	1086.11	4140.17		
p-Value	0.00	0.00	0.00	0.10	0.00	0.00	0.00	0.00		
Akaike's info criterion	1666.87	1360.11	-438.65	-705.81	613.08	477.49	146.78	46.02		
Schwarz info criterion	1706.01	1398.39	-405.74	-673.77	642.67	506.23	169.07	67.46		
Observations	572	520	286	260	198	180	88	80		

The *t*-statistics are in parentheses. \*, \*\*, \*\*\* denotes significance at the 10%, 5% and 1% level.

Table 9: Ordered probit model results for the determinants of credit ratings

Expected signal		All sample			Pre-crisis			Crisis			Post-crisis		
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)				
<b>Moody's Ratings</b>													
Moody's													
GDP growth		+	-0.07 (-1.03)	0.02 (0.21)	0.13 (0.88)	0.32 (1.09)	-0.01 (-0.18)	0.29** (2.94)	-0.47** (-2.66)	-0.87*** (-3.57)			
GDP per capita		+	0.52*** (10.71)	0.53*** (9.66)	2.65*** (8.21)	2.28*** (7.05)	0.47*** (5.84)	0.47*** (4.77)	-0.59*** (-3.38)	-0.99*** (-3.75)			
Gov. Surplus		+	0.02 (1.47)	0.01 (0.55)	-0.05 (-1.22)	-0.01 (-0.28)	-0.00 (-0.02)	0.00 (0.02)	0.06 (1.63)	0.05 (0.78)			
Inflation		-	0.04 (0.74)	0.08 (1.15)	-0.26 (-1.72)	-0.56* (-2.86)	0.17 (1.82)	0.21 (1.86)	0.12 (0.61)	-0.06 (-0.22)			
Unemployment		-	-0.16*** (-9.90)	-0.11*** (-6.07)	0.52*** (5.27)	0.53*** (5.01)	-0.25*** (-8.36)	-0.25*** (-5.92)	-0.88*** (-6.02)	-1.26*** (-4.52)			
Gov. Debt		-	-0.07*** (-20.11)	-0.07*** (-19.68)	-0.20*** (-8.55)	-0.18*** (-6.70)	-0.09*** (-13.43)	-0.11*** (-10.44)	-0.32*** (-6.00)	-0.47*** (-4.68)			
External balance		+	-0.06*** (-6.79)	-0.06*** (-6.50)	0.16*** (4.72)	0.17*** (4.32)	-0.16*** (-9.69)	-0.15*** (-7.68)	0.06 (1.47)	0.14 (1.82)			
10-year yield spread		-	-0.23** (-3.04)	-0.46*** (-6.83)	0.43 (0.71)	1.87* (2.37)	-0.21 (-1.83)	-0.67*** (-6.03)	-0.91*** (-2.73)	-2.08*** (-3.67)			
pseudo-R-squared			0.52	0.51	0.81	0.80	0.55	0.60	0.79	0.85			
p-Value			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00			
Akaike's info criterion			1044.38	816.37	142.82	107.98	417.75	299.56	117.94	78.17			
Schwarz info criterion			1179.20	931.22	190.35	147.15	516.40	382.58	165.01	116.28			
Observations			572	520	286	260	198	180	88	80			

The *t*-statistics are in parentheses. \*, \*\*, \*\*\* denotes significance at the 10%, 5% and 1% level.

# Appendix A

Table A.1: Descriptive statistics for the entire sample period

	Obs.	Mean	Var.	Std. Dev.	Minimum	Maximum
10 year bond yield	611	4.20	6.72	2.59	0.00	34.96
10 year bond yield spread	572	1.15	8.21	2.86	−0.66	33.13
GDP growth	624	0.23	1.17	1.08	−6.90	5.90
GDP per capita	624	7.26	3.32	1.82	3.30	11.40
Gov. Surplus	624	−3.79	29.34	5.42	−43.10	10.80
Inflation	624	0.49	0.66	0.81	−2.10	3.60
Unemployment	624	8.82	21.94	4.68	2.50	27.90
Gov. Debt	624	76.59	947.21	30.78	23.70	177.40
External balance	624	2.58	144.96	12.04	−19.81	51.50
Moody's Ratings	624	19.99	14.62	3.82	2.00	22.00
S&P	624	19.89	12.36	3.52	1.00	22.00
Fitch Ratings	624	20.14	10.27	3.21	5.00	22.00

