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Sovereign Debt Haircuts

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Abstract

Our theoretical model shows impact of balance sheet structure on banks' (in)stability and possible bank run. We analyze and discuss different ways in which bank can generate necessary liquidity buffer in order to avoid solvency trap and the final default with undesired negative externalities.

In the empirical part we analyze stability of banks in EU, ECB's responses as well as sovereign stability. We present overview of liquidity, solvency and general stability improvements that took place over the last five years. Furthermore, we explore yield and its differential on ten years zero coupon sovereign bonds relative to Germany and the United States, as proxies for risk-free bonds. Our analysis, carried out on sample of twelve EU countries, the United States and Japan show that general risk aversion, liquidity risk and credit risk have strong impact on yield and its differential.

1 Introduction

The key drivers of haircuts[1] are default risk of assets submitted as collateral, liquidity of banks' assets and banks' solvency which, if inadequate, leads to bank's default and negative externalities that regulators tend to limit.

[1]Haircuts are defined as a percentage deducted from market value of an underlying assets. They are part of European Central Banks's collateral framework and risk control measures that aim to protect central bank and provide enough liquidity to financial system.

The complexity of eligible collateral and applied haircuts was highlighted during the recent financial and sovereign debt crisis when banks faced sudden shortage of liquidity and could choose between fire sales of assets and recourse to central bank's repo auctions. This means that bank's asset, that is eligible collateral at ECB's repo auctions, is the additional liquidity reserve that provides stability to financial system because recourse to central bank's repo auctions, unlike fire-sales, provides liquidity without losses. Bindseil (2013) shows, with strategic bank run game, that the optimal strategy for a bank is to use the least liquid eligible assets as collateral in central banks' repo auctions and fire sale the most liquid asset — in that way bank maximizes liquidity buffer at minimum cost.

Therefore, ECB's collateral framework as well as applied haircuts are monetary policy instruments that could be used to release additional liquidity during crisis periods. This mechanism was employed during recent financial crisis when ECB expanded range of assets eligible as collateral and provided additional liquidity that reduced further losses and prevented collapse of financial system. Currently, ECB uses credit ratings to classify debt issuers in two broad groups[2]. The first group consists of issuers with credit rating between AAA and A-, and the second group consists of issuers with credit rating between BBB+ and BBB-. Furthermore, ECB differs between marketable and non-marketable eligible assets. The marketable eligible assets is categorized in five liquidity categories and six groups according to their residual maturity. Accordingly, the lowest haircut, 0.5%, is applied on sovereign bonds with credit ratings between AAA and A-, residual maturity within one year and that are part of the first liquidity category, whereas the highest haircut, 44%, is applied on the marketable eligible asset within fourth liquidity category, with credit ratings between BBB+ and BBB-, and with residual maturity over 10 years[3].

[2]ECB relies on four sources of credit ratings. The first source consists of credit assessment institutions: DBRS, FitchRatings, Moody's and Standard & Poor's. The second source consists of national central bank's (NCB's) in-house credit assessments. The third source consists of counterparties' internal ratings-based systems. And the fourth source consists of third-party providers' rating tool.

[3]The first liquidity category consists of central government debt instruments and debt instruments issued by central banks. The fourth category consists of credit institution debt instruments (unsecured) and debt instruments issued by financial corporations other than credit institutions (unsecured). The fifth category consists of asset backed securities. The haircut applied on asset back securities differs only with respect to issuer's credit rating, i.e. 10% haircut is applied on asset backed securities with issuer's credit rating between AAA+ and A-, whereas 22% haircut is applied on asset backed securities with issuer's credit rating between BBB+ and BBB-.

The non-marketable eligible assets is also categorized in six groups according to their residual maturity, and two asset categories that are credit claims and non-marketable retail mortgage-backed debt (RMB debt). The lowest

Currently applied haircuts on sovereign debt (fixed and zero coupon bonds) issued by countries with the highest investment grade, which are mainly old EU members plus Czech Republic, Estonia, Slovakia and Slovenia, are between 0.5% and 10.5% whereas haircuts applied on sovereign debt with credit rating between BBB+ and BBB- are between 6% and 33%. This shows substantial difference in costs for obtaining required liquidity. That is important since sovereign bond yields are benchmark reference rates for setting other key interest rates in real economy.

The recent financial and sovereign debt crisis showed that currently applied haircuts do not fully capture sovereign default risk, i.e. they are not adjusted for difference in fiscal policies, financial stability, and overall economic productivity and output of EU countries. In particular, Spain, Portugal, Italy and Ireland struggled with repayments and new issuances, whereas Greece defaulted on its debt. However, prior to the crisis, these countries had high investment grade, their debt securities were classified as the most liquid ones, and the lowest haircut was applied.

Zettelmeyer, Trebesch, and Gulati (2013) provide overview of the recent restructuring of Greek debt and show that, on aggregate level, investors in Greek bonds lost 55 - 65% of their investments, whereas the country's debt relief was over 50% of 2012 GDP which is above average. Given this generosity and it's impact on European taxpayers, Nyborg (2011), in his brief comment, first brings up possibility to secure sovereign debt in the way that the potential loss is reduced to minimum, and second the author argues that haircuts applied on sovereign debt should also capture countries' indebtedness with aim to reduce sovereign "appetite for borrowing", i.e. default risk. Cruces and Trebesch (2013) show that in case of sovereign default, sovereign bonds lose, on average, 37% of its value, but the variation is large and can be bellow 23% as well as above 53%. Reinhart, Rogoff, and Savastano (2003) find that sovereign defaults take place mainly in the emerging markets and that strong impact on sovereign defaults have repayment history, level of indebtedness and historical macroeconomic stability. According to their overview, between EMU countries, only Portugal and Greece experienced an adverse credit event during the last thirty five years[4]. The authors also point

haircut is 10% and is applied on credit claims with fixed interest payment and a valuation based on a theoretical price assigned by the NCB, with issuer's credit rating between AAA and A-, and with residual maturity up to one year. The highest haircut is 65% and is applied on credit claims with fixed interest payments and a valuation according to outstanding amount assigned by the NCB, with issuer's credit rating between BBB+ and BBB- and with residual maturity over ten years. See ECB press release as of July 18, 2013.

[4]Other EU countries, that are not part of our analysis, but have experienced at least one adverse credit event, such as default, inflation above 40%, sovereign rating below investment grade, debt/GDP above 35%, are: Bulgaria,

out that political anchors such as, EU and EMU, can lead to greater sovereign creditworthiness and reduces default risk. However, their view can not be taken straight forward. In particular, ECB (2014) views the first seven and half years of EMU as period during which investors under priced sovereign credit risk for a number of EMU member countries, and once sovereign debt crisis took place, investors became far more risk averse and repriced sovereign debt risk.

The recent crisis also highlighted interconnection between financial systems and sovereign credit risk. In particular, when financial institutions were on the edge of default, governments bailed them out. The amounts pured into financial systems around Europe were substantial. Laeven and Valencia (2013) provide detailed information on the costs for different crisis over 1970-2011 period, and show that banking crisis in advanced economies resulted with median increase in debt of 23.6% of GDP and fiscal costs of 4.2% of GDP. Acharya, Drechsler, and Schnabl (2014), with credit default swaps (CDS), showed that bailouts of financial sector increased sovereign credit risk. However, the downside of their approach is that CDS might also capture market overreactions, due to, for example, strong negative news flow that took place. Furthermore, US Security and Exchange Commission's report, as of March 15, 2012, shows that the top 15 out of 937 CDS dealers stand for 87% of trading activity in 2011 which implies that CDS trades could be viewed as predominantly financial institutions' phenomenon. The situation might be similar in Europe. Habib and Rochet (2013) support our view. The authors compute a margin of safety as difference between country's maximum sustainable Debt/GDP and current Debt/GDP ratio and show that some countries experienced high increase in cost of debt even though their margin of safety is stable and far from being exhausted. That implies that intensive negative news flow can lead to market overreactions.

We start our analysis with theoretical model where we show impact of balance sheet structure and news flow, i.e. different events, on banks stability and possible bank run. We analyze different ways in which bank can generate necessary liquidity buffer in order to avoid iliquidity, insolvency and default with undesired negative externalities. We show importance and impact of liquidity parameters for asset fire sales and haircuts related to recourse to central bank's repo auction. The parameters capture liquidity of bank's balance sheet, and depending on market conditions, they can change. Furthermore, we analyze cases when liquidity parameters are positively and negatively

Croatia, Cyprus, Estonia, Hungary, Latvia, Poland, Romania, Slovakia plus Iceland.

correlated.

In empirical part we use sample of twelve EU countries plus the United States (US) and Japan to analyze yields, and its differential, on ten years zero coupon bonds relative to Germany and US, as proxies for risk-free bonds. Namely, the yield on zero coupon government bonds, and on sovereign bonds in general, are used as benchmark reference rates for determining other key interests rates in real economy. Therefore we focus on countries' fundamentals and sources of risk and uncertainty that have impact on yields and its differential. In particular, we analyze following risks: banks' stability and impact of banking crisis, ECB's perspective on stability of European financial system, sovereign stability and its fundamentals. We show that general risk aversion, liquidity risk, and credit risk have strong impact on sovereign bond yields and its differential relative to Germany and the United States.

Outline The remainder of this article is organized as follows. In Section 2 we present theoretical model which shows relationship between bank run and liquidity of bank's assets that is used to obtain necessary liquidity buffer and prevent possible default due to bank run. In Section 3 we analyze sovereign fundamentals, and sources of risks and uncertainty that lead to difference in sovereign bonds' yields and its differentials relative to Germany and the United States. The last, Section 4, concludes.

2 Theoretical model

2.1 Assets eligibility during liquidity crisis

Our model follows insights from Geanakoplos (2010) who shows impact of negative news flow and decrease in agents' optimism on value of assets and circumstances in which value of assets goes bellow its fundamental value. And Bindseil (2013) who shows impact of possible bank run on bank's liquidity position and different ways in which bank can generate required liquidity buffer. According to the author, the optimal way to generate the necessary liquidity buffer is to fire sales the most liquid asset and uses less liquid asset as collateral at central bank's repo auctions.

In Bindseil (2013) model balance sheet is set to unity. The total assets is denoted with $x = \sum_{i=0}^{n} x_i$

with $x_i \in [0,1]$, short-term deposits are $d \in [0,1]$, long-term deposits are $t \in [0,1]$ and equity is $e \in [0,1]$, also $e + t \in [0,1]$. Long-term depositors and equity holders provide stable funding for the bank, where as two short term depositors can choose to stay with the bank or to run. Bank's is assets is both, eligible collateral at repo auctions, and can be fire sold, but at different haircuts and fire sale discounts respectively.

Fire sale discounts and collateral haircuts functions are mapping from asset's unity interval $[0,1]$ to fire sales discount and haircuts unity interval $[0,1]$ respectively. Both functions are exponential and we have that:

$$\text{fire sale discount function: } d(x) = x^{\theta} \tag{1}$$

$$\text{haircut function: } h(x) = x^{\delta} \tag{2}$$

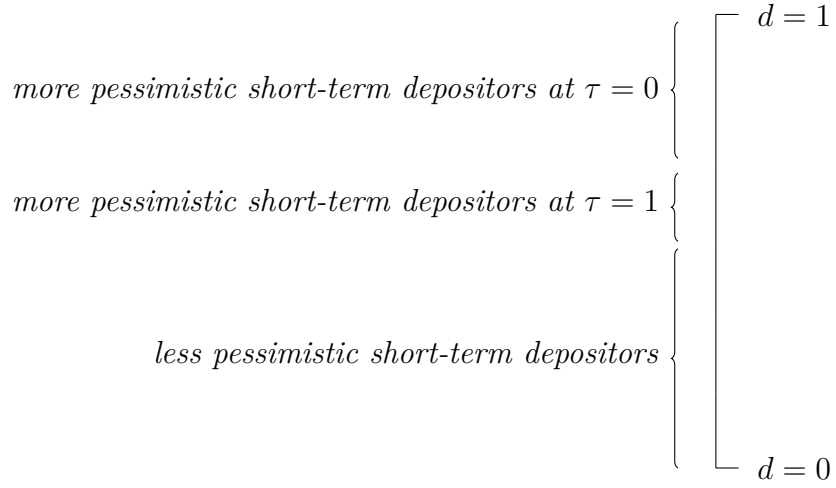
where $\delta, \theta \geq 0$ are liquidity parameters reflecting haircut and fire sales discount applied on bank's assets.

The model defines the Strict Nash No Run equilibrium according to which short-term depositors have the highest payoff when they stay with the bank. Furthermore, the Strict Nash No Run equilibrium is established if bank can obtain enough liquidity to pay out one short-term depositor who decides to run. In that case, the short-term depositor who decided to stay have higher payoff which is the condition for existence of the Strict Nash No Run equilibrium.

We expand the initial model and introduce three periods.

In the model, three elements affect bank's liquidity, first, it is probability of good/bad news flow, i.e. events, that reduces/increases uncertainty about bank's expected liquidity and solvency position. That, in turn, has an impact on short-term depositors' optimism and their decision to stay with the bank or run. Second, bank's ability to generate sufficient liquidity buffer in case of outflow of short-term deposits and third bank's equity size that needs to be sufficient to offset potential losses. The news flow is crucial for the stability of bank's short-term deposits. In particular, short-term depositors observe news flow in the first two periods and based on their observation, in the third period, they make decision whether to stay with the bank (S) or to run (R). Their decision to stay or to run has the major impact on bank's liquidity position. In particular, if they decide to run, the bank needs sufficient liquidity buffer in order to meet outflow of short-term deposits and remain liquid and solvent – otherwise default occurs.

Figure 1: Short-term depositors' heterogeneous beliefs about bank's liquidity and solvency



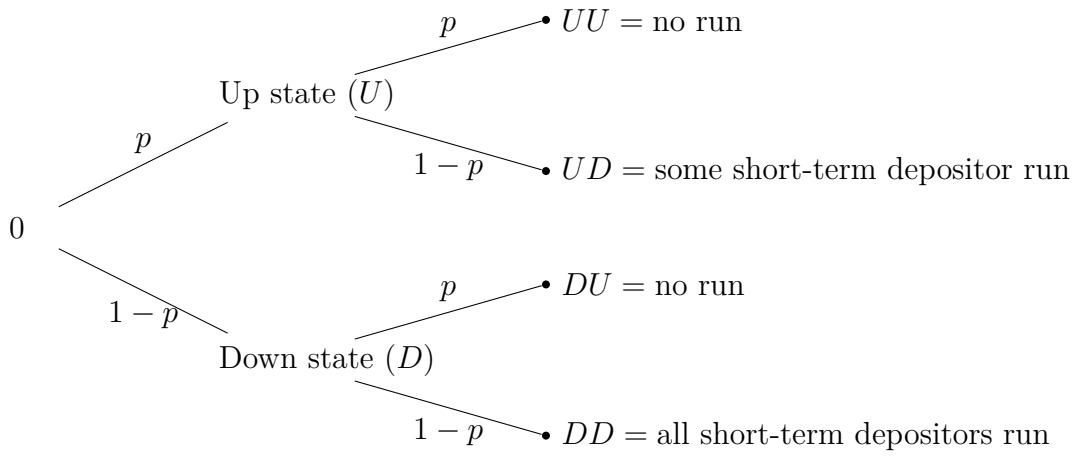
In order to prevent default, bank can obtain required liquidity in three ways: first fire sales of assets, which creates losses that are booked against equity, second participation in central bank's repo auctions for which bank needs eligible collateral, and, third, the bank can combine these two measures in order to generates necessary liquidity buffer and minimize fire sale losses.

However, in case of recourse to central bank's repo auctions, central bank decides which assets is eligible collateral. In particular, central bank has discretion to limit collateral eligibility, and to accept only certain types of liquid assets. In that way, during periods with stable market conditions, central bank creates liquidity buffer that can be released during liquidity crisis. The effectiveness of this monetary measures was visible during recent financial crisis, when unsecured interbank market fell apart, the reference interest rate reached zero bound and European Central Bank relaxed eligibility criteria and accepted wide range of assets. In this way banks generated sufficient liquidity buffer which enabled them to remain liquid and solvent.

