ERASMUS UNIVERSITEIT ROTTERDAM
ERASMUS SCHOOL OF ECONOMICS

The Bail-in-Bailout Mechanism: Applied on the Euro Area sovereign bond market*

P.W. Duvekot†

September 17, 2018

Academic supervisors:
M.A. Pieterse-Bloem*
J.J.G. Lemmen (Second assessor)

Abstract

The Euro Area (EA) sovereign spreads have experienced substantial changes since the introduction of a single monetary policy. This research attempts to assess the impact of the ECB's monetary policy on those spreads by incorporating the Bail-in-Bailout mechanism. This mechanism enables the possibility to examine the triangular relation between monetary policy, sovereign spreads and relevant risk factors. Different models are used featuring variables for credit, liquidity and international risk. Lastly, the actual effect of the implementation of the ECBs Public Sector Purchase Programme is also tested. This research finds evidence for the applicability of the Bail-in-Bailout mechanism on the EA sovereign bond market. At the time of the bail-in (bailout), spreads divergence (convergence) significantly. The risk factors have an evident impact, but their time-varying nature does not emerge clearly from the results. The purchase programme did not mitigate the spreads directly, except for Ireland and Portugal. The most influential factor has been the trust in the function of the ECB as lender of last resort.

JEL classification: E44, E52, G12, G14, G32, H81.
Keywords: EA sovereign spreads, Bail-in-Bailout mechanism, Market discipline, ECB, Monetary policy, Lender of last resort, PSPP.

*This thesis is the final part to graduate as *Master of Science* in Financial Economics.

†Corresponding author: Nieuwstraat 160, 3011GM, Rotterdam (NLD) – E-mail: pita_duvekot@hotmail.com – Faculty: Erasmus School of Economics – Erasmus University Student Number: 362812.

*Special thanks to Mary Pieterse-Bloem for her patience, trust and constructive feedback throughout the process.

Contents

1. Introduction

"Within our mandate, the ECB is ready to do whatever it takes to preserve the euro. Believe me, it will be enough."
Mario Draghi, 2012

From the introduction of a single monetary policy under the authority of the ECB up to now, the yields on sovereign bonds of Euro Area (EA) countries have changed substantially. This time frame can be divided into three different periods. The first period is characterized by low sovereign spreads, the second by high spreads and the third by low spreads again. There are many factors that can cause changes in those spreads. In case of the EA, the ECB plays an important role. No week goes by, where there is no article about their policy published in the news. In particular concerning the enormous size of their *Quantitative Easing programme* and, lately, the termination of it by the end of this year (Fairless and Blackstone, 2018). It remains speculative how this will eventually work out for the sovereign spreads. On the one hand, the debt levels are more sustainable and the risk of EA break-up is lower (Mariathasan, 2018). On the other hand, core inflation staying moderate, persistent uncertainty and political instability still pose a threat (Bensasson, 2018). To obtain a more grounded base on how monetary policy works out in the EA, the movements in sovereign spreads of recent years will be analyzed in this research.

An abundant amount of studies (Codogno et al., 2003; Manganelli and Wolswijk, 2009; Abad et al., 2010) provide evidence of the influence of credit, liquidity and international risk on sovereign bond spreads. Abad et al. (2010) state that countries with a shared monetary policy, like the EA, are less vulnerable to international risk, but the more to domestic factors due to their combined risk. The expectation among investors is that countries will support (i.e., *bailout*) each other in case of financial stress, inducing the sovereign spreads to converge. Unfortunately, this often also provokes moral hazard and future risk instability (Mody, 2014), because sovereign bonds are less valued to their underlying country-specific fundamentals (Baldwin and Giavazzi, 2015). The choice of explanatory variable for liquidity and credit risk and decomposition of both is difficult, because they have many different characteristics (Ejsing et al., 2012; Barrios et al., 2009). However, there exists an unanimous consensus in the existing literature, that the impact varies per country and over time (Beber et al., 2008; Schwarz, 2017). The state of the economy (i.e., international risk factors or risk aversion) affects the composition of this impact, but has also a direct impact on the sovereign spreads (Manganelli and Wolswijk, 2009; Dungey et al., 2000). At times of heightened international risk, domestic factors are considered more important (Abad et al., 2010). This insight causes many researches to be focused on distressed periods, like the recent financial crisis. This study instead attempts to gain a better understanding of the formation of EA sovereign spreads and which factors are of influence, by investigating the *Bail-in-Bailout mechanism*.

Three relations are important to get a comprehensive understanding of the EA sovereign bonds market; the effect of: risk factors on the sovereign yield, monetary policy on risk factors, and monetary policy on the yield. The first two have been studied extensively, but there is still a

lot unknown about the latter relation, especially in specific situations and in combination with changing influence of risk factors. It is difficult to predict how the sovereign yields will react to the monetary policy, such as the Bail-in-Bailout mechanism. This mechanism can be interpreted as differences in who will pay for losses in case of a bankruptcy and thus bears the risk. With a bail-in, the own creditors or depositors are bearing the complete risk, but with a bail-out, external lenders, usually governments, will provide financial support. At the same time, this mechanism entails a change in the assessment on the importance of the influential risk factors. When the risk is attributed to the investors, they will price the sovereign bonds to the related country-specific risk factors, while when the ECB acts as lender of last resort (LOLR), these are perceived as less important and international risk factors will gain influence. By examining the effect of the Bail-in-Bailout mechanism on the EA sovereign bond market, it becomes possible to determine the impact of the ECB's monetary policy on sovereign spreads as well as the time-varying importance of the distinct risk factors.

This research finds evidence for the applicability of the Bail-in-Bailout mechanism on the EA sovereign bond market. By researching the sovereign spread data for three distinct periods, as indicated by the mechanism, new insights are found. At times of strong market discipline, which is typical for a bail-in, a significant divergence of the sovereign spreads is observed. After the trust in the ECB's function as lender of last resort (LOLR) is restored, characterized as the bailout, the spreads within the EA converge again. International, credit and liquidity risk have an evident impact on sovereign spreads, however their time-varying character does not emerge clearly from this research. International risk became more influential during the bailout for the GIIPS countries and the influence of liquidity risk declined. The latter, however, is also the case for countries outside the EA and can therefore be due to a global shift. The implementation of the ECB's Public Sector Purchase Programme (PSPP) exhibit no direct mitigating effect, except for Ireland and Portugal. Recapitulating these outcomes, it can be concluded that the trust in the ECB as LOLR keeps the spreads converged. When this disappears, the sovereign bonds will be valuated on their underlying fundamentals and high spreads may arise when these fundamentals are weak.

The remainder of this research is organized as follows. Section 2 presents the existing academic literature on the effect of different risk factors on the sovereign bond market and ends with a elaboration on the functioning of monetary policy. Section 3 introduces the hypotheses and underlying reasoning. The data and methodology used to examine the hypotheses, are provided in section 4. Subsequently, section 5 elaborates on the results, which are analyzed and discussed per hypothesis. Finally, section 6 concludes with the main findings, limitations and further research recommendations. The tables of the research are all included in the appendices.

2. Theoretical framework

The spread between bond yields is zero if the bonds have identical risk-return characteristics (Manganelli and Wolswijk, 2009). In practice, however, time-varying spreads can be observed. These spreads are important indicators of additional risk that has to be taken into account by any pricing or risk management dealing with European sovereign bonds (Geyer et al., 2004). Before the introduction of the euro as currency in January 1999, Codogno et al. (2003) were in the belief that the spreads could be explained by four risk factors. The first factor was the exchange rate risk, which has evaporated after the introduction of the euro. The second factor was the difference in tax treatments and control on capital movements between countries, which also lost most of its importance after 1999. There are still slight differences, but these are negligible. However the last two factors, credit and liquidity risk, still play an important role in explaining the yield differential after the formation of the European Monetary Union (EMU). In recent years, especially during the recent financial crisis, it became clear that international risk and the corresponding risk aversion also affect the yield spreads. In particular for the EA, euro redenomination risk and contagion risk arose. Redenomination risk is the risk that an euro asset will be redenominated into a devalued legacy currency (De Santis, 2015). Contagion is defined as a signicant increase in co-movements across countries that cannot be explained by the countries fundamentals (Leschinski and Bertram, 2017). This research, however, focuses on credit, liquidity, international and sovereign risk, which will be discussed in the following sections.

2.1. Credit risk

Usually when evaluating sovereign bonds, credit risk is not taken into account, since these bonds are regarded as *risk-free assets* compared to corporate bonds. However, when comparing sovereign bonds of different countries, it can be noted that investors rate the creditworthiness of each sovereign issuer differently which partly explains pricing differences. An investor requires a financial compensation to cover this risk, i.e. the *credit risk premium*. Credit risk can be divided into three components: *default*, *downgrade* and *yield spread* risk (Fabozzi, 2007). *Default* risk can be seen as the probability a government defaults, meaning it is not able to pay back the initial investment (principal) or coupons of the outstanding bonds (Manganelli and Wolswijk, 2009). *Downgrade* risk depends on the creditworthiness of the issuer and is related to the rate given by rating agencies. *Yield spread* risk is caused by changes that affect bonds with the same maturity in different ways (Fabozzi, 2007). When the yield of one bond increases more compared to the benchmark bond, the spread widens. Because of the inverse relation between the yield and the price, this bond will be relatively worth less compared to the rest of the market. All components of credit risk depend on the issuer of the bond and thus are, in case of sovereign bonds, country-specific.

Credit risk is closely related to the current account balance of a country, because this represents the future financial needs (Geyer et al., 2004). When the account balance is negative, additional financing is needed. This results in higher credit risk and could therefore widen the spread. In the

case of the EMU, one element is very important, and that is that the countries are in one monetary union together. The crucial question here is whether these countries will bail each other out - or not - if they land into potential default trouble. If they do bail each other out, then that strengthens the credit worthiness of the weakest and weakens the creditworthiness of the strongest. When the *Maastricht Treaty* promised no devaluation, no default and low inflation forever for all, this was reflected in the credit risk premium of sovereign bonds in the EMU and reduced the yield spread (Baldwin and Giavazzi, 2015). This can be associated with a *market bailout*, caused by weaker market discipline in which investors valuate bonds less to the country-specific features. The lower risk premiums should provoke structural reforms, increasing the creditworthiness. Unfortunately, the aversion to debt restructuring in the EA remain remarkable high despite the hazards (Mody, 2014). Financial sector bailouts and sovereign credit risk are also narrowly related in the EMU. Acharya et al. (2014) show that the announcement of a financial bailout is associated with an immediate, unprecedented widening of sovereign credit spreads and narrowing of bank credit spreads. Fear about the solvency of a country's bank nourishes fears about the solvency of country's government, which weakens the economy and sustainability outlook for the country. Rising risk premium and deteriorating budget deficits can suck countries in a *debt default vortex* (Baldwin and Giavazzi, 2015). The main reason for this phenomenon is that European banks are heavily invested in the debt of their own governments. After the financial crisis the fear of default increased, especially for countries that had built up large current account deficits.

2.2. Liquidity risk

Liquidity risk is the risk for an investor when it has to liquidate (sell before maturity) the bond for a lower price related to bonds of comparable credit quality (Manganelli and Wolswijk, 2009). The liquidity of bonds can vary due to trading volumes, the amount of bonds outstanding, the trading activity of the market makers and the efficiency of the secondary market (Codogno et al., 2003). Liquidity risk is therefore not only country-specific, but even bond-specific (more accurate). An investor is willing to pay more for liquid bonds, because they are easier to sell and have lower transaction costs. The more liquid the bond, the higher the price and the lower the liquidity risk premium or actually how higher the discount. According to Bernoth et al. (2004), the liquidity effect has diminished with the introduction of the EMU - indicating a more integrated financial market. However, there are differing views on the influence of liquidity risk and the extent of integration of the European financial market. Schwarz (2017) has found empirical evidence for some countries that benefit disproportionately from deteriorating liquidity. Beber et al. (2008) find that liquidity plays a bigger role for low credit risk countries and especially during times of heightened market uncertainty. This coincides with the reduced liquidity risk premium in the work of Bernoth et al. (2004), because the formation of the EMU resulted in a fairly stable market. Pozzi and Wolswijk (2008) state that the idiosyncratic components of five European government bond markets converged toward zero by the end of 2006. In other words the markets became almost fully efficient. Pozzi and Wolswijk (2008) attributed the decrease in country-specific risk premia to

evaporated local market impediments and imperfections. The research by Beber et al. (2008) leaves room for differences in bond yields caused by liquidity sensitivity and shows that this liquidity effect depends on market conditions. Pieterse-Bloem et al. (2016) show - based on corporate bonds - there is substantial time variation and no trend towards full financial integration in the EA. Abad et al. (2014) show the same applies to the government bond market integration. This process changes in response to economic and financial conditions. According to them this is mainly due to changes in the level of risk aversion, as will be discussed in the subsection concerning *risk aversion*.

Although there is a unanimous consensus in the existing literature that credit and liquidity risk are reflected in the EMU sovereign bond yields, in practice it remains very hard to decompose their effect and determine the accountable part. This is mainly due to the entanglement of the effect on each other and potential omitted variables. Beber et al. (2008) manage to disentangle the effects by showing a unique negative correlation between both risks in the EA government bond market. To measure the size of each risk, different explanatory variables can be used and the interaction effect can also be included. The importance of liquidity and credit still poses problems with the quantification of the effects for *very liquid* and *highly rated* markets, like German or French sovereign bonds (Ejsing et al., 2012). Within *very liquid* markets, the traditional trading-based measures - like bid-ask spreads - are very low and therefore may not fully reflect differences in liquidity. Besides, sovereign bonds are mostly traded on the over-the-counter (OTC) market, which causes problems with availability and quality of trading-based measures. Within *highly rated* markets, the market-based measures - like credit default swap (CDS) premiums - are often criticized as too sensitive to temporary over- and undershooting effects (Ejsing et al., 2012). This is especially the case when measuring the credit premiums of large countries. When a large and highly-rated country defaults, often the counter parties (who sold CDSs on the sovereign bonds) also become insolvent. This counter party risk can become substantial for large countries and is influencing the premium. The linkage between sovereigns and the financial sector affects the pricing of CDSs. The advantage of using CDS spreads is that they are considered as a "high frequency" measure of credit risk. The frequency of liquidity and credit risk-related factors is another reason that makes it complicated to decompose the effects. Liquidity-related factors influence yields at high frequencies, while credit risk factors are often based on slow-moving macro-economic fundamentals, such as public debt and account balances (Barrios et al., 2009).

As mentioned before, there is variation in the relative role of credit and liquidity by country. Schwarz (2017) demonstrates the liquidity variation using the so-called *K-spread*. This spread is constructed directly from asset prices and measures the differential between two duration-matched bonds that share an identical credit guarantee but differ in market liquidity. In this way it captures the liquidity (risk) effect impounded in prices. The K-spread can be used as common liquidity factor to decompose components of the sovereign bond yields and identify liquidity effects in cross section of EA countries. When using this particular spread, instead of more traditional measures, it can be noticed that liquidity plays a larger role in explaining European sovereign bond spreads. Schwarz (2017) explains this because the K-spread takes into account the compensation investors

require for the possibility that liquidity will deteriorate in the future. Trading-based measurements tend to underestimate this risk premium, which could be especially important in times of market uncertainty. The level of creditworthiness also depends on future obligations (debt sustainability). If market-based measures are used for risks, the expectations are already included in the price, but if a different measure is used, this must be carefully taken into account. The price of an asset reflects both the price of risk and the market expectations of the returns (Basurto et al., 2010).