Table A.2: Descriptive statistics pre-crisis period

	Obs.	Mean	Var.	Std. Dev.	Minimum	Maximum
10 year bond yield	306	4.19	0.35	0.59	0.00	5.57
10 year bond yield spread	286	0.11	0.07	0.26	−0.66	1.14
GDP growth	312	0.61	0.78	0.88	−4.10	5.90
GDP per capita	312	6.94	3.11	1.76	3.30	11.40
Gov. Surplus	312	−1.90	17.56	4.19	−18.10	10.80
Inflation	312	0.63	0.54	0.74	−1.40	2.50
Unemployment	312	7.23	5.20	2.28	2.60	12.00
Gov. Debt	312	63.86	646.12	25.42	23.70	110.50
External balance	312	1.79	128.16	11.32	−19.81	47.11
Moody's Ratings	312	21.24	1.61	1.27	17.00	22.00
S&P Ratings	312	21.04	2.39	1.55	17.00	22.00
Fitch Ratings	312	21.09	2.02	1.42	17.00	22.00

Table A.3: Descriptive statistics crisis period

	Obs.	Mean	Var.	Std. Dev.	Minimum	Maximum
10 year bond yield	209	4.75	15.95	3.99	1.32	34.96
10 year bond yield spread	198	2.40	18.23	4.27	0.07	33.13
GDP growth	216	−0.28	1.60	1.26	−6.90	3.20
GDP per capita	216	7.50	3.00	1.73	3.90	10.30
Gov. Surplus	216	−6.48	38.26	6.19	−43.10	4.50
Inflation	216	0.46	0.76	0.87	−1.70	3.60
Unemployment	216	9.72	25.19	5.02	2.50	26.30
Gov. Debt	216	83.81	808.05	28.43	28.80	170.30
External balance	216	2.18	140.80	11.87	−17.80	41.95
Moody's Ratings	216	19.52	19.03	4.36	2.00	22.00
S&P Ratings	216	19.31	16.94	4.12	1.00	22.00
Fitch Ratings	216	19.79	12.88	3.59	5.00	22.00



Table A.4: Descriptive statistics post-crisis period

	Obs.	Mean	Var.	Std. Dev.	Minimum	Maximum
10 year bond yield	96	3.03	5.09	2.26	0.54	12.44
10 year bond yield spread	88	1.75	4.88	2.21	0.11	11.15
GDP growth	96	0.18	0.44	0.66	-3.70	2.30
GDP per capita	96	7.72	4.14	2.04	3.70	10.40
Gov. Surplus	96	-3.88	20.06	4.48	-29.80	4.50
Inflation	96	0.11	0.64	0.80	-2.10	1.90
Unemployment	96	11.93	49.97	7.07	4.80	27.90
Gov. Debt	96	101.70	979.78	31.30	53.80	177.40
External balance	96	6.04	197.93	14.07	-17.92	51.50
Moody's Ratings	96	17.02	33.02	5.75	2.00	22.00
S&P Ratings	96	17.48	23.97	4.90	7.00	22.00
Fitch Ratings	96	17.83	22.94	4.79	5.00	22.00

