On the Explanatory Power of Sovereign Credit Ratings

Master Thesis International Economics

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Abstract

Sovereign credit ratings for developed economies have been highly volatile during the recent years of economic crisis. The extent to which these ratings affect sovereign bond yields is not clear-cut. Investigating data for Portugal, Italy, Ireland, Greece and Spain with respect to Germany, for the period 7/13/2006 – 5/14/2012, it is found that sovereign credit ratings have significant, independent explanatory power with respect to sovereign bond yield spreads, over and above their correlation with other publicly available information. The direction of the causal effect is found to run from sovereign credit ratings to bond yield spreads. Credit ratings fully capture the effect of sovereign debt; they complement the effects of contagion, ECB policy, liquidity, current account balance, GDP growth and unemployment measures.

Keywords: Credit rating, sovereign bond yield spread.

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1. Introduction

Sunday night the 14th of September 2008. In a desperate last attempt to save the 158 year old investment bank under his command, Dick Fuld contacts friends and foes, anyone that might be willing to extend a sorely needed helping hand. The problems, however, are too big for anyone to handle. Monday afternoon, at 12.30 a press release is send out with a clear message: Lehman Brothers will seek bankruptcy protection. That same day stock prices plunge, a company worth $46 billion half a year earlier, is now valued at about $150 million (White and Grynbaum, 2008). The event reveals the true nature of the financial problems the world is facing. What was long seen as trouble in the US sub-prime mortgage market has evolved into a worldwide credit crisis. It is clear that the crisis will affect all kinds of financial stakeholders.

As one of these stakeholders, governments of Western countries are in trouble. As local economies dwindle, tax revenues fall when large investments to save the financial system and expansionary policy to stimulate the economy are desperately needed. Already heavily indebted sovereigns have no other option but to turn to the bond markets for financing.

Friday the 16th of October 2009. In a courageous first speech in parliament as the new prime-minister of Greece, George Papandreou announces the country is facing severe fiscal problems. Days later it is announced that the budget deficit for 2009 is revised to 12.7% of GDP, double the previous estimate (Thomas, 2011). The event reveals how the crisis, which started in the US mortgage market, has triggered and exposed deep financial problems for sovereigns. The worldwide credit crisis transforms into a European sovereign debt crisis. The diversion of sovereign bond yields in the euro-zone that started in 2008, after a period of conversion since the introduction of the European Economic and Monetary Union (EMU), intensifies in the years that follow (see Figure 2.1).

These events set the scene for the period under investigation in this paper. They re-ignited the debate on the factors that influence sovereign bond yields in developed economies. Not only the level of sovereign debt, but also factors like budget deficits, GDP growth, unemployment levels, the current account balance, contagion, liquidity, and global risk aversion all appear to affect the yield on sovereign bonds (Maltritz, 2011).

A factor that received considerable attention in these years of economic crisis are sovereign credit ratings. Over the past few years, many people in European countries have become accustomed to news bulletins opening with a line like ”Moody’s Again Reduces Greece’s Credit Rating” (Jolly, 2011). As it appears, the terms credit rating, outlook, AAA, S&P, Moody’s and Fitch have found their way to become mainstream language, where these terms were only used *without* explanation in the small niche of the financial world not so long ago. Credit ratings seem to be

interpreted as an important and valuable piece of information by many. Most notably, politicians will make considerable effort to obtain a favourable sovereign credit rating. As an illustration, consider what was coined the "Kunduz agreement" in the Netherlands. Five Dutch political parties managed to put together a package of budget cuts worth over 12 billion euros in just one week, just in time for the deadline set by Brussels. One of many arguments justifying this historical agreement was the fear of losing the beloved AAA status.

Credit ratings are a measure of default risk; as such they are determined by a whole range of other indicators complemented by the specialist knowledge of the rating agencies (IMF, 2010). They may be interpreted as a summary statistic based on factors that themselves have a direct impact on, in this case, sovereign bond yields. However, it may also be that the ratings are more than that; they may have an effect on sovereign bond yields of their own.

This paper investigates the importance of sovereign credit ratings in determining bond yield spreads. Specifically it will try to unravel if sovereign credit ratings have some independent explanatory power with respect to sovereign bond yield spreads over and above their correlation with other publicly available information in the euro-zone. Furthermore we investigate if this explanatory power can be explained by a causal effect of credit ratings on sovereign bond yields.

The results of this analysis may be of importance for a variety of stakeholders. First and foremost, they will explore if the stance of governments with respect to credit ratings, as illustrated by the Dutch example, is legitimized. Furthermore the outcome may justify the call for further regulation of rating agencies (Mathis et al., 2009). Second, academics investigate an endless range of factors influencing bond yield spreads. Some take into account credit ratings or use it as the sole proxy measuring default risk, often legitimizing this choice with the paper by Cantor and Packer (1996) that provides evidence for the explanatory power of sovereign credit ratings. Others do not include the rating scores all together. More profound evidence on this relationship should indicate which stance is correct. Besides these two stakeholders, investors and rating agencies may benefit from more clarity on this subject.

A panel dataset for Portugal, Italy, Ireland, Greece and Spain, five countries that were severely hit by the crisis, is investigated with respect to Germany. The data run from 3th of July 2006 to the 14th of August 2012. First it is verified if regression analyses will provide accurate results by performing unit root tests and co integration analyses. We then thoroughly test the explanatory power of credit ratings by comparing the results of a baseline model, which excludes credit ratings as an explanatory variable, to an ordinal, residual and dummy model. The ordinal model will include a logistically transformed rating score, the residual model includes the residual from a regression of these rating

scores on fundamentals as a measure of the additional information included in the credit rating, and finally the dummy model includes dummy variables for the various rating scores.

In addition we investigate if the results found in these regressions are the result of endogeneity of credit ratings to bond yield spreads. We use lagged versions of the credit ratings scores as instruments in models based on Two-Stage-Least-Squares (TSLS) and the Generalized Method of Moments (GMM). If these models are effective, we can substantiate our findings with evidence regarding the direction of the causal effect. A range of robustness checks is performed to further validate the results found.

The results indicate that the rating scores have a significant effect on bond yield spreads for the ordinal and residual models, the results for the dummy model do not provide further evidence for this finding. Moreover, the 2nd to 4th lag of the rating scores are found to be effective, exogenous instruments, it can therefore be concluded that there is a causal effect of the ratings scores on bond yield spreads. Notwithstanding the results of the dummy model, it may be concluded that this paper presents strong evidence that sovereign credit ratings have independent explanatory power with respect to sovereign bond yield spreads over and above their correlation with other publicly available information in the euro-zone.

The remainder of this paper is organized as follows: Section 2 provides background information on bond yield spreads and a literature review on the risk factors that influence sovereign bond yields. Section 3 indicates how credit ratings are composed, why they are important and how they developed during the euro crisis, furthermore a literature review on the link between credit ratings and yield spreads is provided. Section 4 discusses theoretical arguments in favour and against the presence of explanatory power of credit ratings, a more complete justification for the importance of this subject and a comprehensive overview of all differences with previous research. Section 5 describes the data. Section 6 presents the methodology and results. Section 7 concludes.

2. Sovereign bond yield spreads

This first section will discuss sovereign bond yield spreads. When a definition of the concept is given and the importance and potential impact of changes in the spread are explained in Section 2.1, we will turn to the development of the European financial markets in Section 2.2 and zoom in on the evolution of the sovereign bond yield spreads in Section 2.3. To understand the dynamics of these spreads the factors affecting yields will be discussed in Section 2.4. Since we are interested in default risk in particular, as credit ratings are a measure of this factor, we will examine this factor in more detail in Section 2.5.

2.1. Background

A sovereign bond is a negotiable debt security issued by governments; they are the main medium-term market financing vehicles used particularly in the five-to-ten year segment (Vernimmen et al., 2005). The sovereign bond yield spread represents the difference between bond yields issued on international markets by one country versus those offered by a benchmark government. The use of spreads with a benchmark ensures that some of the overall market tendencies are absorbed compared to an investigation using absolute yield rates. As Bernoth et al. (2012) put it, "looking at the response of interest rate levels does not necessarily yield evidence of how markets price sovereign risk." Consider as an illustration the introduction of more investor friendly fiscal policy in the EMU may increase bond yields in all member countries because it has become more attractive for investors to invest in euro-zone bonds. This, however, does not reflect any changes in the risk involved in those investments. If one wants to measure risk premiums, which is the case in this paper, these effects should be removed by looking at the spreads between bonds.

Small changes in bond yields may have a large impact on total cost of borrowing for sovereigns. Codogno et al. (2003) point out that the small pre-crisis differentials of a tenth of a per cent may already have substantial impact on the cost of borrowing. If these changes can be considered important, consider the Greek debt of about 125% of GDP in 2012 and yields peaking at 40% in May 2012. In the theoretical case where the entire debt would have to be paid this interest rate, which is not the case in practice since older debt is paid a historical, much lower interest rate, the government budget that has to be reserved for interest payments on debt alone would have to be a stunning 50 % of total GDP.

2.2. Financial market integration in the EU

The benefits of financial market integration; risk sharing, improvements in allocation efficiency, reduction in transaction costs and macroeconomic volatility are widely accepted (Prasad et al., 2003). For these reasons Europe has strived to integrate its markets, with the introduction of the EMU and the euro. This development has had its effect on the European bond market we are investigating in this paper. The degree of bond market integration will be important when selecting factors affecting bond yield spreads for our investigation, as we will see in Section 2.4.

As is pointed out by the National Institute of Economic & Social Research (NIESR, 1996) the first stages of this economic integration dealt with barriers to trade in goods. The European Commission started to address competition and co-ordination of industrial and trade policy in the 1960s and 1970s. In the 1980s the focus moved to financial sector, promoting competition and factor mobility. By the end of this decade free capital mobility was a reality in a large part of Western Europe.

Financial market segmentation persisted however, particularly as a result of the exchange rate risk between all the different currencies within the EU. This did not change until the introduction of the EMU that was completed in 1999 and converged the exchange rates of the participating countries. However, even with a common currency, the euro, complete integration has not been realized yet due to the different regulations and institutions in the member states. If financial integration is defined as "a situation in which financial instruments with the same risk and return trade at the same price (Law of One Price), Guiso et al. (2004) conclude that within the EMU full integration has not been achieved so far. Some sectors, however, have come a very long way; in particular the sovereign bond market has become highly integrated since the introduction of the euro.

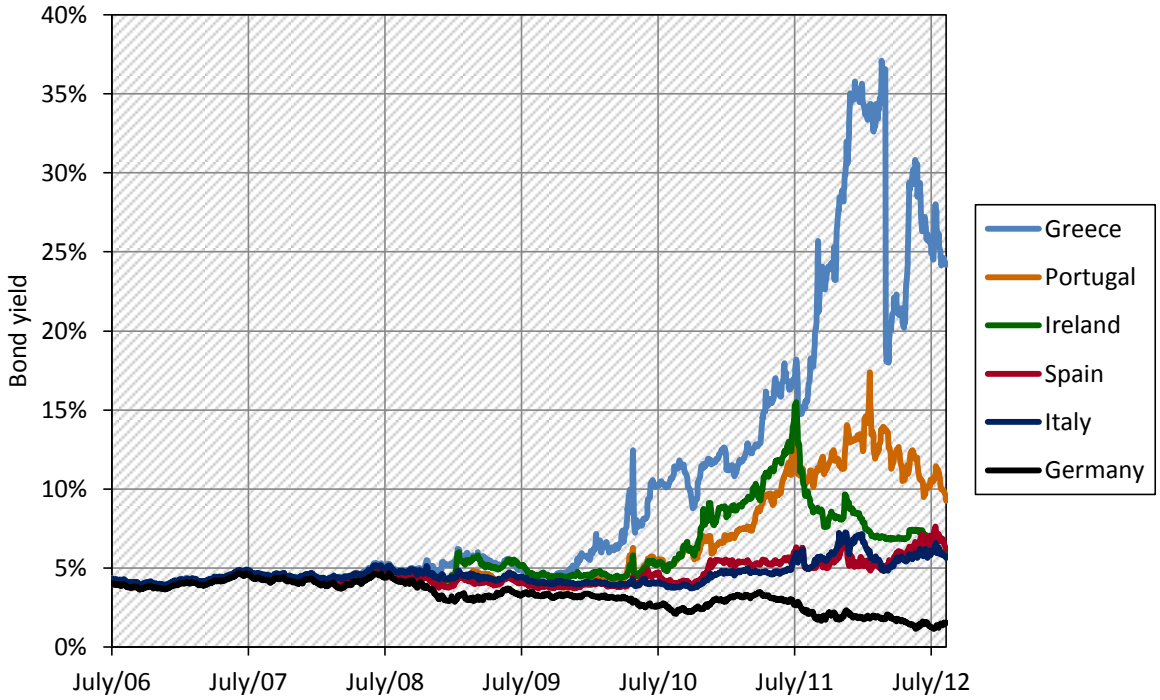
Numerous authors provide statistical evidence for the increase in bond market integration. Abad et al. (2009) compare the relative importance of two sources of systemic risk for yield spreads. They differentiate between world and euro-zone risk and investigate their importance in EMU and non-EMU countries. They find that euro-zone countries are less vulnerable to world risk factors and more so to euro-zone risk factors. The opposite is true for non-EMU countries, suggesting a positive impact of the introduction of the euro on the degree of financial integration of the European government bond markets. Kim et al. (2004) find evidence of "strong contemporaneous and dynamic linkages between euro-zone bond markets with that of Germany".

2.3. Development of yield spreads

As a result of the financial integration in Europe, yields on sovereign bonds issued by EMU member states converged during the 1990s, up until the point where the rates almost equalized as of January 1999. These minor differences in the yields are a strong indication that financial markets assessed the sovereign bonds of different EMU member states as substitutes. The yields remained relatively constant during the first years of the 21th century. However, if we take look at the rates starting from September 2008 and beyond, the picture will change drastically. As we can see from Figure 2.1, bond yields started diverging. A deepening of the financial crisis in the years beyond caused yield spreads to increase more and more. Long term Greek bond yield spreads with Germany were more than 40 basis points at the start of 2010. But there was more to come, doubts about the Greek public finances led to another sharp increase of bond yields in Greece. Fluctuations peeked in March 2012, when the return on Greek sovereign bonds in secondary markets reached an astonishing 37.1%. The problems started spreading and some euro-zone countries with weak fundamentals saw borrowing costs rising. The countries that where hit most severely were coined the PIIGS: Portugal, Italy, Ireland, Greece and Spain. In the meantime, the investors' flight to security put a downward pressure on German bond yields as demand for these relatively safe, AAA rated bonds surged. With

returns on these bonds hovering just above 1% on bonds with a maturity of 10 years, the differences in the euro-zone had never been this big.

Figure 2.1: 10 year maturity sovereign bond yields



10 year maturity sovereign bond yield for Portugal, Italy, Ireland, Greece Spain and Germany. Data provided by Martkit, obtained from Bloomberg. Sample period: 7/13/2006 – 5/14/2012

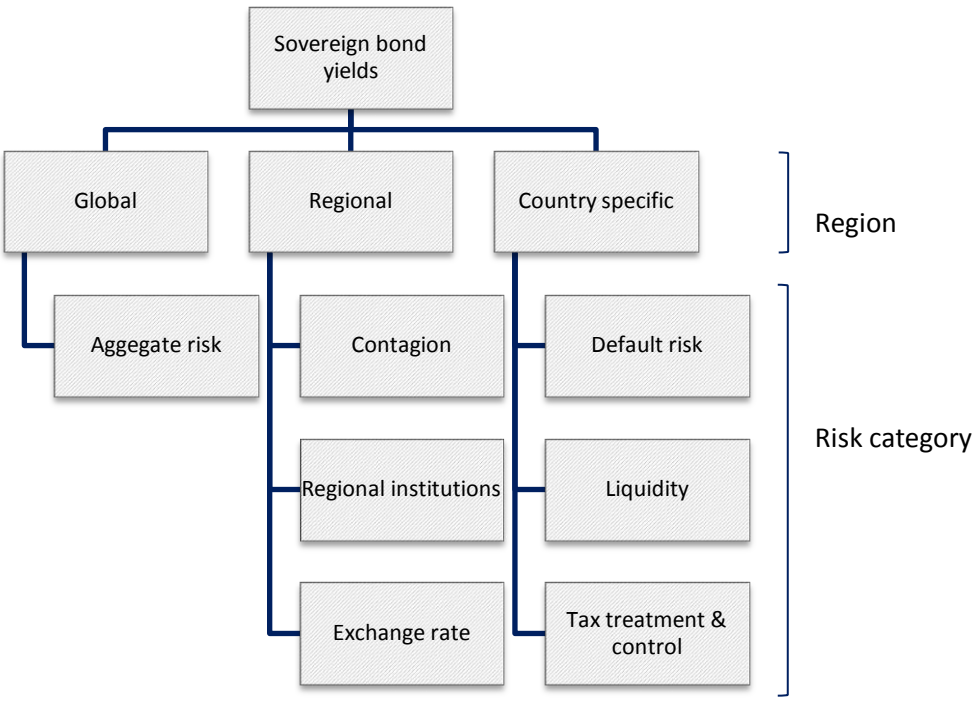
2.4. Factors affecting bond yield spreads

The factors affecting sovereign bond yield spreads can be split into three different categories that are based on the geographic spread of the risk. These are global risk factors, regional risk factors and country specific risk factors. Although the findings of past research provide different insights on the determinants, all can be grouped in one of these three categories. This section will go over all these sources of risk; Figure 2.2 provides an overview of the factors in every category. For the purpose of this paper we are only interested in the behaviour of bond yield spreads in reaction on risk factors in developed countries. There is a vast amount of literature investigating developing economies; this will be left aside since the behaviour of the variables under investigation is fundamentally different in these countries and so are the factors influencing them. Consider for example the possible effects of corruption, lack of institutions, political instability or even war.

2.4.1. Global risk factors

Global risk factors, or aggregate risk factors as these factors are named in most previous literature, are a result of global uncertainty and risk aversion. They reflect the investor's willingness to accept risk, reflected by the investor's risk premium. This risk premium can change over time. In times of great uncertainty, like crisis years, investors are more risk averse and demand a higher premium when enduring a certain level of risk than in times of lower uncertainty. Dungey et al. (2000) provide an examination of this category of risk factors. Investigating movements in spreads on long-term bonds in a number of countries, they decompose spreads into national and global factors. They show that there is strong evidence for the presence of a common international factor in the yield differentials.

Figure 2.2: Factors affecting bond yield spread



2.4.2. Regional risk factors

This branch represents all sorts of "in between" risk factors, that are neither global nor country specific. In the context of this paper it may cover all risk factors influencing the euro-zone or more than one country in the euro-zone. Here we discuss contagion, regional institutions and exchange rate risk.

One of such factors is contagion risk, this factor demanded considerable attention during the recent years of the euro crisis. It is suggested that, as a result of the interdependence between different countries and their economies, changes in one country, for example an increase in the

default risk, may have an impact on the risk born in another country. Arghyrou and Kontonikas (2011) provide a detailed investigation on this subject for the case of the contagion risk of Greece on other euro countries. They add the Greek bond yield spread as a variable to the baseline model for the spreads of bond yields in the other euro-zone countries. They "confirm that the overwhelming majority of EMU countries have experienced contagion from Greece, most prominently Portugal, Ireland and Spain." A result that is confirmed by de Santis (2012).

A second factor in this category stems from the presence of institutions with regional influence on financial markets. Consider the financial integration in the European Union. As we have seen in Section 2.2, the introduction of the euro had an eminent impact on the bond yield differentials in the euro-zone. This can be explained by the notion that markets anticipate financial support for EMU member countries when they experience financial distress. Bernoth et al. (2004) further investigate factors affecting sovereign bond yield spreads in the EU between 1991 and 2002. They provide evidence for the impact of EMU membership on spreads, concluding that EMU members enjoy a lower risk premium than before.

Exposure to fluctuations in exchange rates are also a source of regional risk, as changes in the exchange rate may devaluate holdings of sovereign bonds in a particular devaluating currency. According to the uncovered interest rate parity (UIP) condition, the expected change in exchange rates should be equal to the interest rate differential between foreign and domestic risk-free bonds. There has been a lively debate on UIP, with a large base of empirical work finding evidence that it may not hold entirely, a discussion that started with the paper by Hansen and Hodrick (1980). In reaction explanations like the one by McCallum (1993) followed suit. Although there may not be complete agreement on the topic of UIP in an empirical sense, it is safe to say that economist agree that there is at least some effect of the exchange rate risk on yield spreads, and sovereign bond yield spreads in this particular case. Since we are investigation the euro-zone after the introduction of the euro, this risk factor does not play a role in the investigation at hand.

2.4.3. Country specific risk factors

Country specific risk factors are the most important group of risk factors when it comes to the effect they have on the eventual bond yield spreads. This category covers all factors that can differ by country. It includes default risk, liquidity risk and tax treatment and control.

The most important risk factor in this category is default risk. Default occurs in the event a sovereign is unable to make the required payments on their debt obligations. Investors are exposed to default risk in most forms of credit extensions, this is no different in the sovereign bond market. Credit ratings are a measure of default risk, so it is this specific relation on which this paper aims to

contribute. The literature investigating the effect of default risk on sovereign bond yield spreads will therefore be discussed thoroughly in Section 2.5.

Another widely cited source country specific risk stems from the liquidity in markets. Liquidity risk is constituted by the lack of marketability of an investment. If a particular investment cannot be bought or sold quickly enough to prevent or minimize a loss, investors will want to be compensated for incurring this risk. Research on liquidity goes back decades; consider for example Economides and Siow (1988) who investigate the effect of liquidity factors on the equilibrium outcome of the number of bond- and stock markets. More recently, Favero et al. (2010) find that sovereign bond yields are higher when bonds are less liquid. Bernoth et al. (2012) however, provide evidence that the start of the EMU eliminated liquidity premiums in the euro-zone. So there appears to be some ambiguity on the effect of liquidity risk.

The last factor we will discuss is a result of differences in the tax treatment and control between sovereigns. Since different countries may levy different taxes on the reaps of an investment in sovereign bonds, the return on two otherwise identical bonds may be dissimilar as a result. Since investors are aware of this, they again will want this difference in return to be integrated in the sovereign yield, so that net returns of sovereigns with the same risk are equal. Poterba (1986) examines the effect of changes in tax expectations on yield spreads in the US. "By examining data from four events that substantially altered tax rates (…) this study provides new evidence that both personal and corporate tax changes affect the relative yields on taxable and tax-free bonds."

As has been pointed out before, the financial integration in Europe is poised to eliminate all kinds of market segmenting barriers, including tax treatment and control. Pagano and von Thadden (2004) provide a review of the sources of yield spreads in the euro-zone since the introduction of the euro. They conclude that the small differentials between euro-zone sovereign bonds are a reflection of small differences of fundamental risk. They are not the results of persistent market segmentation. We therefore assume that the effect of tax treatment and control within the euro-zone to be insignificantly small.

This section has introduced all major categories of factors affecting bond yield spreads. We have shown that in light of the purpose of this paper, a global risk factor, regional risk, represented by contagion and EMU policy, and country-specific risk factors, represented by default- and liquidity risk should be taken into account. Exchange rate risk and tax treatment and control are non-essential for our investigation. Credit ratings represent default risk; therefore it is this particular sub-category we are especially interested in. The Section 2.5 will therefore unravel default risk in smaller parts.

2.5. Factors affecting default risk

For the purpose of this paper we are particularly interested in past research on default risk. Recall the overview as visualized in Figure 2.2, last section described all risk categories, this section will break down the default risk category one step further. Evidence on this risk factor dates back decades (see for example Burton and Inoue, 1985) and still stands using modern econometric techniques. A nice starting point is Maltritz (2012), which provides an excellent review on the determinants of sovereign yield spreads in the euro-zone using a Bayesian approach. It includes a total of 10 different factors. The top four variables that had the highest probability of inclusion of all variables under investigation, including liquidity factors and global risk factors, are all proxies for default risk.

Since this topic lies at the heart of our investigation an extensive literature review will be presented. We will segment the different veins by the type of indicators that are used to measure default risk. For every indicator an overview of past research will be provided and a more thorough investigation of the most recent papers is presented.

2.5.1. Debt

The most widely used indicators of default risk are the fiscal fundamentals of a country, in particular debt and deficit. The logic is straightforward, a large debt, or a large growth of that debt indicated by a large budget deficit, increases the total burden that rests on the shoulders of a country. The payments of interest rates and repayment of initial debt may become a large chunk of total government expenditures, as the debt grows this may become an unbearable burden, especially in times of economic downturn. For a country in despair, there may be no other option to repay initial debt than by committing to roll over this debt, by issuing new debt. When total debt size passes a certain barrier, or when government revenues start dropping, the country may reach a position in which it is not able to issue any new debt because no-one is willing to lend them anymore. The country may then become unable to repay initial debt and goes into default.

Some preliminary research on the importance of sovereign debt is provided by Goldstein and Woglom (1991) and later Bayoumi et al. (1995). They provide evidence on the spreads of yields in 39 US state bonds. In their research the use of state bonds effectively provides a way to circumvent the exchange rate risk problems. They find a significant positive correlation of the level of indebtedness with these spreads. Their findings are confirmed by Poterba and Rueben (1997) also investigating the USA, and later by Lemmen (1999) examining state bonds in Australia, Canada and Germany. More recent research by Booth et al. (2007) confirm previous findings that bond yield spreads in

Canadian provinces over the federal government respond positively levels to provincial indebtedness.

Alesina et al. (1992) use data on sovereign bond yields denominated in the same currencies in 12 OECD countries, and find a significant, positive correlation with indebtedness. Bernoth et al. (2012) point out however, that it is not clear if the differential between public and private bond yields used properly reflects sovereign risk. Arguing that default risk of private issuers is likely to be correlated with the default risk of their governments.

Codogno et al. (2003) use the fact that exchange rates are eliminated in the euro-zone and conclude that "The risk of default (…) may be reduced only by further convergence in debt ratios." The findings of Codogno et al. are confirmed by an investigation by Gomez-Puig (2008) using data in the years just before the introduction of the euro, until just after the introduction: 1996 – 2001. Investigating swap rate spreads; they validate that in this period there is also evidence for a positive effect of debt on yield spreads.

2.5.2. Deficit

A very complete review of all research with respect to the explanatory power of deficits up until 1989 is provided by Barth et al. (1991). Examining a total of 42 studies, they conclude that in 17 cases there is a "predominately significant, positive" effect of deficits on interest rates, in 6 cases mixed effects are found; and finally in a total of 19 cases a "predominately insignificant or negative" effect is found. It is thereby indicated that there was a lot of ambiguity surrounding this particular relation, with a small majority of research finding an insignificant, or even negative correlation; to the contrary of theoretical predictions.

Since Feldstein (1986) argued that expected future deficits are more likely to have an influence on bond yields than current deficits, more recent research has used some form of expected or forecasted deficit. Gale and Orszag (2002) build on the research provided by Barth et al. (1991), appending it with more recent research and dividing the papers that use an indicator of real time deficit, and those that use some proxy for expected, future deficit. They conclude from this evidence that "despite recent statements to the contrary, the empirical literature on interest rates and deficits provides support for the notion that changes in expected future deficits affect current long-term interest rates." The large difference between the findings of the two extensive literature reviews may be explained by the forward looking nature of markets. As an indicator of possible default, expected future deficits are more relevant than current deficits. The interest payments and, eventually, the principal on the investments made, have to be collected at some future date by the

sovereign as well. More recent papers by Gale and Orszag (2004), Laubach (2004, 2009) and Thomas and Wu (2009) all confirm the conclusions of Gale and Orszag (2002).