2.3. International risk

Empirical evidence shows that international risk factors tend to affect bond yields proportionally rather than additionally (Codogno et al., 2003). An increase will widen the yield spreads instead of shifting all yields up or down. These risk factors are often proxied by the spread between US corporate and government bonds, because the statistical correlation between the two is often very high (Manganelli and Wolswijk, 2009). Even if there is no proxy used for international risk, e.g. Dungey et al. (2000), a common factor in the long-term bond yield differentials can be subtracted for different countries worldwide. Dungey et al. (2000) demonstrate that there are varying degrees of influence from international factors on yields of different government bonds. They show that Australian and Canadian bonds are predominantly influenced by international effects, while for the UK and Germany country-specific effects prevail. Abad et al. (2010) stated that countries with a shared monetary policy are less vulnerable to international risk factors, but more vulnerable to factors from inside the EMU. Their research was published just before this became very clearly visible. The trust in the *market bailout*, as mentioned under 2.1, was crushed after the *Deauville summit* in October 2010 (Mody, 2014). This conference initiates a period with various insolvent EA countries that desperately needed financial assistance. The solvent EA countries pronounce that the private sector should bear more of the costs in case of a sovereign bailout (Baldwin and Giavazzi, 2015). This is called the *private sector involvement (PSI) agreement*, which attributes risk to investors again (i.e. *bail-in*). Sovereign bond prices and ratings were again adjusted to their creditworthiness causing a tremendous widening of the yield spread. For example, Greek debt investors consequently experienced a substantial loss of half the face value of their investment (Baldwin and Giavazzi, 2015). This shows that in the absence of the bailout mechanism, the EMU will again become more sensitive to country-specific risk factors. Confidence in the mechanism was restored by the speech of ECB's president Mario Draghi in July 2012, where he ensured the market that the ECB would do "whatever it takes" to guarantee the EMU. After this intervention, yields converged again (Baldwin and Giavazzi, 2015).

Codogno et al. (2003) show that international risk factors have different effect on yields due to their interaction with country-specific determinants, such as the previously discussed liquidity (e.g. trading volume) and creditworthiness (e.g. fiscal vulnerability or reputation). For example, the yield of highly indebted countries, like Italy and Spain, fluctuates almost entirely due to changes in default risk and not to international risk factors. Default risk is directly related to domestic fiscal fundamentals, like debt and debt service ratios (Bernoth et al., 2004). Compared to equity capital

flows, Chuhan et al. (1998) find that bond flows are more sensitive to the country's credit rating and secondary market price of debt. This emphasizes the importance of differences in debt ratios and with this the creditworthiness of countries when analysing the impact of international risk factors on yield spreads. Beber et al. (2008) show that the level of international risk factors has impact on the composition of influential country-specific risk factors of bond yields. As mentioned before, liquidity becomes relatively more important during times of heightened international risks. Barrios et al. (2009) and Abad et al. (2014) affirm that domestic factors play a bigger role in times of financial stress. Like Codogno et al. (2003), Barrios et al. show that high debt countries and countries with large account deficits experienced the highest bond yield increases after the crisis. Gerlach et al. (2010) show that international risk has an impact on the yield spread through the domestic banking sector. After the crisis, most governments set up bailout packages of unprecedented size for the financial system, linking the banking sector to the sovereign sector (Attinasi et al., 2009). Countries with large financial sectors - especially with low equity ratios - exhibit larger changes in yield in times of heightened international risk (Gerlach et al., 2010).

However, closed attention should be paid to the year the researches are conducted and what kind of data is used. Most of above mentioned studies have been executed before or during the recent financial crisis. Around the financial crisis, Arghyrou and Kontonikas (2012) find a shift in market pricing behaviour. Before 2017, the price was mainly determined by a 'convergence-trade' model[1]. The demand for some bonds was higher than would be expected based on the condition of the countries' fundamentals. This mispricing is supported by findings of Gibson et al. (2012) who investigated Greece and found that the spreads were significantly lower that what would be predicted by fundamentals. The higher demand for particular bonds is caused by investors who speculate on the convergence of European yield spreads by buying these lower-priced bonds and selling more expensive European bonds. The inaccurate pricing of sovereign bonds in the EA is also noticed by Abad et al. (2014), who stress the crisis revealed the relevance of domestic imbalances and local risk factors in explaining bond returns. After the turmoil of the financial crisis, the market pricing behaviour was more driven by macro-fundamentals and international risk (Arghyrou and Kontonikas, 2012). Whether this pricing reflects the fundamentals correctly still remains questionable. Gibson et al. (2012) find evidence for undershooting of the yield spread, but also for overshooting during and after the financial crisis. Abad et al. (2014) show that the crisis has been more harmful for sovereign bond market of the EMU than to those of non-EMU members.

2.4. Risk aversion

A single common factor driving the yield spreads is international risk aversion (Manganelli and Wolswijk, 2009). Manganelli and Wolswijk argue that risk aversion has effect on spreads through both a direct and indirect channel. The direct channel arises from investors who have greater

[1]Convergence-trade is a trading strategy consisting of two positions: buying one asset forward and selling a similar asset forward for a higher price. Traders do this in the expectation that by the time the assets must be delivered, the prices have become closer to equal (converged) and thus make profit by the amount of convergence.

incentives to take on risk when yields are low (and vice versa). The indirect effect is caused by the state of the economy, which influences both the degree of risk aversion and the level of yields. During economic downturns, risk aversion increases and yields typically decrease either through lower demand or through monetary policies nudging the rate down to increase economic activity. Since risk aversion and the compensation required by investors are time-varying, the bond market and its integration are also subject to financial and economic changes (Abad et al., 2014). Haugh et al. (2009) found that higher risk aversion magnified the importance of fiscal performance (especially the ratio of debt service to tax receipts and expected fiscal deficits). Their results suggest that the effects of deterioration in fiscal performance are non-linear and lead to relative large increases in yield spreads. Attinasi et al. (2009) find a large relevance of international risk aversion in explaining changes in spreads during the financial crisis, i.e. data from July 2007 till March 2009. They also stress the importance of the country's fiscal position when observing the influence or impact of heightened risk aversion. Different studies (Bernoth and Erdogan, 2012; Arghyrou and Kontonikas, 2012) show a shift of attention paid to the fiscal position of EMU countries. After the financial turmoil, the market has become more sensitive to loose fiscal policy (Bernoth and Erdogan) and fiscal imbalances are more penalised (Arghyrou and Kontonikas).

The shift in market pricing behaviour, as described in the subsection *international risk*, can be attributed for a large part to changes in risk aversion. The moment a country joins the EMU, it starts operating within a new framework created by the euro under the regulation of the ECB. Gibson et al. (2012) find that for example investors in Greece become persistently less risk averse and form biased expectations after this country was allowed to become a member. As mentioned before, different factors were considered as less important or even ignored, for example risk factors pointing to unsustainability and macroeconomic imbalances. Basurto et al. (2010) study the effects of international risk and macro-fundamentals influencing the sovereign spreads during and after the financial crisis. Their results show a distinction between the impact of both; during this period global risk aversion was a significant factor, but hereafter, country-specific factors became more and more important.

2.5. Monetary policy

Interest rate risk is the main risk when you are involved in bond markets, since the price of a bond is directly discounted by the interest rate or yield (Fabozzi, 2007). A positive change in the yield immediately lowers the price of a bond (and vice versa). On the one hand, the yield is influenced by all previous mentioned factors. On the other hand, the level of the short-term interest rate is often targeted and controlled by the monetary policy of the central bank. Some investors, as mentioned under subsection 2.3, even pursue an active investment strategy on expected changes in interest rates provoked by monetary policy (Fabozzi, 2007). The impact of monetary policies can be classified as *sovereign risk*. This risk is assessed based on economic and political factors that influence the policies of governments and central banks.

Conducting an active monetary policy means that governments try to stimulate or discourage

the economy by means of the interest rate. In this way, the policy has effect on risk appetite and expectations of investors. Risk appetite is effected, because changes in the interest rates have direct effect on the willingness of investors to take risk and consequently on the risk premiums (Manganelli and Wolswijk, 2009). Tyson (2015) finds a surge in demand for sub-Saharan sovereign bond issues since the financial crisis. She attributes this increase to improved macroeconomic fundamentals of the issuing countries, but also to the exceptionally loose monetary policy in advanced economies creating a "search for yield" in other countries. Not only the risk appetite of investors is affected, but also the risk-taking behaviour of banks. Of all variables Jiménez et al. (2014) have examined, the overnight interest rate (EONIA) is the only variable that has a robust impact on bank risk-taking. When monetary policy is expansionary, banks have higher appetite for risk, but do not seem to price the additional risk adequately (Ioannidou et al., 2009). An active monetary policy also influences the expectations of investors, which can been deducted from a changing yield curve. The shape of the yield curve (also known as the *term structure*[2]) is an invaluable source of information for central banks (Kim and Orphanides, 2007; Fabozzi, 2007). It provides insights to market expectations and their evolution, early warnings for changing macroeconomic fundamentals and feedback on policy decisions. To extract the different types of information, the expectations need to be separated from the term premium. This premium consists of all sources of deviations, such as the presence of interest rate risk when not holding a bond to maturity, but also the credit and liquidity premium. Wright (2012) indicates that monetary policy actions also affect global expectations and risk premia. Neely (2010) states this is because risk-arbitrage narrows the gap between expected returns in a global market with financial flexibility.

On top of that, the expectation or credibility of the policy itself is also of great importance. If there is no belief the policy will succeed or sustain, it can lead to negligible or no effect at all. The credibility of monetary policy is one of the reasons the yields sometimes not reflect the fundamentals (Gibson et al., 2012). A country can benefit from the credibility of the ECB, but can - in case of low confidentiality - also suffer from it. Initially, the benefits for a country with originally low credibility are relatively higher. This is in line with the argument of Abad et al. (2010) that countries with a shared monetary policy are less vulnerable to influence from outside, but more to deterioration within because they face joint risk. According to Dewachter et al. (2016), the sovereign debt crisis can be characterized by the increasing yield spreads and *redenomination risk*. This risk is associated with a declining confidence in the EA or even the expectations of a possible breakdown. This emphasizes again the importance of trust in the EA and with this the policy of the ECB. Another disadvantage of a joint monetary policy is that it cannot be used for country-specific shocks. One way to compensate the loss of this tool is to use the fiscal policy counter-cyclical. However, this is only possible if a country has relatively low fiscal imbalances (Gibson et al., 2012). Hopefully, the recent sovereign debt crisis has been a wake-up call for countries to become more debt sustainable.

Monetary policy decisions affect the real economy though the channels of the transmission

[2]The relation between the yield and different maturities.

mechanism. The processes are characterized by long, variable and uncertain time lags. This makes it difficult to identify the clear effect and exclude all other potential causers. The transmission mechanism have been studied extensively, but insufficient attention has been paid to the relation between monetary policy and the perception and pricing of risk (Borio and Zhu, 2012). Borio and Zhu (2012) argue this relation has become more important lately, because of changes in the financial system and prudential regulation (e.g. minimum capital requirements). This research will examine a facet of the ECB's monetary policy impact on the perception and pricing of risk by focusing on the sovereign yield spread. In this analysis, the aforementioned risk factors, i.e. credit, liquidity and international risk, will also be included.

Since 2009, the ECB has implemented several unconventional monetary policy measures and purchase programmes. By doing so, the ECB has adopted the role of lender of last resort (LOLR) impeccably, which was traditionally fulfilled by central banks (Collignon et al., 2013). With regard to the sovereign bond market, there are three unconventional programmes particularly relevant: the Securities Markets Programme (SMP); the "Outright Monetary Transactions" (OMT); and "Public Sector Purchase Programme" (PSPP). The SMP was introduced in May 2010, when the ECB decided to buy sovereign bonds from Greece, Ireland and Portugal. In August 2011, the programme was expanded with the purchase of Italian and Spanish sovereign bonds. With this programme, the ECB mainly focused on restoring the malfunctioning bond markets of Greece, Italy, Ireland, Portugal and Spain (GIIPS). However, the sovereign yields continued to rise after the introduction of the SMP (Eser and Schwaab, 2016). The increase was arguably higher than would be justified by economic fundamentals, suggesting the programme was not successful in reducing the risk perception of investors (Altavilla et al., 2014). Ghysels et al. (2016) do show that the SMP has been effective in lowering the yields for countries under the programme relative to a no-intervention situation.

In the period July to September 2012, the ECB announced that they will engage directly in the secondary market transactions for sovereign bonds (i.e. OMT). This programme would replace the SMP, but none of the EA countries has ever activated the programme. The announcement, on the other hand, did amplify the function of the ECB as LOLR and had an impact on the sovereign spreads in itself. The PSPP was introduced in March 2015, as part of the expanded asset purchase programme which also consist of the corporate sector, asset-backed securities and third covered bond purchase programme. The PSPP consists, for approximately 90%, of bond purchases from sovereigns and recognised agencies. The other 10% are purchases from international organisations and multilateral development banks. Geographically, the purchases are divided across EA countries on the basis of the ECB's capital key (ECB, 2018). Recently, however, there is some discussion that the ECB has deviated from this (Heinemann, 2017). Like the SMP and OMT programme, PSPP applies to the secondary market and the Governing Council retains full control over the features of the programme (Lombardi and Moschella, 2016). While the first two are focused on smoothing the transmission channel of monetary policy, the PSPP is intended to further ease the the ECB's policy in order to reach their targets again, such as an inflation rate just below 2%.

3. Hypothesis development

In order to get a comprehensive understanding of the EA sovereign bond market, it is essential to examine three relations: (i) risk factors affect both the yield spreads and (ii) the execution of monetary policy and (iii) this policy is in turn implemented to influence the real economy, which affects the yield. As highlighted in section 2, the effects of risk factors on yield spreads have already been studied extensively, but this has not lead to a general consensus yet, unfortunately. Furthermore, a few papers on the effects of risk factors on monetary policy (i.e., sovereign risk) have been discussed in subsection 2.5. In the field of monetary policy and its ambiguous effect on the real economy is still much to gain. Moreover, there is limited research of the effect of monetary policy on the sovereign yield spreads in combination with different other risk factors.

This research distinguishes three periods, in which I expect the relative importance of risk factors on the sovereign spreads to change within the EA, due to a shift from bailout to bail-in, and vice versa. As can be inferred from Figure 1 in the article by Kilponen et al. (2015), the yield on the ten-year sovereign bonds from various EA countries (i.e., especially the GIIPS) heavily increased from 2010 to 2013. This observation, in combination with the academic literature on the three relations described above, have led to the following hypothesis:

Hypothesis 1. *The Euro Area sovereign spreads diverged as a result of the bail-in and converged again after the reinforced function of the ECB as lender of last resort.*

The EA sovereign spreads can be interpreted as the difference with the ten-year sovereign bond yield of Germany, serving as stable benchmark. The bail-in refers to the period after the *Deauville summit* on 19 October 2010 until the speech of Draghi at 26 July 2012. By distinguishing the data in this way, new insights can be obtained because, to my knowledge, this has not been done before. In previous research, the recent financial crisis is often studied as separate period. The bail-in period is characterized by increased sovereign risk, as mentioned under subsection 2.3, which is expected to be caused by a strengthened bond market discipline. Draghi tries to restore confidence in the EA with his statement that the ECB will do "whatever it takes", emphasizing the role of LOLR. De facto, this can be interpreted as a bailout and therefore the associated period will be characterized as the bailout period. This leads to the second hypothesis:

Hypothesis 2. *The relative importance of country factors on the EA sovereign spreads, as compared to international factors, increased during the bail-in and reversed during the bailout, in particular those of the GIIPS countries.*

At times of strong bond market discipline, investors will valuate bonds more based on their underlying fundamentals. Following this reasoning, country factors should have more impact on the yield, and thus on the yield spreads. As highlighted in subsection 2.1, the emergence of the EA improved the creditworthiness of countries with lower credit ratings. Entering the bail-in period caused a partial reversal of this improved ratings, implying that the influence of country factors of the GIIPS countries will increase the most. Subsequently, by acting as lender of last resort,

the ECB tried to lower the impact of these country-specific factors and to improve the economic stability of the EA, ushering the bail-out period. In order to assess the causal relation between the change in influential factors and the bail-in-bailout mechanism within the EA, its is inevitable to examine the empirical results on a control group outside the mandate of the ECB. This resulted in the third hypothesis:

Hypothesis 3. *The relative importance of country factors, compared to international factors, did not change significantly for non-EA countries during the distinct bail-in and bailout periods.*

This hypothesis will be tested using three different groups. First, EMU countries without the euro as official currency, with a high credit rating: United Kingdom, Denmark, and Sweden. Second, EMU countries without the euro, with a low credit rating: Hungary, Czech Republic, and Poland. Third, countries outside the EMU: United States, Japan, Norway, and Switzerland. This sums up to a total of ten control countries.