In our model, we assume the continuum of short-term depositors, $d \in [0, 1]$ (figure 1) with heterogeneous believes about bank's stability. In particular, less risk averse short-term depositors stay with the bank, in spite of arrival of bad news and potential default risk that it indicates. These short-term depositors believe that probability of risk is lower than market expectations — they believe that market is overreacting. And therefore they do not move their deposits to another bank that incurs transaction cost ε.

The news arrives in the first two periods, $\tau = 0, 1$, and leads to two possible states at $\tau = 1$: up state U that occurs after the arrival of good news and down state D that occurs after the arrival of

Figure 2: Probabilities of outcomes and expected payoffs



bad news. Each of those two states have two successors at $\tau = 2$, which are again conditioned upon the arrival of good or bad news and are UU, UD and DU and DD. The decision whether short-term depositors stay with the bank or run depends on the observed news flow, in periods one and two, and discussion between them during which they exchange information about their believes and actions. Their actions, being correlated, lead to correlated Nash equilibrium which maximizes their payoffs in case of either bad or good news. The news flow, and short-term depositors' discussions result with several cases and expected payoffs.

When two good news follow each other (UU-state), the stability of the bank is confirmed and short-term depositors stay with the bank.

But if after good news in the first period, bad news arrives in the second period (UD-state), then some short-term depositor run and the bank is required to pay them out. If bank does not have sufficient liquidity buffer, the default occurs. However, if in the first period bad news arrives, but after that in the second period good news arrives (DU-state), short-term depositors remain with the bank and bank's stability is preserved. The good news in the second period showed that the default risk is not as high as bad news in previous period indicated.

Finally, in case when two bad news arrive (DD-state), when many things go wrong, then short-term depositors decide to run. The available liquidity buffer is shared between them and bank defaults. Therefore state space is defined as $S = \{0, \mathrm{U}, \mathrm{D}, \mathrm{UU}, \mathrm{UD}, \mathrm{DU}, \mathrm{DD}\}$.

The short-term depositors have different views on the occurrence of default, as presented in figure 2, and some are more and some are less optimistic. The occurrence of bad news (D-state) in the second

period increases volatility, jeopardizes short-term deposits and lowers the total expected payoff I. This holds for all short-term depositors. Furthermore, the difference in their optimism leads to more discussions, potential disagreements and consequently more uncertainty.

The bank uses deposits and invests in projects that yield return $R > 1$ at the end of the third period. And short-term depositors are concerned solely about their deposits and expected interest that bank's investments generate.

We denote shot-term depositors payoff in state s with r_s and i_s is the total payoff in state s that consists of short-term deposit and return r that bank's investment projects yield. This holds for all short-term depositors, $d \in \mathrm{D} = \{1, ..., \mathrm{N}\}$. Thus, their utility is expected sum of payoffs in period $\tau = 0, 1, 2$:

$$u^h(d_0, d_U, d_D, d_{UU}, d_{UD}, d_{DU}, d_{DD}) =$$

$$= I_0 + pI_U + (1-p)I_D + p^2 I_{UU} + p(1-p)I_{UD} + (1-p)pI_{DU} + (1-p)^2 I_{DD}$$

We define the payoffs of the banks investments that short-term depositor can expect by:

$I_{UU} = I_{DU} = I_{UD} > 1$, $r_{DD} = I \times 0.2$, and $r_0 = r_U = r_D = 0$.

Within this setup, the short-term depositors' optimism is strong because the news flow in the first and second period are independently and identically distributed – which means that even if bad news arrives in the first period, still arrival of good news in the second period leads to high payoff in the final period. And only two bad news leads to default. In that case, loss in fundamentals took place and bank defaults. The probability of loss in fundamentals is $(1-p)^2$ which is less than $(1-p)$.

In case of bad news flow, the bank needs to generate sufficient liquidity to payout short-term depositors who decide to run. Following Bindseil (2013) the required liquidity buffer which prevents bank run is generated with fire sales of the most liquid assets, denoted with z_t and by using less liquid assets, $1 - z_t$, as collateral at central bank repo auctions in the way that liquidity buffer need to be sufficient to pay out up to half short-term depositors:

$\delta/(\delta+1) + z_t^{\delta+1}/(\delta+1) - z_t^{\theta+1}/(\theta+1) > I/2$

and equity needs to be sufficient to absorb fire sales losses, that occur with probability $p(1-p)$,

$p(1-p) \times (z_t^{\theta+1}/(\theta+1)) < e.$

However, in case that in the first period good news arrives, then there is no danger of loss in fundamentals, i.e. that all depositors run and cause bank's default. In that situation central bank can decide to limit collateral eligibility of bank's assets and to accept only certain types of liquid asset. That measure creates liquidity buffer that can be released during liquidity crisis.
Lets assume that part of assets eligible as collateral at central bank's repo auctions is $w < 1$ and $w \in x_i = [0,1]$ and $0 < z_w < w$, then the total liquidity obtained with assets fire sale and recourse to central bank is:

$$w - \frac{w^{\delta+1}}{\delta+1} + \frac{z_w^{\delta+1}}{\delta+1} - \frac{z_w^{\theta+1}}{\theta+1} \tag{3}$$

whereas fire sales losses are:

$$\int_0^{z_w} x^\theta dx = \frac{z_w^{\theta+1}}{\theta+1} \tag{4}$$

The liquidity buffer than central bank created, by limiting asset eligibility of banks, and that can be used during liquidity crisis is:

$$\frac{z_t^{\delta+1}}{\delta+1} - \frac{z_t^{\theta+1}}{\theta+1} - \frac{z_w^{\delta+1}}{\delta+1} + \frac{z_w^{\theta+1}}{\theta+1} \tag{5}$$

The liquidity parameters, asset fire sale, recourse to central bank repo auctions, and eligibility of bank's assets as potential collateral have also implications on structure of bank's balance sheet.
For example, lets assume that $\delta = 0.5$, $\theta = 1$, $w = 0.25$, return on short-term deposits is zero ($r_d = 0$), return on long-term deposits is 3% ($r_d = 0.03$), and return on equity 12.4% ($r_e = 0.124$). The bank want to minimize average cost of it's liabilities and equity: $min\ 0 * r_d + 0.02 * d_t + 0.124 * r_e$ which is subject to maintaining the Strict Nash No Run equilibrium – meaning that the generated

liquidity buffer must be larger or equal to one short-term deposit ($\frac{\delta}{\delta+1} + \frac{z_w^{\delta+1}}{\delta+1} - \frac{z_w^{\theta+1}}{\theta+1} \geq \frac{1-t-e}{2}$) and assets fire sales losses must be less or equal to the equity($\frac{z_w^{\theta+1}}{\theta+1} \leq e$). The optimization calculus presented in Table 1, panel I, shows:

- the assets foreseen for fire sales remain at stable 0.15 level in spite of increase in collateral eligibility of banks' assets
- the total liquidity generated increases from 0.19 for $w = 0.25$ up to 0.36 when the total asset is accepted as eligible collateral at central bank's repo auctions. If the bank would rely solely on central bank's repo auctions then the total obtain liquidity would be $y_{cb} = \frac{\delta}{\delta+1} = \frac{0.5}{1.5} = 0.33$ which would be insufficient to cover short-term deposits, i.e. bank would need to reduce short-term funding due to potential liquidity risk. Therefore the combination of recourse to central bank's repo auctions and assets fire sales result with 0.026 higher liquidity buffer for the given cost function of bank's liabilities. It maximizes liquidity buffer as well as short-term funding whereas the average remuneration rate of liabilities drops from 1.9% to 0.9%.

In case of negative news flow, banks starts generating liquidity buffer already at time 1, while the liquidity parameters θ and δ are still unchanged. Thereafter, if bad news arrives in the final, third, period, θ drops, central bank reacts and increases δ in order to prevent default and offset illiquid interbank market[5].

3 Empirical tests, sources of risks and uncertainty

The yields on zero coupon government bonds, and on sovereign bonds in general, are used as benchmark reference rates for determining other key interests rates in real economy. In particular, sovereign bond yields transmit ECB's monetary policy to financial markets and real economy[6]. Therefore in this section we analyze determinants of yields and its differentials between EU countries. We focus on countries' fundamentals and sources of risk and uncertainty that lead to volatility and changes in risk premium. We first assess banks' stability and impact of banking crisis. Namely,

[5]Further expand the model. Develop cases with positive/negative correlation between liquidity parameters.

[6]For example, they are benchmark for determining lending rates to households, corporations, as well as corporate bonds yields.

banking crises can be described as situations in which significant financial distress occurs that often leads to policy interventions whose aim is to reduce financial losses and restore stability. When a crisis affects several banks and requires immediate government interventions, it can be characterized as systemic.

Over the past forty years we have experienced number of banking crisis out of which several were systemic, and consequently had strong impact on central bank policies. Hence, as the second source of risk and uncertainty, we analyze ECB's perspective on the stability of European financial system. Namely, ECB's policies and interventions are aimed to preserve stability and liquidity of financial system. And the severeness of the last crisis yielded a new set of regulations that target decrease in default risk by requiring increase of investments into high quality liquid assets, such as sovereign bonds. Therefore, the third factor with strong impact on yields and its differential is sovereign stability.

Sovereign bonds being the high quality liquid assets, favorable from regulatory perspective, are perceived as solid support of financial system and euro. However, the last crisis highlighted that large differences in productivity and development between EU countries and regions are still present. High indebtedness of some countries, difficulties to repay debt and increasing default risk resulted with increase in yields on government bonds as well as increase in yield differential among EU countries that enjoyed several years of stability due to positive incentive that joint currency and European Monetary Union brought.

However, the different stages of financial crisis revealed weaknesses of financial systems. Namely, the first stage of global financial instability started in August 2007 and during the following year financial tensions increased and culminated with collapse of Lehman Brothers on September 15, 2008. Financial markets got frozen and instead of characteristic bank run by depositors, we witnessed beak down of unsecured interbank market and banks' repo run. During that stage ECB released large quantities of liquidity in order to keep financial sector afloat and with those intervention it played a crucial role as lender of last resort. ECB also introduced number of non-standard temporary measures that led to improvements in financial markets conditions. But as some of the introduced measures phased out and government interventions increased, the financial crisis developed into sovereign debt crisis, which started in May 2010. The crisis raised questions about sustainability of euro as common currency, that further increased tensions, and required quick political initiative and determination for finding adequate, long term, solutions.

Therefore, in the subsequent sections we analyze stability of banks in EU, measures that ECB introduced during financial crisis, key indicators of macro economic stability of EU countries, as well as their yields and yields' differentials on zero-coupon government bonds.

In our overview we refer to Euro zone that has changing composition. Namely, in 1999 the following eleven countries were part of Euro zone: Austria, Belgium, Finland, France, Germany, Ireland, Italy, Luxembourg, Netherlands, Portugal and Spain. Greece joined in 2001, Slovenia in 2007, Cyprus and Malta in 2008, Slovakia in 2009, Estonia in 2011 and Latvia in 2014. The corresponding data that we use in our analysis refer to countries that are part of Euro zone at particular year presented in tables.

3.1 Overview of banks' stability

In order to restore stability and assess riskiness of banks loan and investment portfolios, a stress test is introduced in 2009. The created stress test consists of economic and financial adverse scenarios that banks in EU need to be able to withstand. For example, banks need to demonstrate their resilience to a global fire-sale in bond markets, increasing funding costs, a new recession with increase in unemployment, decrease in economic growth, as well as substantial drops in property and equity prices. The majority tested banks passed the test.

However, the stress test, also showed weaknesses. For example, during 2008 and 2009 Belgium, France and Luxembourg recapitalized Dexia with EUR 53.4 bn, provided EUR 135 bn in refinancing guarantees, as well as EUR 3.2 bn of impaired asset measures[7]. And in summer 2011 the bank passed stress test, but already in October 2011 and in 2012 it required further government intervention. Dexia, being former leader in public financing with large exposure to sovereigns, and long-dated loan portfolio, shown to be vulnerable for sovereign debt crisis. And once it took place, Dexia required further restructuring. Belgium and France provided EUR 5.5 bn in capital increase, and together with Luxembourg, refinancing guarantee of EUR 85 bn. But the stress test, carried out in 2011, did not show Dexia's vulnerability, on contrary it showed that the bank is stable.

Therefore we use consolidated balance sheet of credit institutions to analyze improvements between financial systems in EU.

Table 6 contains overview of development in number of banks (credit institutions), their total asset

[7]Sources: European Commission and Dexia's web pages.

and fiscal costs related to the financial crisis that started in 2008.

We find that within our sample, only Finland did not experience the crisis, whereas all other countries were exposed to it to a higher or lower degree[8]. The financial crisis was the most severe in Ireland, where fiscal support to banks came up to 40% of GDP. In the total amount, the Netherlands had the highest fiscal expenditure, over EUR 75 mil. Overall, the total fiscal cost for countries in our sample is about EUR 360 mil., whereas for EU it goes up to EUR 537 mil. over 1970 – 2011 period.

The consequences of the crisis are also visible in banks' total assets that declined substantially across EU. As expected, the decline in total assets, over period 2008-2012, is highest in Ireland and Luxembourg 38% and 27% respectively. The impact on banks in Germany was also strong, value of their assets went down 24%. The countries that were widely discussed in news, and struggled with new bond issuances, Portugal and Spain, maintained relatively stable asset over the crisis and post crisis period. And it was the same in Italy[9].

The selected items of consolidated balance sheet for banking sector in EU, presented in Table 7, show that the largest changes on the assets side are the increase of banks' exposure to debt instruments which, in 2012, fluctuate, in general, between 10% and 20%. Banks in Ireland and Italy, over period 2008-2012, almost doubled their exposure and it reached 18% and 16% of the total assets respectively. Only German banks kept their investment in debt instruments stable, around 17% of the total assets. The largest decrease took place in Netherlands where banks reduced their exposure to debt instrument by 15%, and in 2012, it stood at 10% of the total assets. Gennaioli, Martin, and Rossi (2013) analyzes banks assets and shows that banks on average hold a significant share of their assets in government bonds and that these holdings may crowd out loans during sovereign debt crises.

During the same period, the highest decrease in loans and advances is recorded in Finland, where loans went down from 62% to 40% of the total assets. Other countries that experienced sharp drop in loans are Ireland, Greece, Spain and Italy which is expected given the large restructuring costs that in Ireland exceeded 40% of GDP. According to the reported consolidated balance sheet, loans

[8]The we use Laeven and Valencia (2013) database is the source for financial costs incurred during the crisis. The databases cover 1970 – 2011 period

[9]This supports research regarding impact of news on financial markets, Brenner, Pasquariello, and Subrahmanyam (2009), Arezki, Candelon, and Sy (2011), Scharfstein and Stein (1990), Bikhchandani and Sharma (2001).

and advances are the most stable in Germany, Austria, Netherlands and Luxembourg.

On the liabilities side, between banks' funding sources, we find large changes. In particular, total deposits from credit institutions recorded sharp decrease, and the largest decrease, 44%, took place in Belgium and Greece. In Belgium it went down from 20% to 11% and in Greece from 13% to 7% of the total assets. The only two countries in our sample that increased deposits from credit institutions are Finland, where deposits from credit institutions doubled and reached 24.3% of the total assets in 2012 and Italy, where increase over 2008 – 2012 period recorded 28% and the deposits from credit institutions reached 14% of the total assets.

The banks' funding sources deposits (other than from credit institutions) showed different development. The largest increase in this type of funding, over 2008 – 2012 period, is recorded in Germany and France where it went up 39% and 31% respectively, and in 2012 it reached 39% of the total assets in Germany and 38% in France. This source of financing is the lowest in Ireland (24% of the total assets) and highest in Portugal (51% of the total assets). Overall, the largest decrease in total deposits (other than from credit institutions) took place in Greece, where over 2008 – 2012 period it declined by 18% and in 2012 reached 48% of the total assets, which is still high compared to the other countries and almost as high as in Portugal.