It is important to note however, that the before mentioned studies are performed without using the spread of the interest rate with a benchmark. As has been pointed out in Section 2.1, for the purpose of our investigation it is preferred to look at bond yield spreads. Furthermore most of these studies do not distinguish exchange rate risk factors from default risk factors, as they do not use any proxy for exchange rate risk. A study that does take this into account is provided by Heppke-Falk and Hüfner (2004). They use spreads and use interest rates swap rate instead of sovereign bond yields, which strictly follow the interest rate curve but are denominated in the same base currency. The results are in line with results of earlier studies.

2.5.3. Both debt and deficit

Research incorporating both measures as dependent variables, provides an insight if the variables contain information not included in the other variable, or if they are mere substitutes. Ardagna et al. (2007) find positive effects of both deficit and debt, for the latter they indicate that the effect is only present for countries with higher than average debt ratio's. They do not correct for the exchange rate effect and do not use yield spreads, however, the vast time-span of this paper covering over 4 decades from 1960 – 2002, nevertheless make it an interesting read. Balassone et al. (2004) confirm these finding. Laubach (2010) finds that both factors are significant in a recent and very thorough investigation on the United States. Not only does he use a very long time-span, stretching over 30 years. He also controls for the effects of the business cycle, and associated monetary policy actions, on debt, deficits and interest rates.

Von Hagen et al. (2011) find that both measures are significant when investigating the euro-zone during the recent years of the financial and euro crisis. Furthermore they find that "markets penalise fiscal imbalances much more strongly after the Lehman default in September 2008 than before". These latter findings are confirmed by Bernoth et al. (2012) and Bernoth and Erdogan (2012) who use a more thorough semi parametric time-varying coefficient model to identify, to what extent an observed change in the yield spread is due to a shift in macroeconomic fundamentals or due to altering risk pricing.

2.5.4. Other measures of fiscal fundamentals

In addition to measures of debt and (expected) deficit, a number of scholars include other measures of fiscal fundamentals. Lønning (2000) includes a measure of structural budget surplus, which may be an indicator of future expenditures by indicating the stance of economic policy. It is found that

both debt and deficit have a significant effect, whereas the proxy for future expenditures is insignificant. Barrios et al. (2009) find interest payments on public debt, as an additional indicator of the burden of public debt, to be significant. It is not significant, however, when included simultaneously with debt level. The recent paper by Bernoth et al. (2012) use as an additional variable the total debt service payments; the ratio of government debt service to current government revenues that more accurately measures the burden of debt. Although they find a significant effect of this variable, they do not provide a regression including all three explanatory variables simultaneously. Poterba and Rueben (1997) include a measure of state revenue as a fraction of total income, and find it to be statistically significant. Yields are lower when state revenue represents a higher fraction of personal income.

2.5.5. Current account balance and terms of trade growth

The study by Barrios et al. (2009), in addition to variables on debt and deficit, a variable measuring the current account deficit is found to have a significant effect on bond yield spreads in euro-zone countries. Countries with a high current account deficit may have more difficulties restoring fiscal sustainability. This argument is supported by the public finances report of the Directorate-General for Economic and Financial Affairs of the European Commission (DG ECFIN, 2009), which concluded that post-crisis current account adjustments were instrumental to determine a countries' room for expansionary fiscal policy. Maltritz (2012) finds evidence for the significance of the trade balance, which comprises the most important part of the current account. Hilscher and Nosbusch (2010) find a significant correlation between the terms of trade and yield spreads. When the terms of trade increase, a country pays less for imports relative to the earnings on exports, which favours the economy. Maltritz (2012) confirm that growth in terms of trade has a significant effect on spreads.

The current account and terms of trade are connected through the Marshall-Lerner Condition. The Marshall-Lerner condition states that a devaluation of a currency will only have positive effect on the trade balance, if the decrease in value of net export as a result of the devaluation is more than offset by an increase in volume. This is the case when the price elasticity's of exports and imports sum to more than one. If the Marshall-Lerner condition is satisfied then an improvement in the terms of trade will worsen the current account.

2.5.6. GDP growth

As Alesina et al. (1992) suggest, the economic situation of a country may affect the sovereign default risk may. Most studies incorporating emerging market economies include a GDP growth as a dependent variable when analysing yield spreads (see for example Cantor and Packer, 1996, Powell

and Martínez, 2008). In most studies mentioned in this section, that are all executed on developed economies, it is less common to include such a measure. However, a few studies that do include GDP growth find a significant effect of this variable. De Santis (2012) includes expected GDP growth as a robustness check when analysing the effect of contagion on sovereign bond yield spreads in the euro-zone. Bernoth et al. (2004) include a dummy variable for periods of boom and recessions when GDP deviates substantially from the trend.

2.5.7. Unemployment

When investigating the US state bond market Bayoumi et al. (1995) include a measure of the unemployment rate as an explanatory variable and find it to be statistically significant. Poterba and Rueben (1997) confirm this result. They use it as an indicator of the state of the economy that may affect the probability that the state will be able to repay its interest obligations.

2.5.8. Size of the banking sector

In their study investigating the euro-zone Gerlach et al. (2010) find that the size of the banking sector is an important determinant of sovereign bond yield spreads. In their paper they indicate four variables to capture sovereign default risk determinants. In addition to two measures of public finances they also include the size of the banking sector's aggregate balance sheets and the equity ratio as banking-related proxies for sovereign debt and find them to be significant. Markets incorporate the risk that a government will have to rescue a bank and the effect this will have on the creditworthiness of a sovereign. The larger the banking sector the larger this risk.

2.5.9. Other factors

Although it does not fall under country specific risk, contagion by other countries is also a form of default risk. This factor has already been discussed in Section 2.4. Maltritz (2012) includes a number of other variables that he does not find to be significant. These are the average interest rate, inflation, inflation variation, current account, trade balance and openness. A whole range of papers, including the before mentioned, include other insignificant explanatory variables. This section has only discussed those variables that did turn out to exert significance in the respective paper.

This section has revealed a multitude of factors that may affect a sovereign's default risk and thereby the bond yield spreads. Debt, expected deficit, current account, trade of terms growth, GDP growth, unemployment and contagion are found to have a significant effect past research. There is some ambiguity about the effect of current budget deficits. The size of the banking sector and some

alternative fiscal fundamentals operate in the periphery, with single investigations supporting their importance. Now that we have a broad and deep understanding of all factors at play, we may return to the factor that is of specific interest in the current investigation: Sovereign credit ratings.

3. Credit ratings

This section will start with some background information on the history and development of credit ratings and rating agencies, this first part also contains some basic information on the methodology of the ranking systems. In Section 3.2 we examine sovereign credit ratings, discussing their meaning, the way the agencies compose the rankings and how this differs per agency and country. Section 3.3 will give a better insight in the importance of the credit rating agencies; in Section 3.4 their development in the EU is discussed. 3.5 will discuss previous literature on credit ratings as a measure of sovereign default risk. In Section 3.6 we discuss another branch of research; event study analyses. Section 3.7 will move beyond the explanatory power of credit ratings, when discussing the added value of ratings.

3.1. Background

The first known form of credit rating business developed in the mid-19th century; in the wake of the financial crisis of 1837 an agency, which rated the ability of merchants to pay their financial obligations, was established in New York. It was not until the beginning of the 20th century however that the rating business expanded into evaluating securities, the first to do so was John Moody in 1909, rating U.S. railway bonds and later other industrial securities. Moody's was closely followed by what are now still it's most important competitors: Poor's Publishing Company, Standard Statistics Company (later merged into Standard & Poor's) and Fitch Publishing Company all set up business in the 1920's (Cantor and Packer, 1994). During the 20th century the credit rating business has developed into a multi-billion industry with agencies rating thousands of different securities, bonds, structured products and sovereigns. Although there are over 150 rating agencies by now, the three before mentioned agencies represent 95% of total market share (White, 2010).

The rating agencies issue ratings providing information on the probability of default of a particular borrower. Different agencies describe their work in different ways, but these differences are marginal. The definition used by the European Union is very complete and applicable: "credit rating' means an opinion regarding the creditworthiness of an entity, a debt or financial obligation, debt security, preferred share or other financial instrument, or of an issuer of such a debt or financial obligation, debt security, preferred share or other financial instrument, issued using an established and defined ranking system of rating categories" (DG ECFIN, 2009). Credit ratings are

thus a relative rank order on the probability of default as a result of default risk. Other types of risk, like liquidity, exchange rate, tax and control risks are not taken into account. The rating agencies provide these rankings based on an assessment using a range of different agency specific criteria.

These ratings are expressed by the well-known alphabetical identifiers, which differ slightly per agency. The most well-established are those of S&P ranging from AAA for the most credit worthy rating to D indicating default. To be more specific an additional indicator is added, in the case of S&P these come in the form of a plus or minus sign. All three agencies split the rankings in two categories; everything ranging from AAA to BBB is indicated as 'investment grade', rates below BBB as 'speculative grade'. The exact rankings and their meaning can be found in Table 3.1; this table also provides an indication of the probability of default in five years.

Table 3.1: Credit ratings

Interpretation	Rating Symbol		Moody's 5-Year Default Rates (%)		
	S&P/Fitch	Moody's	Idealized	Corporate	Sovereign
Highest quality	AAA	Aaa	0.003	0.086	0.000
High quality	AA+	Aa1	0.003		
	AA	Aa2	0.068		
	AA-	Aa3	0.142	0.247	0.000
Strong payment capacity	A+	A1	0.261		
	A	A2	0.467		
	A-	A3	0.730	0.806	0.000
Adequate payment capacity	BBB+	Baa1	1.100		
	BBB	Baa2	1.580		
	BBB-	Baa3	3.050	2.027	2.437
Likely to fulfil obligations, on-going uncertainty	BB+	Ba1	5.280		
	BB	Ba2	8.410		
	BB-	Ba3	11.860	11.444	8.079
High-risk obligations	B+	B1	16.120		
	B	B2	20.710		
	B-	B3	27.050	26.240	10.572
Vulnerable to default	CCC+	Caa1	36.314		
	CCC	Caa2	48.750		
	CCC-	Caa3	69.821		
Near or in bankruptcy or default	CC	Ca			
	C	C		52.350	32.458

Source: IMF (2010). Interpretation of sovereign credit rating scores of S&P, Fitch and Moody's. Moody's 5-Year Default Rates (%) provides the probability of default in 5 years for corporates and sovereigns, based on historical data by Moody's.

Most agencies provide an additional indicator of an expected future down or upgrade of a rating. These are mentioned as grades that are on 'review' or on 'watch' when a down or up-grade is expected in the next 90 days, a grade has a negative of positive 'outlook' when a change is expected in the next 2 years for investment grade and 1 year for speculative grade bonds (IMF, 2010).

With these rankings, the agencies essentially provide two services. They provide information services by offering an assessment of the ability of issuers to meet debt obligations. Thereby reducing information costs for borrowers, this may increase the number of potential borrowers and promote liquid markets. In addition, they offer monitoring services. The ranking can be used by the issuer for reflection, a downgrade or negative outlook may be used by the issuer of debt to prevent further loss of creditworthiness (de Haan and Amtenbrink, 2011).

The business models of all three major agencies are based on an issuer-fee basis. This may potentially cause a conflict of interest when a low ranking results in an unsatisfied client, who is unwilling to pay or continue doing business in the future. Thereby putting pressure on the ratings agencies' revenue streams (Bhatia, 2002).

3.2. Sovereign credit ratings

Sovereign credit ratings are "a condensed assessment of a government's ability and willingness to repay its public debt on time, both in principal and in interests." (Afonso et al., 2007). As such they are very much similar to ratings of other instruments, there is however a key difference. These ratings not only indicate a countries capacity to live up to its debt obligations, but also the willingness to pay for them. Since it is often impossible to enforce a country by some global law to pay for its debt when it is capable to do so, but unwilling. As a result different additional input is used for the assessment of sovereign creditworthiness compared to corporate credit ratings.

Credit rating agencies use a wide variety of quantitative and qualitative input to determine sovereign credit ratings. Although each agency has its own unique method there seems to be a substantial overlap in the most important factors. All agencies determine a number of categories to be taken into account like macroeconomic stability, public finance of the financial sector and then select a number of quantitative measures to evaluate the performance of the sovereign in this respect. This data is complemented with qualitative data, which is sometimes transformed into a quantitative number and added into the equation. All three agencies evaluate the numerical computer generated output by some sort of rating committee to determine the final ranking score. The relevance of each factor of input differs by agency and country, creating a complex intertwined system of inputs. For example, the level of reserves a government has is much more important in a country that has a fixed exchange rate regime compared to a country with a floating exchange rate (IMF, 2010).

Because the exact way rating agencies determine (sovereign) credit rating is still a mystery to some extent, a large base of quantitative research has been conducted testing for the correlation of different variables with credit ratings scores. The first systematic analysis on this topic was

performed by Cantor and Packer (1996). Their investigation suggests that "Moody's and Standard and Poor's rating assignments can be explained by a small number of well-defined criteria, which the two agencies appear to weigh similarly." These criteria are GDP growth, inflation, external debt, level of economic development, and default history. Afonso (2003) agrees to a very large extend with the findings of Cantor and Packer, only adding GDP per capita as an extra significant variable. Mellios and Paget-Blanc (2006) agree and in addition point to the importance of corruption as an important indicator for sovereign credit ratings in less developed countries. The IMF (2010) concludes that the most important inputs that all agencies use appear to be GDP per capita, level of indebtedness, financial resources of the government, an indicator of political stability and robustness of the financial sector IMF (2010).

Al-sakka and ap Gwilym (2009) investigate the interdependence of the rating agencies, and conclude that although the overlap between different agencies is between 30 and 50%, indicating substantial disagreement, the "upgrade (downgrade) probabilities are much higher, and downgrade (upgrade) probabilities are much lower for a sovereign issuer with a recent upgrade (downgrade) by another agency." So although these are some differences, the agencies seem to agree with each other in broad terms.

3.3. Importance of ratings

As is put forward by Afonso et al. (2007), sovereign credit ratings influence international financial markets, economic agents and governments in three ways. First, the ratings are used as a means of regulating institutional investors like pension funds. They are often not allowed to invest in funds with a rating lower than BBB, putting a restriction on the contents of low rated sovereign bonds in their portfolios. In the past century there is a clear rise in the influence of credit ratings agencies in this respect. The trend started in the 1930's when accounting rules dictated banks to write down holdings of bonds rated lower than BBB to market value, later commercial banks where prohibited from purchasing 'speculative grade' securities in the US. The rating agencies that were labelled the nationally recognized statistical rating organization's (NRSRO's) had the unique position in de US of providing these ratings. The first three where Moody's, S&P and Fitch, which gave these agencies a tremendous competitive advantage. Moving further into the 20th century, more regulations of this kind where introduced for insurance companies, pension funds, mutual funds, up until the Basel accord's that used credit rating's as an indicator in measuring the size of capital requirements of banks (Cantor and Packer, 1994).

Second, the rating of a country as a whole may not only impact the sovereign interest rate, but also have an impact on ratings of other entities within a country, like cities and government

institutions, as well as domestic banks and other companies. However strong these may be as a sole entity, they face a risk when the country they are located in defaults. So the impact goes beyond the effect on the sovereign interest rate. This particular characteristic will not be evaluated in this paper.

Third, credit ratings may determine the borrowing cost a country faces, since sovereign interest rates in the international financial markets may be dependent on sovereign credit ratings. Afonso et al. (2007) emphasizes this as the third argument; however the evidence for this relationship is not as clear cut as the previous two. It is this relationship we will be investigating in this paper, a thorough review of past research on this particular relationship will be presented in Section 3.5.

During the Asian crisis of the 90s and the more recent financial and euro crisis the rating agencies have endured critique on their failure to predict economic downturns and default. Bhatia (2002) provides an extensive review on the failure of rating agencies. It is concluded that there is a strong upside bias in the ratings and a very strong interagency correlation. Four possible causes of failure are addressed: informational risk, analytical constraints, revenue bias, and other incentive problems. Even so, credit ratings are widely used in all fields of finance and economics. They appear to be an imperfect, but nevertheless very useful tool to evaluate creditworthiness.

3.4. Development of credit ratings

Like bond yields, credit ratings have started to converge in the euro-zone during the period of economic integration of the EMU in the second half of the 20th century. In the early years of the 21th century, almost all European had an AAA score. The only exception where Portugal and Italy, that never had a higher score than AA in the S&P ranking, and Greece, the highest rating being A.

Since the outbreak of the financial crisis in 2008 credit ratings started to soar. The euro crisis worsened the rankings; especially in the PIIGS countries (see Figure A5.11). The downturn eventually hit the very bottom of the pond when Greece was rated D, in February 2012. This provides us with a unique period in European history, never has there been so much information on rating changes for a selected group of European countries. The vast amount of rating changes by the major rating agencies in the period of the crisis years are one of the main building blocks of this paper.

3.5. Credit ratings as measure of default risk

Credit ratings are a complex summary of all possible variables affecting default risk; this sub-section will give an overview of previous research that has used these characteristics and implemented credit ratings as a proxy for default risk when investigating bond yield spreads. Three studies (Cantor and Packer, 1996, Powell and Martínez, 2008, González-Rozada and Yeyati, 2008) explicitly provide empirical evidence on the explanatory power of credit ratings in the presence of other

fundamentals. The review of the other papers is intended to illustrate the wide spread use of credit ratings and, although these papers do not intend to investigate the additional explanatory power of credit ratings in particular, some do provide us with insights in this respect. Contrary to the literature review on the other factors impacting bond yield spreads, studies on developing economies will also be included in the discussion here, since the large majority of evidence on credit ratings stems from studies on developing economies.

Goldstein and Woglom (1991) are the first to incorporate some sort of credit rating variable in their investigation of the bond yields spreads in 39 US states. They use the residual from a regression of Moody's ratings regressed on fiscal variables and find it to be highly significant. They therefore note that credit ratings comprise information not contained in the fiscal variables. Remarkably, in another paper by the same authors the credit ratings are not mentioned as an explanatory variable (Bayoumi et al., 1995).

Cantor and Packer (1996) provide the first formal investigation of sovereign credit ratings as a proxy for default risk. They investigate a sample of 35 countries at one moment in time, in the September 1995. Using credit ratings from Moody's and S&P they find that ratings have considerable power to explain sovereign yield spreads. Furthermore they also investigate the explanatory power of a set of macroeconomic variables, and find that they explain less of the variation in the spreads compared to credit ratings. This leads them to conclude that "ratings appear to provide additional information beyond that contained in the standard macroeconomic country statistics incorporated in market yields." A regression including both the set of macroeconomic explanatory variables and the credit ratings renders the complete set of macroeconomic indicators insignificant. The ratings are concluded to be an effective summary of the information contained in those indicators; the other fundamentals to not add any additional explanatory power over the rating scores.

Eichengreen and Mody (1998) investigate the changing spreads on emerging market debt, evaluating the effect of fundamentals versus market sentiment. In addition to a number of macroeconomic fundamentals of each country, they regress credit ratings on these fundamentals and introduce the residual of this regression in the regression to explain spreads. This residual should reflect the ratings agency opinion and is found to be highly significant.

Building on the evidence of Cantor and Packer (1996), Kamin and von Kleist (1999) use credit ratings to proxy for sovereign default risk, interpreting credit ratings as a precise measure of risk. They conclude that there is positive correlation between credit ratings and yield spreads, furthermore the sensitivity is higher for speculative grade bonds, compared to investment grade. They do not provide a comparison with the more traditional country performance variables.

The study by Lønning (2000) not only includes sovereign credit ratings as a proxy for default risk, but also government debt, current budget deficit, structural budget deficit and the current account. Credit ratings are always found to be significant, while the coefficients for the macroeconomic fundamentals are only significant depending on what variables are included. This is interpreted as evidence that "rating conveys information about default risk beyond the information contained in the macroeconomic variables included, and that the markets and the rating companies differ in their evaluation of default risk." In this same vein, Sy (2002) indicates that ratings are a proper measure of country risk, and uses ratings as the sole proxy for a country's economic fundamentals in 17 emerging market economies. A significant effect of these ratings is found. Balassone et al. (2004) use the index of global creditworthiness measured in Institutional Investor and find ratings to have a significant correlation. Measures of debt and deficit are also found to be significant, however no regression in performed including all these variables simultaneously.

Gómez-Puig (2006) investigates factors affecting sovereign yield spreads on the European continent, with the objective to differentiate between default risk and liquidity risk and see how their impact has changed after the introduction of the euro. Credit ratings are used as a proxy to measure the changes in default risk and are found to have a significant effect on yield spread, in addition to the debt-to-GDP ratio. Manganelli and Wolswijk (2007) provides an extension to Gómez-Puig (2006) confirming his findings. They argue for the use of credit ratings because they are more forward looking than simple debt- or deficit-to-GDP ratios, since they take into account the development of these ratios. Furthermore a number of more qualitative factors are incorporated in the rating scores like political stability.

Dell'Ariccia et al. (2006) follow in the footsteps of Eichengreen and Mody (1998) utilizing the same 'rating residual' methodology when analysing the effects of bailout expectations on sovereign bond spreads in emerging markets. The residual's significant impact is explained to be "due to either other omitted macroeconomic fundamentals that are used in the calculation of ratings, or to the ratings themselves". Other macroeconomic variables are included as well; their significance depends substantially on the different specifications of the models. So no conclusions can be drawn with respect to the added explanatory power of credit ratings.

González-Rozada and Yeyati (2008) use credit ratings as a proxy for default risk; however the authors are unsure if ratings correctly reflect macroeconomic fundamentals. They do not set out to investigate the additional explanatory power of credit ratings in the first place, but when touching upon this subject, they do dedicate a section of the paper to it. They indicate that ratings may only provide a partial indication of the actual likelihood of default of individual countries, and want to evaluate the influence of ratings "beyond and above the evolution of country-specific

fundamentals." The results of a regression with the inclusion of both the fundamentals and the credit ratings provide evidence for the significance of all these explanatory variables. The authors find this to be somewhat intriguing, since the ratings are conceived as summary indicators of these fundamentals, following that logic they should not be significant. They indicate that this can be interpreted as the credit ratings having some independent explanatory power. A second explanation is provided however: Ratings may be endogenous to spreads. They provide an event study analyses for the effect of rating changes, and changes in the outlook, on yield spreads. Since adjustments in spreads seem to *precede* rating and outlook changes it is concluded that "the presumption that ratings are a reasonable proxy for fundamental risk is questioned by the data". They touch upon an important subject here, on which we will come back in Section 3.6.

Powell and Martínez (2008) truly follow in the footsteps of Cantor and Packer (1996) when they set out to consider whether sovereign credit ratings matter for spreads. They use three different techniques. First the method of Eichengreen and Mody (1998) is employed; the residual of a regression of credit ratings on macroeconomic fundamentals is implemented in a regression of these same macroeconomic fundamentals on yield spreads. They find that the residual is highly significant. The second method employed is more in line with Cantor and Packer (1996), including the measure of credit rating in a regression together with the fundamentals. With all the economic fundamentals included, it is found that ratings affect spreads. After eliminating insignificant fundamentals, ratings still remain significant. In the third, more experimental method a dummy variable is created that has a value of 1 when S&P performs an upgrade but Moody's does not and -1 when S&P performs a downgrade but Moody's does not. In a regression of spreads on the credit rating of S&P and this dummy, the dummy is found to be significant. The experiment is repeated switching the rating agencies. These results are evidence that an upgrade (downgrade) by one agency matters, even if the other agency does not upgrade (downgrade). Based on this analyses Powell and Martínez (2008) conclude that controlling for fundamentals, ratings affect spreads.

Hilscher and Nosbusch (2010), like Lønning (2000), also hint at the additional explanatory power of credit ratings. When investigating the importance of the terms of trade they perform regressions including both credit ratings, as robustness check covering default risk, as debt-to-GDP, deficit-to-GDP and terms of trade. They find that all variables are significant. Jaramillo and Tejada (2011) investigate if an investment grade status impacts yield spreads. In a regression, using data on 35 emerging markets between 1998 and 2008, they find credit ratings to be statistically significant when included simultaneously with macroeconomic fundamentals and other risk factors. Finally the recent addition by de Santis (2012) covers the same data that is under investigation in this paper, the recent crisis years in the euro-zone. Investigating contagion risk of the weaker euro countries he

uses credit ratings for they provide an assessment of default risk that is based on a large set of indicators. The ratings are only included for the PIIGS countries, as the other countries did not exhibit any rating changes in the period under investigation. The ratings that are included are found to be significant indicators of bond yields spreads in most cases.

The previous section has provided some preliminary evidence on the potential additional explanatory power of sovereign credit ratings. However, only the papers by Cantor and Packer (1996) and Powell and Martínez (2008) truly set out to investigate this particular relationship. These come closest to the analyses performed in this paper. There is agreement amongst these studies on the significant, additional explanatory power of credit ratings. There are some drawbacks to these studies however; most notably they are all conducted in developing economies. An examination on developed economies may for example provide different results as the information on macroeconomic fundamentals in developed economies is much easier to access.

Eichengreen and Mody (1998), Lønning (2000), González-Rozada and Yeyati (2008), Hilscher and Nosbusch (2010) and Jaramillo and Tejada (2011) touch upon the subject by including macroeconomic fundamentals in tandem with credit ratings, the true purpose of these papers, however, lies elsewhere. Of these papers only Lønning (2000) provide an investigation on developed countries. The conclusions that can be drawn from Goldstein and Woglom (1991), Kamin and von Kleist (1999), Sy (2002), Balassone et al. (2004), Gómez-Puig (2006), Manganelli and Wolswijk (2007), Dell'Ariccia et al. (2006) and de Santis (2012) are even more ambiguous. They are a mere illustration of the explanatory power of credit rating as such and proof of the widespread use of these ratings (of which there is much more not mentioned here (see for example Gaillard, 2009).

3.6. Event study analyses

Another strand of literature performs event study analyses. This type of analyses measures the effect of rating announcements on yield spreads, instead of their correlation. The average movement in yield spreads in a timeframe of for example two days before and two days after an up- or downgrade or change in the outlook or watch list is measured. As a result it is possible to look at causality, and see if ratings lead or lag spreads. If it is found that the rating change affects yield spreads, it apparently conveys information to the market that was not incorporated by the market in the bond yields yet. However, if they lag spreads the ratings are a mere summary of the information that was already taken into account by the market participants or the rating is endogen to the yield. To perform this type of research, the data of only two variables is needed to investigate the information content beyond an infinite number of variables.