In previous hypotheses, the monetary function of the ECB as lender of last resort is assumed to be one and the same embodiment since July 2012. However, as mentioned in subsection 2.5, the ECB has implemented different bailout policy measures and programs. For this research, the focus is on three programs: the Securities Markets Programme (SMP); the "Outright Monetary Transactions" (OMT); and "Public Sector Purchase Programme" (PSPP). Only the last two were introduced after July 2012. However, during the SMP, the ECB bought sovereign bonds of the GIIPS countries. Hence, it can be assumed this program had a direct effect on the spreads of these countries. I expect these programs to have had a mitigating effect on the divergence of spreads in the EA during the investor bail-in period. This leads to the final hypothesis about the effect of the different ECB's bailout programs on the sovereign spreads in the EA:

Hypothesis 4. *The ECB's monetary policy programs (SMP, OMT and PSPP) have a mitigating effect on the sovereign spreads within the EA.*

This hypothesis could have implications for the aforementioned hypotheses. When Hypothesis 4 is confirmed, this could mean that the spreads would have been even higher during the bail-in period if the SMP had not been executed. With regard to the bailout period, previous hypotheses only tested the joint effect of both programmes. By examining the OMT and PSPP separately, the different effect may become more visible. Eventually, the combination of all four hypotheses is expected to provide a more comprehensive view of the influence of the mentioned risk factors and the ECB's monetary policy on the EA sovereign bond market. By making use of the bail-in-bailout mechanism, this research contributes to the existing literature and current research.

4. Research design

This section provides an overview of the dataset used and elaborates on the sample construction and various research methods. The remainder of this section is organized as follows. Subsection 4.1 documents the used dataset and sample construction. Subsection 4.2 provides some descriptive statistics. Finally, subsection 4.3 emphasizes on the methodology used in the remainder of this thesis.

4.1. Data and sample construction

The sample includes 214 observations covering a period ranging from March 2000 to December 2017, with data acquired on a monthly basis. This particular starting date is selected because the EA convergence process might have caused some distortions just after 1999, making a considerable gap desirable. The sample consist of sixteen EMU countries, in- and outside the EA, with both low and high credit ratings, creating four different groups as presented in Table 1. Furthermore, this table shows which countries are included in the control group needed for the assessment of Hypothesis 3.

Table 1: Sample countries per subgroup

EA		Non-EA		Non-EMU
High	Low	High	Low	High
Austria	Greece	Denmark	Czech Republic	Japan
Belgium	Ireland	Sweden	Hungary	Norway
Finland	Italy	United Kingdom	Poland	Switzerland
France	Portugal			United States
The Netherlands	Spain			

Notes: This table shows the ten sample countries, as well as the six non-EA control countries and the four non-EMU control countries in the rightmost column. The countries are divided per area first and then by credit rating.

4.1.1. Dependent variable

The dependent variable in this research entails the yield spreads of the various EA countries mentioned in Table 1. The German bonds are taken as benchmark, since Germany is considered as the most stable and *risk-free* country of the EA (Afonso et al., 2012). Subsequently, the yield spreads are defined by:

$$SPREAD1_{i,t} = Y_{i,t} - Y_{ger,t} \tag{1}$$

where $SPREAD1_{i,t}$ denotes the yield spread of country i, $Y_{i,t}$ represents the yield on a government bond of country i, and $Y_{ger,t}$ reflects the yield on the German government bond at time t. In research on yield spreads, it is common practice to use sovereign bonds with a maturity of ten years. These bonds are used as important proxy for economic sentiment, as they tend to signal investor confidence most accurately (Codogno et al., 2003; Geyer et al., 2004; Afonso et al., 2012).

Calculating the yield spread following equation (1), will result in a single yield spread per country. To test Hypothesis 1, these yield spreads need to be converted into one measure which can be used as dependent variable in the required regression. I will use two different variables to illustrate the convergence and divergence of the yield spreads, as outlined in Table 2. Both variables could provide interesting results, as $SPREAD2_t$ directly highlights the convergence-divergence of yield spreads, while $SPREAD3_t$ measures the absolute difference in spread between high and low rated countries within the EA:

$$SPREAD2_t = \sigma_t = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(Y_{i,t} - \mu)^2} \tag{2}$$

$$SPREAD3_t = SPREAD1_{low,t} - SPREAD1_{high,t} \tag{3}$$

where σ_t denotes the standard deviation at time t, n reflects the number of countries in the sample, μ represents the sample mean, $SPREAD1_{low,t}$ denotes the average yield spread of EA countries with a low credit rating, and $SPREAD1_{high,t}$ refers to the EA countries with a high credit rating.

4.1.2. Independent variables

In research on macroeconomic factors, such as sovereign yield spreads, there are many reciprocal relations. However, as documented in section 2, international, credit, and liquidity risk can be considered as the main drivers of yield spreads. Therefore, the focus of this research will be on variables that measure these distinct risk factors. The VIX rate, which is a measure of the expected volatility implied by S&P500 index options, is typically used as proxy for international risk (Arghyrou and Kontonikas, 2012). However, due to the European focus of this research, the $VSTOXX$ is used as proxy in this research. This measure reflects the implied volatility on European stock market derived from traded options on the EuroStoxx 50 stock index. In addition, given that Germany is taken as benchmark country, the volatility index of the German stock market ($VDAX$) is also included. Both international risk measurements can be found in Table 2.

Credit and liquidity risk are commonly measured in academic research by the credit default swap spread (CDS) and the bid-ask spread (BAS), respectively (Codogno et al., 2003; Beber et al., 2008). In accordance to these studies, this research uses BAS_t as measure of liquidity for the distinct sovereign bonds. However, a different choice has been made for displaying credit risk, as the recent EA sovereign debt crisis caused a structural break in the initially strong relationship between the CDS spread and sovereign yield spreads (Fontana and Scheicher, 2016). Therefore, underlying macroeconomic fundamentals will be used to estimate the credit risk of the various countries, following Afonso et al. (2011) and De Vries and De Haan (2016). Both studies regress several macroeconomic fundamentals on the quantified sovereign credit ratings, as published by the rating agencies. This leads to the variable $INDEX_{i,t}$, which is based on the fundamentals of country i and reflects its credit risk. The exact composition of this index, along with the underlying methodology, is described in more detail in subsection 4.1.3. As can be inferred from Table 2, there

are two more variables used for measuring credit risk, which will be used for the assessment of Hypothesis 1 and will be further explained in subsection 4.3.

To examine the effect of the bail-in-bailout mechanism, various dummy variables are introduced to the distinct models. The first dummy (D_1) will cover the expected *investor bail-in* period, from October 2010 to July 2012. The second dummy (D_2) covers the period after July 2012 to the end of the sample (i.e., December 2017), representing the *ECB bail-out*. By adding these dummy variables, the constant in the regression model will expose the effect before October 2010, defined as the *market bail-out* period.

< Insert Table 2 here >

4.1.3. Credit rating index

As can be noticed from Table 2, one of the independent variables concerns an index based on own calculations ($INDEX2$). This index builds on the set of variables listed in Afonso et al. (2011) that possibly determine the sovereign credit ratings. De Vries and De Haan (2016) use this determinants to estimate coefficients for modelling sovereign credit ratings ($INDEX$). Their sample ranges to 2011 and contains slightly different countries than those considered in this research. Therefore, I have revised their model to estimate new coefficients which are presented Table 3. To be able to preform a regression, the credit ratings are linear transformed to discrete values whereby CCC+ becomes 1 and AAA+ 17. This is translated in the higher the score, the better the credit rating and thus the lower the credit risk.

Initially, the following variables are used: GDP growth (ΔGDP), GDP per capita (GDP/CAP), government investment per GDP ($GINV/GDP$), consumer price index (CPI), harmonized unemployment rate (HUR), government debt per GDP ($GDEBT/GDP$), current account balance per GDP (CA/GDP) and government deficit per GDP ($GDEF/GDP$). However, the variables CPI and CA/GDP turned out to be insignificant. After removing these variables from the model, the other variables remain significant. Therefore, the coefficients of the regression where these variables are excluded, will be used to obtain the index variable. For bench-marking purposes, both credit rating indices will be used in the subsequent analyses, as De Vries and De Haan cover a different period and sample composition. As robustness check, the variables used in the index will also be included separately in the subsequent analyses.

< Insert Table 3 here >

4.2. Descriptive statistics

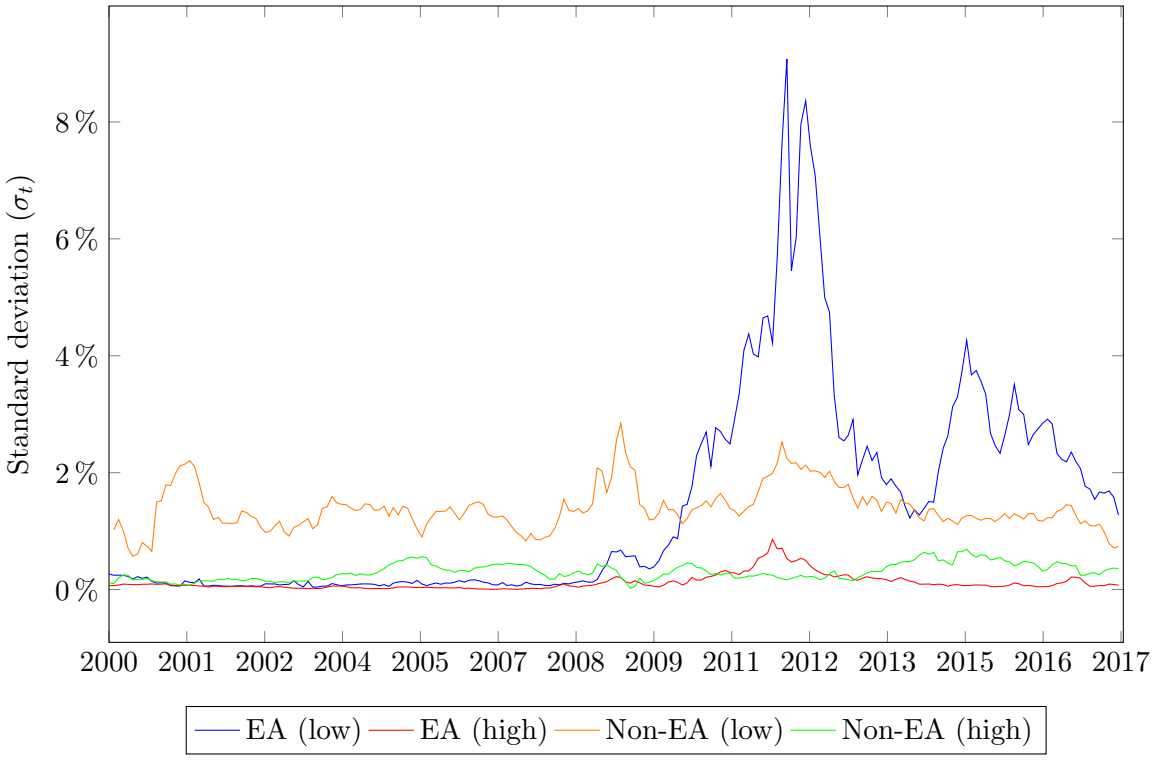
Table 4 highlights some descriptive statistics of the sovereign yield spreads used in this study. From this table can be inferred that the yield spreads are mainly country-specific. There is a wide variation between the mean, standard deviation and maximum (Greece: 27.4%) and minimum (Japan: -3.8%) values. Nevertheless, there is a clear difference between countries with different credit ratings to be observed. The EMU countries with a high rating all have an average spreads

lower than 0.5%, except for United Kingdom, while the countries with a low rating all have an average higher than 1%, except for Czech Republic. Furthermore, it stands out that the low rated EA countries (i.e., GIIPS) all exhibit high standard deviations. This is also reflected in the average standard deviation between the spreads of all EA countries (1,3%), which would only be 0.2% by excluding the GIIPS countries. Lastly, there appears to be a high correlation between the spreads of EA countries, as can be inferred from Table 5.

< Insert Table 4 and Table 5 here >

To show the differences in standard deviation of the yield spreads between countries with different credit ratings, Figure 1 illustrates the time varying standard deviation between four different subgroups. The overall standard deviation of the non-EA countries with a low rating is considerably higher than those of the three other groups, with substantial peaks from 2008 to 2009 and a slightly smaller peak around January 2012. Furthermore, the figure shows an enormous increase in standard deviation of EA countries with a low rating between 2010 and 2012 and another smaller peak from October 2014, which gradually decreases thereafter. A small peak can also be observed for EA countries with a high rating around November 2011, while the standard deviation of non-EA countries with a high rating remains rather low.

Figure 1: Standard deviation of yield spreads



Notes: This figure illustrates the differences in standard deviation (σ_t) between the sovereign spreads of the different country subgroups, as described in Table 1. The blue and red lines represent the EA countries with, respectively, low and high credit ratings. The yellow and green lines feature the non-EA countries of this sample with low and high credit ratings, respectively.

4.3. Methodology

This section describes the methodology separated by subject, as each hypothesis demands a different research approach. Firstly, the convergence and divergence of sovereign bond spread in the EA will be analyzed, to assess whether there is a significant difference between the designated periods. Secondly, the relative influence of country factors compared to international factors during bail-in and bail-out period are examined. Lastly, the monetary programs of the ECB are being scrutinized to reveal their potential effect on sovereign yield spreads.

4.3.1. Convergence and divergence of EA sovereign yield spreads

For the assessment of Hypothesis 1, different regular *Ordinary Least Squares* (OLS) regressions will be performed. The regressions are divided in two panels (Panel I and II) to account for two different dependent variables, $SPREAD2_t$ and $SPREAD3_t$, as outlined in subsection 4.1.1. Subsequently, these two panels are split into four regressions, due to the use of two measurements for the debt-to-GDP ratio, $(DEBT/GDP)_{A,i,t}$ and $(DEBT/GDP)_{B,i,t}$, and the in- and exclusion of $VDAX_t$. An example regression for Panel I, can be defined as:

$$SPREAD2_t = c + \gamma_1 D_1 + \gamma_2 D_2 + \gamma_3 VSTOXX_t + \gamma_5 INF_t + \gamma_6 (DEBT/GDP)_{A,i,t} + \epsilon_t \qquad (4)$$

where c is a constant, D_1 and D_2 are dummies reflecting the bail-in and bail-out periods, and γ_1 till γ_6 represent the coefficients of the concerning variables[3]. All independent variables are time-dependent (t) and the $DEBT/GDP$ variable is also country-specific (i).