Table A.5: Correlation matrix

	10 year bond yield spread	GDP growth	GDP per capita	Gov. surplus	Inflation	Unemp.	Gov. debt	External balance	Moody's Ratings	S&P Ratings	Fitch Ratings
10 year bond yield spread	1.0000										
GDP growth	-0.3251	1.0000									
GDP per capita	-0.2644	0.1014	1.0000								
Gov. Surplus	-0.3126	0.2270	0.2151	1.0000							
Inflation	-0.0449	0.0989	-0.0104	0.0390	1.0000						
Unemployment	0.5934	-0.1794	-0.4797	-0.3566	-0.1254	1.0000					
Gov. Debt	0.5211	-0.1963	-0.3683	-0.3357	-0.0798	0.5157	1.0000				
External balance	-0.0024	0.0259	0.2907	0.1642	-0.0786	-0.0849	-0.0368	1.0000			
Moody's Ratings	-0.7761	0.2194	0.4413	0.3129	0.0996	-0.7565	-0.7569	0.0783	1.0000		
S&P Ratings	-0.7765	0.2408	0.5198	0.3367	0.0835	-0.7385	-0.7785	0.1199	0.9686	1.0000	
Fitch Ratings	-0.7467	0.2066	0.4972	0.3327	0.0937	-0.7508	-0.7816	0.1029	0.9836	0.9774	1.0000
<i>N</i>	624										

Table A.6: Correlation matrix pre-crisis

	10 year bond yield spread	GDP growth	GDP per capita	Gov. surplus	Inflation	Unemp.	Gov. debt	External balance	Moody's Ratings	S&P Ratings	Fitch Ratings
10 year bond yield spread	1.0000										
GDP growth	0.0187	1.0000									
GDP per capita	0.0051	0.1070	1.0000								
Gov. Surplus	-0.1204	0.1660	0.3716	1.0000							
Inflation	0.0464	-0.0671	-0.0338	-0.0937	1.0000						
Unemployment	-0.1526	0.0030	-0.5692	-0.1025	0.0109	1.0000					
Gov. Debt	-0.2296	-0.0949	-0.4603	-0.3863	0.0355	0.3778	1.0000				
External balance	-0.4277	-0.0468	0.2687	0.1126	-0.0983	0.0552	0.0168	1.0000			
Moody's Ratings	0.0284	0.0146	0.6420	0.4100	-0.1099	-0.3138	-0.7193	0.2439	1.0000		
S&P Ratings	0.0606	0.0265	0.6483	0.3912	-0.1266	-0.3261	-0.7081	0.2650	0.9655	1.0000	
Fitch Ratings	0.0354	0.0101	0.6287	0.3903	-0.1073	-0.3432	-0.7656	0.2425	0.9745	0.9618	1.0000
<i>N</i>	312										

Table A.7: Correlation matrix crisis

	10 year bond yield spread	GDP growth	GDP per capita	Gov. surplus	Inflation	Unemp.	Gov. debt	External balance	Moody's Ratings	S&P Ratings	Fitch Ratings
10 year bond yield spread	1.0000										
GDP growth	-0.2773	1.0000									
GDP per capita	-0.4472	0.2571	1.0000								
Gov. Surplus	-0.2017	0.0387	0.2249	1.0000							
Inflation	0.0705	0.1601	0.0046	0.0705	1.0000						
Unemployment	0.6130	-0.1476	-0.5803	-0.4000	0.0243	1.0000					
Gov. Debt	0.6354	-0.0973	-0.4631	-0.1641	0.1186	0.3294	1.0000				
External balance	0.0261	0.1162	0.3455	0.2072	-0.0510	-0.2180	-0.1639	1.0000			
Moody's Ratings	-0.8825	0.2453	0.5273	0.2388	-0.0715	-0.6822	-0.7465	0.1023	1.0000		
S&P Ratings	-0.8879	0.2720	0.6325	0.2689	-0.0590	-0.6593	-0.7849	0.1669	0.9625	1.0000	
Fitch Ratings	-0.8687	0.2425	0.5695	0.2831	-0.0619	-0.6778	-0.7631	0.1273	0.9812	0.9705	1.0000
<i>N</i>	216										