The first to conduct such analyses on sovereign credit ratings are again Cantor and Packer (1996). They find that ratings are already incorporated in the yields by the market to a large extend before a change, for non-investment grade issues however, they do find that announcements have immediate effects on market pricing. Spreads increase (decrease) further after the announcement of the downgrading (upgrading). A result confirmed by Reisen and von Maltzan (1999). Reisen (2001) however argues that ratings lag rather than lead the markets. A recent study by Afonso et al. (2012) presents an event study analyses on credit ratings in the EU. It is concluded that there are "significant responses of government bond yield spreads to changes in rating notations and outlook, particularly in the case of negative announcements." This conclusion is very much in line with other research. Not all scholar's will agree (see for example Ismailescu and Kazemi, 2010), but the majority of research concludes that there is a significant effect of negative announcements while no effect of positive announcements is found (see for example Larraín et al., 1997, Kräussl, 2005, Gande and Parsley 2005).

There are, however, some drawbacks to this type of research. These can be separated in two branches. The first potential problem with this methodology results from the investigation of only two variables. As Powell and Martínez (2008) explain changes in macroeconomic fundamentals are not taken into account. This poses the problem that when these fundamentals are changing, it is not obvious whether any change in the spreads accompanied by a rating change is due to the change in rating, or a change in the fundamentals. Furthermore, even if it is indeed a reaction on a rating change, and so the conclusion that this rating change conveys information to the market that was not incorporated by the market in the bond yields yet is correct, we still do not know above and beyond what other information the ratings have an effect. This is a serious drawback when trying to get a better understanding of the explanatory power of credit ratings. Moreover, the event study analysis does not provide any indication on the power of credit ratings as a summary statistic of default risk.

The second branch stems from the notion that credit rating agencies tend to signal their intentions. As was explained in Section 3.1, rating agencies not only indicate up- and downgrades, they also put sovereigns on 'review' or 'watch', or pose a negative of positive 'outlook' when a down- or upgrade is expected. Although in a well-executed event study analyses this can, and should, be taken into account. Credit rating agencies tend to signal their intentions in many more ways however. For example, as Cavallo et al. (2008) explain, agencies also publish what a particular sovereign would have to do to improve its rating. To lend an example of Powell and Martínez (2008), "it might be announced that a constraint to an upgrade for Peru is tax administration and hence its

overall tax revenue as a percentage of GDP or debt. Thus, if Peru's tax administration improves the market will start to predict an upgrade." In this case even if the ratings in fact do matter for yield spreads, this is not conveyed in an event study analyses. I therefore agree with Powell and Martínez (2008) that these actions by the agencies make the methodology of the event study problematic. An event study analysis provides a very useful addition to research on the impact of sovereign credit ratings. As a result of the drawbacks mentioned here, however, it is not suited for the purpose of our investigation.

3.7. Do ratings add value

Cavallo et al. (2008) move beyond all previous research and set out to determine if credit ratings add value. Additional explanatory power alone does not mean credit ratings contain new information; it can also be that they provide a clear and easy to access overview of the fundamentals. Since these ratings agencies may have a better overview of these fundamentals than an average investor, they determine the level of sovereign spreads. So even if they exert additional explanatory power, it is still unclear if the rating agencies really add information. This paper therefore takes a different approach when both sovereign spreads and credit ratings are viewed as noisy signals of the same true deep economic fundamentals. These economic fundamentals also affect other macroeconomic variables, like stock markets and exchange rates. If spreads and credit ratings reflect the same information, the correlation of these two variables with a third macroeconomic variable should be equal. It is found however that credit ratings have additional explanatory power over and above yield spreads in regressions of a number of macroeconomic variables on spreads and ratings. This can be interpreted as evidence that credit ratings contain additional information.

This concludes the review on previous literature. In the past two sections we introduced bond yield spreads and credit ratings; we discussed a vast amount of previous research on the factors affecting yield spreads and the explanatory power of credit ratings. It has been established that none of the previous research can provide satisfactory evidence whether or not sovereign credit ratings have some independent explanatory power with respect to sovereign bond yield spreads over and above their correlation with other publicly available information in the euro-zone. The next section onwards will set up a theoretical framework to investigate this problem, provide the methodology and data needed and discuss the results of this analysis.

4. Theoretical framework

This section will provide a theoretical framework. In Section 4.1 we set up the theory that will be put to the test. Moreover, the theoretical arguments in favour and against the additional explanatory power of credit ratings will be provided. In Section 4.2 the relevance of this topic is discussed, Section 4.3 provides an overview of the contributions our investigation will provide in comparison with previous research.

4.1. Theory

The purpose of this paper is to examine if sovereign credit ratings have significant, independent explanatory power with respect to sovereign bond yield spreads, over and above their correlation with other publicly available information in addition. And when this is the case, if this can be explained by a causal effect of credit ratings on sovereign bond yields.

There are a number of theoretical arguments in favour of the additional explanatory power of credit ratings. First of all it can be argued that rating agencies provide additional information to the markets. There are two branches within this argument. Either the rating agencies have access to information that is not publicly available, or available to investors. This may be through access to uncovered reports, information that has to be paid for or information from individuals that do not publish this information. Or rating agencies interpret the publicly available information in a way that is different to that of an investors' own interpretation.

Second, as was put forward in Section 3.1, credit ratings are used in regulation. A rating change may therefore oblige the regulated entities to change their holdings of particular bonds. This constitutes a direct link between ratings and yields.

Third, credit ratings are an easy to access and interpret indicator. They may therefore be used as an indicator of default risk, not because investors cannot access the underlying information or they would interpret it differently, but because it is too complicated or time consuming for them to do so. However, in theory this will provide an advantage for those investors that do use the formerly available fundamental information. Basic economic theory would then suggest that in equilibrium, no investor will be using credit ratings if the information conveyed by them is already available to other investors.

Notwithstanding the before mentioned, there are also a number of theoretical arguments against the additional explanatory power of credit ratings. First, and foremost, credit ratings are an indication of default risk, just as the fundamentals are. As was set out in Section 3.2, credit ratings can be explained by a small set of publicly available variables. They represent the same information

set, and should therefore not exert any additional explanatory power.

Second, credit ratings are not a subtle ranking; instead they are presented in a very grain statistic. It should be expected that within one rating category, say AA, there is still substantial variation in default risk between different sovereigns. In turn, fundamentals provide a much more precise measure of default risk.

Third, in contrast to all previous research, we investigate developed economies. The information on fundamentals of these sovereigns is much more readily available, compared to developed nations that may not be very transparent. This may undermine the importance of credit ratings, and lead to different results.

4.2. Relevance

The outcome of this paper is relevant for policy makers, academics, rating agencies and investors. Since the outbreak of the recent financial- and euro crisis, governments seem to be very wary of credit rating agencies, anxious to be downgraded by these, thought to be, powerful institutions. This paper will explore if this stance is legitimized, or if it are in fact other indicators that should be the focus point of governmental policy. In addition to this, there is a call for more regulation of the rating agencies. Critics argue that the agencies are too powerful not to be regulated more tightly (Mathis et al., 2009). This regulation can only be considered justly if credit ratings indeed exhibit market power.

Secondly the evidence of this paper may be relevant for academics. As we have seen in previous sections, there is no standard on how to account for sovereign default risk in regression analyses. We have seen many examples of papers that do not take into account credit ratings; other papers use credit rating as the sole proxy of default risk, while some use a combination of both. Whether it comes to investigating other risk factors, like liquidity risk, to examine country specific risk factors like exchange rate risk, or to explore the impact of specific default risk factors like contagion, it is of great importance to know which variables to include when performing an empirical investigation.

In addition, the information revealed may be of interest to investors. As the party on the other side of the table compared to the government, they may just as likely to be interested if, and how other investors take into account sovereign credit ratings.

Furthermore, credit ratings agencies themselves may have some interest in the topic. They may want to utilize a significant outcome with respect to their influence to legitimize their business.

4.3. Contribution

As we have seen in Section 3, evidence on the explanatory power of sovereign credit ratings is limited. A contribution to this field of research is therefore more than welcome; nevertheless it is important to indicate where the investigation complements the studies identified so far.

The most important contribution of this paper is the examination of a sample of developed countries. With the exception of Cantor and Packer (1996), all previous analysis has been fully focused on emerging market economies. Cantor and Packer (1996) do include a few developed nations in addition to a sample that mainly consists of developing countries, but an investigation of a sample of developed nations only has not been performed before. Furthermore the study by Cantor and Packer has been conducted more than 15 years ago and lacks a sound statistical methodology. Most notably instead of panel data analyses a snap shot on the 29th of September 1995 is used as data input. There are good theoretical and empirical grounds to believe that the focus on a sample of developed countries may provide different insights. Not only do these countries possess a different level of transparency with respect to information on macroeconomic fundamentals, the dynamics of these economies at large are completely different.

No investigation has taken place utilizing data during the recent financial and euro crisis, these years provide a very valuable source of data. As we have seen in Section 2 and 3, both credit ratings and bond yield spreads have been strikingly volatile in the countries under investigation during recent years. There has been no period in developed countries that witnessed comparable swings, providing an interesting dataset to investigate.

Based on the literature review provided in Sections 2 and 3, most previous does not include some potentially important explanatory variables. If we consider the most important past research, Cantor and Packer (1996) do not include any variable on global risk aversion, exchange rate risk or liquidity risk. They do use a wide selection of variables to capture default risk, but use current deficit instead of expected deficit. Powell and Martínez (2008) are more thorough but do omit to include a proxy for liquidity risk in the regressions **o**n yield spreads. Furthermore they use current deficit instead of expected deficit. We will not go into every paper here, but none of the previous research includes a complete set variables.

Moreover, this study will go beyond those mentioned with respect to the econometric analyses performed. The same basic set-up in line with Cantor and Packer (1996), including the ratings as cardinal explanatory variable, and Eichengreen and Mody (1998), using the residual from a regression of macroeconomic fundamentals on credit ratings, is used. Here however, we utilize panel data like Powell and Martínez (2008). Unlike their paper, the ratings of three agencies will be combined in one variable. Additionally, in line with Jaramillo and Tejada (2011), a regression with

dummy variables for each rating category is performed, instead of a cardinal transformation of the ordinal ratings codes. The combination of both these techniques on one dataset is a first. Furthermore we use co integration techniques to analyse the data, a crucial validation that the results found are indeed the result of a long run relation in the data. Moreover, we will move beyond OLS analyses, performing Estimated Generalized Least Squares (EGLS) regressions. A two-stage-least-squares (TSLS) set-up and a Generalized Method of Moments (GMM) model will correct for endogeneity of problems. As will be explained in Section 6.4, these techniques are shown to provide much more firm results when using the type of data analysed here.

5. Data

In this section all the data used in the investigation is discussed. All nine variables discussed here are available for six countries: Germany, Portugal, Italy, Ireland, Greece and Spain. Since we are interested in the examination of the recent financial and euro crisis, the data run from July 2006 through May 2012. This effectively covers two years leading up to the crisis that erupted in September 2008 and four years of crisis. Following the methodology commonly employed in this type of research (see for example Eichengreen and Mody, 1998, de Santis, 2012), data that are not available on a daily basis are kept equal to the last rate provided, up until the day a new data point is available. This best approximates the investor's perception of the data; they base their judgment on the most recent data available. Consider instead for example interpolation of two data points at t = 0 and t = 2 to obtain the value for t = 1, this would use data from t = 2 that was not available at t = 1.

We will discuss the data sources, arguments for, and explanation of the chosen proxies and the interval. Arguments for including the variables are provided in Section 2.4, 2.5 and 3.5. An overview of the variables, the data source and descriptive statistics is given in Table 5.1. This table describes the variables of the six countries in levels. As we will see in Section 6, all regressions are performed with the spread of these variables with the benchmark country; Germany. A visual representation of all variables is available in the appendix, Figure A5.1 to A5.13. Figure 5.1 here provides a clear overview of the different variables and their proxies.

5.1. Sovereign bond yields

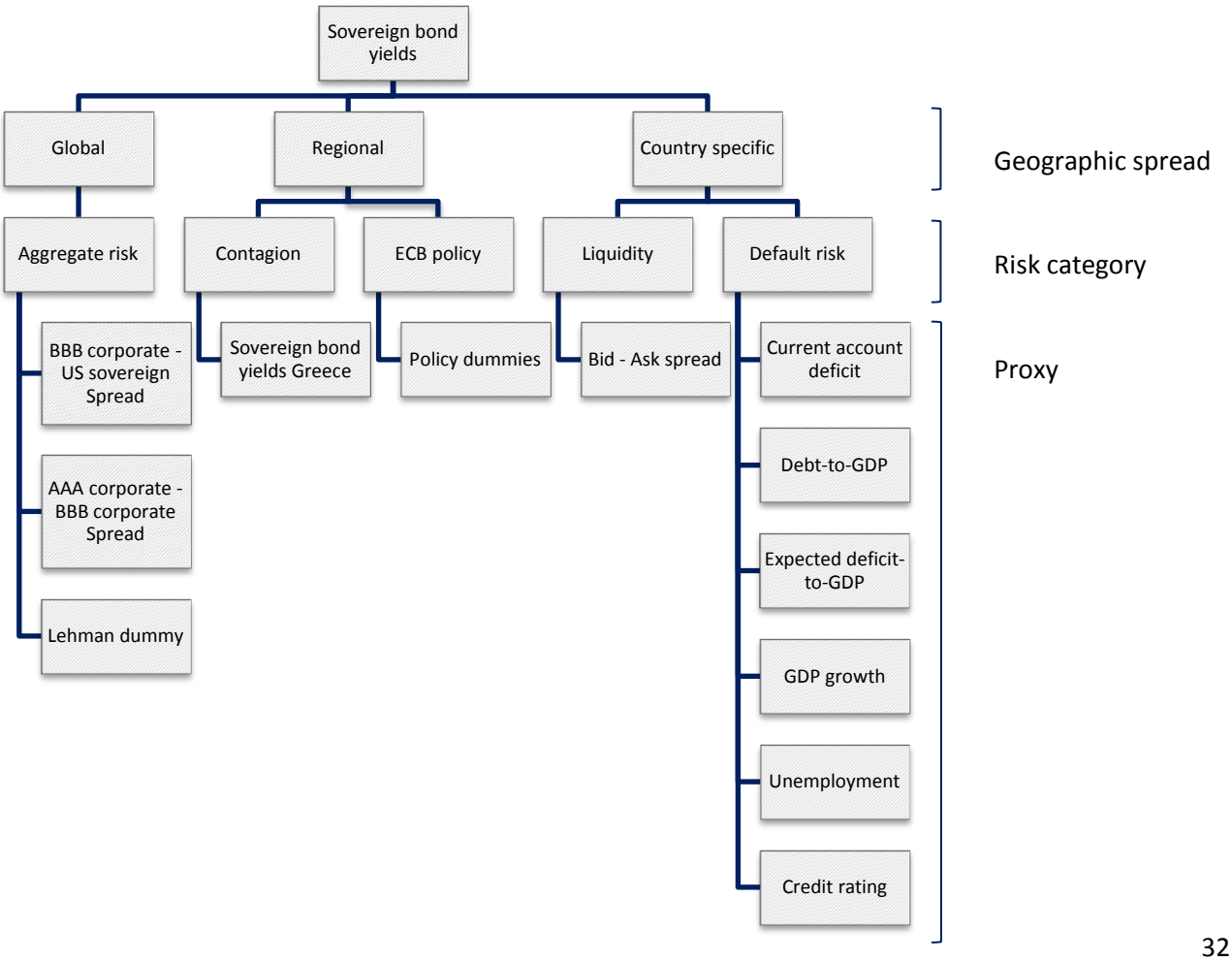
As the dependent variable the sovereign bond yields in secondary market on bonds with a 10-year maturity are used. Bloomberg provides a benchmark index with daily data of these rates, the Iboxx index used is constructed by Markit. The closing rate of the trading day is used. These data are available for all countries in the given period with the exception of Ireland, for which the data between 3/16/2007 to 10/25/2007 and 10/12/2011 to 8/21/2012 are missing since there were no

bonds with a 10-year maturity outstanding at that moment. For these periods the return on bonds with a maturity of 9 years is used instead. An investigation of the data in the periods for which both the return on 10-year maturity and 9-year maturity bonds is available, confirms that the discrepancy between the two rates is very small, thereby validating the use of these 9-year maturity bonds.

5.2. Aggregate risk

To measure global risk aversion we follow the method used in Codogno et al. (2003), Gerlach et al. (2010) and de Santis (2012). The spread between US sovereign bonds and BBB rated US corporate bonds and is interpreted as the spread between the "risk free" interest rate and the rate of return on bonds of a steady risk level, BBB in this case. The evolution of this spread cannot be explained by changes in the underlying risk factors since they are assumed to be constant, so the evolution must be interpreted as changes in the investors' risk premium and can be used as a proxy for aggregate risk. We use daily data of the return on BBB rated US corporate bonds provided by Merill Lynch and sovereign bond yields on US bonds in the same vein as the EU sovereign yields discussed before. The data are obtained using Bloomberg.

Figure 5.1: Overview variables



However, this proxy assumes that the risk of US sovereign bonds is stable. It can be argued that this risk has not been stable in recent years, a notion best illustrated by the downgrade of the US AAA status to AA+ by S&P on August the 5th 2011. For this reason we use a second proxy, the spread between AAA and BBB rated corporate bonds, as a robustness check. In addition a dummy variable with value 1 on the 15th of September 2008, the day Lehman filed for bankruptcy, is included account for the impact this event had on investors risk perception.

5.3. Contagion

We take into account the effect of contagion as results of an increase in the default risk in Greece. The yield on Greek sovereign bonds is added as a variable in the regressions on the other four countries, for Greece this variable is set to 0. The yield spread of Greece is a good indicator of the default risk, this is in line with Arghyrou and Kontonikas (2011). In the same vein De Santis (2012) account for contagion by including the sovereign credit ratings of Greece, since we are investigating these ratings we prefer to use them exclusively for that purpose.

5.4. ECB policy

We account for some important decisions made by the ECB that may have an impact on sovereign bond yields. Dummies are included on the following dates:

10 May 2010 – Euro-zone countries reach an agreement on the support of the euro, the European Commission, the individual euro-zone countries and the IMF agree to back an emergency fund of 720 billion euros.

22 July 2011 – The outcomes of an important euro-zone summit on the 21th are presented after exchanges have closed that day. Euro leaders agree on an elaborate support program for Greece and will mobilize all resources necessary to assist Greece in implementing reforms.

13 March 2011 – After privately held bonds are swapped for new paper with half the nominal value, reducing Greek debt by 100 billion euro, there is agreement on a second bailout package by the euro-zone worth 130bn euros,

Although there are many more notable moments of ECB policy that may be included, these three are the most important. All three are interpreted by the markets as a strong indication that the euro-zone is taking action to mitigate the effects of crisis. This has a relatively strong, suppressing impact on bond yield in the countries with weak fundamentals, while it hardly affects the perception of the fundamentally strong countries like Germany. The impact can be visualized when graphing the yield spreads, as was done in Figure 2.1.

Table 5.1: Data overview

Statistic	Proxy	Max.	Mean	Min.	Std. Dev.	Freq.	Source	Database
Yield spread	iBoxx benchmark sovereign bond yield index for 10 yr. maturity bonds, red. yield. Spread with Germany	35.3	2.7	0.0	4.7	Daily	Markit	Bloomberg
Aggregate risk								
- US govt. - BBB corp.	US govt. - BBB corp. spread	5.5	1.4	0.2	1.2	Daily	Merill Lynch	Bloomberg
- AAA corp. - BBB corp	AAA corp. - BBB corp. spread	4.7	1.8	0.6	0.9	Daily	Merill Lynch	Bloomberg
Contagion	Sovereign bond yield spread Greece	35.3	4.8	0.0	8.0	Daily	Markit	Bloomberg
Liquidity	Bid-Ask spread corresponding sovereign bonds	7.1	0.1	0.0	0.6	Daily	Markit	Bloomberg
Current account	Current account balance as % of GDP	1.7	-6.9	-15.5	4.4	Quarter	Eurostat	Reuters DataStream
Debt-to-GDP	Gross domestic debt as % of GDP	175.7	84.9	24.3	38.2	Quarter	Eurostat	Reuters DataStream
Deficit-to-GDP	Expected budget deficit % of GDP	3.5	-7.2	-95.7	9.5	Quarter	Oxford Economics	Reuters DataStream
GDP growth	GDP growth in %	8.1	-0.1	-8.6	3.5	Quarter	Eurostat	Bloomberg
Unemployment	Unemployed as % of total population	24.4	11.0	4.3	4.7	Month	Eurostat	Bloomberg
Rating - Ordinal								
- Logistic	Logistically transformed sovereign credit rating score	2.0	1.7	0.0	0.4	-	S&P, Moody's, Fitch	Bloomberg
- Linear	Linearly transformed sovereign credit rating score	2.0	1.6	0.0	0.4	-	S&P, Moody's, Fitch	Bloomberg
Rating - Residual	Residual from regression of sovereign credit rating score on fundamentals	1.0	0.2	0.0	0.4	-	S&P, Moody's, Fitch	Bloomberg
Rating - AAA dummy	1 for AAA average rating score, 0 otherwise	1.0	0.2	0.0	0.4	-	S&P, Moody's, Fitch	Bloomberg
Rating - AA dummy	1 for AA average rating score, 0 otherwise	1.0	0.3	0.0	0.5	-	S&P, Moody's, Fitch	Bloomberg
Rating - A dummy	1 for A average rating score, 0 otherwise	1.0	0.3	0.0	0.5	-	S&P, Moody's, Fitch	Bloomberg
Rating - BBB dummy	1 for BBB average rating score, 0 otherwise	1.0	0.1	0.0	0.2	-	S&P, Moody's, Fitch	Bloomberg
Rating - BB dummy	1 for BB average rating score, 0 otherwise	1.0	0.1	0.0	0.3	-	S&P, Moody's, Fitch	Bloomberg
Rating - B dummy	1 for B average rating score, 0 otherwise	1.0	0.0	0.0	0.1	-	S&P, Moody's, Fitch	Bloomberg
Rating - CCC dummy	1 for CCC average rating score, 0 otherwise	1.0	0.0	0.0	0.2	-	S&P, Moody's, Fitch	Bloomberg
Rating - CC dummy	1 for CC average rating score, 0 otherwise	1.0	0.0	0.0	0.0	-	S&P, Moody's, Fitch	Bloomberg

Sample period: 7/13/2006 – 5/14/2012. Number of observations: 7584.

5.5. Liquidity

Liquidity can be measured in various ways, in past research various different indicators have been used, see for example total trading volume, size of a debt issue and bid-ask. Favero et al. (2010) considered "a range of alternative liquidity indicators and selected the bid-ask spread as the most significant measure." This result if confirmed by the study by Beber et al. (2009). An increase in the discrepancy between the bid and ask price of a bond at any moment in time is interpreted as a decrease in liquidity of that bond. The daily, end of day bid and ask rates of the corresponding sovereign bonds discussed before are obtained from Bloomberg, and subtracted from each other.

5.6. Default risk

As was the case in Section 2.5, this rating category comprises a range of different factors and corresponding measures. In addition to the measure sovereign credit ratings, we control for current account, debt, expected deficit, GDP growth and unemployment.

5.6.1. Country specific fundamentals

Eurostat provides quarterly data on the current account balance as a percentage of GDP. These data are obtained for all 6 countries with Bloomberg.

Eurostat provides quarterly data on the debt-to-GDP ratios of sovereigns. The data points are calendared on the day of the press release. These data are obtained for all 6 countries using Thomson Reuters DataStream.

As was explained in Section 2.5, it is crucial to use a proxy for expected deficit in favour of the often utilized proxy of actual deficit. Oxford Economics provides a quarterly forecast on the government balance as a share of GDP. These data are obtained for all 6 countries using Thomson Reuters DataStream.

Data on GDP growth is obtained from Bloomberg. This is quarterly data on the GDP growth rate. Unemployment numbers are provided by Eurostat, they are monthly unemployed-to-total population ratios. These data are obtained for all 6 countries with Bloomberg.

5.6.2. Sovereign credit ratings

The variable under investigation, sovereign credit ratings, is provided by the three largest rating agencies: Standard & Poor's, Moody's and Fitch. As was put forward in Section 3.1, these three agencies represent about 95% of the credit rating market. The data are obtained from Bloomberg. The alphabetical ratings are transformed into a numerical scale to use them in statistical research.

The symbols of S&P and Fitch are exactly the same, Moody's uses slightly different symbols, but they can all be matched with a comparable rating of the other agencies as can be seen from Table 3.1.

The traditional method to transform these symbols into a numerical scale is a linear transformation. Most previous research employs this method (see for example Cantor and Packer, 1996, de Santis, 2012). The highest rating is given a numerical value, in this paper AAA = 2.0, every following one notch downgrade corresponds with a 0.1 lower value, for example AA+ = 1.9, until the lowest credit rating before default, C = 0.0. The assumption here is that a one notch downgrade corresponds with an equal decrease in the underlying risk at every risk level.

As was explained in Section 3.3 however, there is reason to believe that this assumption does not hold. Ratings are used to differentiate between particular groups of risk levels; in particular the difference between investment grade bonds and speculative grade bonds is important. These groups are used in determining policy requirement for institutional investors and banks; furthermore these labels on bonds are taken into consideration by all investors. This reflects a disproportionate increase in risk when a rating is close to the barrier between investment and speculative grade, which lies at BBB – BB+. Jaramillo and Tejada (2011) indeed confirm that a jump to investment grade status is important for the return on sovereign bonds. To incorporate these findings in the transformation process of the alphabetical symbols we use logistic transformation. Risk perception first deteriorates slowly, in this paper from AAA = 2.0 to AA+ = 1.99, than faster at the investment grade – speculative grade barrier, in this paper from BBB = 1.0 to BB+ = 0.81, and finally slowly again for the lowest grades until the lowest credit rating before default, C = 0.0. This method is also employed in Larraín et al. (1997) and Reisen and von Maltzan (1999). A complete overview of all numerical values can be found in the appendix, Table A5.1. However, the difference between the two methods can best be seen in a graph. Figure 5.2 summarizes the two methods.

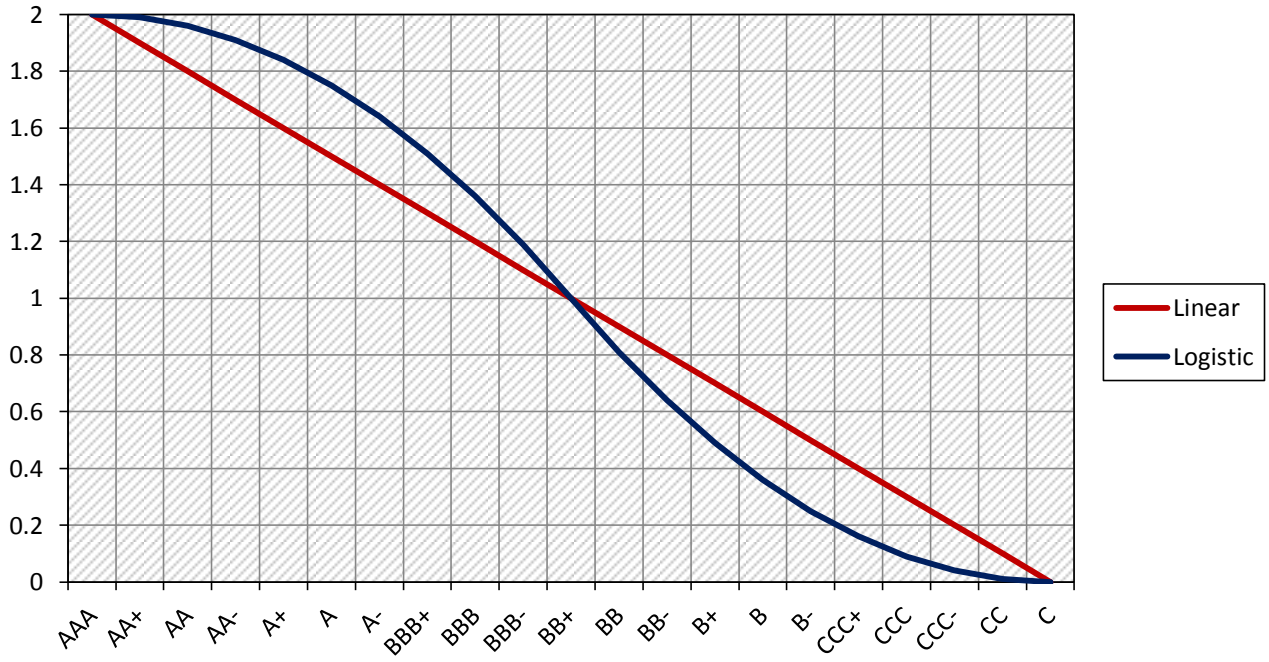
The rating agencies also provide rating outlooks. These outlooks are incorporated in the transformation by subtracting (adding) half the difference between the rating score with a negative (positive) outlook and the rating one notch lower (higher). For example, an AAA rated bond with a negative outlook has a linear transformation value of 2.0 – (0.5*(2.0-1.9) = 1.95, and a logistic transformation value of 2.0 – (0.5*(2.0-1.99) = 1.995.

