Banking and Sovereign Risk in the Euro Area

Stefan Gerlach, Alexander Schulz and Guntram B. Wolff

Abstract

Banking and Sovereign Risk in the Euro Area*

We study the determinants of sovereign bond spreads in the euro area since the introduction of the euro. We show that an aggregate risk factor is a main driver of spreads. This factor also plays an important indirect role for risk spreads through its interaction with the size and structure of national banking sectors. When aggregate risk increases, countries with large banking sectors and low equity ratios in the banking sector experience greater widening in yield spreads, suggesting that financial markets perceive a larger risk that governments will have to rescue banks, increasing public debt and therefore sovereign risk. Moreover, government debt levels and forecasts of future fiscal deficits are also significant determinants of sovereign spreads.

Keywords: sovereign bond markets, banking, liquidity, EMU

JEL-Classification: E43, E44, G12

Stefan Gerlach
Johann Wolfgang Goethe University
Faculty of Economics and Business Administration,
Mertonstr. 17/Box 55
60054 Frankfurt am Main
Germany
Email: stefan.gerlach@wiwi.uni-frankfurt.de

Guntram B. Wolff
Deutsche Bundesbank
Research Centre
Wilhelm-Epstein-Str. 14
60431 Frankfurt / Main
Germany
Email: guntram.wolff@gmx.de

Alexander Schulz
Deutsche Bundesbank
Financial Stability Department
Wilhelm-Epstein-Str. 14
60431 Frankfurt / Main
Germany
Email: alexander.schulz@bundesbank.de

* We thank Wolfgang Lemke, Ralph Setzer, participants of the Bundesbank-ECB-CFS Workshop on Macro and Finance 2009, the ECB Public Finance Workshop 2010 and seminar audiences at Banque de France and Deutsche Bundesbank. All remaining errors are ours. The opinions expressed in this paper do not necessarily reflect the opinions of the Deutsche Bundesbank or its staff.

Banking and Sovereign Risk in the Euro Area

1 Introduction

Much attention has been focussed on the recent surge in sovereign bond yields in the euro area. While the spread of ten-year bond yields against Germany averaged 15 basis points between the introduction of the euro in January 1999 and August 2008, they rose sharply in the financial crisis. Here, Irish and Greek government bonds traded with particularly high premia above the German Bund. Such levels have previously been associated with emerging market debt.

In this paper we seek to understand what factors have been driving these spreads. Noting that the current financial crisis is centered on the financial sector, in particular the banking sector, we argue that bank and sovereign risk has become increasingly interconnected. In particular, after the collapse of Lehman Brothers in September 2008, many if not most governments in the euro area adopted financial sector rescue packages of unprecedented size. For instance, the Irish government issued guarantees covering liabilities of more than 200 percent of GDP.[1] But even before the announcement of such explicit guarantees, investors arguably believed that major banks across Europe enjoyed an implicit – and free – government guarantee simply because the economic consequences of the failure of a systemically important institution was seen as being potentially disastrous. Since government rescues typically lead to large increases in public debt, episodes in which investors are concerned that a banking crisis might erupt are frequently associated with increase perceptions of default risk and thus in sovereign spreads.

In the paper we focus on two key questions. First, is the size of the banking sector, as measured by total assets, a determinant of sovereign spreads? Since the potential for losses in the banking sector depends on its size, we expect a positive relationship between banking sector size and sovereign risk.

[1] For a comprehensive overview of state aid, see the European Commission's web page at http://europa.eu/rapid/pressReleasesAction.do?reference=MEMO/09/111. Attinasi et al. (2009) provide an aggregated synopsis. According to estimates of the ECB (2009), the fiscal impact of the current crisis-related interventions in the banking sector is substantial. While the direct impact amounts to 3.3% of GDP as of May 2009, contingent liabilities provided amount to 7.5% and the announced ceiling on contingent liabilities is slightly below 20% of GDP. Beyond these costs, banking crises entail substantial losses of tax revenue.

Second, the potential cost of a banking sector bailout depends not only on what is at stake, but also on the probability that a bailout will be necessary. Generally, banking sectors with larger equity to liability ratios are less likely to need government support since banks with larger equity cushions are better able to absorb losses arising from bad assets. Furthermore, larger equity ratios increase shareholders exposure to losses and thus improve incentives for more careful investment decisions (see, for example, Haldane 2009). We therefore use the equity-to-asset ratio as a measure of the risk that banks will ask for government support.