The deposits (other than from credit institutions) seems to be the most stable funding source in Spain, Italy and the Netherlands, with fluctuations being ±2-3% over 2008 – 2012 period. That shows that financial turbulences did not have large impact on the deposits, that remained stable within 40% – 48% range of the total assets.

Financing with debt certificates seems to be the most popular in Netherlands. During 2008 – 2012 period, this type of financing increased over six times — starting from the low level of only 3.6% in 2008, it reached 26.3% of the total assets in 2012. In almost all other countries it declined, especially in Greece, where it went down from 11% to 4% of the total assets – that is clear effect of difficulties that country was exposed to. Portugal and Spain, countries that also experienced financial crisis on both banks and sovereign level, had less sharp decline in debt certificates. It went down from 19% – 20% and stabilized around 12% – 13% of the total assets respectively.

The equity financing in almost all countries went up and reached 5% to 7% of the total assets. The exception are Finland and Greece, in both countries it went down from about 5.5% in 2008 to 3.8% in 2012.

Very interesting is the liquidity ratio measured with interbank market dependence ratio[10]. The ratio is absolutely the highest for Luxembourg, and is 41%. Nearly all countries in our sample reduced their dependence on the interbank market, with exception of Finland. Finnish banks almost doubled their exposure to interbank market over 2008 – 2012 period and the ratio reached 24% in 2012. Germany and Austria also have relatively high interbank market dependence ratio and it stood at 25% and 23% respectively in 2012. Interestingly, according to the reported data Ireland and Netherlands depend least on the interbank market, the ratio for these two countries is about 9% — with difference that it is stable in case of Netherlands, whereas in Ireland it went down from 15% (2008) to 9% (2012).

When relating the above presented findings with indicators of banks' assets quality and capital adequacy we find strong impact of financial crisis. Namely all indicators improved over 2008-2012 period. The non-performing loans to total loans ratio is the highest in Greece and Ireland, 18% and 17% respectively. That is expected given the seriousness of the financial and sovereign crisis in these countries. Other countries with high non-performing loans to total loans ratio include Italy, Portugal and Spain, but Italy seems to be the exception, since in 2008, the ratio already reached high 5% and in 2012 it stood at 11%. All other countries reported much lower non-performing loans in 2008. In our sample, Germany demonstrated the strongest financial discipline and stability. Namely, in spite of all difficulties the country was facing, the non-performing loans to total loans ratio, went slightly down, from 1.9% in 2008 to 1.7% in 2012.

Spanish banks reported the highest loss provision to non-performing loans ratio of 68.1% and it went slightly down from 71.4% in 2008. The largest decrease in loss provisions to non-performing loans is in Germany, where it went down from 48% in 2008 to 38% in 2012. Also, Portugal and Greece reduced it at a lower extent and in 2012 it was around 52-54%. In Austria, in spite of low non-performing loans, banks made large provisions (68%) already in 2008 and maintained it throughout the period. All other countries with high non-performing loans have loss provision to non-performing loans ratio around 40% and 50%.

The fluctuations in solvency ratio within sample are much smaller and in 2008 were between 9% and 15%. As expected, the ratio went up and in 2012 was above 13% for all countries apart from Greece whose solvency ratio of 9% is the lowest in the sample. And the same is with reported Tier

[10]Interbank market dependence ratio = Deposits from credit institutions / Total assets.

1 ratio and capital buffer. All countries, other than Greece, improved and increased it, also for several countries these two ratios almost doubled. The highest ones have banks in Luxembourg — their Tier 1 ratio is 19% and capital buffer 14%. Given the degree to which Luxembourg depends on financial industry and high interbank market dependence, in situation when unsecured interbank market is not functioning, this is well expected. Restoring stability and credibility is clearly the starting point.

3.2 Analysis of sovereign debt yields

In our analysis, we combine several sources of data. We download yields on zero-coupon government bonds with ten years time to maturity from Banque centrale du Luxembourg (BCL). From IMF World Economic Outlook Database we download gross domestic product (GDP), general government gross debt to GDP and inflation. The data contains estimates for year 2013. The overall outstanding debt is downloaded from the Bank for International Settlements (BIS). From ECB we download the total submitted collateral, unemployment rates, credit institutions' consolidated balance sheets, ECB's balance sheets, as well as eligible asset files for period April 8, 2010 – March 10, 2014. The eligible assets files contain the complete list of securities which are eligible collateral at ECB's repo auctions.

The yields on zero coupon bonds is monthly data and covers period Jan, 2000 – March, 2014. The overall outstanding debt is quarterly data, and all other data is annual. We transform annual and quarterly data to monthly frequencies with linear transformation.

The total data set consists of 2 394 observations, or 171 observation per country.

In this article, we are analyze period 2000 – 2013. We differ between the stability period before the start of the crisis, that is 2000 – Aug, 2007 period, and the period during and after the crisis, that is Sept, 2007 – 2013. In the focus of our analysis are yields on zero coupon government bonds with ten years time to maturity, and yields differentials with respect to Germany and the United States as proxies for risk-free bonds. Our analysis is carried out on twelve EU countries which are Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal and Spain, plus Japan and the United States.

Furthermore, we differ between countries that experienced sovereign debt crisis at higher extent and those that experienced sovereign debt crisis at lower extent. The countries that experienced

sovereign debt crisis at higher extent are Greece, Ireland, Italy, Spain and Portugal, those countries also have high yields and yields' differentials relative to Germany and US. The yields and yields' differentials are particularly high for Greece, Portugal and Ireland, and lower for Italy and Spain (figure 8 and figure 9).

The countries that experience sovereign debt crisis at lower extent are at the same time low yield countries. We find that also reflected in their yield differential relative to Germany and the US, which is low and for some countries even negative (figure 10 and figure 11). For example, yield spread for Japan is negative over the whole sample period. And, over the long period, and currently, yield differential between Luxembourg and Germany is negative, i.e. yield on zero coupon government bonds is lower for Luxembourg than for Germany.

Interestingly, the summary statistics (Table 15) show that for low yield countries, over period 2000 – 2014, the highest yields are recorded around January and February 2000, and the lowest yields are between December 2012 and April 2013. That is clearly different pattern compared to the high yield countries, for which the highest yields took place during the recent sovereign debt crisis, and the lowest yields in 2005, shortly before the start of financial crisis, when investors' optimism reached maximum. That development highlights strong co-movement patterns within these two groups, as well as clear difference between them.

It is worth mentioning that, prior to the crisis, in 2006, all these countries had S&P credit ratings between AAA and A. But during the crisis, the strong correction took place and credit ratings are adjusted. The partial recovery started in 2012 and 2013. These changes are captured with yields' minimum and maximum values (Table 15). For low yield countries, yields started declining and reached its minimum between Dec, 2012 and April, 2013, whereas for high yield countries, yield started increasing toward its maximum that took place in Nov, 2011 and July, 2012.

The correlation coefficients presented in Table 16 shows very strong co-movements between the countries. They are above 0.9 between low yield EU countries and between 0.7 and 0.9 between the US and Japan and EU countries. This implies that, to the large degree, correlation is explained from global aspect. Interestingly, we find larger variations between high yield countries, the correlation coefficients vary between 0.5 for Italy and Ireland and goes up to 0.95 for Portugal and Greece. And within our sample, Ireland, Portugal and, particularly, Greece have very high standard deviations.

In our econometric model we use several variables that capture impact of credit risk being one of the most important determinant of sovereign bond yields. Furthermore, we also control for liquidity

risk and general risk aversion[11].

In order to asses impact of credit risk on yield differentials for sovereign bonds, we use the following indicators of macroeconomic stability: debt/GDP, current account/GDP, GDP growth, unemployment and inflation. We selected these variables in order to capture main macroeconomic developments within a country. For example, we find large differences in unemployment between the countries, the lowest one is in Austria 4.8% (2012), whereas the highest is in Spain 27% (2012) therefore unemployment can pay a role in overall stability and influence sovereign bond yields. With other measures we try to capture international performance of countries, as well as their fiscal position which changed significantly during the crisis when tax revenues we used for bailout of banks in financial distress.

Therefore, given the fact that the focus of our analysis are yields on ten years government bonds, the important variable for our analysis is fiscal stability. We capture it with debt/GDP ratio that is shown to be reliable proxy. Paesani, Strauch, and Kremer (2006) analyzed the accumulation of debt in the USA, Germany and Italy over 1983-2003 period and showed that a more sustained accumulation of debt results with higher long-term interest rates. That is important for our analysis given the fact that debt/GDP ratio varies substantially between the countries within our sample. However, the strong outlier within our sample is Japan, the country with record high debt/GDP ratio (244%, Dec. 2013). However, Japan also maintained high credit rating (AA) and low yield throughout the crisis.

Furthermore, we also control for liquidity risk. Namely, we use total domestic and international outstanding debt and from that amount we deduct international debt with residual maturity up to one year. The general idea is that in this way we capture the size of the outstanding amount which relates to liquidity.

Following relevant literature, we measure the general risk aversion with spread between Moody's Seasoned Baa and Aaa Corporate Bond Yield. The main idea behind this proxy is that firms that markets perceive as more risky will pay an increased risk premium relative to firms that are perceived as safe investments. Additionally, we also use Chicago Board Options Exchange Market Volatility Index (VIX) which is frequently used measure of the implied volatility of S&P 500 index options which is established proxy for general risk aversion.

[11]Our initial approach follows D'Agostino and Ehrmann (2013).

To determine the impact of the above mentioned variables on the yield differential, we apply OLS, fixed effect, regression model:

$$Yield\ Differential_{it} = \alpha_{it} + \beta_{1it} * Liquidity + \beta_{2it} * Baa\text{-}Aaa\ spread + \beta_{3it} * VIX + \beta_{4it} * Debt/GDP + \beta_{5it} * Current\ account/GDP + \beta_{6it} * GDP\ growth + \beta_{7it} * Unemployment + \beta_{8it} * Inflation$$

We run two sets of panel regressions. In the first set we enter variables that capture credit risk for Germany and US as separate variables. This implies that we allow that Germany and US have different impact compared to sample of other countries. In this way we capture importance of German and US macroeconomic fundamentals compared to the other countries. And in the second set, as the robustness test, we enter variables related to credit risk as differentials relative to Germany and US.

The results of the main regressions are presented in Table 20 and of robustness tests in Table 21.

The regression results show that, overall, liquidity has significant, but small impact on the yield differential with respect to both benchmarks, Germany and US. And, as expected, decrease in liquidity increases yield differential. However, for the period prior to the crisis (2000 - Aug, 2007), we find, very small but positive coefficient which is consistent with several other coefficients for the same time period. This confirms our assumption regarding different impacts on the differentials.

The impact of the proxies for general risk aversion show that increase in Baa-Aaa spread increases yield differential. The impact is strongest for high yield countries. When we use VIX as proxy for general risk aversion, then we find relatively mixed results that seems to depend on the proxy for risk free bonds, i.e. Germany and US. In particular, the regression coefficient is negative when we use Germany as the benchmark, and positive when we use US as the benchmark. This result could be potentially interesting and requires further analysis.

Between variables that capture credit risk, we find that debt/GDP has strongest impact on yield differentials. And German debt/GDP dominates the impact of other countries in our sample. The impact is strongest for high yield countries. That corresponds well with the findings in that field. The increase in overall debt/GDP increases yield differential, and the strongest effect is for Germany. However, when we use US as the benchmark, then the overall impact of the debt/GDP remains the same but it seems that debt/GDP for US has no impact on the differentials.

Furthermore, increase in current account/GDP ratio results with increase yield differential, although

results are relatively mixed and for low yield countries decrease in current account/GDP leads to higher yield differential.

The overall impact of GDP growth has negative sign which means that increase in GDP growth reduces yield differentials. The exception to this are results for US, as separate variable, which has positive signs. According to the preliminary results, increase in GDP growth increases yield differential. This result also requires further analysis.

Unemployment and inflation seems to be important variables that influence yield differential for both benchmarks. The coefficients for Germany and US indicate that inflation increase contributes to increase in yield differentials. The coefficient is much weaker but different for all countries. In particular, according to the regression results, a decrease in inflations leads to higher yield differential.

Finally, when we consider impact of unemployment on yield differential, then we find that unemployment for Germany is not significant, whereas unemployment in US has strong impact on yield differential, much stronger that the coefficient for all countries.

As mentioned, as robustness test, we apply OLS, fixed effects regression, but as explanatory variables related to credit risk, we use spreads relative to Germany and US. The regression results are to certain degree mixed and require further analysis.

We find that increase in debt/GDP spread have strong impact on increase in overall yield differential.

We find that the results for inflation and unemployment are rather mixed. In particular, when we use Germany as benchmark, we find that, for the whole sample, decrease in inflation spread leads to higher yield differential. And when we use US as benchmark, we find that increase in inflation spread leads to higher yield differential. The exception to this is post crisis period, for which, decrease in inflation leads to higher yield differential.

When we analyze impact of spread in current account/GDP ratio, we find that increase in spread leads to higher yield differential, however exception are low yield countries, for which, decrease in spread related to current account/ GDP leads to higher yield differential.

Finally, our proxies for general risk aversion show that increase in their spread leads to higher yield differential. This result is strongest when we use US as benchmark.

4 Conclusion

Our theoretical model shows impact of balance sheet structure on banks' (in)stability and possible bank run. We analyze and discuss different ways in which bank can generate necessary liquidity buffer in order to avoid solvency trap and the final default with undesired negative externalities. In particular, we show that combining asset fire sales and recourse to central bank's repo auctions can optimize required liquidity buffer. Also, central bank can limit asset eligibility and in that way central bank can, during periods with stable market conditions, create liquidity buffer, which can be used as monetary policy tool during crisis periods.

The assessment of overall stability of financial system, shows improvements from period prior and during the financial crisis. In particular, solvency and liquidity ratio improved, and in general, dependence on interbank market is reduced for most of the countries. The situation is similar with sovereign health measures. Apart from Greece, other countries that experienced difficulties, managed to improve overall credit risk and avoid default.

When analyzing yields on zero coupon sovereign bonds, with ten years time to maturity, and yield differential with respect to Germany and US, we find strong pattern between high yield countries, that experienced sovereign debt crisis at higher extent, and low yield countries that experienced sovereign debt crisis at lower extent. In particular, the correlation coefficients shows strong co-movements between low yield countries and are above 0.9. We find larger variations between high yield countries, the correlation coefficients vary between 0.5 for Italy and Ireland and goes up to 0.95 for Portugal and Greece.

The initial regression analysis showed that impact of macroeconomic indicators that are proxies for credit risk to certain degree differ between Germany as risk free benchmark and US. Overall, we find that decrease in sovereign bonds liquidity leads to higher yield differentials, also increase in general risk aversion leads to higher yield differential. However, the result for general risk aversion is to certain degree mixed. Furthermore we find that other variables related to credit risk have significant impact on sovereign yield differential, especially debt/ GDP.

However, our initial regression results are to certain degree mixed and require further analysis.