A weighted average of the ratings of all three rating agencies is taken at each point in time. This way we imitate the investor's behaviour more accurately than by just using a single rating agency, furthermore this provides us with more and more subtle rating changes over time.

In addition to their linear and logistic transformation, the ratings notches are included in a model as dummy variables. We created a dummy variable for every individual rating, and additionally for the rating of for example all three AA ratings taken together. These dummies are created through a

backward conversion of the average rating score obtained in the previous transformation process. They are thus the average rating score of the three agencies.

Figure 5.2: Credit rating transformation



Sovereign credit rating transformation matrix. X-axis indicates cardinal rating score, Y-axis indicates corresponding ordinal value used in regression analyses.

6. Methodology and results

To investigate the additional explanatory power of credit ratings over other variables a number of different approaches is proposed. Before we will elaborate on the models and the results in Section 6.3, Section 6.1 will present an investigation of the variables with respect to their stationarity. In Section 6.2, we discuss co integration analyses to clear the way for the regression analyses. In addition to the initial model set-up, Section 6.4 will use models based on TSLS regressions and GMM to accommodate endogeneity of credit ratings. Some additional robustness will be evaluated in Section 6.5. As will become clear, unless stated otherwise, references to variables indicate the spread of this variables with the benchmark country; Germany.

6.1. Unit root test

It has been shown that in the presence of non-stationary variables, there is a severe risk of running spurious regressions when performing OLS. This can be most easily seen from a regression using two variables that follow an independent random walk with a positive trend. Although the variables are unrelated, the results of OLS of one of these variables on the other are not unlikely to provide significant results. This phenomenon is called spurious regression and was first explained by Granger

and Newbold (1974). More recently Granger and Newbold (2001) and Granger (2007) have provided evidence that these spurious regressions may also occur between stationary, but highly auto correlated variables. Co integration analyses estimates if a linear combination of variables can produce a stationary variable. If this is the case, the two variables are said to be co integrated and the application of regression analyses will not provide spurious results.

Because of the before mentioned, the variables are tested for non-stationarity using a unit root test. When the null hypothesis of a unit root cannot be rejected, co integration analysis is preferred. A panel unit root test will test the Equation 6.1.1.

$$\Delta Y_{i,t} = \alpha_i + \beta_i t \ + \gamma_t + \delta_i Y_{i,t-1} + \varepsilon_{i,t}$$

Equation 6.1.1

There is evidence of a unit root if the null hypothesis δ_i = 0 cannot be rejected, since then past values of Y have no influence on ΔY. If this is the case, the series is non-stationary; estimation using OLS may therefore provide spurious regression results.

The panel unit root test proposed by Im et al. (2003) is based on N (Augmented) Dickey-Fuller tests, one for every country. The t-statistic of all these individual tests are combined and corrected, providing a test statistic. This panel unit root test is preferred because it allows for heterogeneity in the alternative hypothesis, $\delta_i < 0$, so therefore the value of δ may vary over different countries. When interpreting the results of this panel unit root test, it should be taken into account that in the presence of cross-unit co integration relationships, the null hypothesis of a unit root is rejected too often (Banerjee et al., 2005). The sample we test here may contain cross-unit co integration relationships; therefore the results of this analysis have to be interpreted with caution. When the null hypothesis is rejected at low significance levels, this rejection may not provide adequate evidence for stationarity.

The results for a model as presented in Equation 6.1.1 are presented in Table 6.1, this is the Dickey-Fuller (DF) lag selection model. With only the first lag of the dependent variable included, this is a very strict model. However, it allows for comparison of the results because it is the same for all variables. For the variables to become stationary they may depend on further lags, Equation 6.1.1 is therefore augmented with one or more lagged dependent variables. The selection of the number of lags is done by means of the Akaike's Information Criterion, presented by Equation 6.1.2.

$$AIC = log\hat{\sigma}^2 + 2\frac{p+q+1}{T}$$

Equation 6.1.2

Where $\hat{\sigma}^2$ is the estimated variance of $\varepsilon_{i,t}$ in Equation 6.1.1, $p + q + 1$ are the number of free parameters. The criterion thereby provides a statistic that balances the fit of the model, measured by the variance in the error term, and the number of coefficients (Verbeek, 2008). Lag selection using this criterion is performed by selecting the number of lags for which AIC is minimized. When testing the performance of different criteria in a Monte Carlo study for autoregressive processes, Liew (2006) provides evidence that AIC is superior to other criteria for small sample sizes. For this reason we employ AIC lag selection when needed in all tests performed in this paper. Furthermore the results for a test with the inclusion of a trend are provided; the variables are then allowed to fluctuate around a sloped trend line instead of a strictly horizontal line. The results for the set-up with the Akaike lag selection criterion and without a trend are most important. The model with one lag is very restrictive, furthermore stationarity around a trend is weaker evidence that the regression results will not be spurious compared to the stationarity around a strictly horizontal line.

Table 6.1 presents the results of the unit root tests as proposed by Im et al. (2003). As we can see the null hypothesis of a unit root cannot be rejected for most variables. The only exception is the deficit-to-GDP ratio for which it is safe to conclude that this variable is stationary. For three out of four results this can also be said about the liquidity proxy; however we cannot reject the null hypothesis for the model without a trend and Akaike lag selection which is considered the strongest evidence. Since all other variables appear to be non-stationary, this results point us in the direction of a co integration test.

6.2. Co integration analyses

Co integration analyses estimates if a linear combination of variables can produce a stationary variable. A combination of non-stationary variables can only produce a stationary variable if they share long-run components that cancel out, they should have a common trend. The most widely applied method is a test for stationarity on the residuals of an OLS regression. This residual is produced in the OLS regression by linearly combining the variables under investigation and minimizing the variance in the residual. If the residual is stationary, a linear combination of these variables can thus produce a stationary variable, so they are co integrated. Since the residual, or equilibrium error, is then fluctuating around zero, the system is on average in equilibrium. The co integration relationship can therefore be interpreted as evidence for the presence of a long-run equilibrium relationship between the variables. Regression analyses on these variables will not produce spurious results (Verbeek, 2008).

Table 6.1: Unit root test

Trend	Without trend		With trend	
Lag selection	DF	Akaike	DF	Akaike
Yield Spread	3.52	4.07	0.64	1.23
Aggregate risk				
- US govt. - BBB corp.	2.80	-0.54	3.51	0.53
- AAA corp. - BBB corp	-0.68	-1.52 *	1.35	0.04
Contagion	3.40	3.08	0.73	0.52
Liquidity	-8.14 ***	-0.75	-11.30 ***	-1.89 **
Current account	3.58	3.58	1.63	1.63
Debt-to-GDP	2.71	2.71	-0.60	-0.60
Deficit-to-GDP	-4.57 ***	-4.57 ***	-3.99 ***	-3.99 ***
GDP growth	-0.55	-0.55	0.51	0.51
Unemployment	7.32	6.39	4.11	3.72
Rating - Ordinal				
- Logistic	10.81	8.07	7.20	5.46
- Linear	10.20	7.17	5.99	4.25
Rating - Residual	-3.95 ***	-1.01	-3.92 **	-0.51
Levels				
- Liquidity	-8.35 ***	0.95	-10.96 ***	-1.90 **
- Debt-to-GDP	4.63	4.63	-0.31	0.38
- Deficit-to-GDP	0.03	0.03	2.81	2.81
- Capital Formation	4.40	4.40	2.58	2.58
- GDP growth	0.20	0.20	1.49	1.49
- Unemployment	8.47	6.29	3.99	2.90
- Rating - Logistic	10.82	8.11	7.20	5.51
- Rating - Linear	10.31	7.37	6.06	4.44

*Unit root test as proposed by Im et al. (2003). Table presents the W-statistic. ***, ** and * denote significance at the 1%, 5% and 10% level respectively. Sample period: 7/13/2006 – 5/14/2012*

A comparable test as proposed in the previous part on unit roots will now be utilized to test for co integration. We use the test proposed by Kao (1999), it extends the Engle-Granger (Engle and Granger, 1987) co integration test for the use of panel data. It tests the null hypothesis of a unit root in the residual of an OLS regression. This investigation will be performed on all four models, as discussed in the next section: The baseline, ordinal, residual and dummy models.

Table 6.2 provides the results of these co integration tests. Building on the same arguments as provided when testing for a unit root, both Akaike lag selection and a model with only one lagged variable are presented. As we can see the null hypothesis of no co integration can be strongly rejected for all models and for different lag selection. We can therefore safely conclude that

regression analyses on these variables will not provide spurious results. This result clears the way for regression analyses, to which we will turn next.

Table 6.2: Co integration analyses

Model	Baseline	Ordinal	Residual	Dummy
Akaike	-13.14 ***	-12.81 ***	-12.69 ***	-13.09 ***
DF	-81.47 ***	-78.31 ***	-78.31 ***	-78.78 ***
Observations	7605	7605	7605	7605

*Co integration test as proposed by Kao (1999). Table presents the t-statistic. ***, ** and * denote significance at the 1%, 5% and 10% level respectively. Sample period: 7/13/2006 – 5/14/2012.*

6.3. Regression analyses

To thoroughly test the additional explanatory power of sovereign credit ratings we will compare a baseline model without the inclusion of a rating variable, to a number of alternative models including different measures of the rating scores. This way we hope to be able to provide unambiguous conclusions on the topic at hand, furthermore it enables us to compare the results with those in various previous papers discussed.

The models are a baseline model including all explanatory variables except sovereign credit ratings, the ordinal model will include the logistically transformed rating score, as was explained in Section 5.6, the residual model instead includes the residual from a regression of these rating scores on fundamentals as a measure of credit ratings and finally the dummy model which includes dummy variables for the various rating scores.

All models include the lagged dependent variable; this ensures that the other variables included truly capture an effect that extends beyond the current period; it serves as a proxy for omitted variables and it controls for serial correlation. Since the model without the first lag of the dependent variable has severe problems of autocorrelation, this last argument is crucial. Fixed effects are included to capture country specific non-time varying fundamentals like the degree of development, the presence of institutions or the differences in the financial and legal system. Panel Ordinary Least Squares (OLS) regressions suffer from heteroskadasticity, we therefore perform Panel Estimated Generalized Least Squares (EGLS) regressions with cross-section weights for all models. In this model each observation is weighted by a factor, determined by the inverse of the error term. Observations with a small residual variance are thus more heavily weighted than those with large variance. As Verbeek (2008) puts it, the observations that provide the most accurate information about the true model coefficients are given the greatest weight.

6.3.1. Baseline model

The baseline model is presented by Equation 6.3.1.

$$Y_{i,t} - Y_{b,t} = \alpha_i + \beta \left(Y_{i,t-1} - Y_{b,t-1}\right) + \gamma \left(A_{US,t} - A_{BBB,t}\right) + \delta \, Lehman_{i,t} + \zeta \, C_{i,t} + \eta \, ECB_{i,t} + \theta \left(L_{i,t} - L_{b,t}\right) + \iota \left(X_{i,t} - X_{b,t}\right) + \varepsilon_{i,t}$$

Equation 6.3.1

Where the index *i* varies across countries, *b* indicates the benchmark country, in this case Germany. *t* varies over time, in this case days. $Y_{i,t}$ is the sovereign bond yield. α_i represents country fixed effects. $A_{US,t}$ is yield on U.S. government bonds, $A_{BBB,t}$ is the yield on US, BBB rated corporate bonds and so $A_{US,t} - A_{BBB,t}$ represents aggregate risk, or global risk aversion. $Lehman_{i,t}$ is a dummy variable on September the 15th, $C_{i,t}$ is the yield on Greek sovereign bonds representing contagion risk, $L_{i,t}$ is the bid-ask spread on bond yields, representing liquidity risk. $ECB_{i,t}$ is a vector of dummy variables dated on crucial moments of ECB policy. $X_{i,t}$ is a vector of macroeconomic fundamentals, including measures of current account, debt-to-GDP, expected deficit-to-GDP, GDP growth and unemployment. $\varepsilon_{i,t}$ represents disturbances that are independent across countries and time.

6.3.2. Ordinal model

The first augmented model finds its roots in Cantor and Packer (1996). This model includes the credit rating variable by transforming the cardinal ranking into an ordinal variable according to the transition method explained in Section 5.6. This model presented by Equation 6.3.2.

$$Y_{i,t} - Y_{b,t} = \alpha_i + \beta \left(Y_{i,t-1} - Y_{b,t-1}\right) + \gamma \left(A_{US,t} - A_{BBB,t}\right) + \delta \, Lehman_{i,t} + \zeta \, C_{i,t} + \eta \, ECB_{i,t} + \theta \left(L_{i,t} - L_{b,t}\right) + \iota \left(X_{i,t} - X_{b,t}\right) + \kappa \left(R_{i,t} - R_{b,t}\right) + \varepsilon_{i,t}$$

Equation 6.3.2

$R_{i,t}$ represents this measure for sovereign credit ratings.

6.3.3. Residual model

The second alternative model finds its roots in the methodology of Eichengreen and Mody (1998). This model first performs a regression of credit ratings on fundamentals and other explanatory variables of default risk; it then includes the residual from this estimation in a new regression in line with the baseline model. Eichengreen and Mody (1998) argue for this model because credit ratings

are correlated with other country characteristics, here we distil these effects from the rating score. The first regression is shown in Equation 6.3.3.

$$R_{i,t} - R_{b,t} = \alpha_i + \delta\, Lehman_{i,t} + \zeta\, C_{i,t} + \eta\, ECB_{i,t} + \iota\,(X_{i,t} - X_{b,t}) + \lambda(R_{i,t} - R_{b,t}) + r_{i,t}$$

Equation 6.3.3

$r_{i,t}$ is the residual from this first regression. This is the part of the variance in the spread of credit rating, the dependent variable here, which cannot be explained by the independent variables. As Eichengreen and Mody (1998) and Powell and Martínez (2008) explain, this may be interpreted as the rating agencies opinion. This residual includes all the information contained in the ratings that is not included in the other variables.

Before we perform the regression to create the residual, co integration analyses should provide evidence for the validity of this regression since there are non-stationary variables involved. Table 6.3 provides the results of this analysis. The results indicate that we cannot reject the null hypothesis of no co integration in the sample. When performing OLS we therefore run the risk of performing a spurious regression.

Table 6.3: Co integration analyses residual creation

Model	Levels
Akaike	0.16
DF	-1.00
Observations	7605

*Co integration test as proposed by Kao (1999). Table presents the t-statistic. ***, ** and * denote significance at the 1%, 5% and 10% level respectively. Sample period: 7/13/2006 – 5/14/2012*

A method to circumvent this issue is by performing the regression in first differences. The first differences of all variables are, in contrast to their levels, stationary. The first difference regression is performed including fixed effects. Here however, a lagged dependent variable is not included because we only want the right hand variables to capture the effects that are not contained in the credit rating. This way the residual will include all additional information of the rating variable. However, this panel OLS model suffers from severe autocorrelation. Because there are problems with heteroskadasticity as well, we employ the white cross-section coefficient covariance method to correct for both simultaneously.

The results of this regression are presented in the first column of Table 6.4. As we can see the results are not very satisfactory, only the 15 Sept ‘08 and 13 Mar ‘12 dummies and unemployment

variable are significant. Some variables that are shown to have an irrefutable correlation with the rating score in previous research, like level of debt and GDP growth, do not turn significant. Furthermore, the R^2 is only 0.0062 indicating very weak explanatory power of the dependent variables. The reason for this poor performance is the data loss as result of first differencing the variables. The residual of this regression will contain all sorts of information; it can certainly not be interpreted as a proxy for the rating agencies added explanatory information.

Table 6.4: Regression residual creation

Model	First diff.			Level		
Statistic	Coef	t-stat		Coef	t-stat	
First difference						
- Contagion	0.00	1.1				
- 15 Sept ' 08 dummy	0.00	5.0	***			
- 10 May '10 dummy	0.01	1.3				
- 22 July '11 dummy	0.00	1.5				
- 13 Mar ' 12 dummy	0.04	2.2	**			
- Capital Formation	0.00	-0.6				
- Debt-to-GDP	0.00	0.6				
- Deficit-to-GDP	0.00	-0.7				
- GDP growth	0.00	-0.8				
- Unemployment	0.00	5.3	***			
Levels						
- Contagion				-0.002	-7.7	***
- 15 Sept ' 08 dummy				0.047	15.4	***
- 10 May '10 dummy				0.168	24.4	***
- 22 July '11 dummy				-0.225	-31.1	***
- 13 Mar ' 12 dummy				-0.282	-27.1	***
- Capital Formation				-0.008	-6.9	***
- Debt-to-GDP				-0.006	-14.3	***
- Deficit-to-GDP				-0.006	-12.2	***
- GDP growth				0.046	47.4	***
- Unemployment				-0.015	-12.4	***
Adj. R^2	0.0062			0.7287		
Observations	7584			7593		

*Panel estimated generalized least squares regressions. Dependent variable: Logistic credit rating score. Table presents the coefficients and corresponding t-statistic. ***, ** and * denote significance at the 1%, 5% and 10% level respectively. Sample period: 7/13/2006 – 5/14/2012*

It is therefore decided to run the regression we first set out to perform. Even though there is a risk of running a spurious regression, we think this does not outweigh the very poor results of the regression in first differences. Moreover, despite the poor results of the co integration analyses, it

does not seem unrealistic to infer that there is a long-term relationship between the variables investigated here. The second column in Table 6.4 provides the results of this level panel OLS regression with robust standard errors; they are very much in line with the expectations. All variables are significant and the R^2 is 0.729. The residuals from this regression will therefore now be included as a variable in the residual model, indicated by $r_{i,t}$.

The second regression will then be as in Equation 6.3.4.

$$Y_{i,t} - Y_{b,t} = \alpha_i + \beta \left(Y_{i,t-1} - Y_{b,t-1}\right) + \gamma \left(A_{US,t} - A_{BBB,t}\right) + \delta\, Lehman_{i,t} + \zeta\, C_{i,t} + \eta\, ECB_{i,t} + \theta \left(L_{i,t} - L_{b,t}\right) + \iota \left(X_{i,t} - X_{b,t}\right) + \kappa \left(r_{i,t} - r_{b,t}\right) + \varepsilon_{i,t}$$

Equation 6.3.4

6.3.4. Dummy model

The third approach is more in line with Jaramillo and Tejada (2011), instead of transforming the rating to numerical values like the previous two methods, now a dummy variable is created for each different rating grade, thereby allowing for different coefficients across asset classes. This model is given by Equation 6.3.5.

$$Y_{i,t} - Y_{b,t} = \alpha_i + \beta \left(Y_{i,t-1} - Y_{b,t-1}\right) + \gamma \left(A_{US,t} - A_{BBB,t}\right) + \delta\, Lehman_{i,t} + \zeta\, C_{i,t} + \eta\, ECB_{i,t} + \theta \left(L_{i,t} - L_{b,t}\right) + \iota \left(X_{i,t} - X_{b,t}\right) + \kappa\, RD_{i,t} + \varepsilon_{i,t}$$

Equation 6.3.5

$RD_{i,t}$ is a vector of dummy variables for all but one rating grade. We need to exclude one dummy variable to prevent running into the dummy variable trap. The excluded dummy will serve as the benchmark; in this case it is the dummy for the C category. As a result of very insignificant results found when running a regression including dummies for all rating scales, it is decided to include dummies for all base categories only. So instead of a dummy for AA+ AA and AA-, these are all grouped together under in AA rating category. The sample is too small to obtain reliable results using the more specific dummies.

6.3.5. Results

Table 6.5 presents the results for the four panel estimated generalized least squares models in the initial set-up. The first column presents the baseline model. As was to be expected, the first lag of the yield spread is highly significant, since sovereign bond yields are highly auto correlated. The aggregated risk factors, represented here by the spread between the US government bond yield and BBB rated corporate bonds is not significant. This is not in line with the expectations, the first years

of financial crisis where a truly global phenomenon. The euro crisis however, is more regionally focused. It could also be argued that the proxy used is not accurately capturing aggregate risk, a point that will be discussed in the robustness analyses. The ECB policy dummies are all highly significant with the right sign. The liquidity dummy is highly significant as well, although it may be argued that this is the result of endogeneity with the yield spread. This will be discussed in more detail using a two staged least squares regression setup in the robustness section. All proxies for default risk except the deficit-to-GDP ratio are significant with the correct sign. The information contained in this ratio might for a very large extend overlap with some of the other proxies for default risk. Indeed a regression with the deficit-to-GDP as the only proxy of these five does render it significant. The baseline model performs very much in line with expectations based on previous research; it provides a steady foundation to extend the model with measures of credit ratings.

The ordinal model includes the logistic transformation of the rating score; this variable is highly significant with the correct sign. As we can see all global and regional risk factors perform similar to the baseline model. This is not the case for the default risk factors, as the effect of the debt-to-GDP ratio has become insignificant. This is in line with the interpretation of the credit rating as a summary statistic; the effect of this factor is completely captured by the credit rating variable. Current account, GDP growth and unemployment are still significant however.

The results of the residual model are very comparable; this is no surprise since it is a different method to include the same information in the model. It should be noted that the debt-to-GDP is now significant; this is in line with the expectations since the effect of the default measures is distilled from the rating score in the residual variable. More interesting is the significance of the deficit-to-GDP ratio, which is now significant with the right sign.

The signs and coefficients of the dummies in the dummy model are correct and in line relative to each other, except for the AAA rated dummy. Starting from the AA dummy and moving to lower scores, the value of the coefficient becomes higher. However, only the AAA, AA and A dummies are significant at the 10% level. This may be explained by the size of the sample; although it is a period with a lot of different rating grades the A categories are most well represented. As we will see in the robustness section however, a number of dummies for the other categories turn highly significant in the slightly modified models.

Table 6.6 presents the results of an omitted variables test; this is an F-test of the joint significance of omitted variables. We test the significance of the ordinal rating, residual rating and dummy rating variables with respect to the baseline model. The results indicate that the null hypothesis that these variables are irrelevant can be rejected for the rating variables in all three models.

Table 6.5: Regression results

Model	Baseline			Ordinal			Residual			Dummy		
Statistic	Coef	t-stat		Coef	t-stat		Coef	t-stat		Coef	t-stat	
Yield Spread t-1	0.980	524.5	***	0.968	388.8	***	0.968	388.8	***	0.970	401.2	***
Aggregate risk	-0.001	-0.7		0.000	-0.1		0.000	-0.1		0.001	0.6	
15 Sept ' 08 dummy	0.034	0.6		0.029	0.5		0.023	0.4		0.034	0.6	
Contagion	0.001	4.6	***	0.001	3.6	***	0.001	4.7	***	0.002	4.6	***
10 May '10 dummy	-1.014	-17.5	***	-1.007	-17.3	***	-1.030	-17.7	***	-1.010	-17.3	***
22 July '11 dummy	-0.191	-3.3	***	-0.183	-3.1	***	-0.152	-2.6	***	-0.183	-3.1	***
13 Mar ' 12 dummy	-0.408	-7.0	***	-0.444	-7.6	***	-0.406	-6.9	***	-0.429	-7.3	***
Liquidity	0.138	10.2	***	0.147	11.0	***	0.147	11.0	***	0.144	9.5	***
Capital Formation	-0.003	-2.4	**	-0.004	-3.0	***	-0.002	-2.0	**	-0.002	-1.4	
Debt-to-GDP	0.001	3.5	***	0.000	1.5		0.001	5.8	***	0.001	3.0	***
Deficit-to-GDP	0.000	-0.8		0.000	-1.6		0.001	2.6	***	0.000	-1.3	
GDP growth	-0.005	-5.8	***	-0.006	-6.7	***	-0.012	-9.1	***	-0.006	-5.9	***
Unemployment	0.002	2.9	***	0.004	5.2	***	0.006	6.8	***	0.002	3.1	***
Rating - Ordinal				-0.137	-7.0	***						
Rating - Residual							-0.137	-7.0	***			
Rating - AAA dummy										-0.245	-1.7	*
Rating - AA dummy										-0.249	-1.8	*
Rating - A dummy										-0.228	-1.6	*
Rating - BBB dummy										-0.209	-1.5	
Rating - BB dummy										-0.137	-1.0	
Rating - B dummy										-0.024	-0.2	
Rating - CCC dummy										-0.003	0.0	
Rating - CC dummy										0.322	1.3	
Adj. R^2	0.9975			0.9975			0.9975			0.9975		
Observations	7578			7578			7578			7578		

*Panel estimated generalized least squares regressions with cross section fixed effects. Dependent variable: Sovereign bond yield spread. Table presents the coefficients and corresponding t-statistic. ***, ** and * represent significance at the 1%, 5% and 10% levels respectively. Sample period: 7/13/2006 – 5/14/2012*

Table 6.6: F-test rating variables

Model	Ordinal		Residual		Dummy	
F-stat	43.5	***	43.5	***	6.1	***
Observations	7578		7578		7578	

*F-test on results of Panel estimated generalized least squares regressions. Table presents F-statistics. ***, ** and * represent significance at the 1%, 5% and 10% levels respectively. Sample period: 7/13/2006 – 5/14/2012*

6.4. Endogeneity

In this section we investigate if credit ratings and yield spreads are significantly correlated because the ratings have a causal effect on yield spreads, or if the credit rating changes are endogenous to yield spread. As discussed in Section 3.5. amongst others González-Rozada and Yeyati (2008) posed this endogeneity argument. As a preliminary investigation we performed all regressions with the direct inclusion of the first lags of all credit rating variables. As we can see in Table A6.1, the results are very much in line with the results in the initial model set-up. This section, however, will propose a more robust instrumental variable (IV) approach to investigate the causal relation.