Table A.8: Correlation matrix post-crisis

	10 year bond yield spread	GDP growth	GDP per capita	Gov. surplus	Inflation	Unemp.	Gov. debt	External balance	Moody's Ratings	S&P Ratings	Fitch Ratings
10 year bond yield spread	1.0000										
GDP growth	-0.2651	1.0000									
GDP per capita	-0.7557	0.1345	1.0000								
Gov. Surplus	-0.4377	0.1833	0.3223	1.0000							
Inflation	-0.2766	0.1466	0.2277	0.0216	1.0000						
Unemployment	0.7717	-0.1468	-0.8016	-0.3907	-0.2528	1.0000					
Gov. Debt	0.7757	-0.1196	-0.7094	-0.2949	-0.2305	0.6752	1.0000				
External balance	-0.1087	0.0530	0.2089	0.3352	0.0426	-0.2097	-0.2140	1.0000			
Moody's Ratings	-0.8757	0.1555	0.8028	0.3844	0.2661	-0.8685	-0.9089	0.1653	1.0000		
S&P Ratings	-0.8274	0.1442	0.8507	0.3373	0.2585	-0.8801	-0.8806	0.1525	0.9792	1.0000	
Fitch Ratings	-0.8640	0.1438	0.8347	0.3618	0.2736	-0.8771	-0.8979	0.1666	0.9925	0.9890	1.0000
<i>N</i>	96										

Table A.9: Correlation matrix for the 10 year government bond spreads

	Austria	Belgium	Finland	France	Greece	Ireland	Italy	Netherlands	Portugal	Spain	U.K.
Austria	1.0000										
Belgium	0.8843	1.0000									
Finland	0.9158	0.7579	1.0000								
France	0.8424	0.9388	0.7193	1.0000							
Greece	0.7101	0.9250	0.5258	0.9043	1.0000						
Ireland	0.7243	0.8573	0.5630	0.7751	0.8420	1.0000					
Italy	0.7509	0.9178	0.6077	0.9603	0.9430	0.8087	1.0000				
Netherlands	0.8932	0.7804	0.9182	0.7923	0.5594	0.5869	0.6865	1.0000			
Portugal	0.7235	0.9313	0.5515	0.9072	0.9688	0.8948	0.9427	0.6144	1.0000		
Spain	0.6996	0.8621	0.5508	0.9068	0.8831	0.8665	0.9535	0.6623	0.9208	1.0000	
U.K.	-0.3978	-0.3271	-0.4495	-0.2022	-0.1920	-0.3131	-0.1198	-0.3244	-0.1809	-0.1517	1.0000
$N$	52										

Table A.10: Correlation matrix for the 10 year government bond spreads pre-crisis

	Austria	Belgium	Finland	France	Greece	Ireland	Italy	Netherlands	Portugal	Spain	U.K.
Austria	1.0000										
Belgium	0.6803	1.0000									
Finland	0.6773	0.7637	1.0000								
France	0.6249	0.9438	0.7182	1.0000							
Greece	0.4552	0.8116	0.5808	0.8051	1.0000						
Ireland	0.4067	0.5543	0.4151	0.4828	0.4393	1.0000					
Italy	0.0567	0.3515	0.0741	0.3976	0.7688	0.2516	1.0000				
Netherlands	0.7242	0.9529	0.7495	0.9095	0.7547	0.5227	0.2990	1.0000			
Portugal	0.5947	0.5995	0.3369	0.5175	0.3809	0.2398	0.1111	0.6519	1.0000		
Spain	0.6843	0.9453	0.8033	0.8960	0.8170	0.4709	0.3935	0.8909	0.5307	1.0000	
U.K.	-0.3997	-0.5244	-0.6856	-0.4692	-0.2648	-0.3916	0.1905	-0.5052	-0.1319	-0.5331	1.0000
$N$	26										