The choice for these variables is based on previous literature and logical reasoning. The debt-to-GDP ratio is a country-specific macroeconomic variable and its effect on the sovereign yield spread could therefore change during the different periods. According to previous studies (Pozzi and Wolswijk, 2008; Baldwin and Giavazzi, 2015), country factors had less influence on the sovereign yield spreads when the EA was introduced (i.e. c). This influence is expected to increase again during the bail-in period, characterized by D_1, and decrease again during the bail-out period, i.e. D_2. Moreover, the Debt-to-GDP ratio is directly linked to the bond purchase program of the ECB (i.e., the purchase of sovereign bonds of a certain country increases a country's debt-to-GDP ratio), which was executed during both periods, specified by $D1$ and $D2$. Especially the Debt-to-GDP ratio of the GIIPS countries increased substantial after 2008, whereas these ratios for other considered EA countries remained relatively stable. Including these rather stable Debt-to-GDP ratios would possibly weaken the examined effect. Therefore, only the $DEBT/GDP$ ratios of the GIIPS countries will be included. The inflation measure, INF_t, is included in the regression because this variable affects monetary policy decisions made by governments. The overarching goal within monetary policy is targeting an inflation rate just below 2%. Therefore, a change in this rate would probably trigger a change in their policy, analogically.

[3]The number of coefficients sums up to γ_7 in case of inclusion of the $VDAX_t$

4.3.2. Bail-in-bailout mechanism

To assess the bail-in-bailout mechanism in the EA sovereign bond market, various interaction terms are established, which describe the interaction between the independent variables and the two dummy variables. In case of this research, this is translated into the following panel data regression model:

$$\begin{aligned} SPREAD1_{i,t} = c &+ \gamma_1 VSTOXX_t + \gamma_2 D_1 VSTOXX_t + \gamma_3 D_2 VSTOXX_t \\ &+ \gamma_4 INDEX2_{i,t} + \gamma_5 D_1 INDEX2_{i,t} + \gamma_6 D_2 INDEX2_{i,t} \\ &+ \gamma_7 BAS_{i,t} + \gamma_8 D_1 BAS_{i,t} + \gamma_9 D_2 BAS_{i,t} + \epsilon_t \end{aligned} \tag{5}$$

where c is a constant, dummy variables D_1 and D_2 are the same as outlined in equation (4), and the independent variables include international ($VSTOXX$), credit ($INDEX2$) and liquidity (BAS) risk. The variable $INDEX2$ represents the macroeconomic fundamentals of the different countries, as explained in subsection 4.1.3. For bench-marking purposes, the same regression will be performed by including $INDEX$, instead of $INDEX2$, as mentioned earlier. To ensure robustness of the compounded $INDEX$ variables, the model will also be executed including the underlying fundamentals through the following regression:

$$\begin{aligned} SPREAD1_{i,t} = c &+ \gamma_1 VSTOXX_t + \gamma_2 D_1 VSTOXX_t + \gamma_3 D_2 VSTOXX_t + \gamma_4 BAS_{i,t} \\ &+ \gamma_5 D_1 BAS_{i,t} + \gamma_6 D_2 BAS_{i,t} + \gamma_7 \Delta GDP_{i,t} + \gamma_8 D_1 \Delta GDP_{i,t} + \gamma_9 \Delta D_2 GDP_{i,t} \\ &+ \gamma_{10} GDP/CAP_{i,t} + \gamma_{11} D_1 GDP/CAP_{i,t} + \gamma_{12} D_2 GDP/CAP_{i,t} \\ &+ \gamma_{13} GINV/GDP_{i,t} + \gamma_{14} D_1 GINV/GDP_{i,t} + \gamma_{15} D_2 GINV/GDP_{i,t} \\ &+ \gamma_{16} HUR_{i,t} + \gamma_{17} D_1 HUR_{i,t} + \gamma_{18} D_2 HUR_{i,t} + \gamma_{19} GDEBT/GDP_{i,t} \\ &+ \gamma_{20} D_1 GDEBT/GDP_{i,t} + \gamma_{21} D_2 GDEBT/GDP_{i,t} + \gamma_{22} GDEF/GDP_{i,t} \\ &+ \gamma_{23} D_1 GDEF/GDP_{i,t} + \gamma_{24} D_2 GDEF/GDP_{i,t} + \epsilon_t \end{aligned} \tag{6}$$

where the same applies as for Equation (2), except that instead of variable $INDEX2$ the underlying fundamentals, as described under subsection 4.1.3, are added separately. All variables are again interacted with the dummy variables $D1$ and $D2$.

In order to test hypothesis 3, the regressions defined by equation (5) and (6) are also performed for six control countries outside of the EA (Denmark, Sweden, the United Kingdom, the Czech Republic, Hungary and Poland) and four countries even outside of the EMU (Japan, Norway, Switzerland and the United States). By checking the effect for countries outside of the EA, it is possible to carry out robustness checks. This is necessary in contrast to just testing the model for EA countries, which ignores the possibility of a global shift.

4.3.3. Monetary policy programs of the ECB

As discussed in subsection 2.5, the ECB has implemented different bail-out programs of which SMP, OMT and PSPP are the most relevant for this research. However, extensive information and data about these programs contain market sensitive details and are therefore not published typically. For SMP, the total cross-country Eurosystem's portfolio holdings at the end of 2012 are released, but not the specific breakdown of the aggregated purchases (Eser and Schwaab, 2016). Furthermore, there is no data available for the OMT program, because it has never been executed. However, the announcement of the OMT was of major influence, since the ECB positioned itself as lender of last resort, which effect is assessed by Hypothesis 1. The last mentioned program (PSPP) involves four different purchase programs: corporate sector, public sector, asset-backed securities and covered bond. The purchases in the public sector are most likely to affect the sovereign spreads and fortunately the ECB did publish the purchase data on this. They monthly edit the cross-country breakdown of debt securities under the PSPP.

For the last hypothesis, the effect of PSPP on the sovereign yield spreads is examined. The PSPP started in March 2015, leaving 34 observations for the regressions. The variables for international, credit and liquidity risk are also included in the model to assess whether the effect is robust to different regression combinations. This results in the following regression model:

$$SPREAD1_{i,t} = c + \gamma_1 VSTOXX_t + \gamma_3 INDEX2_{i,t} + \gamma_4 BAS_{i,t} + \gamma_5 ECB_{i,t} + \epsilon_t \tag{7}$$

where c denotes the constant, and the independent variables are the same as in equation (5) except for the new independent variable, $ECB_{i,t}$, which will reflect the relative share of the purchased bonds of country i compared to the total amount purchased at time t. For bench-marking purposes, the same regression will be executed with $INDEX$ - instead of $INDEX2$ - as mentioned before. For robustness purposes, the lagged variable for ECB is also added to the regression. The aggregated monthly average amounts concerning PSPP are published every third Monday of the month for the previous month. For this reason, it is plausible that the effect is only visible a month later.

5. Empirical results and analysis

This section presents the empirical results of this study, separately discussed for the four distinct hypotheses. Subsection 5.1 provides the results regarding Hypothesis 1, which examines the convergence and divergence of the EA sovereign spreads. Subsection 5.2 documents the findings of Hypothesis 2, concerning the time varying importance of risk factors on the sovereign spreads within the EA. Whereas subsection 5.3 presents a similar analysis outside of the EA for the assessment of Hypothesis 3. Finally, subsection 5.4 examines the effect of the ECB's PSPP on the sovereign spreads, which provides an answer to Hypothesis 4.

5.1. Hypothesis 1: Convergence and divergence of EA sovereign spreads

From Table 6 can be inferred that dummy variable $D1$ has an economical large and highly significant effect in all regression models, both in Panel I as well as in Panel II, whereas dummy $D2$ exhibits an economical large, significant, and negative effect. For Panel I, this highlights that, from October 2010 till July 2012 (i.e., programmed range of $D1$), the yield spreads in the EA diverged from each other and, moreover, from Panel II can be concluded that the gap between high- and low-rated countries fairly increased. All coefficients for $D1$ are significant at a 1% level. After July 2012 (i.e., start programmed range of $D2$), the overall dispersion within the EA (Panel I) and the gap between the GIIPS and other high-rated EA countries (Panel II) converged again, as can be derived from the negative coefficients. This *convergence effect* is most significant for Panel I, however all coefficients of $D2$ proved to be significant at a 5% level.

The international risk factor, $VSTOXX$, exhibits less significant coefficients. Especially in combination with the second measure for the debt-to-GDP ratio, $(DEBT/GDP)_B$, where the coefficient is insignificant for Panel I and only significant at a 10% level for Panel II. As stated under subsection 4.3.1, the variable $VDAX$ was also supposed to be included. From Table 6 can be observed that this has not been done. After carefully examining the two international risk proxies, they appeared to be highly correlated (0.98). The inclusion of $VSTOXX$ on its own is representative to examine the effect and adding $VDAX$ would even cause biased results. Not to mention that the impact of $VSTOXX$ and $VDAX$ move in opposite direction, making the inclusion of both variables disputable. A higher volatility in Germany indicates more market risk, causing the German bond yields to increase. Naturally this implies that, ceteris paribus, the sovereign spreads relative to this benchmark bond, will decrease. Whereas an EA-wide higher volatility, represented by $VSTOXX$, will result in sovereign spreads to increase.

The measure for inflation, INF_t, is significant at a 1% level for all regressions, except for Panel I where $(DEBT/GDP)_B$ is included. All coefficients are negative, which highlights that an increase of this variable leads to a smaller dispersion between the sovereign spreads in the EA. The variable INF is measured by the absolute difference between the target rate of 2% minus the average CPI growth rate in the EA, as described in Table 2. The more the average CPI growth exceeds the CPI target rate, the more negative variable INF is. This multiplied by the negative coefficient, implies a higher dispersion between sovereign spreads, which is in line with expectations. On the other hand, the more the average CPI growth rate is below the target rate, the higher variable INF is and thus the lower the dispersion between sovereign spreads. This could suggest that, the more the current inflation is below the target level, central banks are prompted to pursue an active monetary policy and thereby reducing the sovereign spreads. Based on these results, no conclusion can be drawn yet without closer research on the effect of monetary policy. This will be the focus of Hypothesis 4.

When observing the two different measures for the debt-to-GDP ratio, $(DEBT/GDP)_A$ and $(DEBT/GDP)_B$, three things stand out. Firstly, the explanatory power (R^2) is larger for the models where $(DEBT/GDP)_A$ is included. Secondly, almost all coefficients are significant at a 1%

level, except for the coefficient of $(DEBT/GDP)_A$ for Ireland, which could be because the debt-to-GDP ratio of Ireland fluctuated considerably during the sample period. Thirdly, for Greece and Italy the coefficients of both debt-to-GDP ratios are negative. A higher level of debt-to-GDP for these countries implies a smaller dispersion in sovereign spreads in the EA. This is in contrast to both the existing literature as well as to the positive coefficients for Ireland, Portugal and Spain. As described in subsection 2.3, the yields of the GIIPS countries fluctuates almost entirely due to changes in default risk, which is directly related to the level of debt. Hence, a positive coefficient was expected initially; the higher the debt-to-GDP level, the higher the yield for that country and thus the higher the dispersion or gap between sovereign spreads in EA. Therefore, the negative coefficients are quite remarkable and possibly indicate omitted variables with an apparent large impact on the spreads of these countries.

< Insert Table 6 here >

5.2. Hypothesis 2: Time varying importance of risk factors within the EA

For the assessment of Hypothesis 2, a careful examination of Table 7 is required. The hypothesis states that the impact on sovereign spreads of country-specific risk factors increased, during the *investor bail-in* (i.e. indicated by dummy $D1$), while the impact of international factors decreased. The opposite is expected during the *ECB bail-out* period (i.e., indicated by dummy $D2$). The coefficients in Table 7, also the γ's in equation (5), reflect the influence of the corresponding risk measure in that specific period. Based on the hypothesis, the coefficients for international risk, $VSTOXX$, should be positive (γ_1), negative (γ_2) and a positive again (γ_3) in chronological order. For credit risk (i.e., measured by variable $INDEX2$), the coefficients are expected to exhibit negative (γ_4), negative (γ_5) and positive (γ_6) values. The variable $INDEX2$ has a negative relation with the sovereign spreads, since a higher credit rating means less credit risk and thus a lower yield spread. For liquidity risk (i.e., measured by variable BAS), the coefficients are expecting to be of opposite signs compared to credit risk, because of the positive relation between the bid-ask spread and the sovereign spread. A higher bid-ask spread indicates lower liquidity and therefore more liquidity risk, which increases the sovereign yield spread. The coefficients for liquidity risk are thus expected to be positive (γ_7), positive (γ_8), and negative (γ_9).

The results in Table 7 show that the explanatory power of the regression models, R^2 is generally higher for the GIIPS countries, which are displayed on the left side of the table. The models are regressed following equation (5) with $SPREAD1_{i,t}$ as dependent variable, instead of $SPREAD2_t$ and $SPREAD3_t$ which were used in the assessment of Hypothesis 1. This variable, outlined in equation (1) and explained in Table 2, entails the country-specific spread in relation to the benchmark yield of Germany. As described under subsection 5.2, the variable $INDEX$ would initially be added for bench-marking purposes. However, after robustness tests, the variable $INDEX2$ proved to perform substantially better for all countries, making inclusion less meaningful. Included are, as can be observed from Table 7, the following independent variables: C, $VSTOXX$, $INDEX2$ and

BAS. The latter three are interacted with the dummy variables. All coefficients for the constant and variable $INDEX2$ are significant at a 1% level and for the variable BAS almost all, except for France at a 5% level and the coefficient for Finland is insignificant. Showing that these chosen variables have an evident effect on the yield spreads. As supposed the coefficients for $INDEX2$ are negative, whereas positive for BAS, for all countries. Unfortunately, the coefficients for $VSTOXX$ are less significant, but the significant ones are, as expected, positive.

The coefficients for the risk variables interacted with the dummy terms, are not all significant. Especially those of the non-GIIPS countries are not, with the exception of the coefficient for $D_1VSTOXX$. It is remarkable that less coefficients for interaction variable $D_1VSTOXX$ are significant for the GIIPS countries compared to the other EA countries and more for $D_2VSTOXX$. $D_1VSTOXX$ was expected to be negative, unfortunately this is not the case for most significant coefficients. The expected effect is only shown for Portugal by -0.020 at a significance level of 5%. This country is also the only GIIPS country with a significant coefficient for $VSTOXX$ at a 5% level. For the other countries a positive effect for $D_1VSTOXX$ is observed, however for most countries (Greece, Italy, Spain, Belgium and the Netherlands) this is still smaller compared to the bailout period. For $D_2VSTOXX$, a higher significant positive effect can be perceived, which is what was expected for this interaction term. Especially for Greece, the coefficient increases tremendous, with 0.176, in relation to the coefficient, -0.002, for the non-interaction variable $VSTOXX$.

Continuing to the interaction terms of $INDEX2$, more coefficients are significant for the GIIPS countries, except for Italy where both coefficients are not significant. All insignificant coefficients for the other EA countries are relatively low, between -0.004 and 0.010. There are two significant $D_1INDEX2$ coefficients for Belgium and the Netherlands. The effect of these interaction variables are, however, contradictory, as for Belgium this is positive and for the Netherlands negative. The $D_1INDEX2$ coefficients for the GIIPS countries also indicate opposite effects. For Greece and Portugal the coefficients are, as expected, negative at a 10% significance level, but positive for Ireland at a 1% level. All $D_2INDEX2$ coefficients for the GIIPS countries are positive, which was expected for this interaction term. Four out of five are significant of which three are significant at a 1% level (Greece, Ireland and Portugal) and the coefficient for Spain at a 10% level.