6.4.1. Two-Stage Least Squares

A lagged version of the rating variables is included as an instrument in a panel two-stage EGLS regression model. The inclusion of these lagged rating scores may provide evidence on the causal effect; we now (indirectly) measure the effect of yesterday's rating score on today's bond yield. Since today's bond yield was not available yesterday, we expect this lagged rating to be exogenous to today's yield. Following Verbeek (2008), in the first stage we perform a regression of the reduced form of the equation in the initial model set-up. We thus regress the rating score of either the ordinal or residual model (the endogenous variable) on all exogenous variables, including all excluded instrumental variables (IV's). These IV's are one or more lags of the rating scores. As an illustration, consider Equation 6.4.1, it presents the reduced form of the ordinal model with one lag.

$$R_{i,t} - R_{b,t} = \alpha_i + \beta \left(Y_{i,t-1} - Y_{b,t-1}\right) + \gamma \left(A_{US,t} - A_{BBB,t}\right) + \delta\, Lehman_{i,t} + \zeta\, C_{i,t} + \eta\, ECB_{i,t} + \theta \left(L_{i,t} - L_{b,t}\right) + \iota \left(X_{i,t} - X_{b,t}\right) + \kappa (R_{i,t-1} - R_{b,t-1}) + \varepsilon_{i,t}$$

Equation 6.4.1

From this first regression we obtain the predicted values of $R_{i,t} - R_{b,t}$, as given by Equation 6.4.2.

$$\hat{R}_{i,t} - \hat{R}_{b,t} = \hat{\alpha}_i + \hat{\beta} \left(Y_{i,t-1} - Y_{b,t-1}\right) + \hat{\gamma} \left(A_{US,t} - A_{BBB,t}\right) + \hat{\delta}\, Lehman_{i,t} + \hat{\zeta}\, C_{i,t} + \hat{\eta}\, ECB_{i,t} + \hat{\theta} \left(L_{i,t} - L_{b,t}\right) + \hat{\iota} \left(X_{i,t} - X_{b,t}\right) + \hat{\kappa} \left(R_{i,t-1} - R_{b,t-1}\right)$$

Equation 6.4.2

In the second stage these predicted values are included in the different models as proposed in Section 6.3. The ordinal model with the first lag as IV is then given by Equation 6.4.3.

$$Y_{i,t} - Y_{b,t} = \alpha_i + \beta \left(Y_{i,t-1} - Y_{b,t-1}\right) + \gamma \left(A_{US,t} - A_{BBB,t}\right) + \delta\, Lehman_{i,t} + \zeta\, C_{i,t} + \eta\, ECB_{i,t} + \theta \left(L_{i,t} - L_{b,t}\right) + \iota \left(X_{i,t} - X_{b,t}\right) + \kappa \left(\hat{R}_{i,t} - \hat{R}_{b,t}\right) + \varepsilon_{i,t}$$

Equation 6.4.3

The yield spread is now regressed on a predicted value of the rating scores, created using lagged versions of these same variables. This method is used on the ordinal and residual models; the dummy model is excluded here because it is not suitable for this methodology. The dummies are cardinal variables; estimation of these variables by instruments wouldn't provide proper results. In addition to a model with the first lag as instrumental variable; a model using the first four lags as IV's is investigated. Table A6.2 and A6.3 present the results, the baseline models here are the same as in the initial set-up. As we can see the results for the ordinal and residual models have changed only very marginally, the effects of all variables being very similar in size and significance.

It is not clear however, if the instruments used here are valid. First the instruments should be strongly correlated with the credit rating score; second they should be uncorrelated with the error terms, so they are exogenous to yield spreads.

The first condition can be tested by performing a regression of the appropriate reduced form model (Verbeek, 2008) and testing for the relevance of the instrument. The proper reduced form model is illustrated for the ordinal model with the first lag of credit ratings as the IV in Equation 6.4.1. We then obtain an F-test statistic on the estimators of the IV. In the before mentioned illustration we test $H_0 : \kappa = 0$, for more than one IV we test the hypothesis that *all* coefficients are 0. The F-test should have values higher than 10, the rule-of-thumb value as presented by Stock and Watson (2007). The first two rows in Table 6.7, incl. covariates, present the results. As we can see the properties of the instruments meet the first condition.

Table 6.7: F-test reduced form model

Model	Ordinal F-stat		Residual F-stat	
Incl. covariates				
- Rating t-1	1595869	***	196351	***
- Rating t-1 to t-4	398335	***	57942	***
- Rating t-2 to t-4	271520	***	47153	***
Excl. covariates				
- Rating t-1	10328299	***	685872	***
- Rating t-1 to t-4	2578106	***	186729	***
- Rating t-2 to t-4	1741337	***	170576	***

*F-test on results of Panel estimated generalized least squares regressions. Table presents F-statistics. ***, ** and * represent significance at the 1%, 5% and 10% levels respectively. Sample period: 7/13/2006 – 5/14/2012*

However, we cannot be sure that all variables besides the IV's in Equation 6.4.1 are truly exogenous. Because endogenous covariates may bias the IV estimates, we also provide the F-test

statistics for the relevance of the IV's on the same model without all covariates as a robustness check. The results in Table 6.7 indicate that this does not alter the conclusions that can be drawn: The IV's have a sufficiently strong correlation with credit rating scores at time t = 0.

The second condition is that the IV's should be exogenous to yield spreads, as we use instrumental variables method to correct for the possible endogeneity of the rating score in the first place. This last property may not be met by these instruments. Unfortunately the statistical software package used does not provide a test for the endogeneity of the instruments in the panel two-stage EGLS regression model.

6.4.2. Generalized Method of Moments

We therefore turn the attention to a Generalized Method of Moments (GMM) model; here we are able to test the properties of the instruments. GMM estimates the coefficients (or parameters as it may) using the moment conditions imposed. These moment conditions are expectations implied by the model. For example one of the moment conditions for the ordinal model, without instruments, could be as Equation 6.4.4.

$$E\left\{\left(\left(Y_{i,t} - Y_{b,t}\right) - \alpha_i - \beta\left(Y_{i,t-1} - Y_{b,t-1}\right) - \gamma\left(A_{US,t} - A_{BBB,t}\right) - \delta\, Lehman_{i,t} - \zeta\, C_{i,t} - \eta\, ECB_{i,t} - \theta\left(L_{i,t} - L_{b,t}\right) - \iota\left(X_{i,t} - X_{b,t}\right) - \kappa\left(R_{i,t} - R_{b,t}\right)\right)\left(Y_{i,t-1} - Y_{b,t-1}\right)\right\} = 0$$

Equation 6.4.4

The number of moment conditions depends on the number of variables in the model. If the number of variables equals the number of parameters, we can solve all moment conditions exactly by choosing the correct value for the parameters. If no instruments are used, the results will then be the same as for an OLS regression. If the number of variables is larger than the number of parameters, as is the case when we have multiple instruments for one endogenous variable, we cannot solve all moment conditions exactly to zero. GMM minimizes a function, which depends on the vector of sample moments and a weighting matrix, as close to zero as possible. It can be shown that the results of this estimation method are consistent and asymptotically normal.

Here we exploit the fact that GMM provides an over identifying restrictions test, the Sargan test. It is tested if the data are consistent with the moment conditions. This test is based on the results that can be obtained when implementing the estimated parameters and data on the variables in the moment conditions. The results from these moment condition should be close to 0. In the case where the number of variables equals the number of parameters, all moment conditions can be

exactly equal to zero and no useful test can be derived. However as was mentioned before, when the number of variables is larger than the number of parameters, this is not possible. The parameters are now over identified. The test basically identifies if all moment conditions have results close to zero. The null hypothesis states that the over identifying restrictions are valid, and will be rejected if the sample evidence is inconsistent with the moment conditions. If the null hypothesis is accepted, all variables included in the models are legitimate. It may then be concluded that the instruments are valid: They are exogenous to the yield spread in this case.

We need more variables than parameters for the Sargan test, so it will not provide additional insights to test the model with one lag of the credit rating as was first posed in the 2SLS model. We therefore immediately turn to the model with the 1^{st} to 4^{th} lag of the rating variables as the instrument for credit ratings. All models here are estimated including cross-section fixed effects and cross-section GLS weights. The results with inclusion of GMM White cross section weights are presented because they are robust for heteroskadasticity. To allow for comparison with the findings presented in Section 6.3, the results for 2SLS GMM weights are provided in the appendix. When no instruments are included, as is the case in the baseline model, this model will provide the exact same results as the panel EGLS model as presented in section 6.3.5.

Table A6.4 and A6.5 provide the results, the baseline model here is the same as before now estimated with GMM. From the J-statistic we can infer that the null hypothesis of valid over-identification restrictions is rejected for the ordinal model with White weights. They are strongly rejected for both models with 2SLS weights. Therefore we cannot conclude on the validity of the instruments and thus the endogeneity of credit ratings to yield spreads.

Hoping to find suitable instruments, we now turn to a model with the 2^{nd} to 4^{th} lag of the rating variables as the instrument for credit ratings. First we have to verify again that the first condition is met; a strong correlation with the endogenous credit rating measures. The results of the F-tests are provided in Table 6.7. The IV's are strongly correlated with credit ratings, so we turn to a test for the second condition. The results of the GMM model are presented in Table 6.8; results for 2SLS weights are available in the Table A6.6 in the appendix. The p-values for the J-statistic indicate that we cannot reject the null hypothesis of valid over-identification restrictions; this is substantiated by the evidence in the appendix. The 2^{nd} to 4^{th} lag thus appear to be valid instruments for the credit rating variables.

Exploring the results for the coefficients, it can be seen that the significance of a number of variables has changed. This is the result of the GMM White cross section weights. The measures for contagion and ECB policy have become insignificant and the debt-to-GDP lost some significance. In contrast, the Lehman dummy has become highly significant. The results for 2SLS weights are very

comparable to the results derived before. More importantly, the results for sovereign credit ratings are very much in line with those obtained earlier, with significant negative parameters for the rating scores. This is an important result as this is substantial evidence that the results found so far are not the result of endogeneity of credit ratings, instead credit ratings have a causal effect on the bond yield spread.

Table 6.8: Generalized Method of Moments, rating t-2 to t-4 as IV, White cross GMM weights

Model	Baseline			Ordinal			Residual		
Statistic	Coef	t-stat		Coef	t-stat		Coef	t-stat	
Yield Spread t-1	0.980	95.0	***	0.972	69.0	***	0.970	73.1	***
Aggregate risk	-0.001	-0.6		0.000	-0.2		0.000	-0.2	
15 Sept ' 08 dummy	0.034	4.7	***	0.031	5.4	***	0.024	3.4	***
Contagion	0.001	1.2		0.001	1.0		0.001	1.3	
10 May '10 dummy	-1.014	-1.3		-1.017	-1.4		-1.031	-1.4	
22 July '11 dummy	-0.191	-0.5		-0.192	-0.5		-0.158	-0.4	
13 Mar ' 12 dummy	-0.408	-0.1		-0.768	-0.3		-0.371	-0.1	
Liquidity	0.138	2.2	**	0.138	2.2	**	0.147	2.4	**
Capital Formation	-0.003	-3.0	***	-0.003	-3.2	***	-0.002	-2.4	**
Debt-to-GDP	0.001	1.7	*	0.000	0.9		0.001	1.9	*
Deficit-to-GDP	0.000	-0.5		0.000	-0.7		0.000	1.4	
GDP growth	-0.005	-3.5	***	-0.006	-3.3	***	-0.011	-3.1	***
Unemployment	0.002	3.0	***	0.003	3.3	***	0.005	3.3	***
Rating - Ordinal				-0.109	-2.0	**			
Rating - Residual							-0.118	-2.3	**
J-statistic				0.66			0.34		
P-value J-statistic				0.72			0.85		
Adj. R^2	0.9975			0.9975			0.9975		
Observations	7578			7563			7547		

*Generalized Method of Moments regressions, with cross section fixed effects, cross section GLS weights and White cross section weights. Dependent variable: Sovereign bond yield spread. Table presents the coefficients and corresponding t-statistic. ***, ** and * represent significance at the 1%, 5% and 10% levels respectively. Sample period: 7/13/2006 – 5/14/2012*

6.5. Robustness

To evaluate the validity of the results obtained and investigate some interesting points more thoroughly a variety of robustness checks will be presented in this section. All tables for this section can be found in the appendix.

6.5.1. Impact of the crisis

As was argued amongst others by von Hagen et al. (2011), Bernoth et al. (2012) and Bernoth and Erdogan (2012), the effect of a number of variables included in our investigation may have changed as a result of outbreak of the financial crisis in 2008. Investors re-evaluated the weight they put on some risk indicators. The relatively large differences between the amounts of sovereign debt in the euro-zone did not result in large differences in sovereign bond yields before the financial crisis. The crisis has made clear that the risk of these high debts may have
been underestimated and investors re-evaluated their perceptions of countries accordingly. It may therefore not be correct to include the variables for periods before and during the crisis years in the same manner. We therefore re-estimate the models with the inclusion of interaction terms of the country specific fundamental variables with a dummy that is positive for all data from the 15th of September onwards, see Table A6.7. These interaction terms may then absorb the additional effects that are only present during the crisis period. In addition we perform an analysis with the exclusion of all data before 15 September 2008, see Table A6.8.

With respect to the credit rating score the results of both these models are similar to the initial set-up; the rating variables are highly significant in the ordinal and residual model, while the performance of the rating dummies model provides only very thin evidence for the explanatory power of credit ratings. The results for the interaction terms are not in line with the findings of von Hagen et al. (2011), Bernoth et al. (2012) and Bernoth and Erdogan (2012). Either the default risk factors or the interaction terms of these factors are significant. Only for the baseline and dummy models we find a significant positive effect of the debt-to-GDP ratio in the crisis period, over a significant pre-crisis result. It may very well be that the sample is too small to split-up the variables like this, the pre-crisis period spans only two years. Table A6.8 does present results that are in line with the changes in perception of investors; all five default risk factors have become more significant and have a larger impact compared to the initial setup. Another notable difference is the decrease in significance of contagion, especially since contagion was predominantly important *during* the crisis. The effect of contagion in the initial set-up of the models however was significant, but nevertheless already very small.

6.5.2. Exclusion of first lag dependent variable

All models are regressed again with the exclusion of the first lag of sovereign bond yield spreads (Table A6.9); although this model suffers from severe autocorrelation the results are nevertheless an interesting contribution. They indicate the power of the different models to explain the variance in the bond yield spread. As we can see from the high adjusted R^2 for all models, the included variables

provide a very complete explanation of the variance in yield spreads. The aggregate risk factor is now significant for all models, as is the deficit-to-GDP ratio for all but the baseline model. The dummy variable model now performs in line with expectations based on the ordinal and residual models.

6.5.3. Alternative proxy for aggregate risk

In Section 6.3 we noted that the proxy used to measure aggregate risk is ambiguous, since it may be argued that the risk on US sovereign bonds is not stable. We therefore re-estimate the models with the inclusion of a different proxy for aggregate risk: the US corporate BBB – AAA bond spread. From Table A6.10 we see that this variable is significant for the 10% level, for the ordinal and residual models. For the baseline and dummy models however, this factor is also insignificant. Even so, the significance of some of the default risk proxies did decrease.

6.5.4. Period fixed effects

The aggregate risk proxy, together with the Lehman and ECB dummies represent a set of variables that are the same across all countries in the sample. These factors outline the circumstances at different moments in time. Another way to proxy for this is by including period-fixed effects. The baseline model is shown in Equation 6.5.4.

$$Y_{i,t} - Y_{b,t} = \alpha_i + \beta_t + \gamma \left(Y_{i,t-1} - Y_{b,t-1}\right) + \delta\, C_{i,t} + \zeta\, (L_{i,t} - L_{b,t}) + \eta\, (X_{i,t} - X_{b,t}) + \varepsilon_{i,t}$$

Equation 6.5.4

β_t is a dummy variable that is the same for all countries, but differs day-by-day. Table A6.11 presents the results; again the most notable difference is the significance of the rating dummies. Apart from some slight other differences, the main conclusions that can be drawn remain the same; the rating scores remain highly significant.

6.5.5. Linear rating transformation

In addition to the inclusion of the logistic transformation of the rating scores, Table A6.12 presents the results with the linear transformation score included as was discussed in Section 5.6. The results are very much in line with those obtained earlier. The significance of the linear rating score did decrease slightly compared to the logistically transformed rating scores, but the difference is only marginal: A t-statistic of -6,5 compared to -7 for the logistic rating score. This does not provide substantial evidence on the best transformation method, further research on this specific relation is needed to draw firm conclusions in this respect.

6.5.6. Interaction aggregate risk and liquidity

In line with Favero et al. (2010), the regression results shown in Table A6.13 include an interaction term between aggregate risk and liquidity. Like Favero et al. (2010) we find that the positive effect of an increase in the bid ask spread on sovereign bond yields is dampened by the aggregate risk factor. It may be that it takes longer for more illiquid bonds to incorporate changes in aggregate risk in their return. Although this is an interesting finding as such, and additional evidence for conclusions drawn by Favero et al. (2010), the inclusion of this interaction term does not significantly alter the other results.

6.5.7. Endogeneity of liquidity

Table A6.14 is the outcome of a two stage least square regression with the first lag of the bid-ask spread as an instrumental variable for liquidity. The same endogeneity arguments provided for the rating changes are valid for the liquidity rate. More notably, when we take a look at the graph of the liquidity proxy in Figure A5.5, we see a strong increase in the bid-ask spread during the crisis. It is unlikely that the corresponding variance in the sovereign bond yield spreads can be explained as a compensation for the high illiquidity of the bonds. It may be more realistic to assume that the high bid-ask spreads are caused some other, third factor that also affects bond yield spreads. Or it may be that the causal effect is the other way around, very volatile yield spreads may make the market illiquid. Capturing the causal effect of liquidity on yield spreads in these volatile datasets is difficult, more so because the time difference between cause and effect can be very small and fluctuate within trading days. Including a one day lag then is a rather artificial method. The purpose of the current investigation however, is not to study liquidity. As we can see from Table A6.14 the results for the ordinal and residual rating variables did not change substantially. The dummy rating scores have all become highly significant. The results of the liquidity variables did change; in fact it switched signs in all four models. This is not in line with expectations; it may be explained by the preceding discussion.

This section has discussed a number of different robustness checks. It may be concluded that the regression results with respect to the ordinal and residual rating scores are robust to the tests presented here. All models provide significant coefficients with the correct sign on these rating variables. The results on the dummy model differ, some alternative models discussed in this section provided highly significant results for the dummy model; some found results more in line with those discussed in the main text.

7. Conclusion

The worldwide financial crisis and European sovereign debt crisis brought the importance of sovereign credit ratings forward in the debate. The free-fall of sovereign bond yields for a group of European countries ran in tandem with amassing downgrades of these sovereigns by rating agencies. However, the extent to which these ratings affect yield spreads is not evident. This paper has provided more insight in the effect of credit ratings on yield spreads.

The econometric evidence in this paper suggests that sovereign credit ratings have significant, independent explanatory power with respect to sovereign bond yield spreads, over and above their correlation with other publicly available information. Evidence is based on a panel dataset employed on Portugal, Italy, Ireland, Greece and Spain, with respect to Germany for a period running from 7/13/2006 – 5/14/2012. This provides the first formal evidence on the explanatory power of sovereign credit ratings with respect to other fundamental factors for developed economies.

When testing for causality of changes in credit ratings on sovereign bond yield spreads, evidence is found that bond yield spreads respond to sovereign credit ratings. This is a crucial finding, instead sovereign spreads may react to credit ratings and so the direction of causation may be questioned. This evidence provides the first proof on the causal relation between ratings and yield spreads in the presence of other factors based on publicly available information.

The results indicate that credit rating cannot be interpreted as a summary statistic of all other factors affecting sovereign default risk. The rating score does fully captures the effect of changes in sovereign debt, as this factor is independent when included simultaneously with the rating score. Other measures of default risk however, remain significant in tandem with the rating score. Although markets value the rating scores, either they do not interpret the underlying information in the same way, or the grain statistic of rating scores lacks the accuracy that may be obtained from interpreting the fundamentals directly.

The finding that sovereign credit ratings affect sovereign bond yield spreads can be explained by one or more of the follow three effects. First, rating agencies provide additional information to the markets. This may be either through access to undisclosed information or re-elaboration of publicly available information. Second, credit ratings are used in regulation and may therefore exert direct impact on bond yields. Third and least plausible, the ease of use and interpretation of ratings makes that they are used by investors unable or –willing to interpret the fundamental information themselves.

A number of additional conclusions can be drawn with respect to the factors that represent fundamentals. These are variables measuring the aggregate risk, contagion, ECB policy, liquidity, current account balance, debt-to-GDP ratio, expected deficit-to-GDP ratio, GDP growth and

unemployment. In contrast to previous literature no significant effect of the aggregate risk factor is found, it is an indication of regional occurrence of the European sovereign debt crisis, unrelated with global risk aversion. The regional contagion factor included which represents infection by Greece, is found to be significant. It thereby provides additional evidence for the importance of this relatively little investigated factor. Furthermore we append the parsimonious evidence on the significance of the current account balance, GDP growth and unemployment.

For academics the results indicate that sovereign credit ratings are a factor that should be taken into account when investigating fluctuations in sovereign bond yield spreads. They should not be interpreted as a summary statistic of other measures of default risk, ratings scores exert explanatory power of themselves, complementing and not substituting other factors. The same is true for policy makers, credit ratings have to be recognized as one of many factors influencing bond yield spreads. This argues for policies that aim at obtaining a favourable rating score, more importantly however, it justifies the call for regulation of credit rating agencies.

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Appendix

Table A5.1: Credit rating transformation

Interpretation	Rating Symbol		Linear		Logistic	
	S&P / Fitch	Moody's	Stable	Negative Outlook	Stable	Negative Outlook
Highest quality	AAA	Aaa	2.00	1.95	2.00	1.995
High quality	AA+	Aa1	1.90	1.85	1.99	1.975
	AA	Aa2	1.80	1.75	1.96	1.935
	AA-	Aa3	1.70	1.65	1.91	1.875
Strong payment capacity	A+	A1	1.60	1.55	1.84	1.795
	A	A2	1.50	1.45	1.75	1.695
	A-	A3	1.40	1.35	1.64	1.575
Adequate payment capacity	BBB+	Baa1	1.30	1.25	1.51	1.435
	BBB	Baa2	1.20	1.15	1.36	1.275
	BBB-	Baa3	1.10	1.05	1.19	1.095
Likely to fulfill obligations,	BB+	Ba1	1.00	0.95	1.00	0.905
ongoing uncertainty	BB	Ba2	0.90	0.85	0.81	0.725
	BB-	Ba3	0.80	0.75	0.64	0.565
High-risk obligations	B+	B1	0.70	0.65	0.49	0.425
	B	B2	0.60	0.55	0.36	0.305
	B-	B3	0.50	0.45	0.25	0.205
Vulnarable to default	CCC+	Caa1	0.40	0.35	0.16	0.125
	CCC	Caa2	0.30	0.25	0.09	0.065
	CCC-	Caa3	0.20	0.15	0.04	0.025
Near or in bankruptcy or	CC	Ca	0.10	0.05	0.01	0.005
default	C	C	0.00	0.00	0.00	0.000

Source: IMF (2010). Linear and logistic transformation matrix sovereign credit ratings, stable and negative outlook

Table A6.1: First lags ratings variables

Model	Baseline			Ordinal			Residual		
Statistic	Coef	t-stat		Coef	t-stat		Coef	t-stat	
Yield Spread t-1	0.980	524.5	***	0.969	389.4	***	0.970	397.4	***
Aggregate risk	-0.001	-0.7		0.000	-0.2		0.000	-0.2	
15 Sept ' 08 dummy	0.034	0.6		0.030	0.5		0.030	0.5	
Contagion	0.001	4.6	***	0.001	3.6	***	0.001	4.7	***
10 May '10 dummy	-1.014	-17.5	***	-1.007	-17.3	***	-1.006	-17.3	***
22 July '11 dummy	-0.191	-3.3	***	-0.184	-3.1	***	-0.184	-3.2	***
13 Mar ' 12 dummy	-0.408	-7.0	***	-0.442	-7.6	***	-0.436	-7.5	***
Liquidity	0.138	10.2	***	0.147	10.9	***	0.146	10.8	***
Capital Formation	-0.003	-2.4	**	-0.003	-3.0	***	-0.002	-2.0	**
Debt-to-GDP	0.001	3.5	***	0.000	1.6		0.001	5.6	***
Deficit-to-GDP	0.000	-0.8		0.000	-1.6		0.000	2.3	**
GDP growth	-0.005	-5.8	***	-0.006	-6.7	***	-0.012	-8.8	***
Unemployment	0.002	2.9	***	0.003	5.1	***	0.005	6.5	***
Rating – Ordinal t-1				-0.129	-6.6	***			
Rating – Residual t-1							-0.126	-6.6	***
Adj. R^2	0.9975			0.9975			0.9975		
Observations	7578			7578			7574		

*Panel estimated generalized least squares regressions with cross section fixed effects. Dependent variable: Sovereign bond yield spread. Table presents the coefficients and corresponding t-statistic. ***, ** and * represent significance at the 1%, 5% and 10% levels respectively. Sample period: 7/13/2006 – 5/14/2012*

Table A6.2: Two-Stage-Least-Squares; rating t-1 as IV

Model	Baseline			Ordinal			Residual		
Statistic	Coef	t-stat		Coef	t-stat		Coef	t-stat	
Yield Spread t-1	0.980	524.5	***	0.969	389.0	***	0.969	384.4	***
Aggregate risk	-0.001	-0.7		0.000	-0.1		0.000	-0.1	
15 Sept ' 08 dummy	0.034	0.6		0.030	0.5		0.023	0.4	
Contagion	0.001	4.6	***	0.001	3.6	***	0.001	4.7	***
10 May '10 dummy	-1.014	-17.5	***	-1.008	-17.3	***	-1.030	-17.7	***
22 July '11 dummy	-0.191	-3.3	***	-0.184	-3.1	***	-0.154	-2.6	***
13 Mar ' 12 dummy	-0.408	-7.0	***	-0.442	-7.6	***	-0.405	-6.9	***
Liquidity	0.138	10.2	***	0.147	10.9	***	0.147	10.9	***
Capital Formation	-0.003	-2.4	**	-0.003	-3.0	***	-0.002	-2.0	**
Debt-to-GDP	0.001	3.5	***	0.000	1.6		0.001	5.7	***
Deficit-to-GDP	0.000	-0.8		0.000	-1.6		0.001	2.5	**
GDP growth	-0.005	-5.8	***	-0.006	-6.7	***	-0.012	-8.8	***
Unemployment	0.002	2.9	***	0.003	5.1	***	0.006	6.6	***
Rating - Ordinal				-0.129	-6.6	***			
Rating - Residual							-0.133	-6.6	***
Adj. R^2	0.9975			0.9975			0.9975		
Observations	7578			7578			7574		

*Panel two stage estimated generalized least squares regressions with cross section fixed effects. Dependent variable: Sovereign bond yield spread. Table presents the coefficients and corresponding t-statistic. ***, ** and * represent significance at the 1%, 5% and 10% levels respectively. Sample period: 7/13/2006 – 5/14/2012*