Table A.11: Correlation matrix for the 10 year government bond spreads crisis

	Austria	Belgium	Finland	France	Greece	Ireland	Italy	Netherlands	Portugal	Spain	U.K.
Austria	1.0000										
Belgium	0.6854	1.0000									
Finland	0.8342	0.3123	1.0000								
France	0.6886	0.8838	0.2928	1.0000							
Greece	0.4614	0.9321	0.0430	0.8880	1.0000						
Ireland	0.1185	0.6290	-0.2078	0.5221	0.7398	1.0000					
Italy	0.5132	0.8953	0.1194	0.9270	0.9623	0.6914	1.0000				
Netherlands	0.8212	0.3293	0.8897	0.3600	0.0716	-0.1077	0.1262	1.0000			
Portugal	0.4045	0.8990	0.0190	0.8297	0.9618	0.8453	0.9161	0.0748	1.0000		
Spain	0.2606	0.7005	-0.1280	0.7626	0.8367	0.8309	0.8835	-0.0069	0.8618	1.0000	
U.K.	-0.6353	-0.4015	-0.6320	-0.4280	-0.2855	-0.2138	-0.3470	-0.6587	-0.2511	-0.2167	1.0000
$N$	18										

Table A.12: Correlation matrix for the 10 year government bond spreads post-crisis

	Austria	Belgium	Finland	France	Greece	Ireland	Italy	Netherlands	Portugal	Spain	U.K.
Austria	1.0000										
Belgium	0.9056	1.0000									
Finland	0.6534	0.8437	1.0000								
France	0.8579	0.9212	0.7650	1.0000							
Greece	0.3975	0.5062	0.1227	0.3876	1.0000						
Ireland	0.8934	0.9751	0.7417	0.9108	0.6265	1.0000					
Italy	0.8791	0.9201	0.5871	0.8674	0.7322	0.9772	1.0000				
Netherlands	0.8597	0.9836	0.8660	0.9318	0.4490	0.9654	0.8960	1.0000			
Portugal	0.9185	0.8961	0.5358	0.8559	0.6027	0.9143	0.9456	0.8526	1.0000		
Spain	0.8794	0.9403	0.6498	0.9142	0.6800	0.9850	0.9897	0.9205	0.9313	1.0000	
U.K.	-0.7602	-0.9016	-0.6240	-0.8120	-0.8217	-0.9456	-0.9580	-0.8720	-0.8715	-0.9527	1.0000
$N$	8										

Table A.13: Correlation matrix for Moody's Ratings

	Austria	Belgium	Finland	France	Germany	Greece	Ireland	Italy	Netherlands	Portugal	Spain	U.K.
Austria	.											
Belgium	.	1.0000										
Finland	.	.	.									
France	.	0.7924	.	1.0000								
Germany	.	.	.	.	.							
Greece	.	0.8905	.	0.6934	.	1.0000						
Ireland	.	0.8433	.	0.6311	.	0.9768	1.0000					
Italy	.	0.9753	.	0.8754	.	0.8840	0.8264	1.0000				
Netherlands	.	.	.	.	.	.	.	.	.			
Portugal	.	0.9243	.	0.7202	.	0.9824	0.9732	0.9121	.	1.0000		
Spain	.	0.9659	.	0.8171	.	0.9354	0.8932	0.9778	.	0.9526	1.0000	
U.K.	.	0.7385	.	0.9320	.	0.6333	0.5742	0.8159	.	0.6635	0.7549	1.0000
N	52											

Table A.14: Correlation matrix for Standard &amp; Poor's Ratings

	Austria	Belgium	Finland	France	Germany	Greece	Ireland	Italy	Netherlands	Portugal	Spain	U.K.
Austria	1.0000											
Belgium	0.9536	1.0000										
Finland	0.2663	0.3778	1.0000									
France	0.9282	0.8717	0.3437	1.0000								
Germany	0.0862	0.3821	0.4331	0.0357	1.0000							
Greece	0.7841	0.8117	0.2555	0.6873	0.2794	1.0000						
Ireland	0.7954	0.8079	0.2103	0.7079	0.2321	0.9692	1.0000					
Italy	0.9116	0.8707	0.3345	0.8924	0.0832	0.8160	0.8275	1.0000				
Netherlands	0.5979	0.6103	0.4598	0.8411	0.1842	0.4308	0.4482	0.6451	1.0000			
Portugal	0.8837	0.8676	0.2665	0.8172	0.1587	0.9534	0.9702	0.9209	0.5408	1.0000		
Spain	0.9643	0.9080	0.2377	0.9115	0.0449	0.7950	0.8445	0.8894	0.6031	0.9079	1.0000	
U.K.	.	.	.	.	.	.	.	.	.	.	.	.
N	52											