The impact of interaction terms involving BAS, show a similar picture to the interaction coefficients concerning $INDEX2$. They also present ambiguous results, except D_2BAS for the GIIPS countries, highlighting negative coefficients for all models, as expected. The coefficients for Italy are, like the results for the interaction terms of $INDEX2$, highly insignificant. Furthermore, it can be concluded that only the models examining the spread of Greece and Portugal provide results which are perfectly in accordance to the earlier mentioned expectations. The impact of $INDEX2$ increased substantially during the bail-in period for these countries, while its importance decreased thereafter during the bail-out, and the same conclusion can be drawn on the importance of BAS. For Portugal, the results are also in accordance with the hypothesis on the decrease of international risk factors during the bail-in period and increase in the period hereafter. In general, the expected effect can be observed more clearly for the GIIPS countries, especially during the bail-out period.

< Insert Table 7 here >

As robustness check, this regression is also performed by incorporating the underlying factors of $INDEX2$ separately as variables in the models, instead of using solely the compounded index variable. The results of Regression 6 for the EA countries are displayed in Table 8. The explaining power (R^2) of the model increases for all countries, as well as the adjusted R^2. The latter is a better measure of comparison when more variables are added. However, the examined effect of Hypothesis 2 is observed less clearly. For variable $VSTOXX$, less coefficients are significant and the significant ones do not all show the expected results. In fact, only the coefficients for France demonstrate the expected signs of positive, negative and positive in chronological order. From this can be concluded that there is no significant change in impact of international risk observable through this model. For variable BAS, the same number of coefficients is significant and they all have the expected sign. The coefficients for the GIIPS countries are higher compared to the other EA countries, which implies a stronger impact of liquidity risk on the sovereign spreads. For these countries, the coefficients also show a significant decrease in impact during the bail-out, but there is no longer a significant increase in impact observed for any country during the bail-in period.

Where all coefficients for $INDEX2$ were significant negative, the coefficients for the separate variables give ambiguous results. All significant coefficients of ΔGDP are negative, as expected, while the interaction coefficients only expose a few significant results with the expected signs for the GIIPS countries. The coefficients of $GINV/GDP$, HUR and $GDEBT/GDP$ show contradictory results for the GIIPS and other EA countries. Those of $GINV/GDP$ and HUR show the expected signs for the GIIPS countries and those of $GDEBT/GDP$ for the other EA countries with Portugal as the only the exception. The interaction coefficients for these variables do not demonstrate the expected change in impact. The same applies for GDP/CAP and $GDEF/GDP$, which coefficients exhibit ambiguous results for all countries. Overall it can be concluded that, when the variables are tested individually, no clear change in impact can be observed.

< Insert Table 8 here >

5.3. Hypothesis 3: Time varying importance of risk factors outside of the EA

For the assessment of Hypothesis 3, the same examination as for Hypothesis 2 has been conducted. However, to validate Hypothesis 3, the impact of the risk factors should *not* change significantly during the distinct bail-in and bail-out periods, which is in contrast to the previous hypothesis. The results will be discussed per country group, as presented in Table 1, from left to right. To start with the non-EA high-rated EMU countries, all R^2 are relatively low and only a third of the coefficients is significant. For Sweden, most of the coefficients are significant. Deviating from the results in Table 7, these significant coefficients have the same sign and about the same size for the interaction terms of a certain risk variable during the bail-in and bail-out period. For example, the coefficient for risk variable $VSTOXX$ decreases by -0.020 during the bail-in and -0.019 during the bail-out. The same applies for the insignificant $VSTOXX$ interaction coefficients

for Denmark and the United Kingdom. The influence of the international risk factors for all three countries thus remains stable during the distinct periods, while for Sweden also the influence of country risk factors was hardly affected.

The $INDEX2$ interaction coefficients for Denmark and the United Kingdom all have a negative sign, but they are not of equally size. For Denmark, this coefficient is three times larger during the bail-in period and for the United Kingdom more than four times larger during the bail-out period. For the United Kingdom, the coefficient for variable BAS interacted with $D2$ is even thirteen times larger compared to the one interacted with $D1$. This implies that influence of the country risk factors increased more during the bail-out period for the UK, while the influence during the bail-in period remained relatively unchanged. For Denmark, the sign of coefficient for the BAS interaction terms changes from positive during the bail-in to negative again during the bail-out. The expected sign for this variable would be positive, but compared to small bid-ask spreads these negative coefficients are negligible. Therefore, it can be stated that the influence of the country risk factors remained approximately the same during the bail-out period, but increased during the bail-in period. However, no decisive conclusion can be drawn for all non-EA high-rated EMU countries within the sample.

The results for the non-EA low-rated EMU countries also show ambiguous effects. The model has the highest explaining power for Hungary with a R^2 of 0.741. For this country, the coefficients for the international risk variables $VSTOXX$ did not change substantial between the bail-in and bail-out period. The impact increased by 0.05, approximately, compared to the period before the bail-in. However, the coefficient for $VSTOXX$ is not significant and has a value of zero. The effect of the country risk factors, on the other hand, did increase more during the bail-in period than during the bail-out period. For the Czech Republic and Poland, the results show an increase in influence for the variable $VSTOXX$ during both periods. However, this effect is twice as large for the bail-out period. The coefficients for the variable $INDEX2$ interacted with the bail-in period are significant negative and, because of the positive coefficient for $INDEX2$, the effect of this variable decreased during this period. The coefficients for this variable interacted with the bail-out period are positive and insignificant for both countries. The coefficients for the BAS interaction terms are different for the Czech Republic and Poland. For the Czech Republic, a substantial significant increase can be observed during the bail-in period and a small insignificant decrease during the bail-out period. Two negative coefficients are shown for the interaction terms of Poland, of which the effect is larger and only significant for the bail-out period.

Remarkable for the high-rated non-EMU countries is that all coefficients for the non-interacted variables are significant at a 1% level, but unfortunately they do not exhibit the same sign for each country. The coefficients for the interacted $VSTOXX$ variables of Japan and Switzerland are both significant. For these countries, the influence of this international risk factor increases, but only for Japan this increase was of equally size during the distinct periods and thus its influence remained stable. For Switzerland, the influence increases by more than double during the bail-out period, which is consistent with Hypothesis 2 and thus contradictory with Hypothesis 3. The coefficients

for the interacted $INDEX2$ variable are significant for Norway and the United States. For Norway, the influence of credit risk increases and remains stable. The coefficients for the United Stated have negative signs, but, because $INDEX2$ also has a negative sign, the influence does increase. This increase in impact is larger during the bail-out period and therefore does not support Hypothesis 3, but is also not in line with Hypothesis 2. For variable BAS, only the coefficients of the variables interacted with D_2 are significant. These coefficients are all smaller than the coefficients for the variables interacted with D_1, supporting Hypothesis 2.

The results summarized, it can be concluded that only for Sweden the relative importance of all risk factors did not change significantly. For the international risk factors this applies to Denmark, the United Kingdom, Hungary and Japan. Concerning the country risk factors, the results only show a stable effect for credit risk in Norway. All other countries show a difference in the impact of credit risk between the distinct periods, of which Denmark and Hungary, significantly, support the expectation as expressed in Hypothesis 2. The other countries show an increase in impact during the bail-out period, but only the results for the US are significant. None of the coefficients for the liquidity risk factor show a stable influence over the distinct periods, except for Sweden. It is remarkable that for all countries, except the United Kingdom, the influence of this risk factor is relatively stronger during the bail-in compared to the bail-out period. This is in accordance to Hypothesis 2, which means that the increased impact of liquidity risk during the bail-in period also occurs in countries outside of the EA and is therefore not typically attributable to this area.

< Insert Table 9 here >

Similar to Hypothesis 2, the underlying fundamentals of $INDEX2$ will be added separately to the model to check for robustness. The results of Regression 6 for countries outside of the EA are shown in Table 10. Again the adjusted explaining power (R^2) increases for all countries, but unfortunately the examined stable effect is also less visible. Whereas for Sweden the coefficients for the distinct periods were approximately the same size for all three risk factors, this is no longer the case for the results of regression. The impact of international risk and liquidity risk is higher during the bail-in period, while most of the fundamental variables, although all insignificant, have more impact during the bail-out period. For other countries, the influence of international risk is only stable for Norway and liquidity risk for no country. As regard to international risk, this is considerable lower compared to the results in Table 9, where a stable effect can be observed for five countries. Concerning liquidity risk, no stable effect was discernible in the previous model nor in this model. Nonetheless, a stronger impact during the bail-in period became visible in previous model. The coefficients in Table 10 show more mixed results. Liquidity risk has more impact during the bail-out period not only for the United Kingdom, but also for Poland and Norway, which makes Hypothesis 2 slightly more robust. The coefficients for the credit risk variables exhibit various results of which no unambiguous conclusion can be drawn. The model neither confirms nor rejects Hypothesis 3, making it less suitable to use in comparison with the model of Table 9, which did show some interesting outcomes. This indicates that the combined fundamental variables can produce different kind of outcomes.

< Insert Table 10 here >

5.4. Hypothesis 4: The effect of the ECB's PSPP on sovereign spreads

For the assessment of Hypothesis 4, the new variable ECB is introduced as described in the research design under subsection 4.3.3. The results of the regression models defined by equation (7) are shown in table 11. From this table immediately appears that no regression has been carried out for Greece. This country could not be incorporated, because the ECB did not purchase Greek sovereign bonds under the PSPP due to their low debt sustainability. Another remarkable change is the decrease in number of observations from 214 to 34. The PSPP has only started in March 2015, which yields 34 observations up to the end of the sample in December 2017. As mentioned before, the number of observations has influence on the explaining power (R^2) of a model. This can be one of the reason why the R^2 in Table 11 are relatively low, except for Italy and Portugal. In terms of significant variables, most of the models perform reasonably well with the exception of the Netherlands where no variable is significant. As mentioned in section 4.3.3, the lagged variable of ECB would also be added. However, in practice this did not induce any differences and therefore the results are not included in Table 11.

As seen from the results from Hypotheses 2 and 3, the separate inclusion of the underlying variables of $INDEX2$ does not make the model more suitable to expose the effect examined in this study. In this hypothesis, the emphasis does not lie on the specific time-varying effect of credit risk but particularly on the impact of the PSPP. Hence the regressions are only performed with the compound variable $INDEX2$. The significant coefficients of the variables for international, credit and liquidity risk all exhibit the expected signs. The insignificant coefficients of variables $VSTOXX$ and $INDEX2$ even show, respectively, positive and negative values. Only the coefficients of variable BAS for Ireland and Finland are against expectation negative, but also insignificant. The coefficients of variable ECB, however, expose ambiguous results. Most of the coefficients are against expectation positive, except for Ireland, Portugal and the Netherlands. Of these countries, solely the coefficients of the first two countries are significant. From this can be concluded that, by means of this research, only the reducing effect of PSPP on sovereign yields spreads is observable for Ireland and Portugal. For all other countries, especially Belgium, an increase in the relative share of purchased bonds increases the spread with the German bond yield. Recapitulating this outcome with the results of previous hypotheses, it can be concluded that the announcement of Draghi, emphasizing the role of the ECB as LOLR, had a more significant and drastic effect on the sovereign yield spreads compared to the actual implementation of the PSPP.

< Insert Table 11 here >

6. Conclusion

Over the past twenty years, EA sovereign spreads experienced substantial changes. The main objective of this research is to elaborate on the impact of ECB's monetary policy on the EA sovereign bond market. By using the Bail-in-Bailout mechanism to explain movements in sovereign spreads, the triangular relation between monetary policy, sovereign spreads and risk factors can be examined. An attempt is made to gain a better understanding of the formation of spreads and which factors are of influence.

In order to investigate whether the Bail-in-Bailout mechanism is applicable on the EA sovereign bond market, several hypotheses had to be tested. The first hypothesis is focused on defining whether there is a bail-in or bailout ongoing and, if so, during which time frame can this be observed. For the assessment of Hypothesis 1, two periods are selected based on their likely relevance, which are incorporated using dummy variables to examine if there has occurred a significant change in sovereign spreads. Hypothesis 2 examines if the country-specific risk factors actually gained more (less) influence during the period characterized as bail-in (bailout). Various country-specific and international risk factors are interacted with the aforementioned dummy variables to investigate this. For international and liquidity risk the market-based variables $VSTOXX$ and BAS are used. For credit risk an index, $INDEX$, was created in order to obtain a more fluent time series, since its underlying fundamentals are prone to infrequent adjustments. The model is also performed with the index' underlying fundamentals incorporated as separate variables, to ensure the robustness of this index variable.

For Hypothesis 3 the same examination as for Hypothesis 2 has been done, but then for a control group of countries outside the EA. This is inevitable to assess the causal relation between the Bail-in-Bailout mechanism and the EA sovereign bond market and to exclude the possibility of a global shift. The previous three hypotheses assume that the ECB's acted as LOLR for a consecutive period. However, the ECB has implemented several quantitative easing programs that contribute to this function. Hypothesis 4 focuses specifically on the effect of the Public Sector Purchase Programme (PSPP), which should have the most direct effect on the sovereign bond market. This hypothesis is tested by adding the purchase data about this program to the model without the use of dummy variables, because the program is fully implemented in the period characterized as bailout.

The main conclusion that can been drawn from this research is that the Bail-in-Bailout mechanism is applicable on the EA sovereign bond market. There has been a significant increase in the overall dispersion of EA sovereign spreads after the *Deauville summit* in October 2010. Moreover, the gap between the sovereign spreads of the GIIPS and other EA countries has also widened. After the speech of Draghi in July 2012, in which he emphasizes the role of the ECB as LOLR, the sovereign spreads converged again and the gap narrowed. This confirms Hypothesis 1. The variables that represent the country-specific risk factors, exhibit an evident effect on all considered EA sovereign spreads, but their time-varying relative importance is less pronounced. The expected effect is perfectly reflected for Greece and Portugal and partly for Ireland, Spain and

the Netherlands. An increase in importance is visible for the Netherlands during the bail-in and for Ireland and Spain a decrease in importance is observable during the bailout. The results for the international risk factor are even less significant and those that are significant are showing an unexpected sign. Contrary to expectations, an increase in importance is observed for the bail-in period. On the other hand, the increase for the bailout period is larger, which slightly confirms the expectations again. Solely the model for Portugal exhibit coefficients that are both significant and all have the expected sign. Adding the country fundamentals separately, did not alter the outcome of these results. Therefore, Hypothesis 2 is partially confirmed, but not for most of the considered EA countries.

The same applies to Hypothesis 3, which can only be confirmed perfectly for Sweden. The international risk factor remains stable for Denmark, the United Kingdom, Hungary and Japan. Regarding the country factors, only the effect of credit risk for Norway remains stable. The results of credit risk for Denmark and Hungary even support Hypothesis 2, as well as those of liquidity risk for all control countries, except for the United Kingdom. This refutes Hypothesis 3, meaning the time-varying effect of liquidity is not typically attributable to the EA. Hypothesis 4 is only confirmed for Ireland and Portugal, but significantly rejected for Spain, Austria, Belgium and France. Recapitulating this outcome with the results of previous hypotheses, it can be concluded that the ECB's reinforced function as LOLR had more impact on the sovereign yield spreads than the implementation of the PSPP.

This renewed way of dividing the sample provides new insights, but is also associated with some drawbacks. First of all, this research does not make use of time-varying factor models, but instead uses dummy variables to characterize different periods. With regard to the time-varying nature of the risk factors, there is certainly room for improvement here and should be investigated in further research. Secondly, attention need to be paid to the time this research is conducted. The ECB has just announced that it will terminate its purchase program, which inaugurates a new period with possible changes. Lastly, as mentioned before, many different factors have influence on sovereign spreads of which only a small amount is investigated. For example, redenomination and contagion risk, as mentioned at the beginning of section 2, could be included in the model. However the impact of these risk were not the aim of this study. Another example is that no account is taken of the activity on the secondary market, which plays an important role in liquidity risk. As measure for liquidity risk, bid-ask spreads are used. This market-based variable incorporates future expectations, but is also very small and may not fully reflect the risk. Therefore, it should be emphasized that, despite that this research provides a more comprehensive understanding of the EA sovereign bond market, this is just part of the complete story which stipulates the importance of further research on this matter in the coming years.