Table A6.3: Two-Stage-Least-Squares; rating t-1 to t-4 as IV

Model	Baseline			Ordinal			Residual		
Statistic	Coef	t-stat		Coef	t-stat		Coef	t-stat	
Yield Spread t-1	0.980	524.5	***	0.969	388.6	***	0.969	384.1	***
Aggregate risk	-0.001	-0.7		0.000	-0.2		0.000	-0.2	
15 Sept ' 08 dummy	0.034	0.6		0.030	0.5		0.024	0.4	
Contagion	0.001	4.6	***	0.001	3.6	***	0.001	4.7	***
10 May '10 dummy	-1.014	-17.5	***	-1.008	-17.3	***	-1.030	-17.6	***
22 July '11 dummy	-0.191	-3.3	***	-0.184	-3.1	***	-0.155	-2.6	***
13 Mar ' 12 dummy	-0.408	-7.0	***	-0.442	-7.6	***	-0.406	-6.9	***
Liquidity	0.138	10.2	***	0.147	10.9	***	0.147	10.9	***
Capital Formation	-0.003	-2.4	**	-0.004	-3.0	***	-0.002	-2.0	**
Debt-to-GDP	0.001	3.5	***	0.000	1.6		0.001	5.6	***
Deficit-to-GDP	0.000	-0.8		0.000	-1.6		0.001	2.4	**
GDP growth	-0.005	-5.8	***	-0.006	-6.7	***	-0.012	-8.6	***
Unemployment	0.002	2.9	***	0.003	5.1	***	0.005	6.4	***
Rating - Ordinal				-0.129	-6.6	***			
Rating - Residual							-0.129	-6.4	***
Adj. R^2	0.9975			0.9975			0.9975		
Observations	7578			7563			7547		

*Panel two stage estimated generalized least squares regressions with cross section fixed effects. Dependent variable: Sovereign bond yield spread. Table presents the coefficients and corresponding t-statistic. ***, ** and * represent significance at the 1%, 5% and 10% levels respectively. Sample period: 7/13/2006 – 5/14/2012*

Table A6.4: Generalized Method of Moments, rating t-1 to t-4 as IV, White cross GMM weights

Model	Baseline			Ordinal			Residual		
Statistic	Coef	t-stat		Coef	t-stat		Coef	t-stat	
Yield Spread t-1	0.980	95.0	***	0.971	68.8	***	0.971	73.1	***
Aggregate risk	-0.001	-0.6		0.000	-0.1		0.000	-0.2	
15 Sept ' 08 dummy	0.034	4.7	***	0.030	5.3	***	0.025	3.5	***
Contagion	0.001	1.2		0.001	1.0		0.001	1.2	
10 May '10 dummy	-1.014	-1.3		-1.018	-1.4		-1.037	-1.4	
22 July '11 dummy	-0.191	-0.5		-0.192	-0.5		-0.158	-0.4	
13 Mar ' 12 dummy	-0.408	-0.1		-0.904	-0.3		-0.723	-0.3	
Liquidity	0.138	2.2	**	0.134	2.1	**	0.138	2.3	**
Capital Formation	-0.003	-3.0	***	-0.003	-3.3	***	-0.002	-2.4	**
Debt-to-GDP	0.001	1.7	*	0.000	0.7		0.001	1.8	*
Deficit-to-GDP	0.000	-0.5		0.000	-0.6		0.001	1.5	
GDP growth	-0.005	-3.5	***	-0.006	-3.5	***	-0.011	-3.0	***
Unemployment	0.002	3.0	***	0.003	3.6	***	0.005	3.3	***
Rating - Ordinal				-0.116	-2.1	**			
Rating - Residual							-0.119	-2.3	**
J-statistic				6.48			1.74		
P-value J-statistic				0.09	*		0.63		
Adj. R^2	0.9975			0.9975			0.9975		
Observations	7578			7563			7547		

*Generalized Method of Moments regressions, with cross section fixed effects, cross section GLS weights and White cross section weights. Dependent variable: Sovereign bond yield spread. Table presents the coefficients and corresponding t-statistic. ***, ** and * represent significance at the 1%, 5% and 10% levels respectively. Sample period: 7/13/2006 – 5/14/2012*

Table A6.5: Generalized Method of Moments, rating t-1 to t-4 as IV, 2SLS GMM weights

Model	Baseline			Ordinal			Residual		
Statistic	Coef	t-stat		Coef	t-stat		Coef	t-stat	
Yield Spread t-1	0.980	524.5	***	0.969	388.6	***	0.969	384.1	***
Aggregate risk	-0.001	-0.7		0.000	-0.2		0.000	-0.2	
15 Sept ' 08 dummy	0.034	0.6		0.030	0.5		0.024	0.4	
Contagion	0.001	4.6	***	0.001	3.6	***	0.001	4.7	***
10 May '10 dummy	-1.014	-17.5	***	-1.008	-17.3	***	-1.030	-17.6	***
22 July '11 dummy	-0.191	-3.3	***	-0.184	-3.1	***	-0.155	-2.6	***
13 Mar ' 12 dummy	-0.408	-7.0	***	-0.442	-7.6	***	-0.406	-6.9	***
Liquidity	0.138	10.2	***	0.147	10.9	***	0.147	10.9	***
Capital Formation	-0.003	-2.4	**	-0.004	-3.0	***	-0.002	-2.0	**
Debt-to-GDP	0.001	3.5	***	0.000	1.6		0.001	5.6	***
Deficit-to-GDP	0.000	-0.8		0.000	-1.6		0.001	2.4	**
GDP growth	-0.005	-5.8	***	-0.006	-6.7	***	-0.012	-8.6	***
Unemployment	0.002	2.9	***	0.003	5.1	***	0.005	6.4	***
Rating - Ordinal				-0.129	-6.6	***			
Rating - Residual							-0.129	-6.4	***
J-statistic				108.04			9.28		
P-value J-statistic				0.00	***		0.03	**	
Adj. R^2	0.9975			0.9975			0.9975		
Observations	7578			7563			7547		

*Generalized Method of Moments regressions, with cross section fixed effects, cross section GLS weights and 2SLS cross section weights. Dependent variable: Sovereign bond yield spread. Table presents the coefficients and corresponding t-statistic. ***, ** and * represent significance at the 1%, 5% and 10% levels respectively. Sample period: 7/13/2006 – 5/14/2012*

Table A6.6: Generalized Method of Moments, rating t-2 to t-4 as IV, 2SLS GMM weights

Model	Baseline			Ordinal			Residual		
Statistic	Coef	t-stat		Coef	t-stat		Coef	t-stat	
Yield Spread t-1	0.980	524.5	***	0.970	388.9	***	0.970	381.7	***
Aggregate risk	-0.001	-0.7		0.000	-0.2		0.000	-0.2	
15 Sept ' 08 dummy	0.034	0.6		0.030	0.5		0.025	0.4	
Contagion	0.001	4.6	***	0.001	3.7	***	0.001	4.6	***
10 May '10 dummy	-1.014	-17.5	***	-1.008	-17.3	***	-1.028	-17.6	***
22 July '11 dummy	-0.191	-3.3	***	-0.184	-3.2	***	-0.158	-2.7	***
13 Mar ' 12 dummy	-0.408	-7.0	***	-0.440	-7.5	***	-0.407	-6.9	***
Liquidity	0.138	10.2	***	0.146	10.8	***	0.146	10.8	***
Capital Formation	-0.003	-2.4	**	-0.003	-2.9	***	-0.002	-2.1	**
Debt-to-GDP	0.001	3.5	***	0.000	1.8		0.001	5.4	***
Deficit-to-GDP	0.000	-0.8		0.000	-1.5		0.000	2.1	**
GDP growth	-0.005	-5.8	***	-0.006	-6.6	***	-0.011	-8.1	***
Unemployment	0.002	2.9	***	0.003	4.8	***	0.005	6.0	***
Rating - Ordinal				-0.114	-5.8	***			
Rating - Residual							-0.118	-5.8	***
J-statistic				1.08			0.65		
P-value J-statistic				0.58			0.72		
Adj. R^2	0.9975			0.9975			0.9975		
Observations	7578			7563			7547		

*Generalized Method of Moments regressions, with cross section fixed effects, cross section GLS weights and 2SLS cross section weights. Dependent variable: Sovereign bond yield spread. Table presents the coefficients and corresponding t-statistic. ***, ** and * represent significance at the 1%, 5% and 10% levels respectively. Sample period: 7/13/2006 – 5/14/2012*

Table A6.7: Interaction crisis period dummies

Model	Baseline			Ordinal			Residual			Dummy		
Statistic	Coef	t-stat		Coef	t-stat		Coef	t-stat		Coef	t-stat	
Yield Spread t-1	0.974	470.0	***	0.962	362.8	***	0.962	362.8	***	0.964	376.1	***
Aggregate risk	0.002	0.9		0.002	1.0		0.002	1.0		0.002	0.8	
15 Sept ' 08 dummy	0.030	0.5		0.022	0.4		0.016	0.3		0.028	0.5	
Contagion	0.001	3.8	***	0.001	3.3	***	0.001	4.3	***	0.002	4.5	***
10 May '10 dummy	-1.021	-17.6	***	-1.012	-17.4	***	-1.036	-17.8	***	-1.009	-17.4	***
22 July '11 dummy	-0.191	-3.3	***	-0.181	-3.1	***	-0.149	-2.5	***	-0.180	-3.1	***
13 Mar ' 12 dummy	-0.409	-7.0	***	-0.437	-7.5	***	-0.397	-6.8	***	-0.423	-7.3	***
Liquidity	0.162	11.6	***	0.174	12.5	***	0.174	12.5	***	0.164	10.6	***
Current account	-0.007	-3.6	***	-0.007	-3.5	***	-0.006	-2.9	***	-0.008	-3.6	***
Debt-to-GDP	0.001	4.7	***	0.001	3.0	***	0.002	6.1	***	0.001	3.9	***
Deficit-to-GDP	0.000	0.5		0.001	1.1		0.002	2.0	**	0.001	1.1	
GDP growth	0.000	0.1		0.000	-0.2		-0.007	-3.1	***	0.000	0.0	
Unemployment	-0.006	-2.9	***	-0.003	-1.2		-0.001	-0.3		-0.004	-1.6	
Interaction crisis dummy												
- Current account	0.001	1.2		0.000	0.6		0.000	0.6		0.001	1.4	
- Debt-to-GDP	0.000	2.7	***	0.000	1.6		0.000	1.6		0.000	2.3	**
- Deficit-to-GDP	-0.001	-0.9		-0.002	-1.7	*	-0.002	-1.7		-0.002	-1.7	*
- GDP growth	-0.008	-3.8	***	-0.009	-4.0	***	-0.009	-4.0	***	-0.008	-3.6	***
- Unemployment	0.010	3.7	***	0.008	2.8	***	0.008	2.8	***	0.009	3.2	***
Rating - Ordinal				-0.142	-7.1	***						
Rating - Residual							-0.142	-7.1	***			
Rating - AAA dummy										-0.227	-1.6	
Rating - AA dummy										-0.233	-1.7	*
Rating - A dummy										-0.229	-1.6	*
Rating - BBB dummy										-0.194	-1.4	
Rating - BB dummy										-0.137	-1.0	
Rating - B dummy										-0.043	-0.3	
Rating - CCC dummy										-0.011	-0.1	
Rating - CC dummy										0.353	1.4	
Adj. R^2	0.9975			0.9975			0.9975			0.9975		
Observations	7578			7578			7578			7578		

*Panel estimated generalized least squares regressions with cross section fixed effects. Dependent variable: Sovereign bond yield spread. Table presents the coefficients and corresponding t-statistic. ***, ** and * represent significance at the 1%, 5% and 10% levels respectively. Sample period: 7/13/2006 – 5/14/2012*

Table A6.8: Crisis period only

Model	Baseline			Ordinal			Residual			Dummy		
Statistic	Coef	t-stat		Coef	t-stat		Coef	t-stat		Coef	t-stat	
Yield Spread t-1	0.970	347.1	***	0.957	269.4	***	0.957	269.4	***	0.957	273.1	***
Aggregate risk	0.004	1.4		0.004	1.6	*	0.004	1.6	*	0.003	1.1	
15 Sept ' 08 dummy	0.037	0.5		0.031	0.4		0.023	0.3		0.037	0.5	
Contagion	0.001	2.2	**	0.001	1.4		0.001	2.1	**	0.001	1.6	
10 May '10 dummy	-1.012	-13.9	***	-0.999	-13.7	***	-1.025	-14.0	***	-0.989	-13.5	
22 July '11 dummy	-0.185	-2.5	**	-0.173	-2.4	**	-0.138	-1.9	*	-0.174	-2.4	**
13 Mar ' 12 dummy	-0.421	-5.7	***	-0.444	-6.1	***	-0.400	-5.5	***	-0.439	-6.0	***
Liquidity	0.170	9.6	***	0.184	10.3	***	0.184	10.3	***	0.189	9.3	***
Current account	-0.010	-3.2	***	-0.012	-3.8	***	-0.011	-3.4	***	-0.018	-4.4	***
Debt-to-GDP	0.002	4.1	***	0.001	2.4	**	0.002	4.4	***	0.002	3.2	***
Deficit-to-GDP	0.000	-2.0	**	-0.001	-2.6	***	0.000	1.1		-0.001	-2.6	***
GDP growth	-0.008	-6.1	***	-0.009	-6.7	***	-0.016	-8.5	***	-0.008	-5.1	***
Unemployment	0.010	3.3	***	0.013	4.5	***	0.015	5.1	***	0.021	5.2	***
Rating - Ordinal				-0.156	-6.0	***						
Rating - Residual							-0.156	-6.0	***			
Rating - AAA dummy										-0.077	-0.4	
Rating - AA dummy										-0.101	-0.6	
Rating - A dummy										-0.112	-0.6	
Rating - BBB dummy										-0.051	-0.3	
Rating - BB dummy										-0.001	0.0	
Rating - B dummy										0.039	0.2	
Rating - CCC dummy										0.025	0.2	
Rating - CC dummy										0.394	1.3	
Adj. R^2	0.9968			0.9969			0.9969			0.9968		
Observations	4743			4743			4743			4743		

*Panel estimated generalized least squares regressions with cross section fixed effects. Dependent variable: Sovereign bond yield spread. Table presents the coefficients and corresponding t-statistic. ***, ** and * represent significance at the 1%, 5% and 10% levels respectively. Sample period: 9/15/2008 – 5/14/2012*

Table A6.9: Exclusion yield spread t-1

Model	Baseline			Ordinal			Residual			Dummy		
Statistic	Coef	t-stat		Coef	t-stat		Coef	t-stat		Coef	t-stat	
Aggregate risk	0.095	10.6	***	0.050	6.8	***	0.050	6.8	***	0.070	8.1	***
15 Sept ' 08 dummy	-0.241	-0.7		-0.314	-1.2		-0.578	-2.1	**	-0.203	-0.7	
Contagion	0.097	59.6	***	0.031	23.3	***	0.045	35.0	***	0.079	50.8	***
10 May '10 dummy	-0.411	-1.2		-0.427	-1.6		-1.379	-5.1	***	-0.319	-1.1	
22 July '11 dummy	0.402	1.1		-0.085	-0.3		1.188	4.4	***	0.116	0.4	
13 Mar ' 12 dummy	1.128	3.2	***	-0.075	-0.3		1.523	5.7	***	0.557	2.0	
Liquidity	5.637	138.4	***	3.477	107.7	***	3.477	107.7	***	3.207	75.8	***
Current account	0.097	59.6	***	0.031	23.3	***	0.045	35.0	***	0.079	50.8	***
Debt-to-GDP	0.041	27.7	***	0.004	4.0	***	0.041	41.1	***	0.026	18.4	***
Deficit-to-GDP	0.000	-0.3		-0.011	-9.4	***	0.025	21.3	***	-0.010	-8.7	***
GDP growth	-0.204	-35.6	***	-0.115	-28.5	***	-0.373	-89.9	***	-0.116	-23.2	***
Unemployment	0.064	14.4	***	0.104	35.5	***	0.191	59.7	***	0.073	19.6	***
Rating - Ordinal				-5.659	-100	***						
Rating - Residual							-5.659	-100	***			
Rating - AAA dummy										-10.823	-23.1	***
Rating - AA dummy										-11.140	-24.0	***
Rating - A dummy										-10.820	-23.3	***
Rating - BBB dummy										-9.486	-20.3	***
Rating - BB dummy										-7.153	-15.7	***
Rating - B dummy										-3.253	-6.8	***
Rating - CCC dummy										0.077	0.2	
Rating - CC dummy										4.754	5.9	***
Adj. R^2	0.9188			0.9626			0.9626			0.9584		
Observations	7584			7584			7584			7584		

*Panel estimated generalized least squares regressions with cross section fixed effects. Dependent variable: Sovereign bond yield spread. Table presents the coefficients and corresponding t-statistic. ***, ** and * represent significance at the 1%, 5% and 10% levels respectively. Sample period: 7/13/2006 – 5/14/2012*

Table A6.10: Aggregate risk, US corporate AAA – BBB spread

Model	Baseline			Ordinal			Residual			Dummy		
Statistic	Coef	t-stat		Coef	t-stat		Coef	t-stat		Coef	t-stat	
Yield Spread t-1	0.980	519.0	***	0.968	383.3	***	0.968	383.3	***	0.969	397.8	***
US AAA - BBB spread	0.002	0.8		0.004	1.7	*	0.004	1.7	*	0.004	1.6	
15 Sept ' 08 dummy	0.034	0.6		0.031	0.5		0.024	0.4		0.036	0.6	
Contagion	0.002	5.0	***	0.001	4.0	***	0.002	5.2	***	0.002	4.8	***
10 May '10 dummy	-1.012	-17.5	***	-1.005	-17.2	***	-1.029	-17.6	***	-1.010	-17.3	***
22 July '11 dummy	-0.189	-3.3	***	-0.180	-3.1	***	-0.148	-2.5	**	-0.182	-3.1	***
13 Mar ' 12 dummy	-0.406	-7.0	***	-0.443	-7.6	***	-0.403	-6.9	***	-0.426	-7.3	***
Liquidity	0.140	10.3	***	0.150	11.1	***	0.150	11.1	***	0.146	9.6	***
Current account	-0.002	-1.4		-0.002	-1.8	*	-0.001	-0.9		-0.001	-0.8	
Debt-to-GDP	0.001	3.3	***	0.000	1.2		0.001	5.6	***	0.001	2.7	***
Deficit-to-GDP	0.000	-0.8		0.000	-1.7	*	0.001	2.6	***	0.000	-1.4	
GDP growth	-0.006	-6.0	***	-0.007	-7.1	***	-0.013	-9.4	***	-0.006	-6.1	***
Unemployment	0.001	1.6	*	0.003	3.4	***	0.005	5.3	***	0.002	2.0	**
Rating - Ordinal				-0.141	-7.2	***						
Rating - Residual							-0.141	-7.2	***			
Rating - AAA dummy										-0.251	-1.8	*
Rating - AA dummy										-0.253	-1.8	*
Rating - A dummy										-0.232	-1.6	*
Rating - BBB dummy										-0.210	-1.5	
Rating - BB dummy										-0.141	-1.0	
Rating - B dummy										-0.024	-0.2	
Rating - CCC dummy										-0.001	0.0	
Rating - CC dummy										0.325	1.3	
Adj. R^2	0.9975			0.9975			0.9975			0.9975		
Observations	7578			7578			7578			7578		

*Panel estimated generalized least squares regressions with cross section fixed effects. Dependent variable: Sovereign bond yield spread. Table presents the coefficients and corresponding t-statistic. ***, ** and * represent significance at the 1%, 5% and 10% levels respectively. Sample period: 7/13/2006 – 5/14/2012*

Table A6.11: Period fixed effects

Model	Baseline			Ordinal			Residual			Dummy		
Statistic	Coef	t-stat		Coef	t-stat		Coef	t-stat		Coef	t-stat	
Yield Spread t-1	0.920	255.8	***	0.881	196.7	***	0.881	196.7	***	0.884	201.9	***
Aggregate risk												
15 Sept ' 08 dummy												
Contagion	-0.044	-17.1	***	-0.039	-15.3	***	-0.038	-14.8	***	-0.048	-15.7	***
10 May '10 dummy												
22 July '11 dummy												
13 Mar ' 12 dummy												
Liquidity	0.191	13.9	***	0.293	19.1	***	0.293	19.1	***	0.267	16.4	***
Current account	0.032	7.9	***	0.020	4.9	***	0.024	6.0	***	0.019	4.2	***
Debt-to-GDP	0.002	4.2	***	0.001	1.2		0.004	8.3	***	0.003	5.2	***
Deficit-to-GDP	-0.001	-3.0	***	-0.002	-4.7	***	0.001	2.3	**	-0.002	-4.7	***
GDP growth	-0.012	-6.1	***	-0.007	-3.4	***	-0.028	-12.5	***	-0.003	-1.3	
Unemployment	-0.025	-9.2	***	-0.012	-4.4	***	-0.005	-1.8	*	-0.010	-3.1	***
Rating - Ordinal				-0.464	-14.3	***						
Rating - Residual							-0.464	-14.3	***			
Rating - AAA dummy										-0.442	-3.8	***
Rating - AA dummy										-0.486	-4.3	***
Rating - A dummy										-0.467	-4.1	***
Rating - BBB dummy										-0.387	-3.4	***
Rating - BB dummy										-0.158	-1.5	
Rating - B dummy										-0.186	-1.7	*
Rating - CCC dummy										-0.037	-0.4	
Rating - CC dummy										0.485	2.8	***
Adj. R^2	0.9974			0.9975			0.9975			0.9975		
Observations	7578			7578			7578			7578		

*Panel estimated generalized least squares regressions with cross section fixed effects. Dependent variable: Sovereign bond yield spread. Table presents the coefficients and corresponding t-statistic. ***, ** and * represent significance at the 1%, 5% and 10% levels respectively. Sample period: 7/13/2006 – 5/14/2012*

Table A6.12: Linear rating transformation

Model	Baseline			Ordinal			Residual		
Statistic	Coef	t-stat		Coef	t-stat		Coef	t-stat	
Yield Spread t-1	0.980	524.5	***	0.971	413.6	***	0.971	413.6	***
Aggregate risk	-0.001	-0.7		0.000	0.3		0.000	0.3	
15 Sept ' 08 dummy	0.034	0.6		0.030	0.5		0.025	0.4	
Contagion	0.001	4.6	***	0.001	1.8	*	0.001	4.4	***
10 May '10 dummy	-1.014	-17.5	***	-1.005	-17.3	***	-1.025	-17.6	***
22 July '11 dummy	-0.191	-3.3	***	-0.184	-3.2	***	-0.159	-2.7	***
13 Mar ' 12 dummy	-0.408	-7.0	***	-0.444	-7.6	***	-0.404	-6.9	***
Liquidity	0.138	10.2	***	0.145	10.8	***	0.145	10.8	***
Capital Formation	-0.003	-2.4	**	-0.004	-3.5	***	-0.002	-2.0	**
Debt-to-GDP	0.001	3.5	***	0.000	-0.2		0.001	5.0	***
Deficit-to-GDP	0.000	-0.8		0.000	-0.4		0.000	2.0	**
GDP growth	-0.005	-5.8	***	-0.006	-6.8	***	-0.011	-8.7	***
Unemployment	0.002	2.9	***	0.003	4.2	***	0.005	6.4	***
Linear transformation									
- Rating - Ordinal				-0.161	-6.5	***			
- Rating - Residual							-0.161	-6.5	***
Adj. R^2	0.9975			0.9975			0.9975		
Observations	7578			7578			7578		

*Panel estimated generalized least squares regressions with cross section fixed effects. Dependent variable: Sovereign bond yield spread. Table presents the coefficients and corresponding t-statistic. ***, ** and * represent significance at the 1%, 5% and 10% levels respectively. Sample period: 7/13/2006 – 5/14/2012*

Table A6.13: Interaction term aggregate risk, liquidity risk

Model	Baseline			Ordinal			Residual			Dummy		
Statistic	Coef	t-stat		Coef	t-stat		Coef	t-stat		Coef	t-stat	
Yield Spread t-1	0.977	493.5	***	0.967	384.9	***	0.967	384.9	***	0.967	389.5	***
Aggregate risk	0.001	0.8		0.002	1.0		0.002	1.0		0.004	2.0	**
15 Sept ' 08 dummy	0.033	0.6		0.030	0.5		0.024	0.4		0.035	0.6	
Contagion	0.002	5.7	***	0.001	4.5	***	0.002	5.5	***	0.002	6.0	***
10 May '10 dummy	-1.008	-17.5	***	-1.004	-17.2	***	-1.025	-17.6	***	-1.005	-17.3	***
22 July '11 dummy	-0.208	-3.6	***	-0.197	-3.4	***	-0.170	-2.9	***	-0.201	-3.5	***
13 Mar ' 12 dummy	-0.398	-6.9	***	-0.436	-7.5	***	-0.401	-6.9	***	-0.417	-7.2	***
Liquidity	0.315	8.6	***	0.284	7.6	***	0.284	7.6	***	0.332	8.0	***
Current account	-0.003	-2.2	**	-0.003	-2.8	***	-0.002	-1.9	**	-0.001	-1.0	
Debt-to-GDP	0.001	3.2	***	0.000	1.5		0.001	5.3	***	0.001	3.7	***
Deficit-to-GDP	0.000	-0.6		0.000	-1.3		0.001	2.4	***	0.000	-1.5	
GDP growth	-0.005	-5.6	***	-0.006	-6.5	***	-0.011	-8.3	***	-0.005	-5.3	***
Unemployment	0.002	3.2	***	0.004	5.2	***	0.005	6.5	***	0.002	2.7	***
Aggregate risk*Liquidity	-0.218	-5.2	***	-0.170	-3.9	***	-0.170	-3.9	***	-0.233	-4.9	***
Rating - Ordinal				-0.123	-6.2	***						
Rating - Residual							-0.123	-6.2	***			
Rating - AAA dummy										-0.122	-0.8	
Rating - AA dummy										-0.126	-0.9	
Rating - A dummy										-0.108	-0.8	
Rating - BBB dummy										-0.111	-0.8	
Rating - BB dummy										-0.031	-0.2	
Rating - B dummy										0.068	0.5	
Rating - CCC dummy										0.136	1.1	
Rating - CC dummy										0.415	1.7	*
Adj. R^2	0.9975			0.9975			0.9975			0.9975		
Observations	7578			7578			7578			7578		