A Appendix

A.1 Bank's balance sheet structure and liquidity parameters

Table 1: Implications of liquidity conditions and parameters

Average remuneration rate of liabilities:

$r_d * d + r_t * t + r_e * e = 0 * d + 0.03 * t + 0.124 * e$

Panel I:	$r_t = 3\%,\ r_e = 12.4\%,\ \delta = 0.5,\ \theta = 1$					
w	0.25	0.4	0.55	0.7	0.85	1
Short-term deposits ($d = 1 - t - e$)	0.39	0.52	0.61	0.67	0.71	0.72
Long-term deposits	0.6	0.47	0.38	0.32	0.28	0.27
Fire sales losses $\leq$ Equity	0.011	0.011	0.011	0.011	0.011	0.011
Assets foreseen for fire sales (z)	0.15	0.15	0.15	0.15	0.15	0.15
Haircut	0.04	0.13	0.23	0.35	0.48	0.63
Generated liquidity $\leq (1 - t - e)/2$	0.19	0.26	0.31	0.34	0.36	0.36
Remuneration rate of liabilities	1.9%	1.6%	1.3%	1.1%	1%	0.9%
Panel II:	$r_t = 3\%,\ r_e = 12.4\%,\ w = 0.5,\ \theta = 1$					
δ	0.3	0.4	0.5	0.6	0.7	0.8
Short-term deposits ($d = 1 - t - e$)	0.44	0.41	0.39	0.38	0.39	0.41
Long-term deposits	0.53	0.57	0.6	0.61	0.61	0.59
Fire sales losses $\leq$ Equity	0.031	0.022	0.011	0.004	0.001	0
Assets foreseen for fire sales (z)	0.25	0.21	0.15	0.09	0.04	0
Haircut	0	0.02	0.04	0.05	0.05	0.05
Generated liquidity $\leq (1 - t - e)/2$	0.22	0.21	0.19	0.19	0.2	0.2
Remuneration rate of liabilities	2%	2%	1.9%	1.9%	1.8%	1.8%
Panel III:	$r_t = 3\%,\ r_e = 12.4\%,\ w = 0.25,\ \delta = 0.5$					
θ	0.5	1	1.5	2	2.5	3
Short-term deposits ($d = 1 - t - e$)	0.33	0.39	0.48	0.49	0.5	0.5
Long-term deposits	0.67	0.6	0.51	0.51	0.50	0.50
Fire sales losses $\leq$Equity	0	0.011	0.013	0.005	0.002	0.001
Assets foreseen for fire sales (z)	0	0.15	0.25	0.25	0.25	0.25
Haircut	0.08	0.04	0	0	0	0
Generated liquidity $\leq (1 - t - e)/2$	0.17	0.19	0.24	0.24	0.25	0.25
Remuneration rate of liabilities	2%	2%	1.7%	1.6%	1.5%	1.5%

A.2 Credit rating

We use Standard & Poor's Sovereign Rating And Country T&C Assessment Histories report as of February 5, 2014. The report contains historical long-term, foreign currency, sovereign ratings and outlooks data. And we transform the rating to 0-100 points numerical scale. In particular, S&P determines sovereigns' financial strength with ten-point scale where "AAA" is the highest and "D" the lowest rating. Ratings from "BBB" to "AAA" have investment characteristics, whereas ratings from "BB" to "C" have speculative characteristics. The scale also contains "+" and "-" modifiers and "positive", "stable", "watch neg." and "negative" outlook which indicate relative status within the major category from "AA" to "CCC". The points are assigned in the following way: to the lowest credit rating "D" we assign 5 points and thereafter to every subsequent major category we add ten points. In this way, the highest rating, "AAA", has 95 points. Furthermore, "+" and "-" modifiers, defining relative status within a major category, carry additional ± 2 points, whereas outlooks add ± 1 point. For example, 85-points is assigned to "AA/Stable", whereas 82 points is assigned to "AA-/Negative" and 88 points is assigned to "AA+/Positive". Finally, since 5 points is assigned to the lowest rating, "D", we add 5-points to the highest rating, "AAA", and in that way we create symmetrical distribution.

Table 2: Transformed Standard & Poor's credit rating scale

S&P rating	Numerical rating	(+) $+2 points$	(−) $-2 points$	Stable $0 points$	Positive $+1 point$	Watch Neg. $-0.5 point$	Negative $-1 point$	Numerical scale
AAA/Stable	95			0				95
AAA/Watch Neg	95					-0.5		94.5
AAA/Negative	95						-1	94
AA+/Positive	85	+2			+1			88
AA+	85	+2						87
AA+/Stable	85	+2		0				87
AA+/Negative	85	+2					-1	86
AA/Positive	85				+1			86
AA/Stable	85			0				85
AA/Watch Neg	85					-0.5		84.5
AA/Negative	85						-1	84
AA-/Positive	85		-2		+1			84
AA-/Stable	85		-2	0				83
AA-/Watch Neg	85		-2			-0.5		82.5
AA-/Negative	85		-2				-1	82
A+/Positive	75	+2			+1			78
A+	75	+2						77
A+/Stable	75	+2		0				77
A+/Watch Neg	75	+2				-0.5		76.5
A+/Negative	75	+2					-1	76
A/Positive	75				+1			76
A/Stable	75			0				75
A/Watch Neg	75					-0.5		74.5
A/Negative	75						-1	74
A-/Positive	75		-2		+1			74
A-/Stable	75		-2					73
A-/Negative	75		-2				-1	72
BBB+/Positive	65	+2			+1			68
BBB+/Stable	65	+2		0				67
BBB+/Watch Neg	65	+2				-0.5		66.5
BBB+/Negative	65	+2					-1	66
BBB/Positive	65				+1			66
BBB/Stable	65			0				65
BBB/Watch Neg	65					-0.5		64.5
BBB/Negative	65						-1	64
BBB-/Positive	65		-2		+1			64
BBB-/Stable	65		-2	0				63
BBB-/Watch Neg	65		-2			-0.5		62.5
BBB-/Negative	65		-2				-1	62
BB+/Positive	55	+2			+1			58
BB+/Stable	55	+2		0				57
BB+/Watch Neg	55	+2				-0.5		56.5
BB+/Negative	55	+2					-1	56
BB/Positive	55				+1			56
BB/Stable	55			0				55
BB/Watch Neg	55					-0.5		54.5
BB/Negative	55						-1	54
BB-/Stable	55		-2	0				53
B+/Positive	45	+2			+1			48
B/Positive	45				+1			46
B-/Stable	45		-2	0				43
B-/Negative	45		-2				-1	42
CCC+/Negative	35	+2					-1	36
CC/Negative	25						-1	24
C	15							15
D	5							5

A.3 Overview of ECB's liquidity categories for marketable assets and the corresponding haircuts

Liquidity categories for *marketable* assets which is eligible collateral at ECB's repo auctions:

- **Category I**
  - **Central government debt instruments**
  - **Debt instruments issued by NCBs**
- **Category II**
  - **Local and regional government debt instruments**
  - Jumbo covered bank bonds
  - Agency debt instruments
  - Supranational debt instruments
- Category III
  - Traditional covered bank bonds
  - Debt instruments issued by non- financial corporations and other issuers
  - Other covered bank bonds
- Category IV
  - Credit institution debt instruments (unsecured)
  - Debt instruments issued by financial corporations other than credit institutions (unsecured)
- Category V
  - Asset-backed securities

Table 3: Overview of ECB's haircuts (%), marketable assets

		Liquidity categories of marketable assets that are eligible collateral at ECB's repo auctions								
	Residual	Category I		Category II		Category III		Category IV		Category V
Credit rating	maturity (years)	fixed coupon	zero coupon	fixed coupon	zero coupon	fixed coupon	zero coupon	fixed coupon	zero coupon	-
AAA to A-	0-1	0.5	0.5	1.0	1.0	1.0	1.0	6.5	6.5	
	1-3	1.0	2.0	1.5	2.5	2.0	3.0	8.5	9.0	
	3-5	1.5	2.5	2.5	3.5	3.0	4.5	11.0	11.5	10.0
	5-7	2.0	3.0	3.5	4.5	4.5	6.0	12.5	13.5	
	7-10	3.0	4.0	4.5	6.5	6.0	8.0	14.0	15.5	
	>10	5.0	7.0	8.0	10.5	9.0	13.0	17.0	22.5	
BBB+ to BBB-	0-1	6.0	6.0	7.0	7.0	8.0	8.0	13.0	13.0	
	1-3	7.0	8.0	10.0	14.5	15.0	16.5	24.5	26.5	
	3-5	9.0	10.0	15.5	20.5	22.5	25.0	32.5	36.5	22.0
	5-7	10.0	11.5	16.0	22.0	26.0	30.0	36.0	40.0	
	7-10	11.5	13.0	18.5	27.5	27.0	32.5	37.0	42.5	
	>10	13.0	16.0	22.5	33.0	27.5	35.0	37.5	44.0	

Source: ECB Press Release as of July 18, 2013, Annex

Liquidity categories for *non-marketable* assets which is eligible collateral at ECB's repo auctions:

- Credit claims
- Non-marketable retail mortgage-backed debt (RMB debt)

A.4 Summary statistics for sovereign health measures

Table 4: Mean values for sovereign health measures, period 1980-2013

Country	Start of rating	Sovereign rating*	Debt/GDP (%)	GDP growth (%)	Current account/GDP (%)	Government revenue/GDP (%)	Inflation (%)
Austria	1980	94.49	64.71	2.03	0.25	49.42	2.59
Belgium	1988	86.75	110.05	1.85	1.91	48.73	2.95
Finland	1980	92.10	35.60	2.25	1.14	53.42	3.61
France	1980	94.43	52.34	1.73	-0.04	49.09	3.49
Germany	1983	94.98	63.04	1.71	2.26	44.63	2.26
Greece	1988	64.88	89.41	1.02	-5.47	34.98	10.19
Ireland	1988	85.08	73.01	3.95	-1.47	38.74	4.37
Italy	1988	81.6	110.23	1.14	-0.74	44.69	5.53
Luxembourg	1994	94.93	10.40	3.99	9.30	42.47	3.49
Netherlands	1989	94.62	60.16	2.00	4.8	45.76	2.33
Portugal	1988	78.8	67.59	2.24	-5.26	39.07	7.61
Spain	1989	85.86	49.85	2.29	-2.80	36.78	5.43

Source: S&P sovereign rating transformed to numerical values. The calculation is presented in Table 2.

Table 5: Sovereign credit ratings, summary statistics

Sovereign credit rating, scale 0-100, low value implies high default probability					
Country	Mean	St. deviation	Mean – St.dev.	Min	Max
Austria	94.49	2.03	92.45	86	95
Belgium	86.75	1.03	85.72	84	88
Finland	92.1	4.44	87.66	83	95
France	94.43	2.27	92.16	85	95
Germany	94.98	0.09	94.89	94.5	95
Greece	64.88	12.33	52.56	24	77
Ireland	85.08	8.96	76.12	66	95
Italy	81.6	6.25	75.35	64	88
Luxembourg	94.93	0.24	94.68	94	95
Netherlands	94.62	1.6	93.02	87	95
Portugal	78.8	8.99	69.81	54	85
Spain	85.86	8	77.86	62	95

Table 6: Credit institutions, total assets and banking crisis, selected years

	Number of credit institutions								Total assets (EUR bil.)				Fiscal costs of banking crisis**	
Country	2005	2007	2008	2009	2012	Apr/2014	Change (%) 2005-Apr/'14	Change (%) 2008-2012	2008	2009	2012	Change (%) 2008-2012	% of GDP	EUR mil.
Austria	796	809	803	800	766	727	-8.67	-4.61	1 175.7	1 139.9	1 163.6	-1.03	4.9	13 854.47
Belgium	104	105	109	107	108	103	-0.96	-0.92	1 419.65	1 190.34	1 048.7	-26.13	6	20 782.5
Finland	362	361	360	357	323	294	-18.78	-10.28	385.93	382.07	598.88	55.18	-	-
France	891	827	744	720	658	573	-35.69	-11.56	7 150.5	6 316.2	6 810.45	-4.76	1	19 331.95
Germany	2 141	2 041	2 021	1 984	1 894	1 840	-14.06	-6.28	9 957.57	8 410.9	7 566.32	-24.01	1.8	44 528.4
Greece	62	62	64	66	57	40	-35.48	-10.94	457.97	490.05	409.08	-10.68	27.3	63 662.97
Ireland	-	-	-	501	480	458	-	-	1621.1	1 339.1	998.84	-38.39	40.7	73 361.55
Italy	785	810	819	813	749	688	-12.36	-8.55	2 757.8	2 651.4	2 849.46	3.32	0.3	4 725.43
Luxembourg	161	154	155	153	142	151	-6.21	-8.39	1 008.1	873.9	740.02	-26.59	7.7	2 877.61
Netherlands	461	346	341	299	284	245	-46.85	-16.72	2 994.7	2 648.1	2 688.36	-10.23	12.7	75 499.09
Portugal	195	177	178	172	155	148	-24.1	-12.92	476.9	510.9	496.08	4.02	0	0
Spain	345	352	357	359	333	237	-31.3	-6.72	3 637.35	3 740.7	3 884.04	6.78	3.8	41 335.94
Total	6 383	6 122	6 033	6 331	5 949	5 504	-13.77	-1.39	33 043.27	29 693.56	29 253.83	-11.47	-	359 959.91
Euro area	6 383	6 149	6 288	6 568	6 189	5 740	-10.07	-1.57	-	-	-	-	-	-
European Union	-	-	-	-	-	-	-	-	44 816	42 524.07	43 510.47	-2.91	-	536 632.95

*Changing composition: in 1999 the Euro area consisted on 11 countries whereas today it has eighteen countries. The details about expansion are presented in Section **??**.

**Fiscal costs are defined as the component of gross fiscal outlays related to the restructuring of the financial sector. They include fiscal costs associated with bank recapitalizations but exclude asset purchases and direct liquidity assistance from the Treasury. Source: Laeven and Valencia (2013).

Source: ECB

Table 7: Selected balance sheet items

	Domestic banks		Foreign banks		Austria		Belgium		Germany		Spain		Finland		France	
	2008	2012	2008	2012	2008	2012	2008	2012	2008	2012	2008	2012	2008	2012	2008	2012
Assets (% of total assets):																
Total loans and advances	56.6	55.89	61.5	44.01	69.5	69.9	54.2	60.6	48.4	48.8	73.7	64.6	62.2	39.6	49.3	53.3
Total debt instruments	13.1	16.2	13.5	19.3	14.5	15.5	21.6	18.4	17.4	17.9	10.8	14.8	2.1	10.6	14.1	12.3
Total equity instruments	1.7	1.85	13.5	1.89	1.9	1.15	1.1	0.59	2	3.16	2.4	0.96	0.5	0.5	2.7	2.69
Liabilities (% of total assets):																
Total deposits from credit institutions	12.6	9.23	25.1	19.26	20	17.18	19.5	10.96	20.1	16.22	13.7	11.17	12.6	24.27	13.1	8.89
Total deposits (other than from credit institutions)	35	41.83	28	27.29	40.6	46.22	39.3	49.27	27.7	38.57	48.5	48.07	30.8	27.86	28.5	37.46
Total debt certificates (including bonds)	17.1	18.43	13.2	13.07	21	18.3	8.8	10.64	16.2	13.48	18.5	13.08	19.5	17.04	16.2	15.94
Value of equity (% of total assets):																
Total equity	4	5.3	4.3	5.37	5.4	7.4	3.3	5.76	2.9	4.25	5.5	5.58	5.5	3.8	3.7	4.97
Liquidity ratio (% of total assets):																
Interbank market dependence ratio	14	10.02	28.3	20.98	24.9	22.65	19.5	10.96	27.6	25.41	14.6	11.71	12.6	24.27	13.1	8.89

	Greece		Ireland		Italy		Luxembourg		Netherlands		Portugal	
	2008	2012	2008	2012	2008	2012	2008	2012	2008	2012	2008	2012
Assets (% of total assets):												
Total loans and advances	78.5	69.4	55.4	42.2	74.1	67	66.5	67.8	66.5	69	78.9	73.1
Total debt instruments	10.8	11.1	10	17.7	8.5	15.8	23	20.7	12.1	10.3	10.5	15.5
Total equity instruments	0.4	0.37	0.2	0.13	1.2	0.93	1.4	1.83	1	0.63	1.4	1.05
Liabilities (% of total assets):												
Total deposits from credit institutions	13	7.24	14.5	8.51	11	14.03	42.9	41.19	9.8	8.62	15.6	12.36
Total deposits (other than from credit institutions)	58.3	48.05	21	23.77	39.7	39.07	32.8	35.72	43.6	45.11	45.7	50.62
Total debt certificates (including bonds)	11.2	4.44	14.4	10.52	23.8	20.01	8.7	8.81	3.6	26.3	19.8	11.43
Value of equity (% of total assets):												
Total equity	5.4	3.76	3.3	6.32	7	6.96	3.9	6.61	3.1	4.5	5.5	6.45
Liquidity ratio (% of total assets):												
Interbank market dependence ratio	13	7.24	14.5	8.51	11	14.03	42.9	41.19	9.9	9.17	15.6	12.36