References

Abad, P., Chuliá, H., and Gómez-Puig, M. (2010). Emu and european government bond market integration. *Journal of Banking & Finance*, 34(12):2851–2860.

Abad, P., Chuliá, H., and Gómez-Puig, M. (2014). Time-varying integration in european government bond markets. *European Financial Management*, 20(2):270–290.

Acharya, V., Drechsler, I., and Schnabl, P. (2014). A pyrrhic victory? bank bailouts and sovereign credit risk. *The Journal of Finance*, 69(6):2689–2739.

Afonso, A., Arghyrou, M., and Kontonikas, A. (2012). The determinants of sovereign bond yield spreads in the emu. *ECB Working Paper No. 1781*.

Afonso, A., Gomes, P., and Rother, P. (2011). Short-and long-run determinants of sovereign debt credit ratings. *International Journal of Finance & Economics*, 16(1):1–15.

Altavilla, C., Giannone, D., and Lenza, M. (2014). The financial and macroeconomic effects of omt announcements. *Centre for Economic Policy Research (CEPR)*.

Arghyrou, M. G. and Kontonikas, A. (2012). The emu sovereign-debt crisis: Fundamentals, expectations and contagion. *Journal of International Financial Markets, Institutions and Money*, 22(4):658–677.

Attinasi, M.-G., Checherita-Westphal, C., and Nickel, C. (2009). What explains the surge in euro area sovereign spreads during the financial crisis of 2007-09? *ECB Working Paper, No. 1131*.

Baldwin, R. E. and Giavazzi, F. (2015). *The Eurozone crisis a consensus view of the causes and a few possible solutions*. CEPR Press London.

Barrios, S., Iversen, P., Lewandowska, M., Setzer, R., et al. (2009). Determinants of intra-euro area government bond spreads during the financial crisis. Technical report, Directorate General Economic and Financial Affairs (DG ECFIN), European Commission.

Basurto, M. A. S., Caceres, C., and Guzzo, V. (2010). *Sovereign spreads: Global risk aversion, contagion or fundamentals?* International Monetary Fund.

Beber, A., Brandt, M. W., and Kavajecz, K. A. (2008). Flight-to-quality or flight-to-liquidity? evidence from the euro-area bond market. *The Review of Financial Studies*, 22(3):925–957.

Bensasson, M. (2018). Slide in euro-area economic confidence poses risk to growth. *Bloomberg*. Retrieved from: **website**.

Bernoth, K. and Erdogan, B. (2012). Sovereign bond yield spreads: A time-varying coefficient approach. *Journal of International Money and Finance*, 31(3):639–656.

Bernoth, K., von Hagen, J., and Schuknecht, L. (2004). Sovereign risk premia in the european government bond market. *ZEI Working Paper No. B26-2003*.

Borio, C. and Zhu, H. (2012). Capital regulation, risk-taking and monetary policy: a missing link in the transmission mechanism? *Journal of Financial Stability*, 8(4):236–251.

Chuhan, P., Claessens, S., and Mamingi, N. (1998). Equity and bond flows to latin america and asia: the role of global and country factors. *Journal of Development Economics*, 55(2):439–463.

Codogno, L., Favero, C., and Missale, A. (2003). Yield spreads on emu government bonds. *Economic Policy*, 18(37):503–532.

Collignon, S., Esposito, P., and Lierse, H. (2013). European sovereign bailouts, political risk and the economic consequences of mrs. merkel. *Journal of International Commerce, Economics and Policy*, 4(02):1350010.

De Santis, R. A. (2015). A measure of redenomination risk. *ECB Working Paper No. 1785*.

De Vries, T. and De Haan, J. (2016). Credit ratings and bond spreads of the giips. *Applied Economics Letters*, 23(2):107–111.

Dewachter, H., Iania, L., and Wijnandts, J.-C. (2016). The response of euro area sovereign spreads to the ecb unconventional monetary policies. *National Bank of Belgium, Working Paper, No. 309*.

Dungey, M., Martin, V. L., and Pagan, A. R. (2000). A multivariate latent factor decomposition of international bond yield spreads. *Journal of Applied Econometrics*, 15(6):697–715.

ECB (2018). Asset purchase programmes. *European Central Bank*. Retrieved from: **website**.

Ejsing, J., Grothe, M., and Grothe, O. (2012). Liquidity and credit risk premia in government bond yields. *ECB Working Paper, No. 1440*.

Eser, F. and Schwaab, B. (2016). Evaluating the impact of unconventional monetary policy measures: Empirical evidence from the ecb s securities markets programme. *Journal of Financial Economics*, 119(1):147–167.

Fabozzi, F. J. (2007). *Fixed income analysis*, volume 6. John Wiley & Sons.

Fairless, T. and Blackstone, B. (2018). Ecb lowers growth forecasts as it confirms plan to end easy money. *The Wall Street Journal*. Retrieved from: **website**.

Fontana, A. and Scheicher, M. (2016). An analysis of euro area sovereign cds and their relation with government bonds. *Journal of Banking & Finance*, 62:126–140.

Gerlach, S., Schulz, A., Wolff, G. B., et al. (2010). Banking and sovereign risk in the euro area. Technical report, Deutsche Bundesbank, Research Centre.

Geyer, A., Kossmeier, S., and Pichler, S. (2004). Measuring systematic risk in emu government yield spreads. *Review of Finance*, 8(2):171–197.

Ghysels, E., Idier, J., Manganelli, S., and Vergote, O. (2016). A high-frequency assessment of the ecb securities markets programme. *Journal of the European Economic Association*, 15(1):218–243.

Gibson, H. D., Hall, S. G., and Tavlas, G. S. (2012). The greek financial crisis: Growing imbalances and sovereign spreads. *Journal of International Money and Finance*, 31(3):498–516.

Haugh, D., Ollivaud, P., Turner, D., et al. (2009). What drives sovereign risk premiums?: An analysis of recent evidence from the euro area. Technical Report No. 718, OECD Publishing.

Heinemann, F. (2017). Die bedeutung der ezb-anleihekäufe für die schuldenfinanzierung der euro-staaten. *ZEW, Oktober*.

Ioannidou, V., Ongena, S., and Peydró, J. L. (2009). Monetary policy and subprime lending: a tall tale of low federal funds rates, hazardous loans and reduced loan spreads. *European banking centre discussion paper*, 45.

Jiménez, G., Ongena, S., Peydró, J.-L., and Saurina, J. (2014). Hazardous times for monetary policy: What do twenty-three million bank loans say about the effects of monetary policy on credit risk-taking? *Econometrica*, 82(2):463–505.

Kilponen, J., Laakkonen, H., Vilmunen, J., et al. (2015). Sovereign risk, european crisis-resolution policies, and bond spreads. *International Journal of Central Banking*, 11(2):285–323.

Kim, D. H. and Orphanides, A. (2007). The bond market term premium: what is it, and how can we measure it? *BIS Quarterly Review*, page 27.

Leschinski, C. and Bertram, P. (2017). Time varying contagion in emu government bond spreads. *Journal of Financial Stability*, 29:72–91.

Lombardi, D. and Moschella, M. (2016). The government bond buying programmes of the european central bank: an analysis of their policy settings. *Journal of European Public Policy*, 23(6):851–870.

Manganelli, S. and Wolswijk, G. (2009). What drives spreads in the euro area government bond market? *Economic Policy*, 24(58):191–240.

Mariathasan, J. (2018). Euro-zone: What comes after qe? *Investment & Pensions Europe*. Retrieved from: **website**.

Mody, A. (2014). The ghost of deauville. *VoxEU. org*, 7.

Neely, C. J. (2010). *The large scale asset purchases had large international effects*. Federal Reserve Bank of St. Louis, Research Division.

Pieterse-Bloem, M., Qian, Z., Verschoor, W., and Zwinkels, R. (2016). Time-varying importance of country and industry factors in european corporate bonds. *Journal of Empirical Finance*, 38:429–448.

Pozzi, L. and Wolswijk, G. (2008). Have euro area government bond risk premia converged to their common state? *Tinbergen Institute Discussion Paper*, 042(2).

Schwarz, K. (2017). Mind the gap: Disentangling credit and liquidity in risk spreads. *Unpublished Working Paper, University of Pennsylvania, Wharton School, Philadelphia, PA*.

Tyson, J. (2015). Sub-saharan africa international sovereign bonds. *Overseas Development Institute*.

Wright, J. H. (2012). What does monetary policy do to long-term interest rates at the zero lower bound? *The Economic Journal*, 122(564).

Appendix A. Descriptive statistics

Table 2: Description of variables and their sources

Variable	Description	Measure of	Source
Dependent variables			
$SPREAD1_{i,t}$	The yield spread of country i as described in equation (1)	Sovereign risk	OECD
$SPREAD2_t$	The standard deviation between spreads of all observed EA countries (11)	Divergence/ Convergence	Own calculations
$SPREAD3_t$	The difference between the average spread of EA countries with a high and a low credit rating	Divergence/ Convergence	Own calculations
Independent variables			
$VSTOXX_t$	Implied volatility of near term options on the EuroStoxx 50 index	International risk	Datastream
$VDAX_t$	Implied volatility of near term options on the Deutsche Aktienindex (DAX)	International risk	Datastream
$(DEBT/GDP)_{A,i,t}$	The natural logarithm of the debt-to-GDP ratio of country i divided by the average of the EA19	Credit risk	Eurostat / OECD
$(DEBT/GDP)_{B,i,t}$	The absolute difference in debt-to-GDP ratio between country i and the average of the EA19	Credit risk	Eurostat / OECD
INF_t	The absolute difference between the target (2%) and average EA19 consumer price index growth rate	Inflation risk	OECD
$INDEX_{i,t}$	Index based on coefficients estimates from the model of De Vries and De Haan (2016)	Credit risk	Article 2016
$INDEX2_{i,t}$	Index based on country fundamentals	Credit risk	Newly acquired
$BAS_{i,t}$	Spread between the bid and ask price of 10-year sovereign bonds of country i	Liquidity risk	Bloomberg
$ECB_{i,t}$	Relative share of purchased bonds compared to total of country i at time t	Monetary policy	ECB
Fundamentals of country i			
$\Delta GDP_{i,t}$	Month-on-month growth of GDP	Econ. growth	OECD
$(GDP/CAP)_{i,t}$	Gross Domestic Product per capita	Productivity	OECD
$(GINV/GDP)_{i,t}$	Government investment per GDP	Investment	OECD
$CPI_{i,t}$	The consumer price index (CPI) measures the annual change in prices of a basket of typically purchased goods and services	Inflation	OECD
$HUR_{i,t}$	The harmonised unemployment rate (HUR) measures as unemployment as percentage of the labour force according to an uniform definition (working age, available & actively searching)	Unemployment	OECD
$(GDEBT/GDP)_{i,t}$	Government debt per GDP	Fin. leverage	OECD
$(CA/GDP)_{i,t}$	Current account balance per GDP	Int. trading	OECD
$(GDEF/GDP)_{i,t}$	Government deficit per GDP	Gov. budget	OECD

Notes: This table lists all the variables that are used in this study with a brief description of (*i*) how they are measured, (*ii*) what they are a measure of and (*iii*) where the data was obtained. The variables are divided horizontally into three groups, starting with the dependent variables, then the used independent variables and finally the fundamentals on which the index variables are based.

Table 3: Estimating the fundamental drivers of sovereign credit ratings

	De Vries and De Haan (2016)		This research	
	Coefficient	Implied weight	Coefficient	Implied weight
Constant	12.520***		20.623***	
	1.911		0.645	
ΔGDP	0.086***	12%	0.380***	41%
	0.027		0.161	
GDP/CAP	0.000***	0%	-0.000***	0%
	0.000		0.000	
$GINV/GDP$	0.124**	17%	0.125***	13%
	0.052		0.034	
CPI	-0.194***	27%		
	0.052			
HUR	-0.194***	27%	-0.266***	28%
	0.046		0.039	
$GDEBT/GDP$	-0.013***	2%	-0.048***	5%
	0.005		0.006	
CA/GDP	0.117***	16%		
	0.029			
$GDEF/GDP$			-0.119***	13%
			0.030	
		100%		100%
R^2	0.600		0.877	
Period	1995-2011		1999-2017	
Countries	13		10	

Notes: The used variables are equal to those in De Vries and De Haan (2016), however, the variable names have been slightly adjusted for consistency purposes. The implied weight percentages are displayed as absolute values. De Vries and de Haan (2016) excluded the government budget balance ($GDEF/GDP$), because this variable is insignificant in their model. In the model of this research, $GDEF/GDP$ is significant and thus included. The variables for inflation (CPI) and the current account balance per GDP (CA/GDP) are not significant and therefore excluded. Additional countries of De Vries and De Haan (2016): Germany, Slovakia and Slovenia. The asterisks ***, **, * indicate significance at the 1, 5, 10% level respectively.

Table 4: Descriptive statistics of the yield spreads per country

Countries	Mean	Median	Std. dev.	Min.	Max.
Austria (AUT)	0.315	0.270	0.269	0.000	1.490
Belgium (BEL)	0.478	0.330	0.481	0.030	2.970
Finland (FIN)	0.227	0.230	0.155	-0.050	0.800
France (FRA)	0.312	0.217	0.294	0.015	1.538
The Netherlands (NLD)	0.201	0.168	0.154	-0.021	0.693
Greece (GRC)	4.473	1.560	5.704	0.130	27.390
Ireland (IRL)	1.234	0.395	1.892	-0.180	8.810
Italy (ITA)	1.114	0.595	1.126	0.137	5.187
Portugal (PRT)	1.988	0.486	2.675	-0.004	12.029
Spain (ESP)	1.021	0.354	1.223	0.001	5.555
Denmark (DNK)	0.203	0.220	0.150	-0.230	0.520
Sweden (SWE)	0.241	0.220	0.257	-0.380	0.710
United Kingdom (UK)	0.707	0.694	0.408	-0.052	1.635
Czech Republic (CZE)	0.669	0.520	0.625	-0.270	2.490
Hungary (HUN)	3.831	3.550	1.295	1.670	8.630
Poland (POL)	2.681	2.645	1.088	0.960	7.040
Japan (JPN)	-1.879	-1.963	1.159	-3.849	0.205
Norway (NOR)	0.881	0.860	0.406	0.180	1.760
Switzerland (CHE)	-1.052	-1.168	0.400	-1.934	-0.080
United States (US)	0.671	0.535	0.690	-0.630	2.240

Notes: This table summarizes the descriptive statistics of the yield spreads per country, including the mean, median, standard deviation, minimum and maximum value. The ordering of the countries is in line with the groups shown in Table 1. The abbreviations of the countries have been added between the parentheses, because these will be used in various tables from now on.