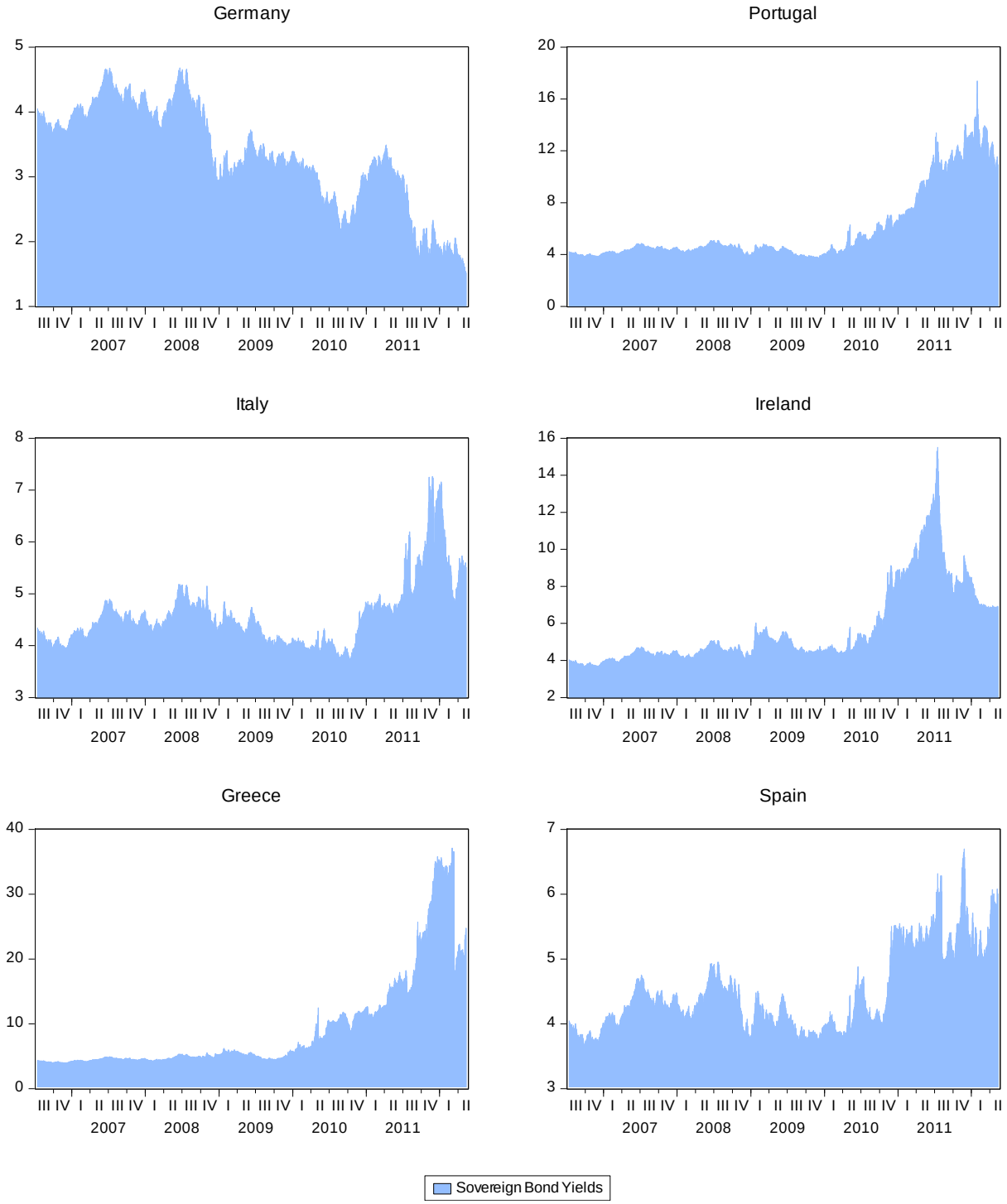
*Panel estimated generalized least squares regressions with cross section fixed effects. Dependent variable: Sovereign bond yield spread. Table presents the coefficients and corresponding t-statistic. ***, ** and * represent significance at the 1%, 5% and 10% levels respectively. Sample period: 7/13/2006 – 5/14/2012*

Table A6.14: Two-Stage-Least-Squares; bid-ask spread t-1 as IV

Model	Baseline			Ordinal			Residual			Dummy		
Statistic	Coef	t-stat		Coef	t-stat		Coef	t-stat		Coef	t-stat	
Yield Spread t-1	1.005	507.1	***	0.996	390.2	***	0.996	390.2	***	0.995	398.8	***
Aggregate risk	-0.002	-1.1		-0.001	-0.6		-0.001	-0.6		0.000	-0.1	
15 Sept ' 08 dummy	0.043	0.7		0.039	0.7		0.034	0.6		0.042	0.7	
Contagion	-0.001	-1.7	*	-0.001	-2.5	**	-0.001	-1.7	*	0.000	1.3	
10 May '10 dummy	-1.033	-17.6	***	-1.026	-17.5	***	-1.045	-17.8	***	-1.025	-17.4	***
22 July '11 dummy	-0.208	-3.5	***	-0.204	-3.5	***	-0.179	-3.1	***	-0.194	-3.3	***
13 Mar ' 12 dummy	-0.441	-7.5	***	-0.454	-7.7	***	-0.423	-7.2	***	-0.445	-7.6	***
Liquidity	-0.076	-5.2	***	-0.071	-4.8	***	-0.071	-4.8	***	-0.131	-7.8	***
Capital Formation	-0.001	-1.2		-0.002	-1.7	*	-0.001	-0.9		-0.001	-0.6	
Debt-to-GDP	0.000	1.1		0.000	-0.5		0.001	2.9	***	0.001	2.3	**
Deficit-to-GDP	0.000	1.9	*	0.000	1.2		0.001	4.3	***	0.000	1.0	
GDP growth	-0.002	-2.8	***	-0.003	-3.6	***	-0.008	-6.0	***	-0.003	-2.9	***
Unemployment	0.000	0.7		0.002	2.6	***	0.003	4.1	***	0.001	0.8	
Rating - Ordinal				-0.109	-5.5	***						
Rating - Residual							-0.109	-5.5	***			
Rating - AAA dummy										-1.176	-7.9	***
Rating - AA dummy										-1.184	-8.0	***
Rating - A dummy										-1.176	-7.9	***
Rating - BBB dummy										-1.140	-7.8	***
Rating - BB dummy										-1.081	-7.5	***
Rating - B dummy										-1.057	-6.9	***
Rating - CCC dummy										-0.720	-5.4	***
Rating - CC dummy										-0.201	-0.8	
Adj. R^2	0.9974			0.9975			0.9975			0.9974		
Observations	7572			7572			7572			7572		

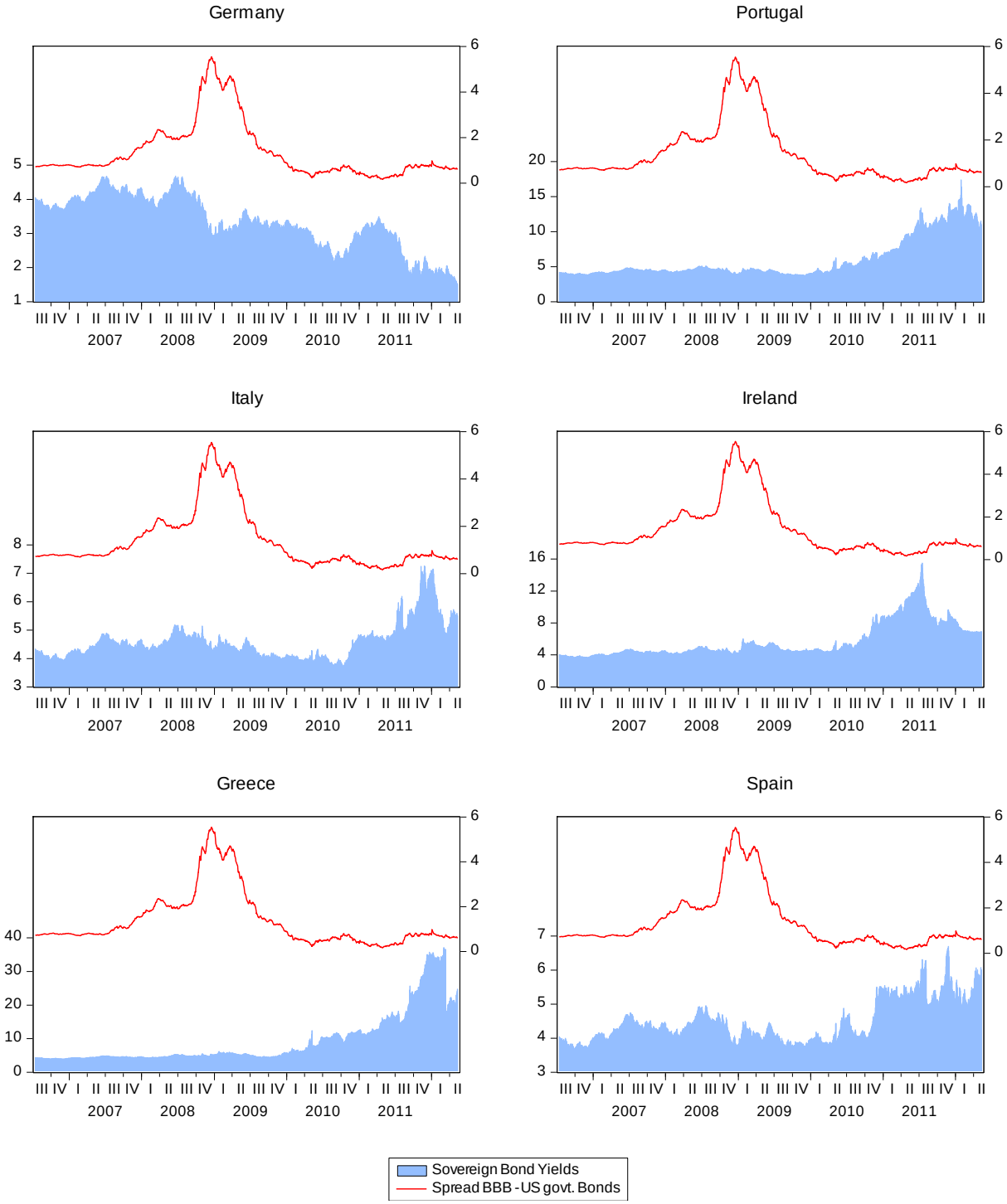
*Panel estimated generalized least squares regressions with cross section fixed effects. Dependent variable: Sovereign bond yield spread. Table presents the coefficients and corresponding t-statistic. ***, ** and * represent significance at the 1%, 5% and 10% levels respectively. Sample period: 7/13/2006 – 5/14/2012*

Figure A5.1: Sovereign bond yields



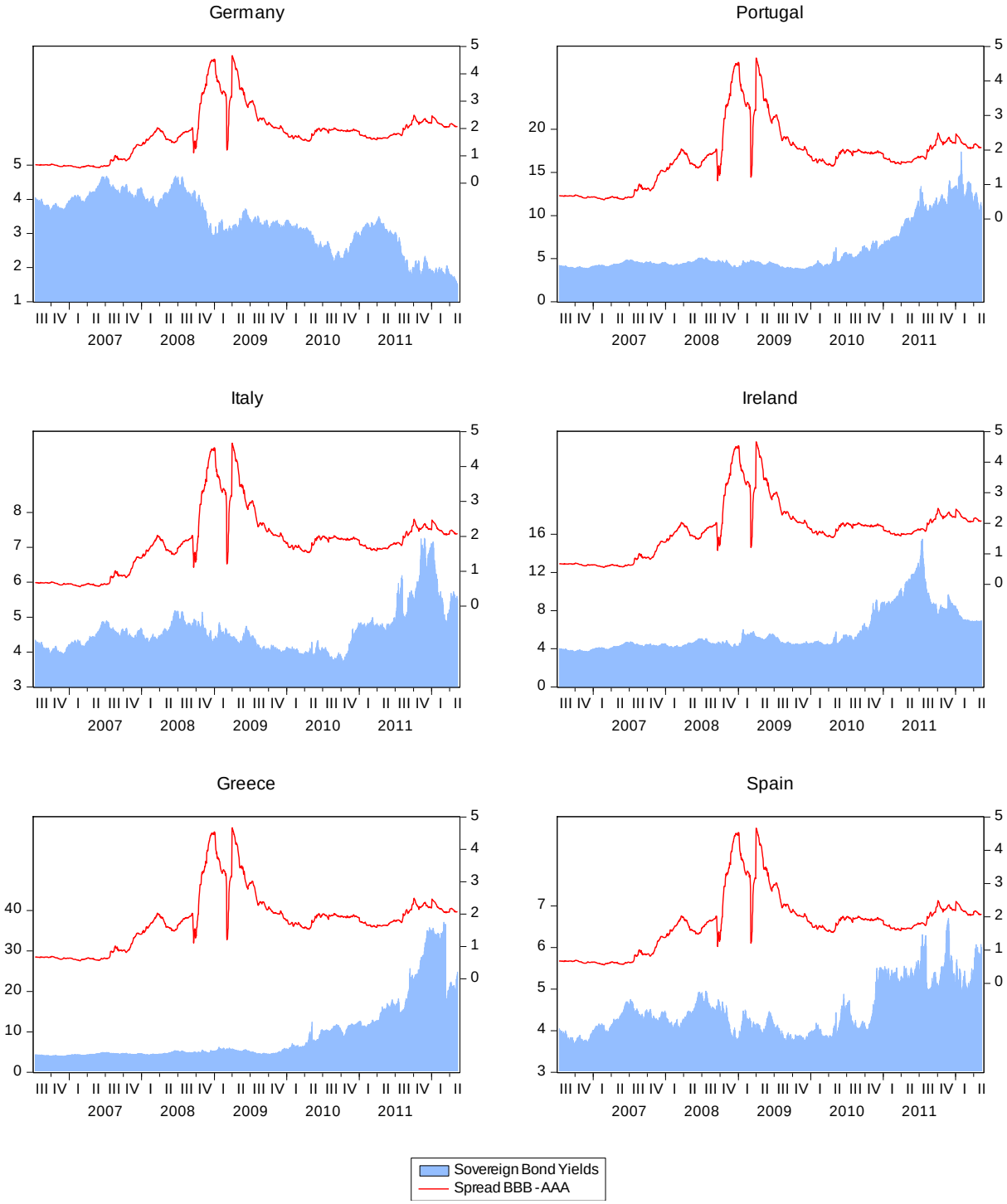
In blue: 10 year maturity sovereign bond yield, Martkit, Bloomberg. Sample period: 7/13/2006 – 5/14/2012

Figure A5.2: Aggregate risk; US sovereign – BBB corporate spread



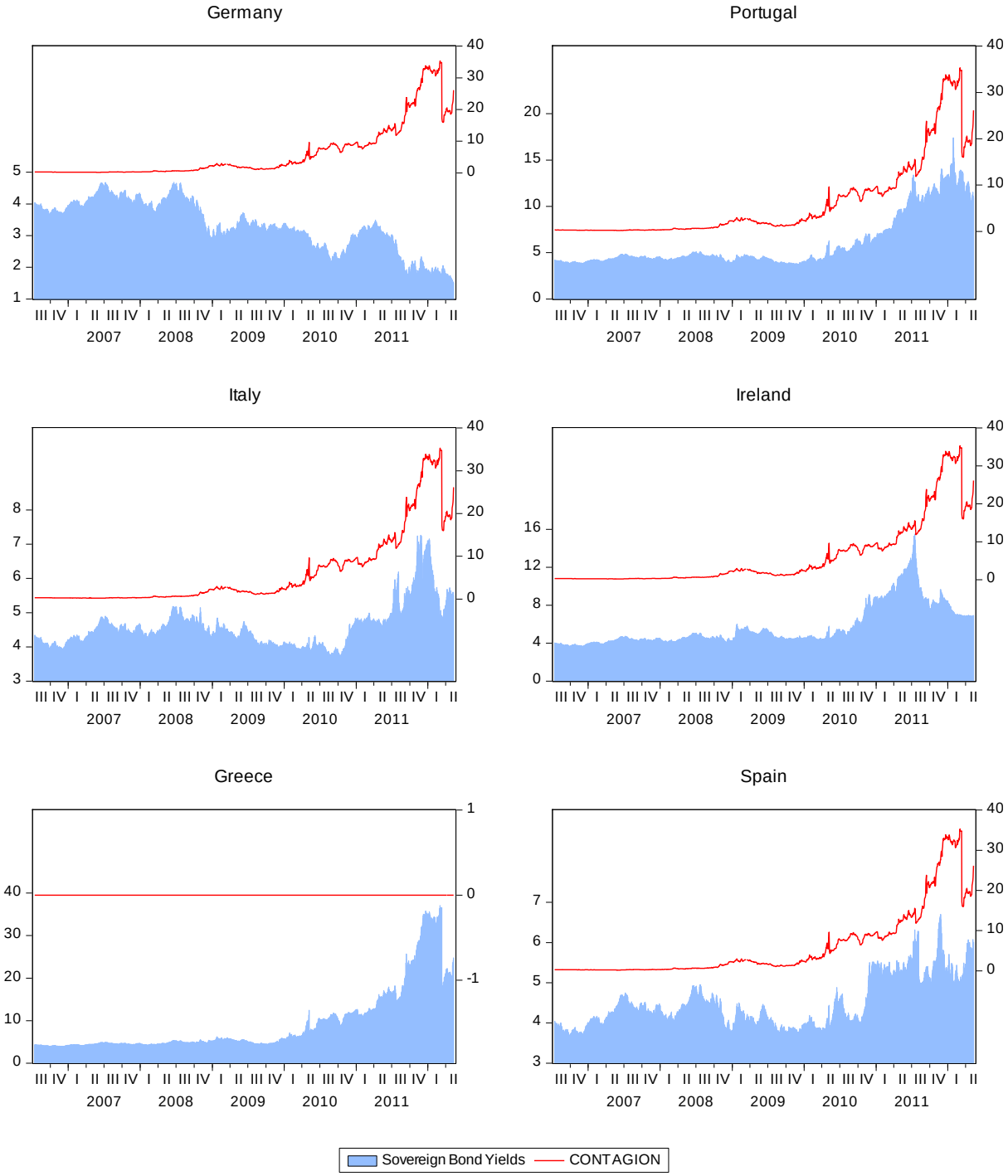
In blue: 10 year maturity sovereign bond yield, Martkit, Bloomberg. In red: Yield spread US government 10 year maturity bonds – BBB rated corporate bonds, Markit/Merill Lynch, Bloomberg. Sample period: 7/13/2006 – 5/14/2012

Figure A5.3: Aggregate risk; AAA corporate – BBB corporate spread



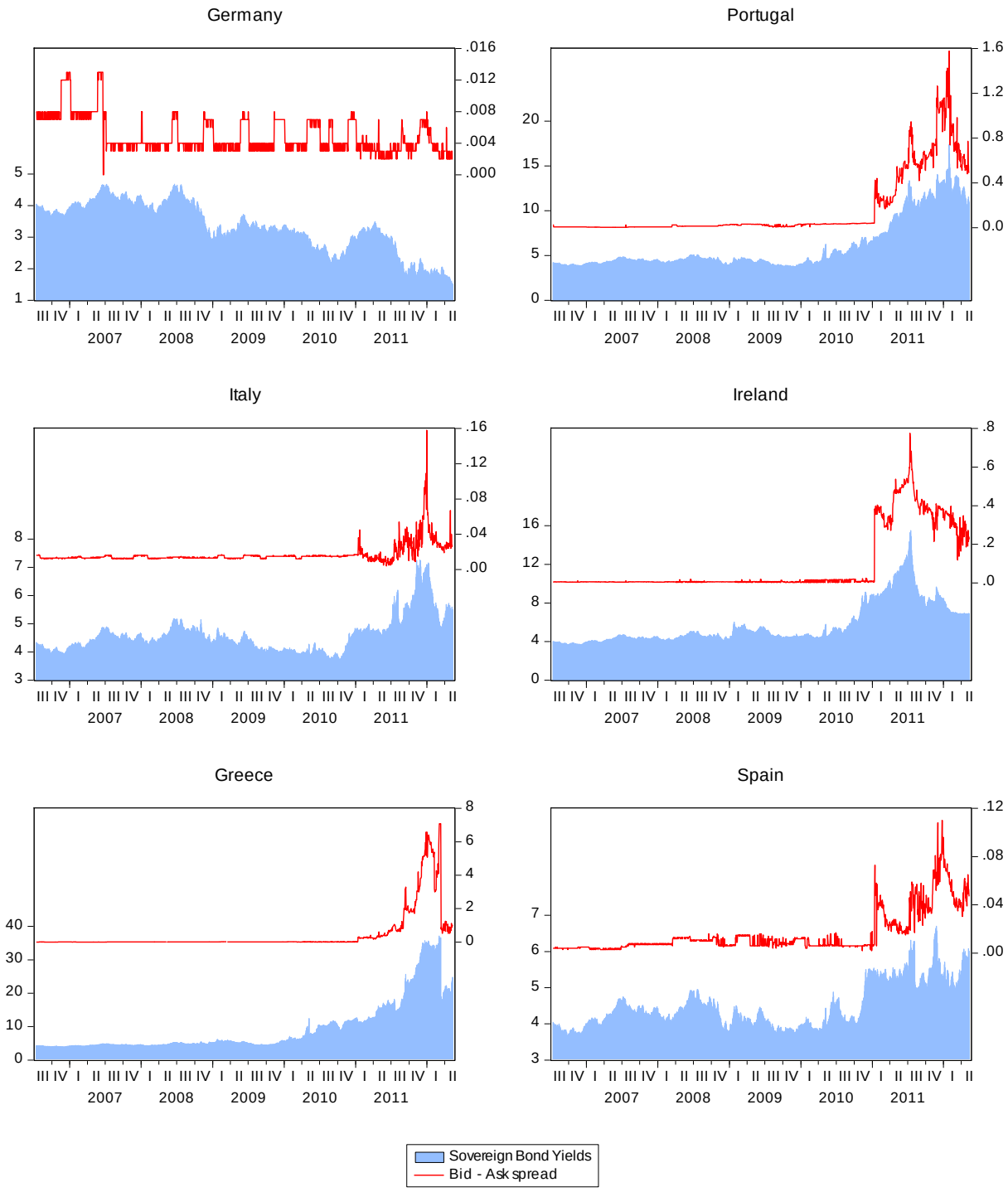
In blue: 10 year maturity sovereign bond yield, Martkit, Bloomberg. In red: AAA rated corporate bonds – BBB rated corporate bonds, Markit/Merill Lynch, Bloomberg. Sample period: 7/13/2006 – 5/14/2012

Figure A5.4: Contagion; sovereign bond yields Greece



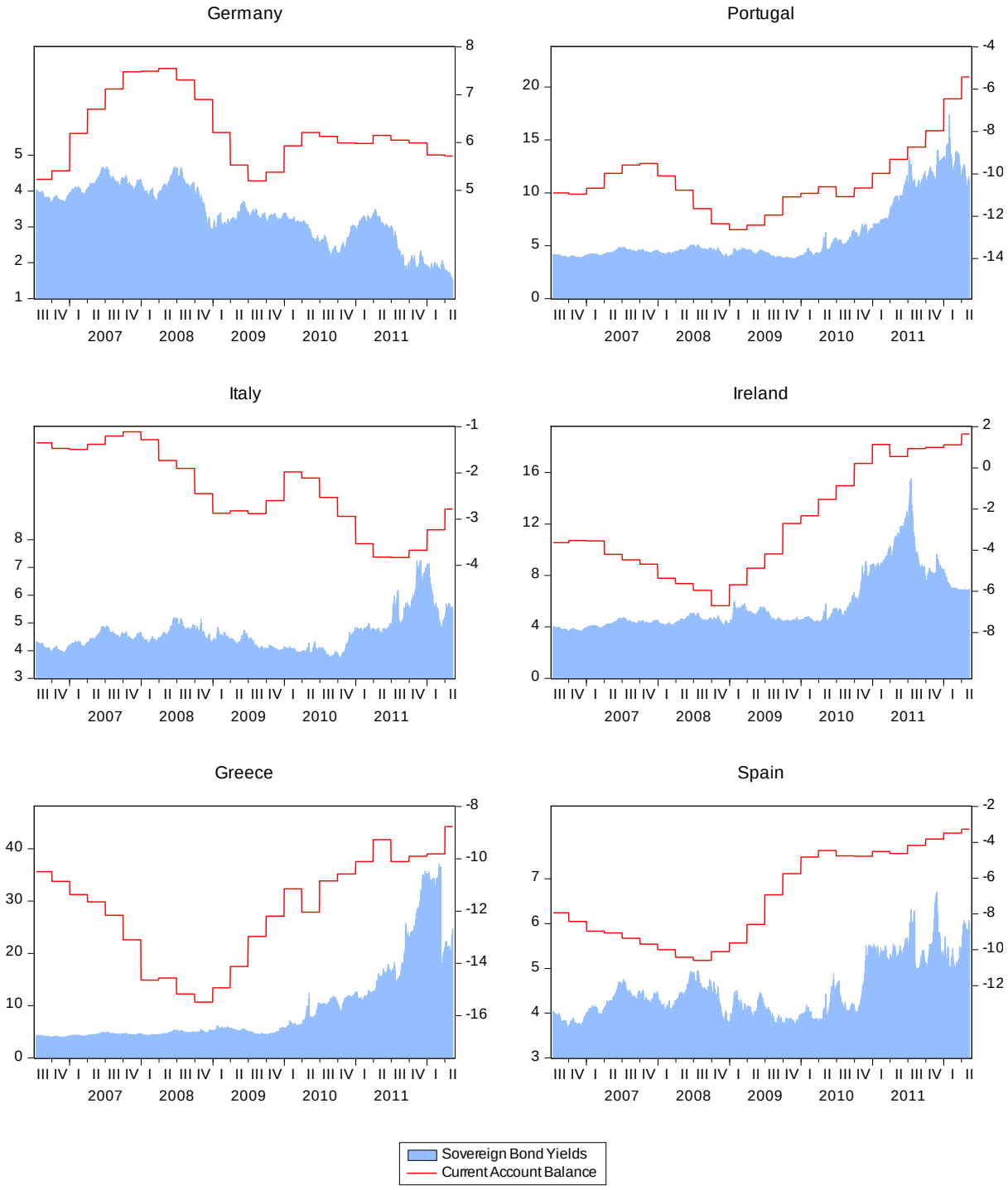
In blue: 10 year maturity sovereign bond yield, Martkit, Bloomberg. In red: 10 year maturity sovereign bond yield Greece, Markit, Bloomberg. Sample period: 7/13/2006 – 5/14/2012