Table A.15: Correlation matrix for Fitch Ratings

	Austria	Belgium	Finland	France	Germany	Greece	Ireland	Italy	Netherlands	Portugal	Spain	U.K.
Austria	.											
Belgium	.	1.0000										
Finland	.	.	.									
France	.	0.2691	.	1.0000								
Germany	.	.	.	.	.							
Greece	.	0.2811	.	0.4846	.	1.0000						
Ireland	.	0.0966	.	0.4372	.	0.9397	1.0000					
Italy	.	0.2456	.	0.6585	.	0.9071	0.8124	1.0000				
Netherlands	.	.	.	.	.	.	.	.	.			
Portugal	.	0.2541	.	0.5331	.	0.9767	0.9441	0.8878	.	1.0000		
Spain	.	0.4440	.	0.5987	.	0.9371	0.8052	0.9490	.	0.8968	1.0000	
U.K.	.	0.3295	.	0.8497	.	0.6208	0.5569	0.8063	.	0.6528	0.7565	1.0000
$N$	52											

Table A.16: Correlation matrix for Moody's Ratings pre-crisis

	Austria	Belgium	Finland	France	Germany	Greece	Ireland	Italy	Netherlands	Portugal	Spain	U.K.
Austria	.											
Belgium	.	.										
Finland	.	.	.									
France	.	.	.	.								
Germany	.	.	.	.	.							
Greece	.	.	.	.	.	1.0000						
Ireland	.	.	.	.	.	.	.					
Italy	.	.	.	.	.	0.5538	.	1.0000				
Netherlands	.	.	.	.	.	.	.	.	.			
Portugal	.	.	.	.	.	.	.	.	.	.		
Spain	.	.	.	.	.	.	.	.	.	.	.	
U.K.	.	.	.	.	.	.	.	.	.	.	.	.
$N$	8											

Table A.17: Correlation matrix for Moody's Ratings crisis

	Austria	Belgium	Finland	France	Germany	Greece	Ireland	Italy	Netherlands	Portugal	Spain	U.K.
Austria	.											
Belgium	.	1.0000										
Finland	.	.	.									
France	.	0.3911	.	1.0000								
Germany	.	.	.	.	.							
Greece	.	0.7842	.	0.3373	.	1.0000						
Ireland	.	0.7151	.	0.2797	.	0.9510	1.0000					
Italy	.	0.9521	.	0.5319	.	0.8055	0.7195	1.0000				
Netherlands	.	.	.	.	.	.	.	.	.			
Portugal	.	0.8402	.	0.3400	.	0.9631	0.9540	0.8431	.	1.0000		
Spain	.	0.9106	.	0.4555	.	0.8788	0.8103	0.9571	.	0.8967	1.0000	
U.K.	.	.	.	.	.	.	.	.	.	.	.	.
<i>N</i>	18											

Table A.18: Correlation matrix for Moody's Ratings post-crisis

	Austria	Belgium	Finland	France	Germany	Greece	Ireland	Italy	Netherlands	Portugal	Spain	U.K.
Austria	.											
Belgium	.	.										
Finland	.	.	.									
France	.	.	.	.								
Germany	.	.	.	.	.							
Greece	.	.	.	.	.	1.0000						
Ireland	.	.	.	.	.	0.8340	1.0000					
Italy	.	.	.	.	.	.	.	.				
Netherlands	.	.	.	.	.	.	.	.	.			
Portugal	.	.	.	.	.	0.8347	0.9612	.	.	1.0000		
Spain	.	.	.	.	.	0.8006	0.8980	.	.	0.7646	1.0000	
U.K.	.	.	.	.	.	.	.	.	.	.	.	.
<i>N</i>	8											