Source: ECB

Table 8: Non-performing loans, solvency ratio and capital buffer

	Austria					Belgium					Germany				
	2008	2009	2010	2011	2012	2008	2009	2010	2011	2012	2008	2009	2010	2011	2012
Non-performing loans/ Total loans (gross)	2	2.72	3.89	4.05	4.29	3.9	4.09	3.94	4.18	5.05	1.9	2.72	2.39	1.61	1.73
Loss provisions / Non-performing loans (gross)	67.7	73.32	68.17	67.47	68.53	16.8	29.11	29.3	31.56	28.1	48	41.85	34.99	40.12	38.32
Overall solvency ratio	11	12.72	13.2	13.55	14.18	16.4	17.27	19.29	18.55	18.2	13	14.27	15.28	15.78	17.39
Tier 1 ratio	7.7	9.27	9.98	10.34	10.99	11.5	13.23	15.52	15.12	15.86	9.3	10.63	11.41	11.72	13.8
Capital buffer (%)	3	4.72	5.2	5.55	6.18	8.4	9.27	11.29	10.55	10.2	5	6.27	7.28	7.78	9.39
	Spain					Finland					France				
	2008	2009	2010	2011	2012	2008	2009	2010	2011	2012	2008	2009	2010	2011	2012
Non-performing loans/ Total loans (gross)	2.6	3.63	4.13	5.23	6.4	0.8	1.15	0.9	0.8	0.76	3.1	4.3	4.5	4.63	4.49
Loss provisions / Non-performing loans (gross)	71.4	60.94	65.82	57.32	68.08	-	-	-	-	-	40.7	39.52	40.77	43.8	42.04
Overall solvency ratio	11.3	12.23	11.89	12.16	11.46	13.7	14.61	14.56	14.39	17.24	10.3	12.24	12.56	12.23	13.99
Tier 1 ratio	8.1	9.33	9.65	10.26	9.8	12.5	13.79	13.73	13.72	16.31	8.4	10.12	10.76	10.94	13.33
Capital buffer (%)	3.3	4.23	3.89	4.16	3.46	5.7	6.61	6.56	6.39	9.24	2.3	4.24	4.56	4.23	5.99
	Greece					Ireland					Italy				
	2008	2009	2010	2011	2012	2008	2009	2010	2011	2012	2008	2009	2010	2011	2012
Non-performing loans/ Total loans (gross)	3.1	5.23	7.08	12.1	17.81	-			-	16.6	5	7.51	8.37	9.47	10.99
Loss provisions / Non-performing loans (gross)	53.5	43.61	46.73	57.67	51.84	-			52.58	53.18	46.6	39.89	40.29	40.2	39.96
Overall solvency ratio	9.4	11.75	12.22	-	8.7	12	12.79	14.5	18.93	19.24	10.4	11.63	12.06	12.68	13.42
Tier 1 ratio	7.9	10.76	10.9	-	7.96	9.2	9.79	11.56	16.66	16.69	6.9	8.26	8.66	9.53	10.54
Capital buffer (%)	1.4	3.75	4.22	-	0.7	4	4.79	6.5	10.93	11.24	2.4	3.63	4.06	4.68	5.42
	Luxembourg					Netherlands					Portugal				
	2008	2009	2010	2011	2012	2008	2009	2010	2011	2012	2008	2009	2010	2011	2012
Non-performing loans/ Total loans (gross)	-	-	-	-	-	1.9	0.44	2.32	2.42	2.64	1.6	2.5	3.75	5.33	7.04
Loss provisions / Non-performing loans (gross)	-	-	-	-	-	25.4	21.41	36.5	40.43	36.97	67.7	76.21	61.52	56.62	54.25
Overall solvency ratio	15.1	18.12	17.82	17.82	21.87	12	14.96	14.11	13.74	14.54	9.4	10.54	10.33	9.78	12.64
Tier 1 ratio	12.7	15.59	15.09	15.32	18.59	9.7	12.48	11.84	11.83	12.33	6.6	7.88	8.31	8.56	11.31
Capital buffer (%)	7.1	10.12	9.82	9.82	13.87	4	6.96	6.11	5.74	6.54	1.4	2.54	2.33	1.78	4.64

Source: ECB

Table 9: Liquidity category of assets eligible at ECB's repo auctions (Apr/2010-Mar/2014)

Issuer residence	Liq cat I	Liq cat II	Liq cat III	Liq cat IV	Liq cat V	Total
Austria	439	22	771	2 951		4 183
Belgium	874	3 167	4 502	4 730	35	13 308
Switzerland	23		11	118		152
Cyprus	128		7	6	1	142
Germany	409	3 387	6 680	16 158	54	26 688
Denmark	9	9	208	1103		1329
Spain	278	795	1329	11 577	984	14 963
Finland	78	27	89	137	3	334
France	609	1 279	13 335	66 537	354	82 114
United Kingdom	293	35	493	5 114	326	6 261
Greece	304	1	42	68	2	417
Ireland	60	14	762	3 048	193	4 077
Italy	673	139	268	5 041	371	6 492
Japan	732		4	5		741
Luxembourg	6	127	552	709	65	1 459
Malta	466			4		470
Netherlands	158	102	893	8 270	430	9 853
Norway		30	87	267		384
Portugal	79	22	533	611	39	1 284
Sweden	114	36	186	1 434		1 770
Slovenia	89	1	10	33		133
Slovakia	48		196	15	5	264
United States			62	736		798
Supranational Issuer		1 183				1 183
Other countries*	109	26	90	188	0	413
Total	5 978	10 402	31 110	128 860	2 862	179 212

*Other countries include: Bulgaria, Canada, Czech Republic, Estonia, Croatia, Hungary, Iceland, Lichtenstein, Lithuania, Latvia, Poland, Romania, and Non-EEA countries

Source: ECB

Table 10: Eligible assets with government guarantees

	Guarantor		
Issuer group	Central government	Regional/local government	Total
Central bank	0	0	0
Central government	177	0	177
Corporate and other issuers	249	206	455
Credit Institution*	2838	1501	4339
Regional/local government	1	42	43
Supranational issuer	0	0	0
Agency - non credit institution	322	17	339
Agency - credit institution	416	537	953
Financial corporations**	124	19	143
Total	4127	2322	6449

	Guarantor		
Issuer residence	Central government	Regional/local government	Total
Austria	138	361	499
Belgium	73	196	269
Germany	530	1696	2226
Spain	418	19	437
France	1270	1	1271
United Kingdom	128		128
Greece	218		218
Ireland	600	1	601
Italy	350	1	351
Luxembourg	119	2	121
Portugal	94	1	95
Other	189	44	233
Total	4127	2322	6449

*Excluding agencies.

**Other than credit institutions.

Table 11: Submitted collateral and monetary policy operations

Year	Assets submitted as collateral* (EUR bil.)	Lending to euro area banks related to monetary policy operations* (EUR bil.)	Percentage of collateral in use
2004	853	312.4	37
2005	920	378.12	41
2006	973	422.93	43
2007	1173	449.54	38
2008	1627	539.49	33
2009	2053	708.64	35
2010	2040	659.3	32

*Annual averages. Source: ECB

Establish that assets are important and show it through ECB balance sheet.