Table 5: Correlation matrix of yield spreads per country

	AUT	BEL	FIN	FRA	NLD	GRC	IRL	ITA	PRT	ESP	DNK	SWE	UK	CZE	HUN	POL	JPN	NOR	CHE	US
AUT	1	0.911	0.864	0.861	0.888	0.695	0.748	0.774	0.758	0.719	-0.036	-0.251	-0.176	0.649	0.762	0.414	0.331	-0.041	0.262	-0.215
BEL	0.911	1	0.735	0.913	0.811	0.821	0.878	0.885	0.910	0.846	-0.208	-0.189	-0.110	0.511	0.691	0.376	0.392	-0.089	0.272	-0.167
FIN	0.864	0.735	1	0.703	0.895	0.502	0.564	0.602	0.548	0.553	0.256	-0.103	-0.132	0.581	0.644	0.417	0.292	0.182	0.299	-0.148
FRA	0.861	0.913	0.703	1	0.830	0.881	0.736	0.960	0.920	0.909	-0.295	-0.063	0.105	0.403	0.611	0.320	0.631	0.039	0.536	0.084
NLD	0.888	0.811	0.895	0.830	1	0.640	0.671	0.767	0.692	0.733	0.036	-0.101	-0.014	0.535	0.675	0.338	0.437	0.072	0.428	-0.102
GRC	0.695	0.821	0.502	0.881	0.640	1	0.754	0.917	0.943	0.926	-0.426	-0.046	0.162	0.240	0.496	0.262	0.675	-0.014	0.516	0.165
IRL	0.748	0.878	0.564	0.736	0.671	0.754	1	0.744	0.839	0.776	-0.297	-0.208	-0.094	0.405	0.590	0.274	0.331	-0.199	0.173	-0.215
ITA	0.774	0.885	0.602	0.960	0.767	0.917	0.744	1	0.947	0.967	-0.400	-0.045	0.112	0.313	0.547	0.279	0.667	0.007	0.561	0.100
PRT	0.758	0.910	0.548	0.920	0.692	0.943	0.839	0.947	1	0.931	-0.414	-0.077	0.059	0.305	0.537	0.296	0.582	-0.055	0.433	0.050
ESP	0.719	0.846	0.553	0.909	0.733	0.926	0.776	0.967	0.931	1	-0.417	0.005	0.093	0.294	0.534	0.277	0.624	-0.001	0.506	0.067
DNK	-0.036	-0.208	0.256	-0.295	0.036	-0.426	-0.297	-0.400	-0.414	-0.417	1	0.200	-0.244	0.268	0.014	0.196	-0.397	0.279	-0.249	-0.118
SWE	-0.251	-0.189	-0.103	-0.063	-0.101	-0.046	-0.208	-0.045	-0.077	0.005	0.200	1	0.136	-0.229	-0.223	0.124	0.018	0.615	0.121	0.201
UK	-0.176	-0.110	-0.132	0.105	-0.014	0.162	-0.094	0.112	0.059	0.093	-0.244	0.136	1	-0.440	-0.136	-0.358	0.704	-0.052	0.616	0.655
CZE	0.649	0.511	0.581	0.403	0.535	0.240	0.405	0.313	0.305	0.294	0.268	-0.229	-0.440	1	0.612	0.736	-0.100	-0.010	-0.039	-0.264
HUN	0.762	0.691	0.644	0.611	0.675	0.496	0.590	0.547	0.537	0.534	0.014	-0.223	-0.136	0.612	1	0.277	0.180	-0.347	0.047	-0.260
POL	0.414	0.376	0.417	0.320	0.338	0.262	0.274	0.279	0.296	0.277	0.196	0.124	-0.358	0.736	0.277	1	-0.061	0.358	-0.006	-0.084
JPN	0.331	0.392	0.292	0.631	0.437	0.675	0.331	0.667	0.582	0.624	-0.397	0.018	0.704	-0.100	0.180	-0.061	1	0.047	0.888	0.628
NOR	-0.041	-0.089	0.182	0.039	0.072	-0.014	-0.199	0.007	-0.055	-0.001	0.279	0.615	-0.052	-0.010	-0.347	0.358	0.047	1	0.206	0.268
CHE	0.262	0.272	0.299	0.536	0.428	0.516	0.173	0.561	0.433	0.506	-0.249	0.121	0.616	-0.039	0.047	-0.006	0.888	0.206	1	0.615
US	-0.215	-0.167	-0.148	0.084	-0.102	0.165	-0.215	0.100	0.050	0.067	-0.118	0.201	0.655	-0.264	-0.260	-0.084	0.628	0.268	0.615	1

Notes: This table shows the correlations between the yield spread of the examined countries. The closer the correlation is to one, the more the corresponding spreads move linearly. For example, the correlation between the yields of the GIIPS countries is relatively high. A negative correlation means that when the yield spread of country A increases, the yield spread of country B decreases. The abbreviations of Table 4 are used instead of the full country names.

Appendix B. Tables of results

Table 6: Modelling EA sovereign spreads using dummy variables

Independents	PANEL I: $SPREAD2$		PANEL II: $SPREAD3$	
C	10.875***	8.647***	13.433***	9.727***
	(1.049)	(1.378)	(1.220)	(1.585)
D_1	1.476***	1.848***	1.991***	2.382***
	(0.349)	(0.374)	(0.406)	(0.430)
D_2	-1.333***	-1.661***	-1.248**	-1.742**
	(0.497)	(0.593)	(0.578)	(0.682)
$VSTOXX$	0.0144***	0.008	0.017***	0.010*
	(0.005)	(0.005)	(0.006)	(0.006)
INF	-0.341***	-0.078	-0.582***	-0.242***
	(0.058)	(0.059)	(0.067)	(0.067)
$(DEBT/GDP)_A$				
Greece	-10.556***		-10.644***	
	(1.318)		(1.532)	
Ireland	0.393		1.084***	
	(0.291)		(0.339)	
Italy	-8.356***		-13.272***	
	(2.637)		(3.065)	
Portugal	6.893***		7.213***	
	(0.780)		(0.906)	
Spain	4.914***		4.936***	
	(0.648)		(0.754)	
$(DEBT/GDP)_B$				
Greece		-0.055***		-0.048***
		(0.009)		(0.010)
Ireland		0.018***		0.035***
		(0.004)		(0.005)
Italy		-0.102***		-0.125 ***
		(0.034)		(0.039)
Portugal		0.086***		0.091***
		(0.010)		(0.011)
Spain		0.075***		0.072***
		(0.013)		(0.015)
R^2	0.882	0.867	0.916	0.907
Adjusted R^2	0.877	0.861	0.912	0.903

Notes: The regression models are estimated over the time period 2000.03-2017.12 (N=214). The dummy variables D_1 and D_2 correspond to October 2010 to July 2012 and from August 2012 on wards, respectively. Panel I reports on the standard deviation between sovereign spreads of the EA and Panel II on the absolute distance between the average sovereign spread of the GIIPS and the other EA countries (Austria, Belgium, Finland, France and the Netherlands). Numbers between the parentheses denote the standard errors of the concerning coefficient. The asterisks ***,**,* indicate significance at the 1, 5, 10% level respectively.

Table 7: Modelling the time-varying effect of risk factors on sovereign spreads of EA countries

	GRC	IRL	ITA	PRT	ESP	AUT	BEL	FIN	FRA	NLD
Constant	7.396***	1.156***	6.565***	5.482***	3.034***	1.095***	2.863***	1.574***	2.109***	1.175***
	(0.996)	(0.227)	(0.311)	(0.242)	(0.206)	(0.14)	(0.267)	(0.221)	(0.112)	(0.090)
$VSTOXX$	-0.002	0.001	0.008	0.013**	0.001	0.004***	0.003	0.004***	0.002	0.004***
	(-0.020)	(0.006)	(0.006)	(0.005)	(0.004)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)
$D_1VSTOXX$	0.020	0.018*	0.012	-0.020**	0.013	0.006**	0.013***	0.008***	0.006**	0.000
	(0.039)	(0.011)	(-0.010)	(0.010)	(0.008)	(0.003)	(0.004)	(0.002)	(0.003)	(0.002)
$D_2VSTOXX$	0.176***	-0.013	0.065***	0.054***	0.027*	0.004	0.033***	0.005	0.000	0.005*
	(0.056)	(0.015)	(0.017)	(0.017)	(0.015)	(0.005)	(0.007)	(0.003)	(0.005)	(0.003)
$INDEX2$	-0.491***	-0.079***	-0.529***	-0.338***	-0.215***	-0.074***	-0.236***	-0.100***	-0.137***	-0.074***
	(0.074)	(0.015)	(0.027)	(0.016)	(0.013)	(-0.010)	(0.023)	(0.014)	(0.009)	(0.006)
$D_1INDEX2$	-0.173*	0.103***	0.005	-0.035*	0.028	-0.002	0.025**	-0.003	0.002	-0.011***
	(0.092)	(0.035)	(0.047)	(0.02)	(0.022)	(0.005)	(0.011)	(0.005)	(0.007)	(0.004)
$D_2INDEX2$	0.494***	0.395***	-0.044	0.102***	0.057*	0.010	0.002	-0.001	-0.004	0.002
	(0.146)	(0.033)	(0.038)	(0.031)	(0.03)	(0.009)	(0.014)	(0.006)	(0.009)	(0.005)
BAS	19.801***	22.693***	57.894***	18.335***	56.244***	8.586***	29.848***	3.082	8.280**	8.678***
	(1.744)	(1.994)	(9.249)	(0.874)	(4.054)	(2.015)	(4.035)	(1.939)	(3.665)	(2.883)
D_1BAS	294.946***	-123.380***	-19.147	58.123***	-56.545*	0.650	-48.630***	-4.135	-13.908	31.929***
	(81.503)	(-45.260)	(40.509)	(8.717)	(32.182)	(2.436)	(9.381)	(5.715)	(15.133)	(6.825)
D_2BAS	-17.604***	-16.143***	-7.944	-11.135***	-24.973***	3.453	-10.220**	4.636	41.325***	1.298
	(-1.750)	(2.115)	(12.577)	(0.943)	(5.872)	(2.583)	(4.901)	(3.838)	(6.445)	(5.524)
R^2	0.887	0.923	0.816	0.965	0.877	0.776	0.856	0.606	0.808	0.711
Adjusted R^2	0.882	0.919	0.807	0.964	0.872	0.767	0.850	0.589	0.800	0.698
Observations	214	214	214	214	214	214	214	214	214	214

Notes: This table provides the results from the OLS regression as outlined in equation (5). The regression models are estimated over the time period 2000.03-2017.12 (N=214). The dummy variables D_1 and D_2 correspond to October 2010 to July 2012 and from August 2012 on wards, respectively. The ordering of the countries is in line with the groups shown in Table 1. The low-rated EA countries are displayed on the left side and the high rated ones on the right side. Numbers between the parentheses denote the standard errors of the concerning coefficient. The asterisks ***, **, * indicate significance at the 1%, 5%, 10% level respectively. These notes also apply to Table 8.

Table 8: Modelling the time-varying effect of risk factors and country fundamentals on sovereign spreads of EA countries

	GRC	IRL	ITA	PRT	ESP	AUT	BEL	FIN	FRA	NLD
Constant	3.316**	-0.145	-3.108***	3.961***	0.972	-0.701***	-2.415***	0.645**	-4.971***	-1.359***
	(1.360)	(0.618)	(0.971)	(0.963)	(0.626)	(0.172)	(0.379)	(0.291)	(0.429)	(0.212)
$VSTOXX$	0.007	-0.003	0.005	-0.002	-0.001	0.000	-0.003*	0.003***	0.005***	-0.001
	(0.012)	(0.004)	(0.005)	(0.005)	(0.003)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)
$D_1VSTOXX$	0.020	0.038***	0.007	0.002	0.010	0.008***	0.007	0.006***	-0.003	0.002
	(0.022)	(0.009)	(0.009)	(0.010)	(0.007)	(0.002)	(0.005)	(0.002)	(0.003)	(0.002)
$D_2VSTOXX$	0.001	-0.028	0.053***	0.028	0.015	0.009**	0.047***	0.002	0.007**	0.007**
	(0.048)	(0.025)	(0.020)	(0.019)	(0.015)	(0.004)	(0.008)	(0.003)	(0.004)	(0.003)
BAS	19.507***	14.631***	60.953***	17.213***	26.426***	4.157***	9.224**	3.127*	7.319***	1.047
	(1.096)	(1.620)	(7.796)	(0.866)	(3.517)	(1.514)	(4.167)	(1.682)	(2.505)	(2.351)
D_1BAS	38.549	51.378	-39.037	12.745	-31.422	0.187	-22.253**	-3.539	-7.374	-5.302
	(70.091)	(36.035)	(36.563)	(13.948)	(19.277)	(2.502)	(9.494)	(5.140)	(10.854)	(10.176)
D_2BAS	-19.528***	-6.468***	-28.647**	-11.958***	-17.201***	4.914**	3.425	-0.652	25.499**	-5.896
	(1.118)	(2.351)	(12.639)	(0.956)	(6.506)	(1.947)	(4.997)	(4.772)	(10.106)	(6.999)
ΔGDP	0.093	-0.023	-1.109***	-0.080	-1.532***	-0.080	-0.334***	-0.070**	-0.156*	-0.116***
	(0.255)	(0.028)	(0.234)	(0.168)	(0.334)	(0.062)	(0.112)	(0.028)	(0.082)	(0.044)
$D_1\Delta GDP$	-0.802*	0.108	0.660*	-0.764*	-0.357	-0.109	-0.135	0.034	-0.122	0.182**
	(0.432)	(0.135)	(0.343)	(0.395)	(0.627)	(0.082)	(0.206)	(0.041)	(0.164)	(0.071)
$D_2\Delta GDP$	1.568	0.278	-0.974	1.902	5.421**	-0.303**	-1.891***	-0.022	-0.262	0.119
	(1.113)	(0.479)	(1.266)	(1.240)	(2.491)	(0.138)	(0.706)	(0.119)	(0.327)	(0.144)
GDP/CAP	0.000**	-0.000*	0.000***	-0.000***	0.000***	0.000	0.000***	-0.000***	0.000***	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
D_1GDP/CAP	-0.002***	0.000	-0.000**	-0.000***	-0.000***	0.000	0.000	0.000	0.000*	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
D_2GDP/CAP	-0.003***	0.000	0.000	-0.001	-0.001	0.001***	-0.011***	0.000***	-0.000***	-0.000**
	(0.001)	(0.000)	(0.000)	(0.001)	(0.001)	(0.000)	(0.004)	(0.000)	(0.000)	(0.000)

Table 8 continued from previous page

	GRC	IRL	ITA	PRT	ESP	AUT	BEL	FIN	FRA	NLD
$GINV/GDP$	-0.246***	-0.001	0.019	-0.109***	-0.075**	-0.012	0.215***	0.009	0.195***	0.045***
	(0.032)	(0.024)	(0.036)	(0.034)	(0.033)	(0.012)	(0.043)	(0.010)	(0.019)	(0.011)
D_1GINV/GDP	2.081***	-0.074	-0.262**	0.226***	0.004	-0.197	0.009	0.064	-0.053	0.010
	(0.759)	(0.057)	(0.131)	(0.068)	(0.057)	(0.274)	(0.195)	(0.043)	(0.070)	(0.043)
D_2GINV/GDP	1.973***	0.178	-0.467	0.736	0.242	0.313	-7.934***	-0.441**	0.778***	-0.138
	(0.387)	(0.147)	(0.690)	(2.982)	(0.244)	(0.270)	(2.828)	(0.181)	(0.287)	(0.117)
HUR	0.513***	0.106**	0.610***	0.051**	0.090***	-0.170***	-0.027	-0.130***	-0.019	-0.037***
	(0.102)	(0.046)	(0.069)	(0.021)	(0.020)	(0.019)	(0.026)	(0.026)	(0.024)	(0.009)
D_1HUR	0.693	-0.127	-1.051***	-0.243	-0.323***	0.034	-0.008	0.014	0.040	-0.397***
	(0.608)	(0.086)	(0.325)	(0.405)	(0.094)	(0.052)	(0.116)	(0.067)	(0.128)	(0.072)
D_2HUR	0.112	-0.431	-0.410	0.347	0.184	0.620***	-0.326*	-0.503**	0.192	-0.011
	(0.251)	(0.384)	(0.440)	(0.329)	(0.361)	(0.120)	(0.188)	(0.208)	(0.537)	(0.163)
$GDEBT/GDP$	-0.048**	0.004	-0.074***	0.042***	-0.019***	0.023***	0.001	0.024***	0.019***	0.016***
	(0.023)	(0.004)	(0.018)	(0.004)	(0.005)	(0.003)	(0.004)	(0.003)	(0.003)	(0.001)
D_1GDEBT/GDP	0.112	0.043*	0.150***	0.095	0.182***	-0.021***	-0.016	-0.033***	-0.020	0.018**
	(0.094)	(0.022)	(0.037)	(0.066)	(0.039)	(0.008)	(0.017)	(0.008)	(0.014)	(0.009)
D_2GDEBT/GDP	0.380***	0.030	0.228*	0.097***	0.188**	-0.376***	-0.141***	-0.014	-0.057	0.095***
	(0.072)	(0.037)	(0.136)	(0.028)	(0.092)	(0.092)	(0.050)	(0.022)	(0.051)	(0.032)
$GDEF/GDP$	0.149***	-0.019	-0.012	0.089**	-0.119***	-0.030***	0.007	0.015*	0.109***	0.024**
	(0.051)	(0.028)	(0.062)	(0.039)	(0.042)	(0.008)	(0.018)	(0.008)	(0.014)	(0.010)
D_1GDEF/GDP	1.876**	0.012	-0.357*	0.104	0.079	-0.137	-0.034	-0.046***	-0.070	-0.028
	(0.817)	(0.035)	(0.215)	(0.076)	(0.054)	(0.109)	(0.043)	(0.016)	(0.043)	(0.022)
D_2GDEF/GDP	0.760	-0.067	-0.162	0.759	-0.274	-0.517***	-134.957***	-0.350***	0.662***	-0.086
	(1.807)	(0.076)	(0.731)	(5.234)	(1.450)	(0.144)	(46.318)	(0.124)	(0.209)	(0.202)
R^2	0.974	0.972	0.907	0.983	0.966	0.921	0.924	0.833	0.922	0.878
Adjusted R^2	0.971	0.968	0.895	0.981	0.962	0.911	0.915	0.812	0.912	0.863