Figure A5.5: Liquidity; bid-ask spread



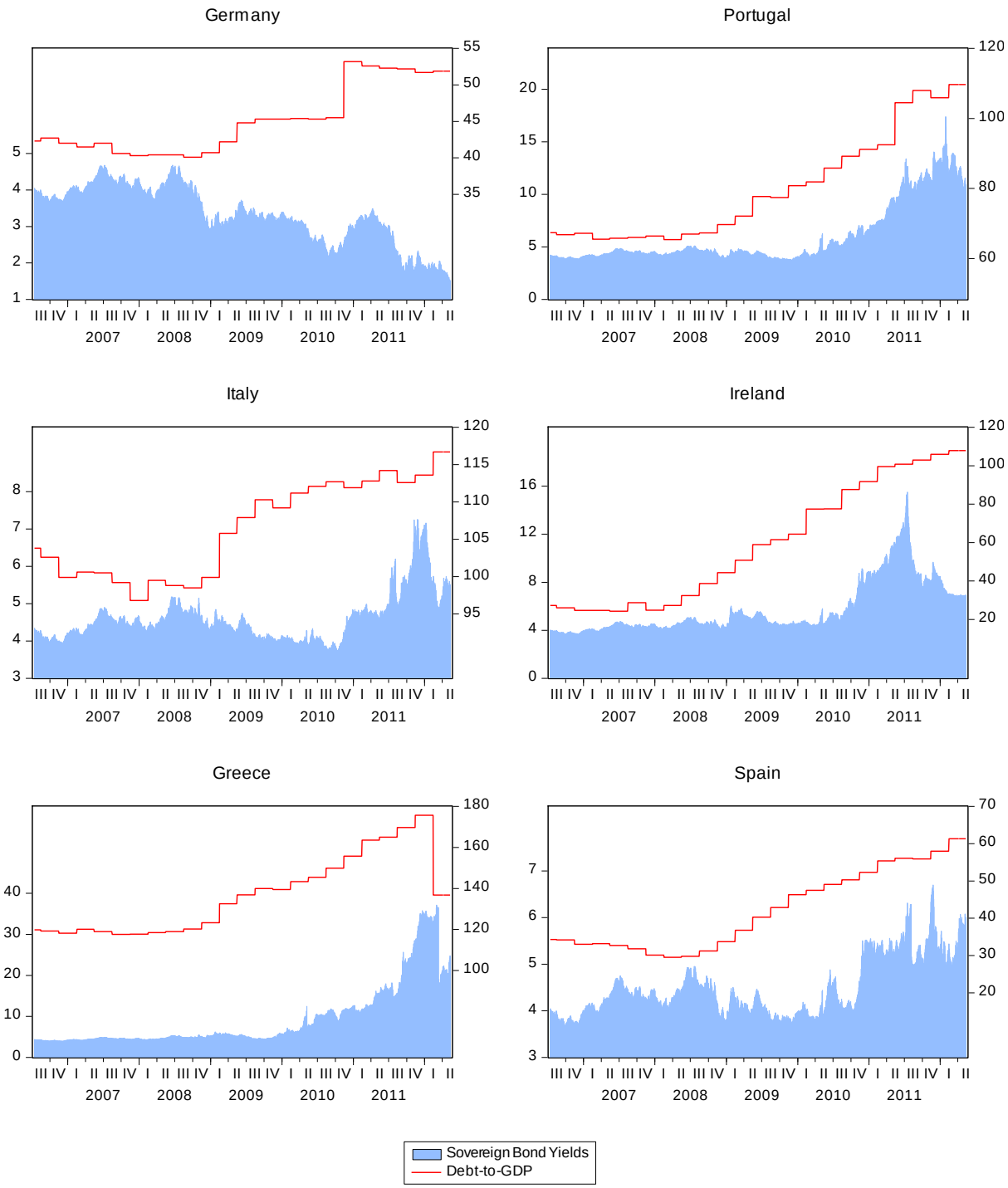
In blue: 10 year maturity sovereign bond yield, Martkit, Bloomberg. In red: spread bid-ask price, 10 year maturity sovereign bond yield, Markit. Sample period: 7/13/2006 – 5/14/2012

Figure A5.6: Default risk; current account balance



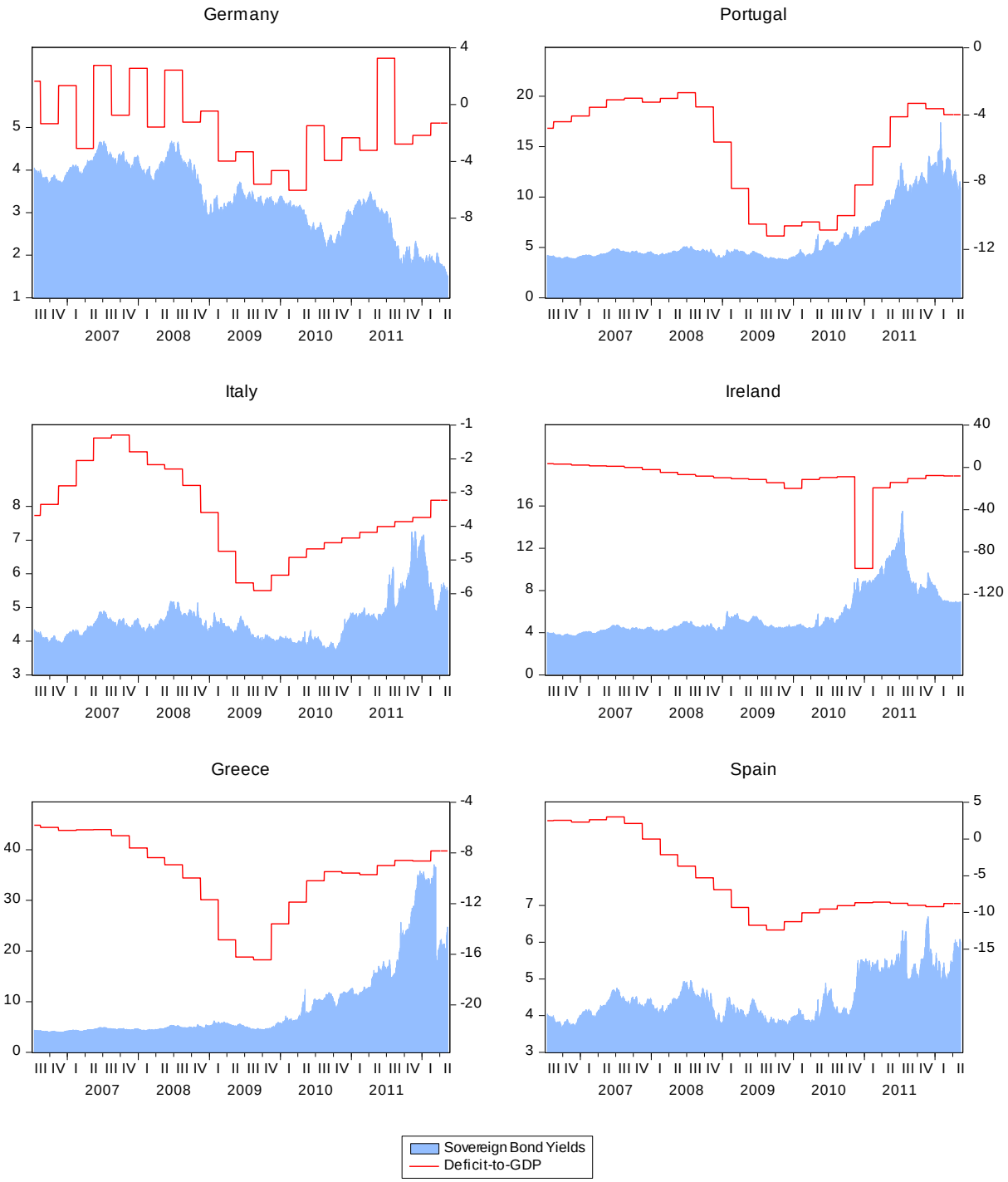
In blue: 10 year maturity sovereign bond yield, Martkit, Bloomberg. In red: Current account balance as % of GDP, Eurostat, Bloomberg. Sample period: 7/13/2006 – 5/14/2012

Figure A5.7: Default risk; debt-to-GDP ratio



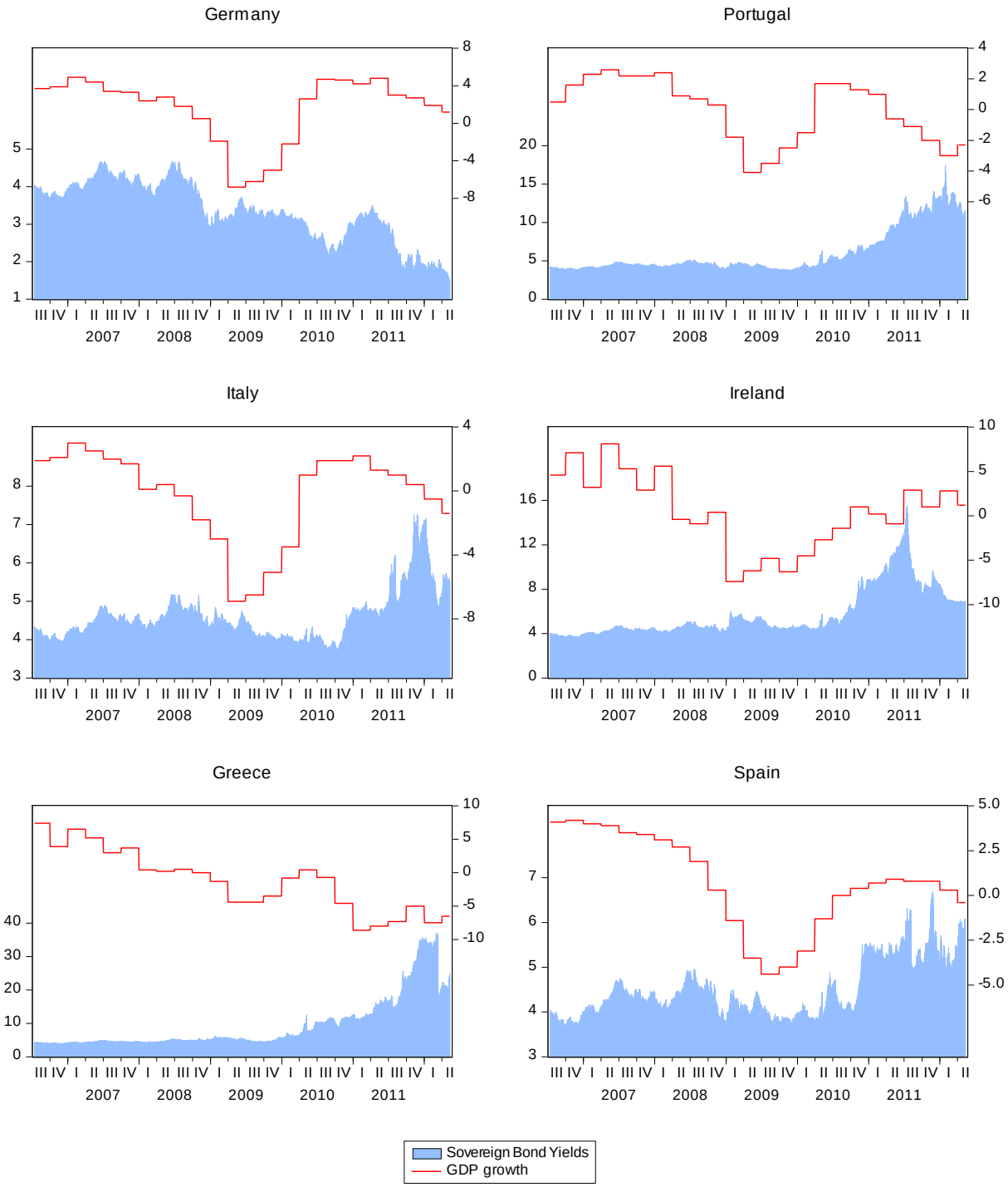
In blue: 10 year maturity sovereign bond yield, Martkit, Bloomberg. In red: Debt as % of GDP, Eurostat, Thomson Reuters Datastream. Sample period: 7/13/2006 – 5/14/2012

Figure A5.8: Default risk; deficit-to-GDP ratio



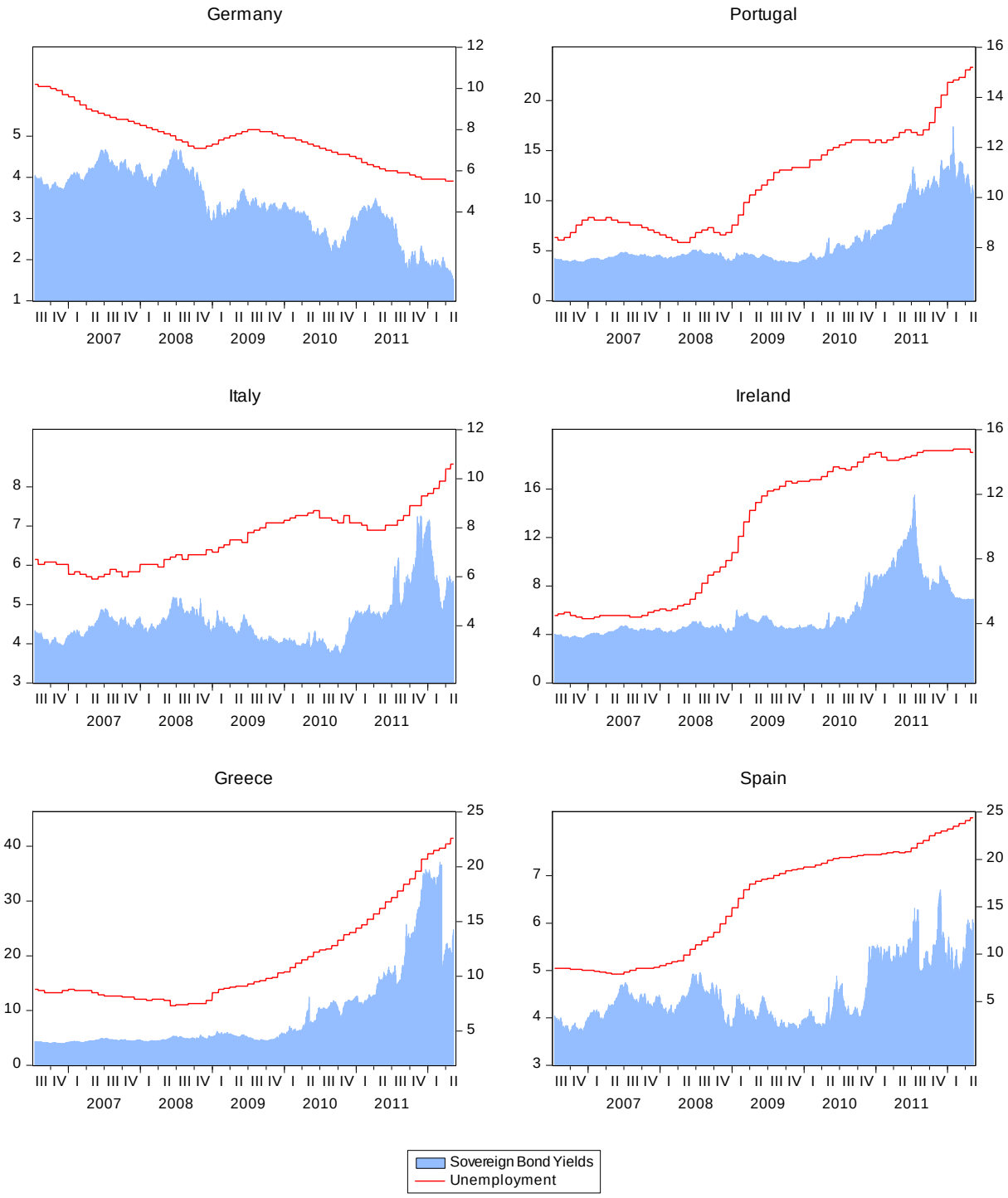
In blue: 10 year maturity sovereign bond yield, Martkit, Bloomberg. In red: Expected deficit as % of GDP, Oxford Economics, Thomson Reuters Datastream. Sample period: 7/13/2006 – 5/14/2012

Figure A5.9: Default risk; % GDP Growth



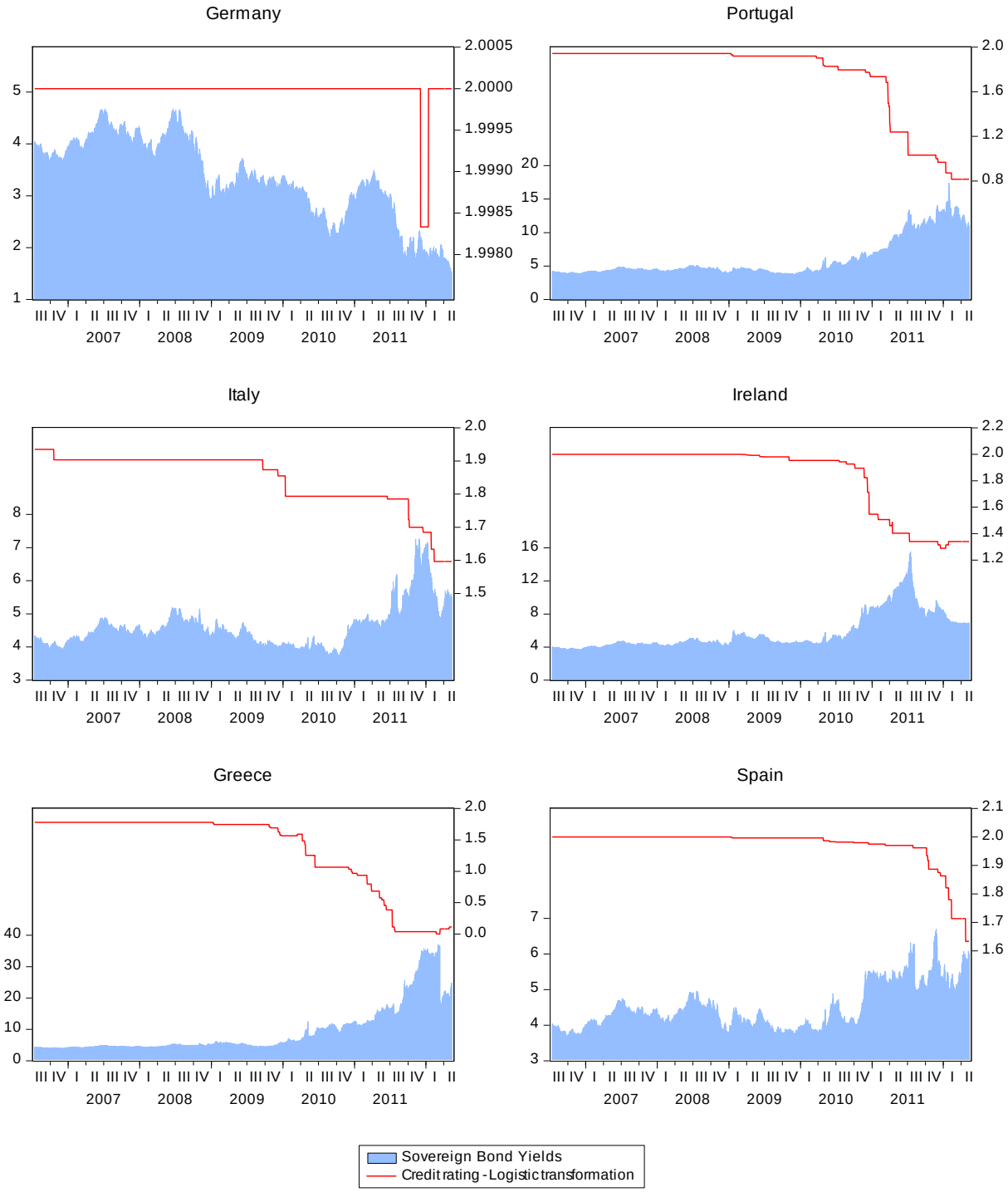
In blue: 10 year maturity sovereign bond yield, Martkit, Bloomberg. In red: GDP growth in %, Eurostat, Thomson Reuters Datastream. Sample period: 7/13/2006 – 5/14/2012

Figure A5.10: Default risk; unemployment-to-total population



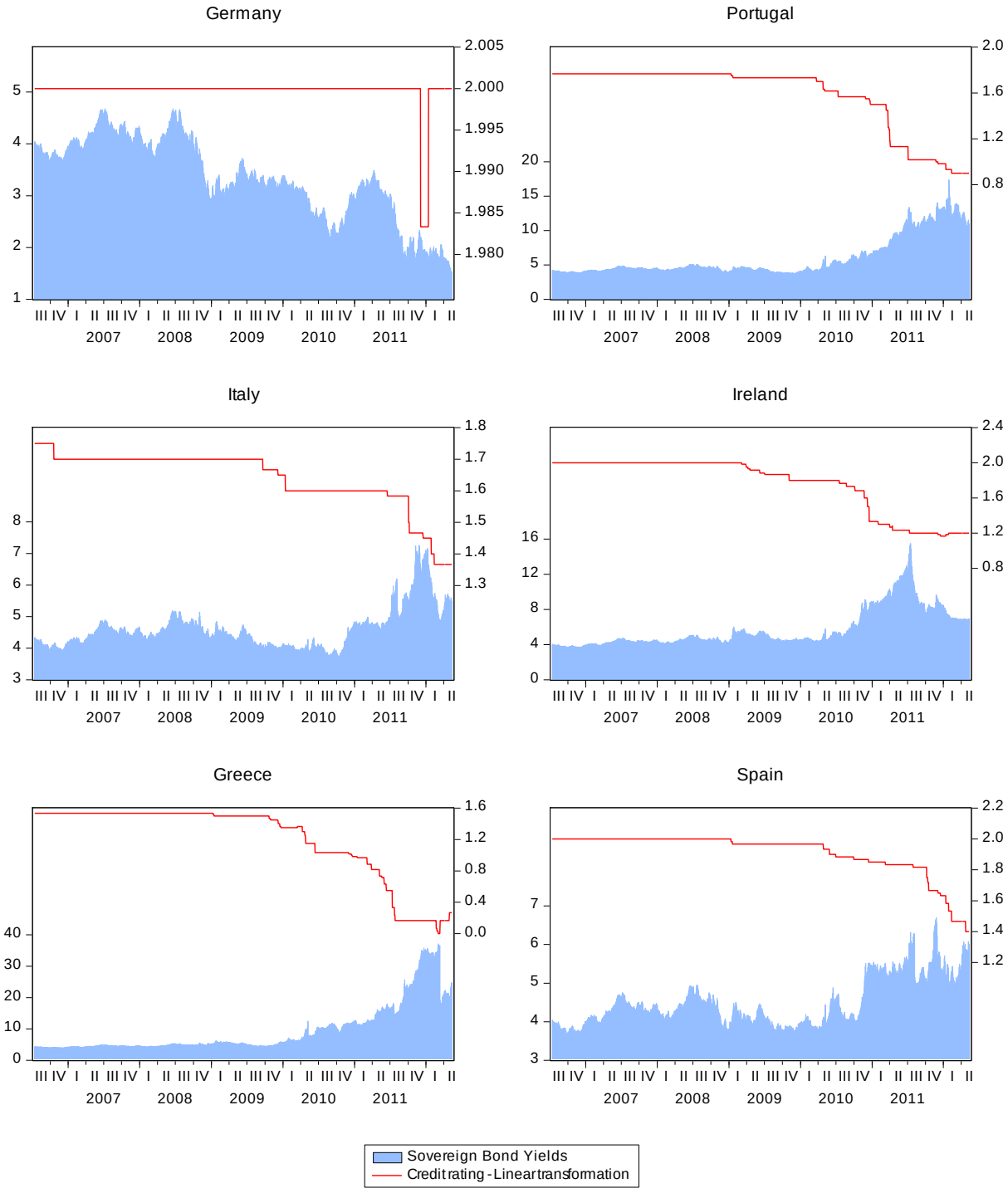
In blue: 10 year maturity sovereign bond yield, Martkit, Bloomberg. In red: Unemployment as % of total population, Eurostat, Thomson Reuters Datastream. Sample period: 7/13/2006 – 5/14/2012

Figure A5.11: Default risk; ordinal credit rating – logistic transformation



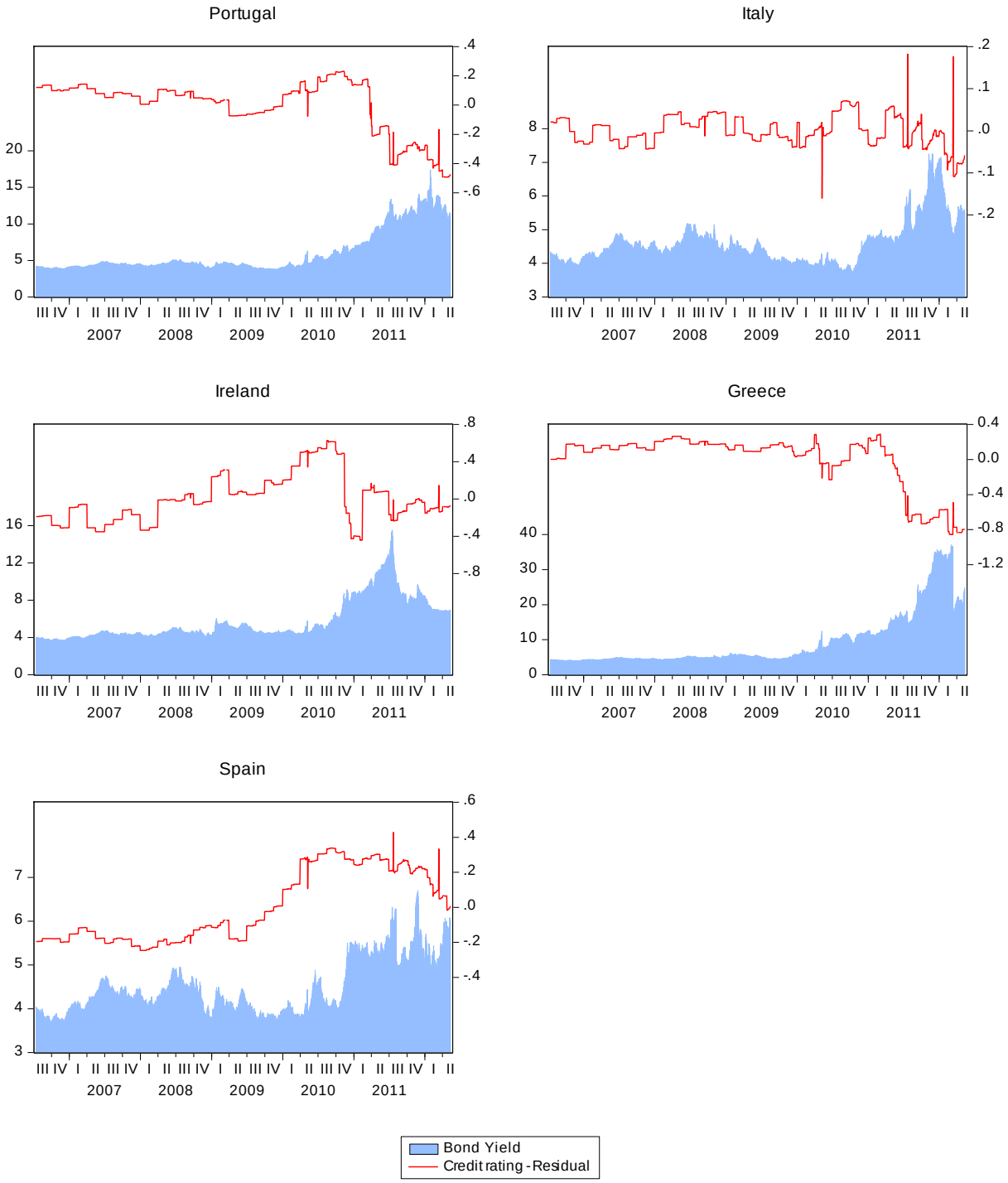
In blue: 10 year maturity sovereign bond yield, Martkit, Bloomberg. In red: Logistic transformation sovereign credit ratings, S&P, Moody's, Fitch, Bloomberg. Sample period: 7/13/2006 – 5/14/2012

Figure A5.12: Default risk; ordinal credit rating – linear transformation



In blue: 10 year maturity sovereign bond yield, Martkit, Bloomberg. In red: Linear transformation sovereign credit ratings, S&P, Moody's, Fitch, Bloomberg. Sample period: 7/13/2006 – 5/14/2012

Figure A5.13: Default risk; residual credit rating



In blue: 10 year maturity sovereign bond yield, Martkit, Bloomberg. In red: Residual regression sovereign credit ratings on fundamentals, S&P, Moody's, Fitch, Bloomberg. Sample period: 7/13/2006 – 5/14/2012