Figure 3: ECB balance sheet: Open market operations, 1999 - May, 2014

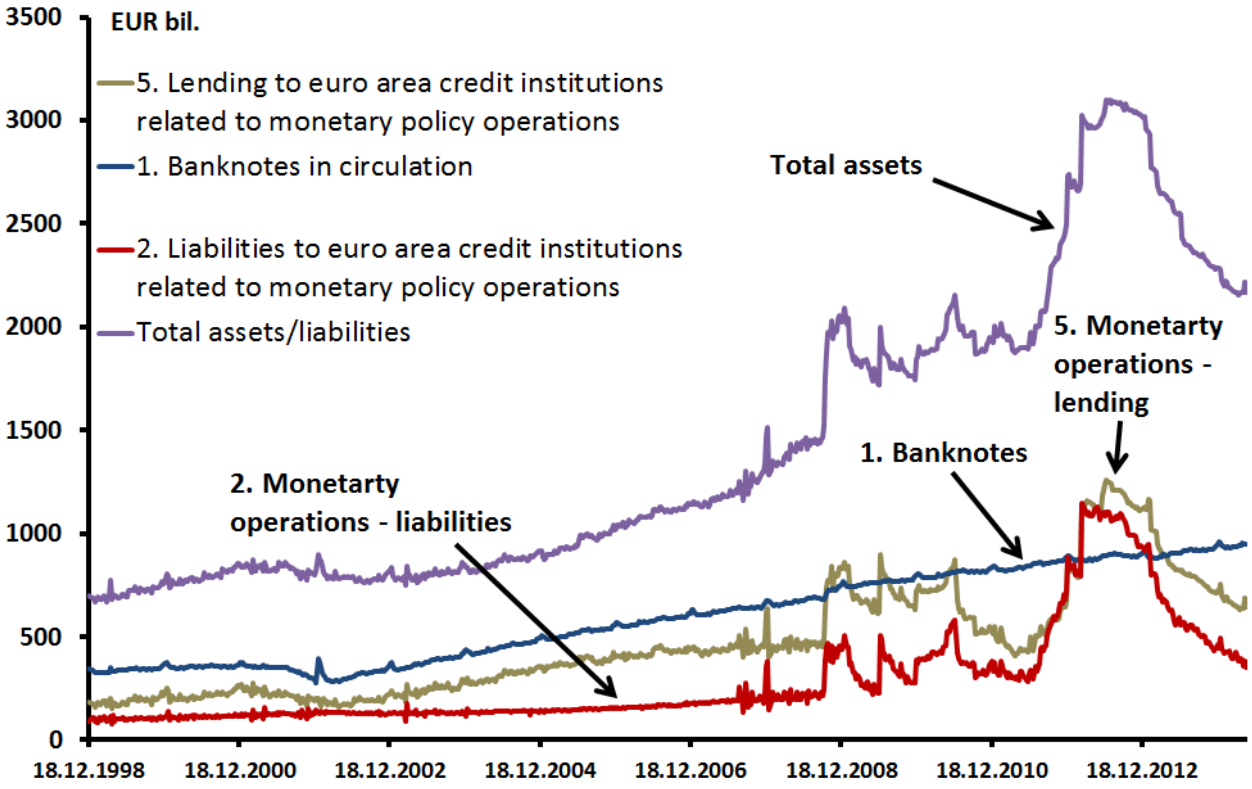


Figure 4: ECB balance sheet: assets, period: 1999 - May, 2014

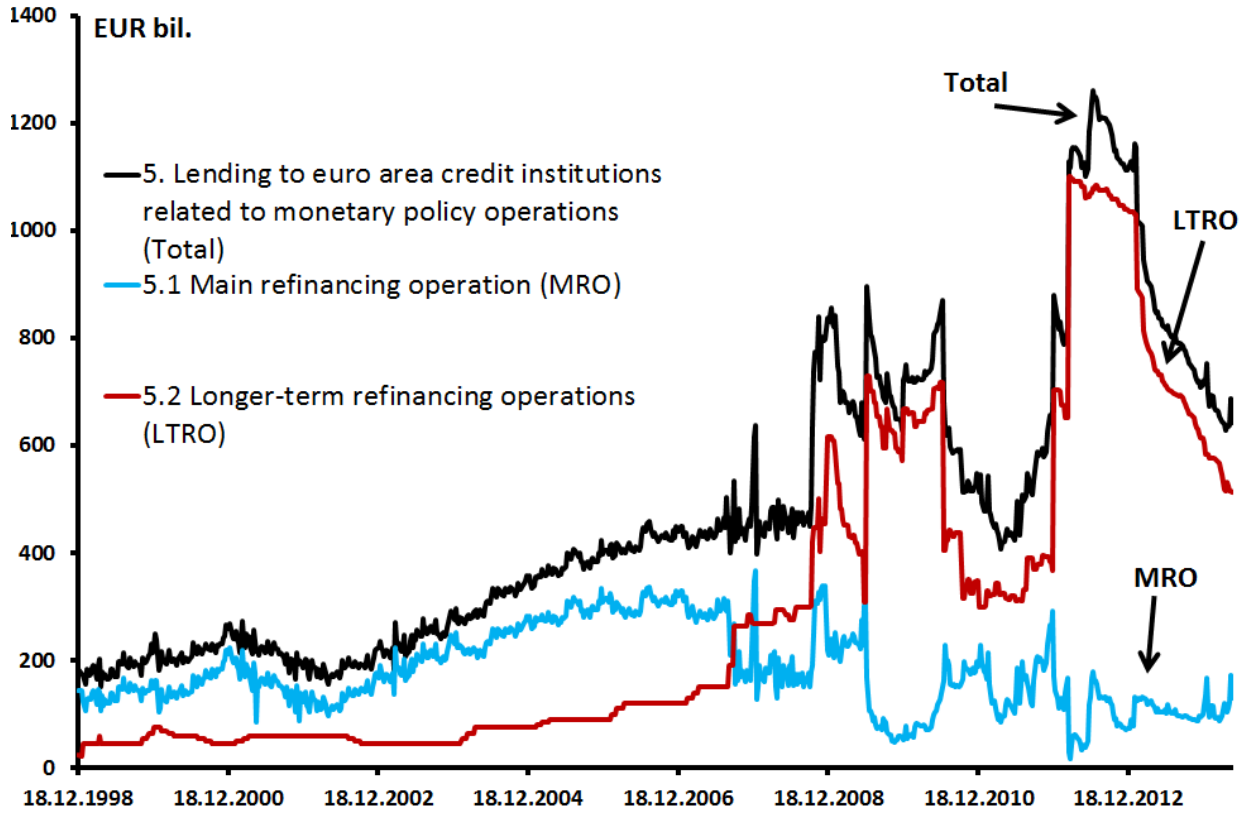


Figure 5: ECB balance sheet: Liabilities, 1999 - May, 2014

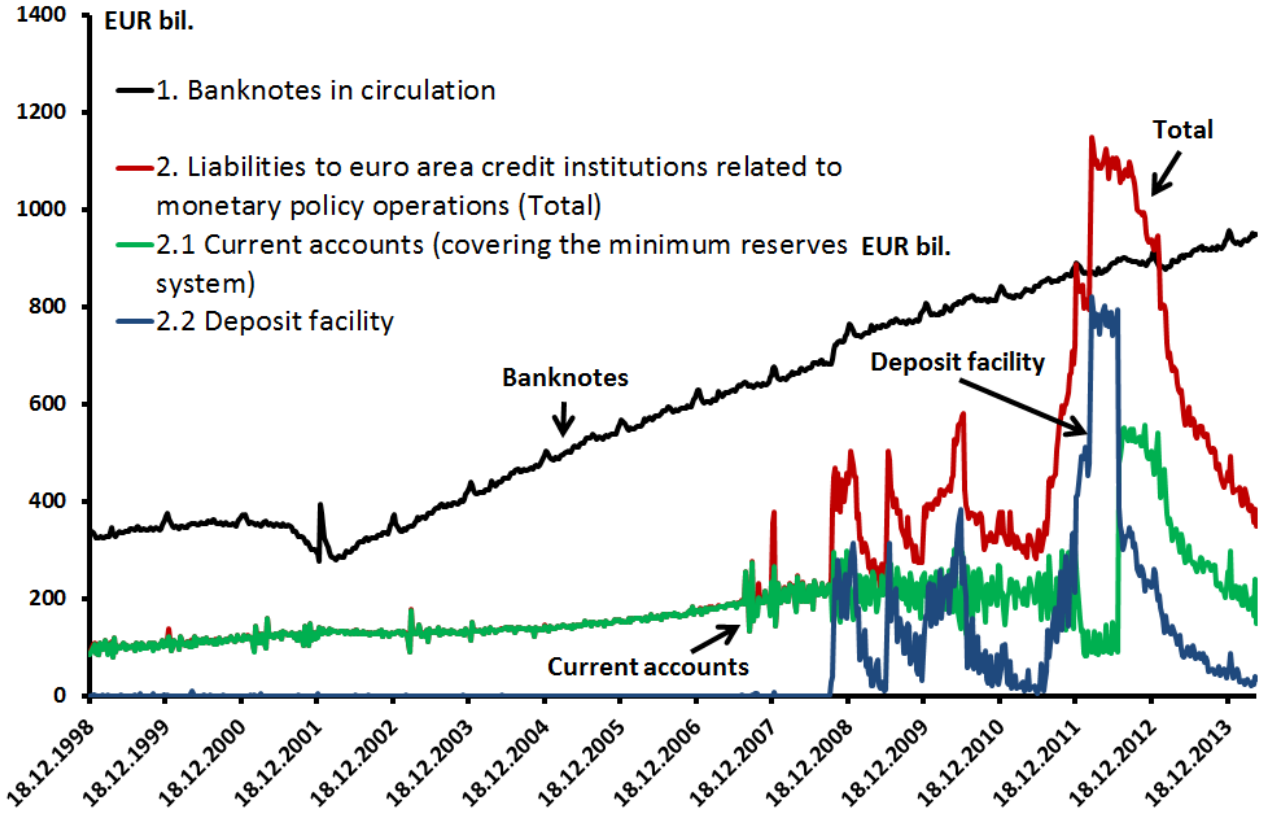


Table 12: Current account balance, 1995-2014

	Current account balance, % of GDP							
Country	1995	2000	2007	2008	2010	2011	2012	2013
Austria	-2.898	-0.734	3.51	4.866	3.416	1.364	1.78	2.802
Belgium	5.404	4.025	1.892	-1.315	1.911	-1.14	-1.602	-0.7
Finland	4.09	7.776	4.265	2.615	1.497	-1.534	-1.778	-1.631
France	0.466	1.452	-1.003	-1.744	-1.314	-1.759	-2.186	-1.585
Germany	-1.172	-1.732	7.45	6.21	6.252	6.176	6.954	5.972
Greece	-2.439	-7.791	-14.609	-14.922	-10.131	-9.895	-3.369	-0.986
Ireland	3.317	-0.359	-5.338	-5.642	1.127	1.231	4.422	2.316
Italy	2.156	-0.201	-1.281	-2.85	-3.513	-3.057	-0.739	-0.011
Luxembourg	11.951	13.223	10.091	5.357	8.225	7.105	5.714	5.996
Netherlands	6.306	2.044	6.72	4.288	7.793	10.181	10.098	10.867
Portugal	-0.113	-10.343	-10.102	-12.638	-10.569	-7.009	-1.548	0.907
Spain	-0.308	-3.961	-9.995	-9.623	-4.491	-3.802	-1.12	1.434
United States	-1.482	-4.046	-4.927	-4.629	-3.005	-2.947	-2.711	-2.699
Japan	2.089	2.528	4.869	3.297	3.713	2.023	1.014	1.22

Source: IMF

Table 13: Government revenues and net debt

	General government revenue, % of GDP								General government net debt, % of GDP							
Country	1995	2000	2007	2008	2010	2011	2012	2013	1995	2000	2007	2008	2010	2011	2012	2013
Austria	52.725	50.091	47.608	48.332	48.311	48.284	49.149	49.139	48.422	43.176	40.877	42.03	52.791	52.202	53.292	53.631
Belgium	47.577	49	48.144	48.741	48.666	49.473	50.853	51.1	115.757	97.415	73.068	73.314	79.684	81.144	81.973	83.431
Finland	54.922	55.359	52.728	53.557	52.984	54.124	54.279	55.054	-23.998	-31.092	-72.521	-52.292	-65.561	-54.274	-55.367	-51.633
France	48.927	50.165	49.858	49.938	49.479	50.597	51.78	52.9	47.434	51.431	59.551	62.27	76.098	78.59	83.975	87.206
Germany	45.371	46.234	43.743	44.006	43.582	44.25	44.782	44.433	37.979	41.122	50.576	50.097	56.223	55.338	57.369	56.255
Greece	36.68	43.002	40.739	40.672	40.617	42.383	44.108	42.942	64.93	102.891	106.931	112.375	147.366	168.02	154.849	172.567
Ireland	37.493	36.002	36.74	35.425	34.865	34.08	34.521	35.208	77.072	34.656	10.529	21.194	70.372	85.109	92.846	105.515
Italy	44.779	44.953	46.041	45.928	46.053	46.173	47.693	47.887	107.181	93.177	87.086	89.347	100.032	102.59	106.066	110.483
Luxembourg	42.107	43.564	39.942	42.319	41.956	41.545	42.145	42.841	-	-	-	-	-	-	-	-
Netherlands	47.228	46.142	45.438	46.659	45.779	45.256	46.104	47.429	40.581	24.861	21.632	20.617	26.063	28.367	32.426	35.152
Portugal	36.262	38.302	41.149	41.107	41.647	45.001	41.044	43.148	n/a	41.872	63.658	67.49	89.569	97.864	112.356	117.512
Spain	38.074	38.239	41.134	36.963	36.724	36.286	37.128	37.733	57.008	50.381	26.7	30.801	50.11	58.564	73.483	80.762
United States	32.569	34.076	32.869	31.559	30.266	30.476	30.448	32.474	52.439	34.442	46.48	52.432	72.787	79.881	84.107	87.363
Japan	29.52	29.237	31.224	31.62	29.61	30.808	31.108	31.614	23.487	59.6	80.488	95.281	113.124	127.43	133.453	139.88

Source: IMF

Table 14: GDP per capita and unemployment rate

	GDP per capita								Unemployment rate, %						
Country	1995	2000	2007	2008	2010	2011	2012	1995	2000	2007	2008	2010	2011	2012	2013
Austria	23 000	26 000	33 000	34 000	34 100	35 700	36 400	3.917	3.6	4.4	3.8	4.4	4.2	4.335	4.8
Belgium	21 500	24 600	31 600	32 400	32 700	33 600	34 000	9.692	6.933	7.475	7.108	8.208	7.208	7.617	8.7
Finland	19 600	25 500	34 000	34 900	33 300	35 000	35 500	15.397	9.783	6.867	6.367	8.383	7.775	7.75	8.034
France	20 200	23 700	29 600	30 100	29 900	30 700	31 100	10.525	9.008	8.375	7.775	9.733	9.617	10.258	10.953
Germany	23 600	24 900	29 500	30 100	30 500	31 900	32 600	8.275	8	8.783	7.6	7.058	5.95	5.467	5.591
Greece	8 500	12 600	19 900	20 800	19 600	18 500	17 200	9.071	11.35	8.276	7.654	12.531	17.653	24.238	26.986
Ireland	14 400	27 800	43 100	40 100	34 700	35 500	35 700	14.1	4.252	4.674	6.4	13.853	14.625	14.672	13.745
Italy	15 200	21 000	26 200	26 300	25 700	26 000	25 700	11.15	10.1	6.108	6.775	8.425	8.425	10.675	12.5
Luxembourg	38 600	50 300	78 000	76 400	77 400	80 300	80 700	2.961	2.4	4.2	4.2	5.8	5.7	6.07	6.563
Netherlands	20 700	26 300	34 900	36 200	35 300	35 900	35 800	7.064	3.06	3.576	3.066	4.458	4.448	5.293	7.136
Portugal	9 000	12 500	16 000	16 200	16 300	16 100	15 600	7.2	4.002	7.985	7.592	10.797	12.739	15.653	17.409
Spain	11 600	15 600	23 500	23 900	22 700	22 700	22 300	22.9	13.85	8.275	11.3	20.075	21.65	25	26.875

Source: ECB

A.5 Summary statistics for sovereign yields and regression results

Figure 6: Yields on 10-years government bonds, zero coupon, countries that experienced sovereign debt crisis at lower extent

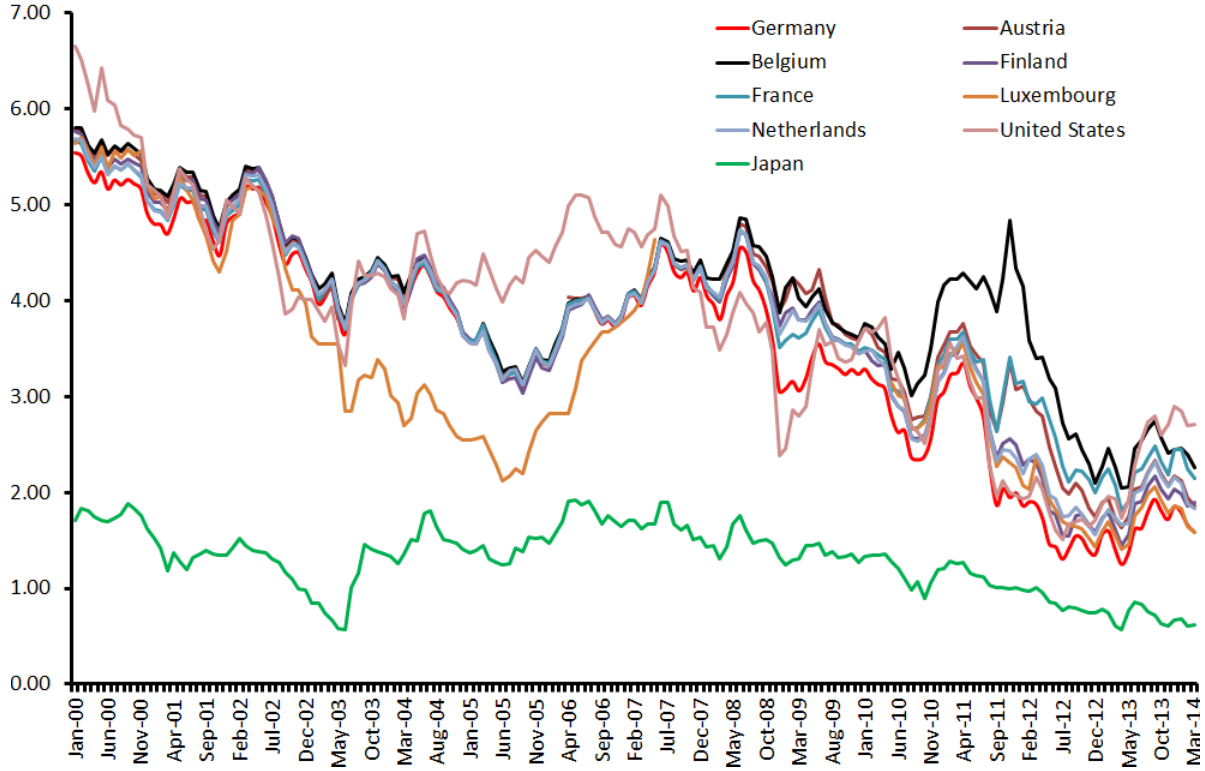


Figure 7: Yields on 10-years government bonds, zero coupon, countries that experienced sovereign debt crisis

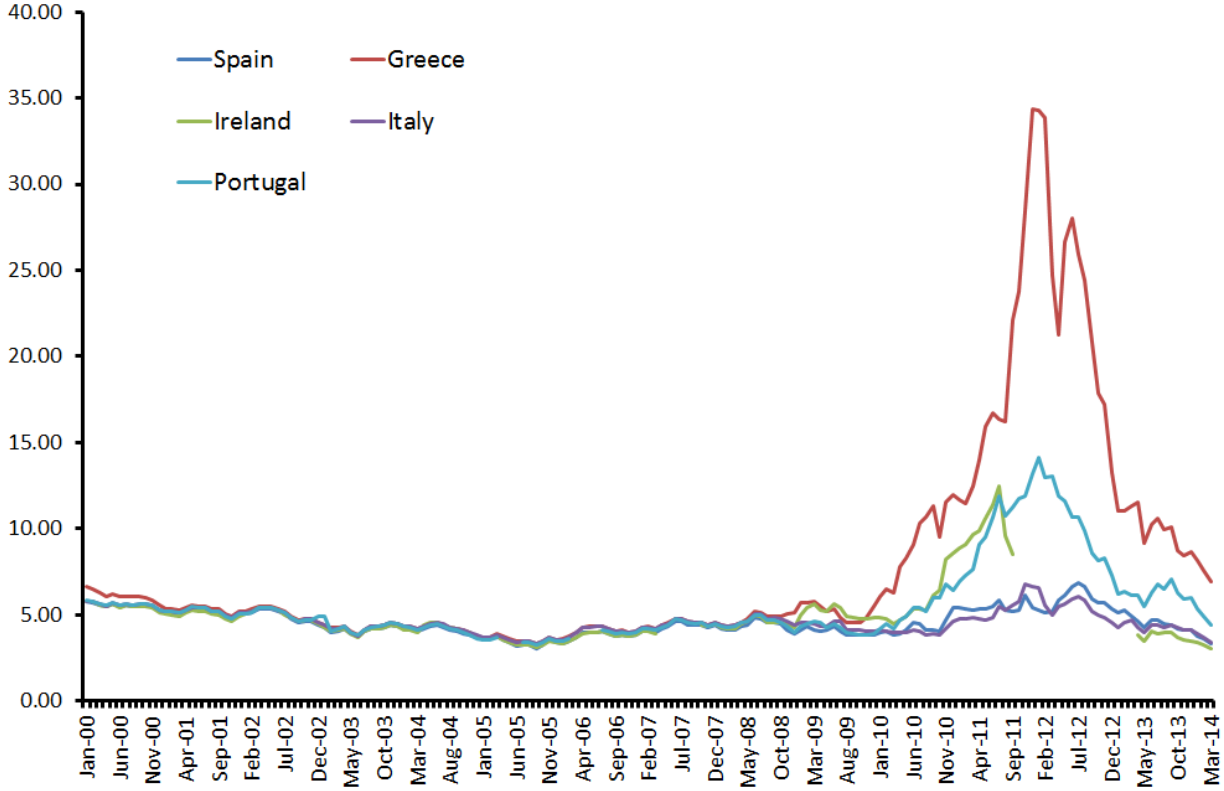


Figure 8: Yield differential between high yield countries and Germany, 10-years government bonds, zero coupon

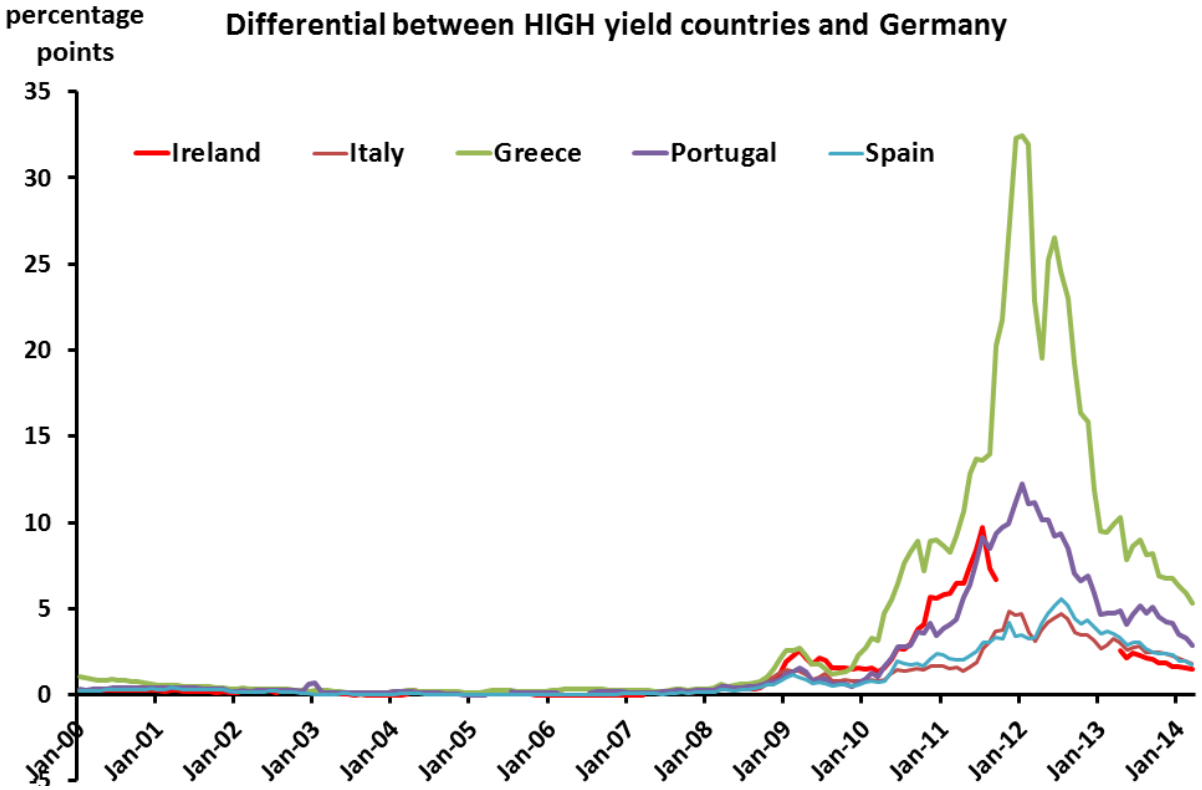


Figure 9: Yield differential between high yield countries and the US, 10-years government bonds, zero coupon