Table 9: Modelling the time-varying effect of risk factors on sovereign spreads of the control countries

	DNK	SWE	UK	CZE	HUN	POL	JPN	NOR	CHE	US
Constant	0.436	-0.209	4.250***	-1.194	11.941***	-3.828**	2.529***	-2.875***	0.293	5.999***
	(0.322)	(0.619)	(0.464)	(1.261)	(1.641)	(1.530)	(0.378)	(0.294)	(0.329)	(0.346)
$VSTOXX$	0.008***	0.010***	-0.016***	-0.007	0.000	-0.024***	-0.060***	0.010***	-0.010***	-0.020***
	(0.001)	(0.003)	(0.003)	(0.006)	(0.007)	(0.008)	(0.008)	(0.003)	(0.002)	(0.004)
$D_1VSTOXX$	-0.002	-0.020***	0.014**	0.019***	0.049***	0.030**	0.071***	-0.008	0.012***	0.006
	(0.002)	(0.004)	(0.006)	(0.011)	(0.014)	(0.015)	(0.016)	(0.005)	(0.003)	(0.007)
$D_2VSTOXX$	-0.001	-0.019***	0.015	0.026	0.046**	0.063***	0.085**	-0.017*	0.028***	0.019
	(0.004)	(0.007)	(0.010)	(0.018)	(0.022)	(0.024)	(0.035)	(0.009)	(0.006)	(0.014)
$INDEX2$	-0.026	0.011	-0.202***	0.096	-0.491***	0.332***	-0.142***	0.223***	-0.103***	-0.312***
	(0.021)	(0.039)	(0.035)	(0.069)	(0.090)	(0.088)	(0.023)	(0.022)	(0.021)	(0.021)
$D_1INDEX2$	-0.009	0.028**	-0.015	-0.110***	-0.230***	-0.072**	-0.195	0.043***	0.023	-0.109***
	(0.008)	(0.016)	(0.015)	(0.044)	(0.032)	(0.041)	(0.490)	(0.016)	(0.026)	(0.036)
$D_2INDEX2$	-0.003	0.035***	-0.068**	0.002	-0.149***	0.029	-0.277	0.041**	0.003	-0.140***
	(0.007)	(0.013)	(0.033)	(0.030)	(0.046)	(0.051)	(0.189)	(0.017)	(0.013)	(0.026)
BAS	-1.280**	6.397	8.124	3.638	-0.16	42.027***	-94.215***	10.915***	16.464***	-64.177***
	(0.596)	(3.944)	(9.471)	(2.882)	(2.320)	(3.123)	(16.509)	(0.975)	(1.039)	(13.090)
D_1BAS	18.153*	-15.918	3.016	130.984***	64.431***	-6.189	21.052	-18.93	-37.142	107.905
	(10.552)	(16.746)	(24.901)	(51.764)	(14.549)	(21.687)	(256.745)	(15.307)	(26.279)	(73.566)
D_2BAS	-2.589*	-15.104**	90.422	-0.883	16.785***	-51.542***	47.906	-9.756***	-24.766***	48.222**
	(1.459)	(7.143)	(70.744)	(4.828)	(3.546)	(16.615)	(65.475)	(2.649)	(3.411)	(19.254)
R^2	0.369	0.378	0.482	0.271	0.741	0.564	0.441	0.657	0.780	0.763
Adjusted R^2	0.342	0.351	0.460	0.239	0.729	0.543	0.416	0.642	0.770	0.753
Observations	214	214	214	214	214	204	214	214	214	214

Notes: This table provides the results from the OLS regression as outlined in equation (5). The regression models are estimated over the time period 2000.03-2017.12 (N=214), except for Poland (N=204). Their yield was only available from January 2001, resulting in a loss of ten observations. The dummy variables D_1 and D_2 correspond to October 2010 to July 2012 and from August 2012 on wards, respectively. The ordering of the countries is in line with the groups shown in Table 1. Grouping is done accordingly: on the left the high rated EMU control countries, in the middle the low rated EMU control countries and on the right the non-EMU control countries. Numbers between the parentheses denote the standard errors of the concerning coefficient. The asterisks ***, **, * indicate significance at the 1%, 5%, 10% level respectively. These notes also apply to Table 10.

Table 10: Modelling the time-varying effect of risk factors and country fundamentals on sovereign spreads of the control countries

	DNK	SWE	UK	CZE	HUN	POL	JPN	NOR	CHE	US
Constant	-1.038***	-4.609***	-0.058	-2.969***	2.639***	-4.378***	-1.130	6.803***	-4.612***	3.738***
	(0.143)	(0.898)	(0.449)	(1.017)	(0.867)	(1.182)	(1.224)	(0.752)	(1.237)	(0.717)
$VSTOXX$	0.002*	0.001	-0.008***	-0.004	-0.008	-0.001	0.004	0.008***	-0.011***	-0.009***
	(0.001)	(0.002)	(0.002)	(0.005)	(0.007)	(0.007)	(0.004)	(0.002)	(0.003)	(0.002)
$D_1VSTOXX$	0.001	-0.010**	0.012**	0.019*	0.013	0.009	0.011*	-0.012***	0.010*	0.013**
	(0.003)	(0.005)	(0.006)	(0.011)	(0.018)	(0.012)	(0.006)	(0.004)	(0.005)	(0.006)
$D_2VSTOXX$	-0.004	-0.006	0.020*	0.005	0.097***	0.029	0.033**	-0.010	0.027***	0.006
	(0.007)	(0.005)	(0.011)	(0.024)	(0.023)	(0.022)	(0.014)	(0.008)	(0.009)	(0.009)
BAS	-1.522	-10.053***	4.849	13.229***	6.626**	46.971***	-19.616**	-14.794***	2.551	-2.885
	(0.934)	(3.002)	(7.080)	(2.355)	(2.839)	(2.348)	(8.853)	(1.969)	(2.352)	(7.219)
D_1BAS	10.020	47.850**	-6.409	17.921	37.552**	-56.214***	-643.993***	16.523	-28.601	56.101
	(10.141)	(19.566)	(18.624)	(39.546)	(18.149)	(17.969)	(175.96)	(12.263)	(33.132)	(44.515)
D_2BAS	-1.365	13.836*	8.975	-9.177	8.386	-27.369	5.360	24.645***	-7.549	5.285
	(1.845)	(7.649)	(63.164)	(8.373)	(5.441)	(23.443)	(44.742)	(8.21)	(6.428)	(12.228)
ΔGDP	-0.021	-0.043	0.268	-0.408**	0.351	-0.510***	0.309***	0.052	0.191	0.256**
	(0.029)	(0.064)	(0.215)	(0.200)	(0.279)	(0.140)	(0.104)	(0.044)	(0.148)	(0.101)
$D_1\Delta GDP$	-0.067	-0.028	-0.288	0.558	-0.717	0.373	-0.308**	-0.069	-0.238	0.283
	(0.093)	(0.117)	(0.287)	(0.385)	(0.437)	(0.340)	(0.140)	(0.097)	(0.236)	(0.245)
$D_2\Delta GDP$	-0.107	0.280*	-0.374	1.071	-0.611	-0.779	-0.481**	-0.130	0.243	-0.818*
	(0.109)	(0.168)	(0.556)	(1.601)	(0.786)	(1.618)	(0.223)	(0.132)	(0.493)	(0.416)
GDP/CAP	0.000***	0.000***	0.000***	0.000***	0.000	0.000***	-0.000***	0.000***	0.000***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
D_1GDP/CAP	0.000*	0.000	0.000	-0.000	-0.000***	0.000	0.000**	0.000*	0.000	-0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
D_2GDP/CAP	-0.000	0.000	0.000	-0.000	-0.001**	0.000	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)

Table 10 continued from previous page

	DNK	SWE	UK	CZE	HUN	POL	JPN	NOR	CHE	US
$GINV/GDP$	-0.038***	0.126***	-0.040**	-0.045***	-0.098***	-0.085***	-0.112***	-0.128***	0.200***	-0.245***
	(0.012)	(0.033)	(0.016)	(0.011)	(0.025)	(0.022)	(0.033)	(0.030)	(0.058)	(0.042)
D_1GINV/GDP	-0.059	0.013	-0.201	0.087	-0.140	-0.005	0.446***	-0.772**	-0.446	0.888***
	(0.038)	(0.066)	(0.239)	(0.123)	(0.103)	(0.160)	(0.168)	(0.312)	(0.699)	(0.293)
D_2GINV/GDP	0.155	0.021	0.063	0.205	0.815	0.184	0.541**	-0.020	-1.447	-0.406
	(0.216)	(0.200)	(0.084)	(0.276)	(0.689)	(0.195)	(0.247)	(0.095)	(0.939)	(0.499)
HUR	-0.104***	-0.092***	-0.167***	0.469***	0.081	0.074*	-0.371***	-0.322***	-0.061	-0.196***
	(0.019)	(0.020)	(0.034)	(0.070)	(0.079)	(0.041)	(0.108)	(0.034)	(0.058)	(0.037)
D_1HUR	0.189***	0.115*	-0.059	-0.344**	-0.840***	-0.251	0.601**	0.599***	-0.360	0.197**
	(0.060)	(0.059)	(0.122)	(0.172)	(0.244)	(0.277)	(0.274)	(0.163)	(0.558)	(0.092)
D_2HUR	0.418**	0.207	-0.003	-1.421	0.900	0.811	0.510	0.213	-0.068	-0.007
	(0.222)	(0.180)	(0.406)	(0.902)	(1.457)	(1.202)	(0.716)	(0.461)	(0.403)	(0.327)
$GDEBT/GDP$	0.027***	0.042***	0.001	-0.106***	0.017	0.093***	0.040***	-0.036***	0.002	0.011***
	(0.003)	(0.006)	(0.003)	(0.015)	(0.025)	(0.015)	(0.004)	(0.003)	(0.012)	(0.003)
D_1GDEBT/GDP	-0.035**	-0.038*	0.025**	0.073	0.301***	0.062	-0.039**	0.059***	0.060	0.022**
	(0.015)	(0.020)	(0.011)	(0.061)	(0.064)	(0.082)	(0.016)	(0.023)	(0.040)	(0.011)
D_2GDEBT/GDP	0.003	-0.019	-0.046	0.319**	-0.154	-0.219	0.003	0.067***	0.590	-0.007
	(0.036)	(0.080)	(0.060)	(0.142)	(0.133)	(0.595)	(0.043)	(0.025)	(0.472)	(0.073)
$GDEF/GDP$	-0.011	-0.072***	-0.105***	-0.051	0.011	0.149	0.080***	-0.142***	0.021	-0.005
	(0.007)	(0.017)	(0.016)	(0.034)	(0.030)	(0.092)	(0.028)	(0.015)	(0.033)	(0.016)
D_1GDEF/GDP	-0.018	0.126	-0.118	-0.115	0.887**	-0.266**	-0.020	-0.350*	-0.672	0.511***
	(0.018)	(0.078)	(0.256)	(0.199)	(0.412)	(0.132)	(0.089)	(0.196)	(1.238)	(0.179)
D_2GDEF/GDP	0.198	0.147	0.048	-0.130	-0.228	-0.051	1.122***	-0.149	0.186	-0.904
	(0.262)	(0.103)	(0.092)	(0.340)	(0.671)	(0.828)	(0.236)	(0.150)	(0.581)	(0.697)
R^2	0.621	0.781	0.773	0.721	0.833	0.841	0.964	0.859	0.827	0.946
Adjusted R^2	0.573	0.753	0.744	0.685	0.812	0.820	0.959	0.841	0.804	0.940

Table 11: Modelling the effect of the ECB's public sector purchase programme (PSPP) on sovereign spreads of EA countries

	IRL	ITA	PRT	ESP	AUT	BEL	FIN	FRA	NLD
Constant	1.667***	6.043**	15.861***	0.675	0.737	2.212**	4.265***	6.467**	1.146
	(0.502)	(2.967)	(2.451)	(0.998)	(1.347)	(1.019)	(1.29)	(3.083)	(1.105)
VSTOXX	0.007	0.003	0.039	0.021***	0.012***	0.015***	0.006**	0.004	0.003
	(0.006)	(0.007)	(0.024)	(0.005)	(0.003)	(0.004)	(0.003)	(0.004)	(0.002)
INDEX2	-0.087*	-0.596**	-1.198*	-0.101	-0.086	-0.306***	-0.296***	-0.482**	-0.054
	(0.044)	(0.231)	(0.208)	(0.084)	(0.084)	(0.084)	(0.094)	(0.211)	(0.067)
BAS	-5.275	24.857***	14.466***	9.021***	2.421	12.560***	-2.192	25.814***	6.029
	(3.652)	(8.206)	(8.023)	(2.647)	(2.434)	(4.140)	(2.721)	(8.519)	(3.764)
ECB	-21.718***	6.307	-86.446***	8.635*	27.505*	33.684***	7.749	5.723**	-5.333
	(9.194)	(5.826)	(24.531)	(4.625)	(14.169)	(11.851)	(7.890)	(2.458)	(4.691)
R^2	0.390	0.769	0.778	0.558	0.416	0.522	0.466	0.498	0.181
Adjusted R^2	0.303	0.737	0.748	0.497	0.335	0.456	0.392	0.429	0.069
Observations	33	34	34	34	34	34	34	34	34

Notes: This table provides the results from the OLS regression as outlined in equation (7). The regression models are estimated over the time period 2015.03-2017.12 (N=34), except for Ireland (N=33) since one outlier was excluded. The ordering of the countries is in line with the groups shown in Table 1. The low-rated EA countries are displayed on the left side and the high-rated ones on the right side. Greece is excluded, because the ECB did not purchase Greek sovereign bonds under the PSPP. Numbers between the parentheses denote the standard errors of the concerning coefficient. The asterisks ***, **, * indicate significance at the 1%, 5%, 10% level respectively.