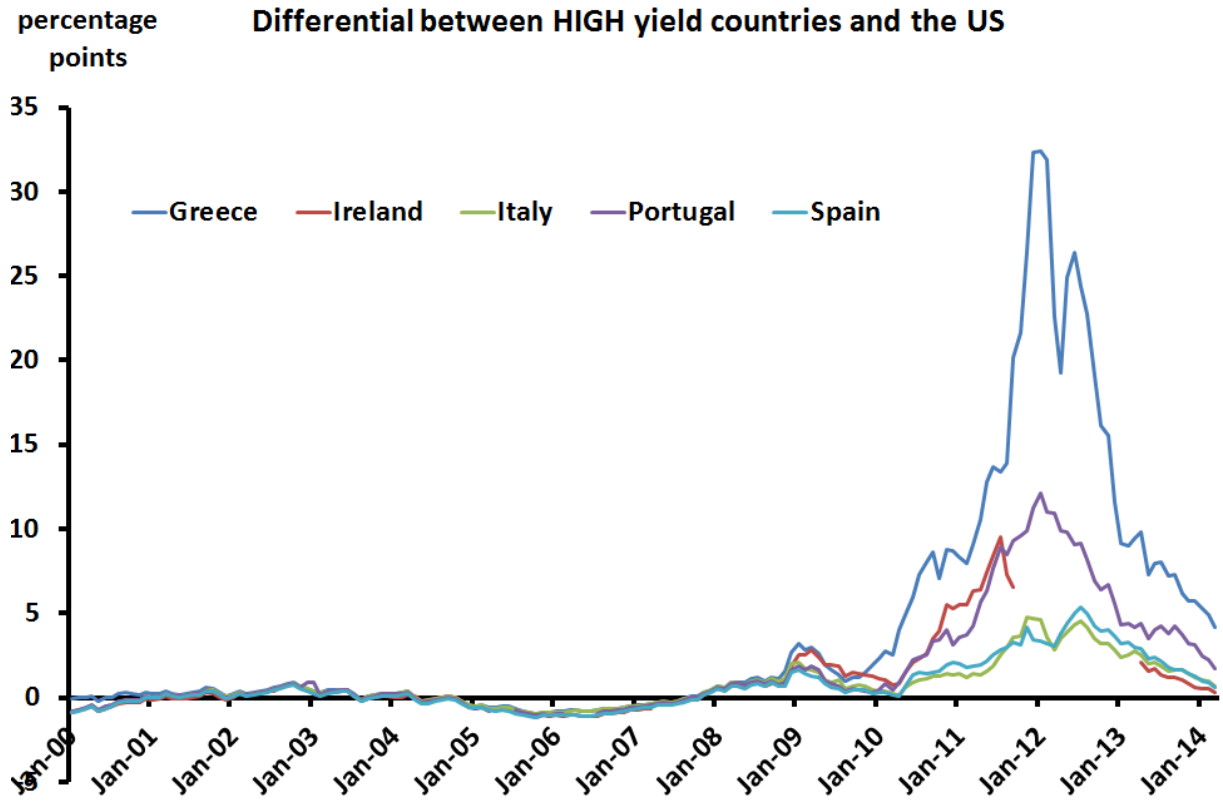


Figure 10: Yield differential between low yield countries and Germany, 10-years government bonds, zero coupon

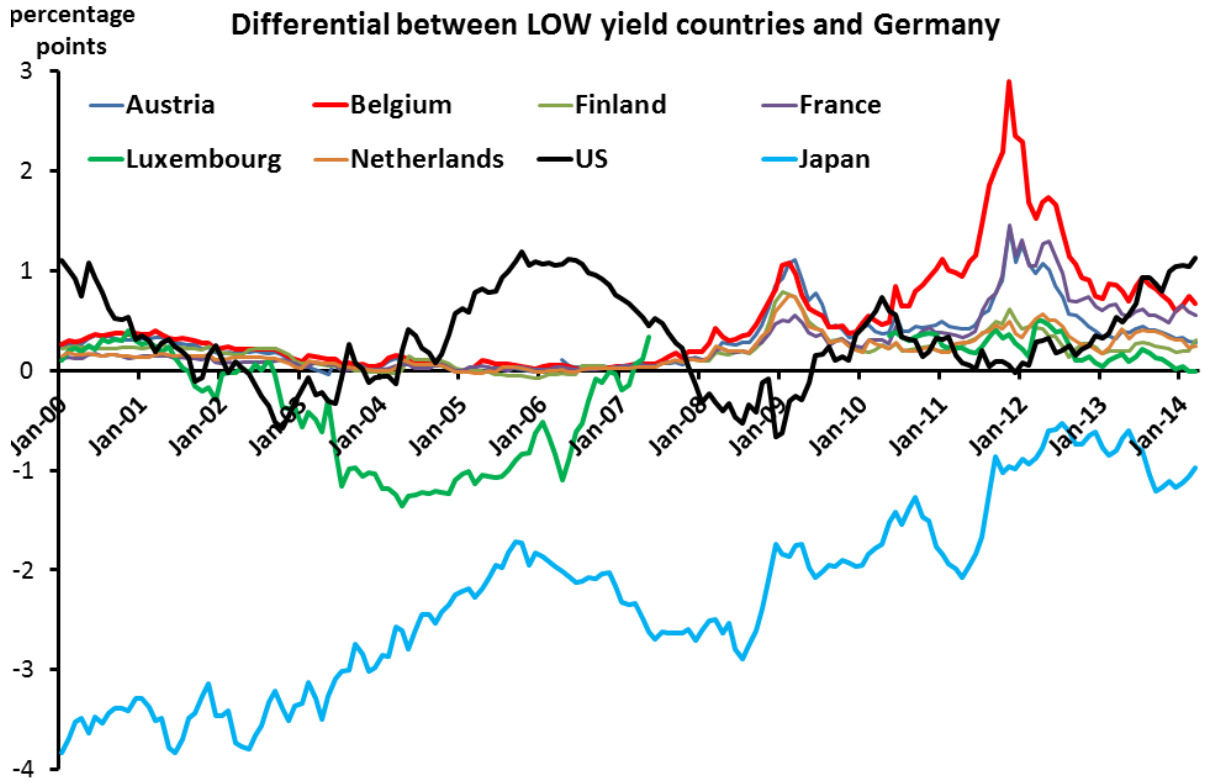


Figure 11: Yield differential between low yield countries and the US, 10-years government bonds, zero coupon

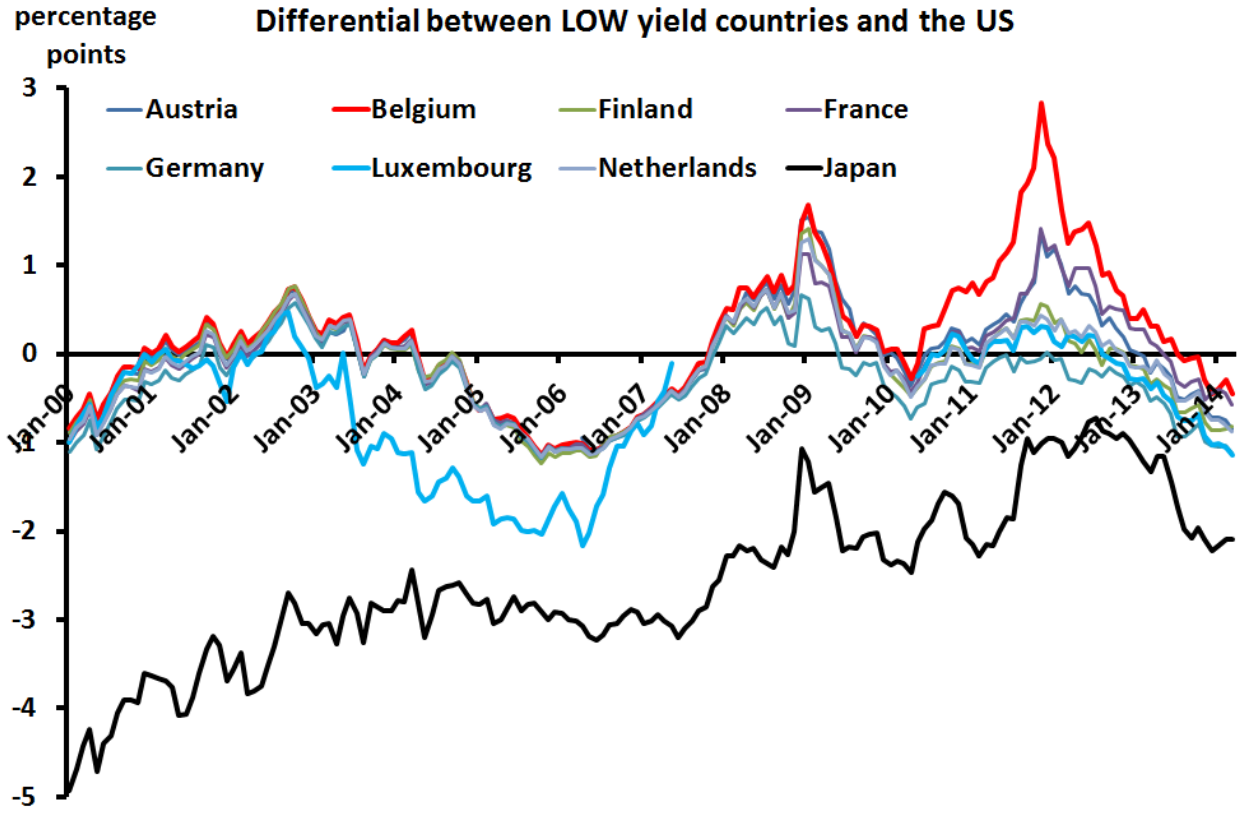


Table 15: Yields on 10 years government bonds, zero coupon, 2000-2014

Country	obs.	st.dev.	mean	median	min	max
Belgium	171	0.88	4.04	4.12	2.05	5.81
month/year	-	-	-	-	*Apr/2013*	*Jan/2000*
France	171	0.93	3.83	3.89	1.81	5.66
month/year	-	-	-	-	*Apr/2013*	*Jan/2000*
Austria	171	1.02	3.86	4.02	1.64	5.78
month/year	-	-	-	-	*Apr/2013*	*Feb/2000*
Netherlands	171	1.06	3.74	3.9	1.56	5.69
month/year	-	-	-	-	*Dec/2012*	*Jan/2000*
Finland	171	1.1	3.75	3.9	1.45	5.77
month/year	-	-	-	-	*Apr/2013*	*Jan/2000*
Germany	171	1.14	3.56	3.8	1.25	5.54
month/year	-	-	-	-	*Apr/2013*	*Jan/2000*
United States	171	1.16	3.87	4.02	1.5	6.65
month/year	-	-	-	-	*July/2012*	*Jan/2000*
Luxembourg	171	1.23	3.31	3.06	1.41	5.7
month/year	-	-	-	-	*Apr/2013*	*Feb/2000*
Japan	171	0.35	1.3	1.35	0.57	1.92
month/year	-	-	-	-	*Apr/2013*	*May/2006*
Italy	171	0.68	4.59	4.47	3.29	6.8
month/year	-	-	-	-	*Sept/2005*	*Nov/2011*
Spain	171	0.76	4.55	4.38	3.07	6.86
month/year	-	-	-	-	*Sept/2005*	*July/2012*
Ireland	171	1.59	4.87	4.54	3.04	12.5
month/year	-	-	-	-	*Apr/2014*	*July/2011*
Portugal	171	2.27	5.57	4.76	3.23	14.09
month/year	-	-	-	-	*Sept/2005*	*Jan/2012*
Greece	171	6.38	7.78	5.2	3.31	34.33
month/year	-	-	-	-	*Sept/2005*	*Dec/2011*

Source: Banque centrale du Luxembourg, monthly data, period: January, 2000 – March, 2014

Table 16: Correlation coefficients of yields between countries

	Austria	Belgium	Finland	France	Germany	Greece	Ireland	Italy	Luxembourg	Netherlands	Portugal	Spain	U.S.	Japan
Austria	1													
Belgium	0.9620*	1												
p-values	0.0000													
Finland	0.9912*	0.9322*	1											
p-values	0.0000	0.0000												
France	0.9927*	0.9598*	0.9892*	1										
p-values	0.0000	0.0000	0.0000											
Germany	0.9700*	0.8948*	0.9899*	0.9773*	1									
p-values	0.0000	0.0000	0.0000	0.0000										
Greece	-0.5040*	-0.2883*	-0.5912*	-0.4940*	-0.6413*	1								
p-values	0.0000	0.0001	0.0000	0.0000	0.0000									
Ireland	0.097	0.2795*	0.0515	0.0661	-0.0199	0.7693*	1							
p-values	0.2442	0.0006	0.5354	0.4263	0.8105	0.0000								
Italy	0.3398*	0.5319*	0.2494*	0.3564*	0.1713*	0.5584*	0.4919*	1						
p-values	0.0000	0.0000	0.001	0.0000	0.025	0.0000	0.0000							
Luxembourg	0.9400*	0.9226*	0.9297*	0.9367*	0.9000*	-0.4237*	0.2280*	0.4137*	1					
p-values	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0138	0.0000						
Netherlands	0.9893*	0.9258*	0.9988*	0.9883*	0.9916*	-0.6017*	0.039	0.2400*	0.9268*	1				
p-values	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.6391	0.0016	0.0000					
Portugal	-0.3751*	-0.1416	-0.4618*	-0.3607*	-0.5152*	0.9530*	0.8389*	0.6527*	-0.3011*	-0.4716*	1			
p-values	0.0000	0.0704	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0005	0.0000				
Spain	0.1282	0.3138*	0.0539	0.1530*	-0.0091	0.6127*	0.6580*	0.9012*	0.2766*	0.049	0.7048*	1		
p-values	0.0958	0.0000	0.4842	0.0457	0.9056	0.0000	0.0000	0.0000	0.0011	0.5244	0.0000			
U.S.	0.8595*	0.7640*	0.8884*	0.8753*	0.9224*	-0.6604*	-0.1401	0.0584	0.8357*	0.8935*	-0.5409*	-0.0964	1	
p-values	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0905	0.448	0.0000	0.0000	0.0000	0.2098		
Japan	0.7105*	0.6293*	0.7092*	0.6943*	0.7243*	-0.4880*	-0.0328	0.0467	0.6124*	0.7127*	-0.4216*	-0.1371	0.7789*	1
p-values	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.6931	0.5442	0.0000	0.0000	0.0000	0.0738	0.0000	

Table 17: Summary statistics for regression variables, 1st part

	Country	Obs	Mean	Std. Dev.	Min	Max
Yields (%)	Austria	170	3.862	1.022	1.637	5.776
	Belgium	171	4.045	0.884	2.046	5.806
	Finland	171	3.746	1.1	1.448	5.766
	France	171	3.828	0.925	1.814	5.664
	Germany	171	3.561	1.139	1.251	5.544
	Greece	171	7.781	6.384	3.306	34.334
	Ireland	147	4.87	1.59	3.044	12.504
	Italy	171	4.594	0.68	3.293	6.796
	Japan	171	1.304	0.349	0.565	1.919
	Luxembourg	136	3.314	1.232	1.41	5.705
	Netherland	171	3.744	1.058	1.56	5.691
	Portugal	164	5.573	2.274	3.232	14.091
	Spain	171	4.546	0.758	3.069	6.86
	US	171	3.873	1.163	1.504	6.649
Spread to Germany (percentage points)	Austria	170	0.301	0.291	-0.035	1.426
	Belgium	171	0.484	0.526	-0.008	2.889
	Finland	171	0.184	0.164	-0.075	0.786
	France	171	0.267	0.306	-0.007	1.46
	Greece	171	4.22	7.167	0.102	32.455
	Ireland	147	1.105	1.889	-0.04	9.719
	Italy	171	1.032	1.222	0.098	4.847
	Japan	171	-2.257	0.918	-3.833	-0.531
	Luxembourg	136	-0.208	0.555	-1.359	0.494
	Netherland	171	0.182	0.164	-0.028	0.744
	Portugal	164	2.015	3.04	-0.021	12.231
	Spain	171	0.984	1.374	-0.021	5.554
	US	171	0.312	0.454	-0.669	1.184
Spread to US (percentage points)	Austria	170	-0.006	0.596	-1.171	1.548
	Belgium	171	0.172	0.751	-1.142	2.839
	Finland	171	-0.127	0.538	-1.242	1.411
	France	171	-0.045	0.57	-1.148	1.41
	Germany	171	-0.312	0.454	-1.184	0.669
	Greece	171	3.908	7.205	-0.983	32.381
	Ireland	147	0.787	1.99	-1.163	9.519
	Italy	171	0.721	1.313	-0.991	4.797
	Japan	171	-2.569	0.918	-4.936	-0.729
	Luxembourg	136	-0.604	0.717	-2.163	0.465
	Netherland	171	-0.129	0.523	-1.165	1.302
	Portugal	164	1.732	3.072	-1.062	12.157
	Spain	171	0.673	1.448	-1.205	5.356
General risk aversion	Baa Aaa spread	171	1.098	0.475	0.55	3.38
	VIX	171	21.318	8.797	10.818	62.64
Liquidity risk: outstanding amounts of public debt (USD bil.)	Austria	171	185.068	50.439	100.412	264.11
	Belgium	171	360.739	82.303	221.002	486.177
	Finland	171	76.536	21.537	48.861	126.456
	France	171	1367.686	523.999	567.712	2245.742
	Germany	171	1473.935	510.845	650.837	2244.163
	Greece	171	218.894	103.189	83.748	400.347
	Ireland	171	62.436	46.767	11.126	156.529
	Italy	171	1705.784	434.089	984.062	2382.407
	Japan	171	6980.154	2300.236	3940.214	11703.71
	Luxembourg	171	2.169	2.511	0	8.344
	Netherland	171	303.82	94.009	158.893	479.278
	Portugal	171	114.813	47.361	43.07	200.918
	Spain	171	562.637	253.075	267.354	1131.11
	US	171	8256.608	3500.276	4132.91	14818.63

Table 18: Summary statistics for regression variables, 2nd part

	Country	Obs	Mean	Std. Dev.	Min	Max
Credit risk:	Austria	168	67.591	4.457	60.223	74.42
debt	Belgium	168	96.409	6.247	84.006	107.779
to GDP ratio	Finland	168	44.754	6.56	33.939	58.022
	France	168	72.343	12.313	56.942	93.464
	Germany	168	70.589	7.993	59.142	82.44
	Greece	168	124.859	28.274	97.444	175.735
	Ireland	168	58.888	37.023	24.604	123.341
	Italy	168	112.725	9.692	103.277	132.266
	Japan	171	196.584	30.281	140.145	243.544
	Luxembourg	168	12.103	6.482	6.07	22.895
	Netherland	168	57.668	8.965	45.295	74.417
	Portugal	168	78.602	26.112	48.359	123.8
	Spain	168	57.376	17.577	36.301	93.706
	US	171	76.665	19.319	53	107.315
Credit risk:	Austria	168	2.287	1.259	-0.819	4.866
current account	Belgium	168	1.271	2.014	-1.602	4.474
to GDP ratio	Finland	168	3.143	3.387	-1.778	8.459
	France	168	-0.547	1.243	-2.186	1.756
	Germany	168	4.76	2.43	-1.732	7.45
	Greece	168	-8.203	3.871	-14.922	-0.986
	Ireland	168	-0.899	2.717	-5.642	4.422
	Italy	168	-1.228	1.093	-3.513	0.273
	Japan	171	2.861	1.026	1.014	4.869
	Luxembourg	168	8.627	2.094	5.357	13.223
	Netherland	168	6.883	2.751	2.044	10.867
	Portugal	168	-7.956	3.891	-12.638	0.907
	Spain	168	-4.727	3.201	-9.995	1.434
	US	171	-3.975	1.067	-5.762	-2.647
Credit risk:	Austria	171	1.503	1.553	-3.822	3.706
GDP growth (%)	Belgium	168	1.274	1.306	-2.787	3.669
	Finland	168	1.562	2.868	-8.539	5.335
	France	168	1.114	1.334	-3.147	3.68
	Germany	168	1.177	1.845	-5.085	3.886
	Greece	168	0.234	4.474	-7.105	5.944
	Ireland	168	2.445	3.618	-6.384	10.648
	Italy	168	0.091	1.908	-5.494	3.654
	Japan	171	0.963	1.719	-5.527	4.652
	Luxembourg	168	2.491	2.579	-4.073	8.441
	Netherland	168	0.97	1.814	-3.668	3.941
	Portugal	168	0.145	1.723	-3.238	3.916
	Spain	168	1.43	2.4	-3.832	5.053
	US	171	1.846	1.448	-2.802	4.091
Credit risk:	Austria	168	4.42	0.415	3.6	5.2
unemployment	Belgium	168	7.808	0.549	6.667	8.7
	Finland	168	8.182	0.799	6.367	9.783
	France	168	9.233	0.839	7.775	10.953
	Germany	168	8.098	1.783	5.467	11.208
	Greece	168	13.24	6.218	7.654	26.986
	Ireland	168	8.208	4.481	3.93	14.672
	Italy	168	8.61	1.706	6.108	12.5
	Japan	171	4.598	0.444	3.833	5.358
	Luxembourg	168	4.446	1.373	2.2	6.563
	Netherland	168	4.367	1.214	2.544	7.136
	Portugal	168	9.222	4.094	4.002	17.409
	Spain	168	15.226	6.373	8.275	26.875
	US	171	6.536	1.738	3.967	9.625

Table 19: Summary statistics for regression variables, 3nd part

	Country	Obs	Mean	Std. Dev.	Min	Max
Credit risk:	Austria	168	2.066	0.595	0.401	3.552
inflation (%)	Belgium	168	2.166	0.75	-0.009	4.492
	Finland	168	2.043	0.909	0.14	3.914
	France	168	1.83	0.523	0.102	3.161
	Germany	168	1.708	0.508	0.234	2.754
	Greece	168	2.751	1.355	-0.8	4.713
	Ireland	168	2.145	1.811	-1.706	5.254
	Italy	168	2.145	1.811	-1.706	5.254
	Japan	171	-0.177	0.652	-1.342	2.852
	Luxembourg	168	2.31	0.55	0.764	3.5
	Netherland	168	2.696	0.791	0.014	4.09
	Portugal	168	2.305	1.019	0.93	5.111
	Spain	168	2.388	1.179	-0.903	4.41
	US	171	2.345	0.871	-0.32	3.815
Credit risk:	Austria	168	93.75	2.977	86	95
S&P rating	Belgium	168	86.321	1.162	84	87
	Finland	168	93.893	2.429	88	95
	France	168	93.607	3.328	85	95
	Germany	168	94.964	0.129	94.5	95
	Greece	168	65.095	16.299	24	77
	Ireland	168	86.298	11.697	66	95
	Italy	168	78.107	6.462	64	85
	Japan	171	84.105	3.22	82	95
	Luxembourg	168	94.893	0.28	94	95
	Netherland	168	94.321	2.056	87	95
	Portugal	168	76.589	11.224	54	85
	Spain	168	85.821	10.495	62	95
	US	171	93.035	3.633	86	95

Table 20: Regression results

		Whole sample			High yield countries	Low yield countries
Panel A:		2000 - 2013	2000 - Aug, 2007	Sept, 2007 - 2013	2000 - 2013	2000 - 2013
Liquidity		-.0002***	.0003**	0.0002	-.0043***	-.0001***
(std.err.)		(0.000)	(0.000)	(0.000)	(0.001)	(0.000)
Baa-Aaa spread		.9121***	-0.0104	0.5545	2.0958***	.1781***
(std.err.)		(0.187)	(0.065)	(0.35)	(0.433)	(0.048)
VIX		-.0162*	0.0006	-0.0143	-.0373*	-.00459*
(std.err.)		(0.007)	(0.002)	(0.012)	(0.017)	(0.002)
Debt/GDP	National	.0385***	.0156***	0.0119	-.0361**	.024***
	(std.err.)	0.004	0.001	0.011	0.011	0.001
	Germany	.0645***	-.0421*	0.1059	.2751***	.0166***
	(std.err.)	(0.018)	(0.021)	(0.109)	(0.048)	(0.005)
Current account/GDP	National	.0842***	.0302***	0.0147	.573***	-.0123*
	(std.err.)	(0.022)	(0.005)	(0.052)	(0.065)	(0.005)
	Germany	-.1157*	-0.0138	2.646***	-.2884*	-0.002
	(std.err.)	(0.052)	(0.01)	(0.386)	(0.121)	(0.014)
GDP growth	National	-.297***	-.0533***	-.2859***	-.5634***	-0.0127
	(std.err.)	(0.03)	(0.008)	(0.058)	(0.058)	(0.01)
	Germany	.1314**	.087***	-0.1024	.2172*	.0336**
	(std.err.)	(0.041)	(0.011)	(0.195)	(0.104)	(0.012)
Unemployment	National	.24***	-.0799***	.569***	-0.073	-.1636***
	(std.err.)	(0.026)	(0.009)	(0.063)	(0.058)	(0.013)
	Germany	0.0814	0.0559	0.4137	-.2919*	-.0426**
	(std.err.)	(0.051)	(0.039)	(0.454)	(0.136)	(0.014)
Inflation	National	0.00132	0.0211	-.3241**	-.2912**	0.034
	(std.err.)	(0.045)	(0.011)	(0.106)	(0.089)	(0.02)
	Germany	1.508***	-0.0377	1.7532**	3.6359***	-0.0079
	(std.err.)	(0.153)	(0.056)	(0.646)	(0.349)	(0.043)
Observations		2117	1180	937	809	1308
R-squared		0.54	0.5567	0.5806	0.6429	0.5643
Panel B:						
Liquidity		0.00013	.0008***	0.0001	-.0041***	-.00042***
(std.err.)		(0.000)	(0.000)	(0.000)	(0.001)	(0.000)
Baa-Aaa spread		1.2912***	-.2335***	1.1493***	2.7558***	.2883***
(std.err.)		(0.172)	(0.053)	(0.301)	(0.393)	(0.051)
VIX		-0.004	.0102***	-0.0171	-0.0126	.0069**
(std.err.)		(0.008)	(0.002)	(0.012)	(0.017)	(0.002)
Debt/GDP	National	.02745***	.00628***	0.01057	-.03422**	.01064***
	(std.err.)	(0.005)	(0.002)	(0.012)	(0.011)	(0.002)
	US	0.0306	0.0082	0.0012	0.0466	.0785***
	(std.err.)	(0.03)	(0.008)	(0.132)	(0.071)	(0.008)
Current account/GDP	National	.1089***	0.0013	0.0182	.3401***	-.0246***
	(std.err.)	(0.018)	(0.005)	(0.051)	(0.063)	(0.004)
	US	.6713***	.4173***	8.968***	1.931***	.154***
	(std.err.)	(0.083)	(0.036)	(1.303)	(0.222)	(0.024)
GDP growth	National	-.4366***	-.02244*	-.24386***	-.7736***	-.088***
	(std.err.)	(0.029)	(0.01)	(0.057)	(0.057)	(0.011)
	US	.399***	.0332*	1.134***	.912***	.0577***
	(std.err.)	(0.039)	(0.015)	(0.145)	(0.101)	(0.012)
Unemployment	National	.2106***	0.00136	.5566***	-0.08766	0.02266
	(std.err.)	(0.024)	(0.011)	(0.06)	(0.057)	(0.012)
	US	-.2714*	.6354***	-2.587***	-.7548**	-.1628***
	(std.err.)	(0.106)	(0.055)	(0.273)	(0.259)	(0.032)
Inflation	National	0.0454	-.0274*	-.2762**	-.1795*	.1637***
	(std.err.)	(0.043)	(0.013)	(0.104)	(0.086)	(0.022)
	US	.8485***	0.0165	1.744***	1.84***	-0.044
	(std.err.)	(0.086)	(0.042)	(0.198)	(0.222)	(0.03)
Observations		2120	1180	940	144	1311
R-squared		0.5664	0.8322	0.5698	0.6586	0.6842

Table 21: Robustness tests

	Relative values	Whole sample			High yield countries	Low yield countries
		2000 - 2013	2000 - Aug, 2007	Sept, 2007 - 2013	2000 - 2013	2000 - 2013
		1	2	3	4	7
Benchmark:	Germany					
	Liquidity	-.00024***	.00027***	0	-.0016**	-.00005***
	(std.err.)	0	0	0	0.001	0
	Baa-Aaa spread	.457***	-.068*	0.422	.878**	0.056
	(std.err.)	0.129	0.034	0.216	0.016	0.036
	VIX	-.0235***	0.0006	0.0213	-.04*	-0.0001
	(std.err.)	0.007	0.001	0.012	0.317	0.002
Spreads	Debt/GDP	.042***	.0166***	0.005	-0.0009	.0265***
relative to	(std.err.)	0.004	0.001	0.012	0.01	0.002
Germany:	Current account/GDP	.0697***	.0279***	-0.052	.2056***	-.0448***
	(std.err.)	0.014	0.003	0.048	0.039	0.004
	GDP growth	-.285***	-.094***	-.3018***	-.534***	-.0486***
	(std.err.)	0.027	0.006	0.055	0.058	0.01
	Unemployment	.172***	-.045***	.53***	.201***	.0285***
	(std.err.)	0.016	0.007	0.049	0.039	0.006
	Inflation	-.088*	.04***	-0.196	-.22*	.15***
	(std.err.)	0.044	0.011	0.11	0.09	0.021
	Observations	2117	1180	937	809	1308
	R-squared	0.5058	0.5242	0.4866	0.5645	0.444
Benchmark:	US					
	Liquidity	.0007***	.0004***	0.0003	0.00005	.0003***
	(std.err.)	0	0	0.0001598	0	0
	Baa-Aaa spread	.403**	.03***	0.323	0.35	.219***
	(std.err.)	0.124	0.054	0.0124863	0.288	0.002
	VIX	.030***	.254***	.0267*	0.029	.016***
	(std.err.)	0.007	0.002	0.2080867	0.015	0.038
Spreads	Debt/GDP	0.001	.012***	0.02	0.016	.006***
relative to	(std.err.)	0.004	0.002	0.0125289	0.01	0.001
US:	Current account/GDP	0.031	.032***	0.073	0.051	-.0273***
	(std.err.)	0.018	0.006	0.0532353	0.048	0.005
	GDP growth	-.53***	-.136***	-.557***	-.69***	-.103***
	(std.err.)	0.023	0.008	0.054066	0.048	0.009
	Unemployment	.306***	-.124***	.34***	.30***	-.04***
	(std.err.)	0.021	0.013	0.0488611	0.041	0.01
	Inflation	.091*	.113***	-.58***	0.02	.153***
	(std.err.)	0.041	0.015	0.0995335	0.08	0.021
	Observations	2120	1180	940	809	1311
	R-squared	0.5	0.6825	0.4655	0.5867	0.6275

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