However, while it is easy to see that in situations of financial instability, a large banking sector is a source of financial risk to governments, in good economic times a large banking sector can be a source of government revenue and driver of economic growth. The impact of banking sector size on spreads is therefore likely to depend on the state of the economy, including investors' willingness to hold risky assets. Yield spreads are therefore likely to fluctuate over time.

In our estimations we include a number of other variables and show that fiscal policy and liquidity factors impact on sovereign spreads. We demonstrate that our results are neither sensitive to exactly how liquidity and risk are measured, nor to the choice of specification of the regression equations. All-in-all, we establish that country-specific risk factors, apart from liquidity risk, contribute to sovereign spreads.

The remainder of the paper is structured as follows. The next section reviews the literature on sovereign bond spreads in EMU. Section 3 outlines our empirical approach before turning to the data set in Section 4. Section 5 presents the main estimation results. Section 6 provides an extensive robustness analysis while the last section concludes.

2 Related Literature

In this section, we briefly review some of relevant literature on sovereign spread determinants, which has mainly focussed on the role of aggregate risk, liquidity risk and a country's fiscal position. It is established in the literature that measures of general perception of risk and investors' willingness to bear risk are important determinants of sovereign bond spreads in Europe. Favero et al. (1997) identify a common trend for Spanish and Italian interest rate spreads against Germany. They go on to show that it is driven by international risk factors and that it accounts for a large fraction of the variation of spreads.

Codogno et al. (2003), using data from 1992 to 2002, confirm that an international risk factor, proxied by the US swap spread or spreads between US corporate bond spreads – the difference in the yields on US corporate bonds and treasury securities of similar maturity – is an important driver of European bond spreads. In contrast, liquidity only plays a minor role.[2] This result is robust both to the choice of sample and estimation strategy: Geyer et al. (2004) study data for Austria, Belgium, Germany, Italy and Spain and come to similar conclusions, using state space techniques. Longstaff et al. (2007) focus on sovereign Credit Default Swaps instead of bond yields and find that excess returns from investing in sovereign credit stem primarily from the associated global risk, while country-specific risk factors are hardly remunerated. Manganelli and Wolswijk (2009) use the short term interest rate to identify aggregate risk and argue that low interest rates result in compression of sovereign spreads if investors have absolute return objectives.

Turning to liquidity, Gomez-Puig (2006) finds that greater liquidity of sovereign bonds results in lower sovereign spreads during 1996-2001. Favero et al. (2009) provide both theoretical justification for, and empirical evidence of, a role of liquidity in the determination of sovereign risk spread and how it may interact with the aggregate risk factor. In a sample spanning 2002 and 2003, they confirm the role of the aggregate risk factor and demonstrate that liquidity is only significant when interacted with the aggregate risk factor. Thus, liquidity has a smaller effect on sovereign spreads in periods in which the level of risk is high. The total effect of liquidity risk on sovereign risk is thus negative in periods of high aggregate risk. This is explained by a reduced set of alternative investment opportunities limiting the willingness of investors to move away from bonds. Therefore, although in general investors value liquidity, they value it less when risk increases. In contrast, Beber et al (2009) find that liquidity considerations are more important during episodes of market stress in a sample covering 2003 and 2004.[3]

Turning to the literature on fiscal policy and sovereign spreads, Bernoth et al. (2004) study changes in the European bond market in the period 1991-2002 and find that debt, deficits and debt-service ratios all have a positive impact on sovereign spreads. Schuknecht et al. (2009) extend the study to regional government debt and show that regions also pay higher risk premia when fiscal fundamentals are weak. Heppke-Falk and Wolff (2008) and Schulz and Wolff (2009) study the German sub-national bond market in detail and

[2] The swap spread is defined as the difference between the US dollar (fixed for floating) swap rate and the yield on US Treasuries with identical maturity.

[3] They employ a rich orderbook data set from the electronic trading platform MTS. However, in their specification no aggregate risk factor is accounted for.

find weak evidence of market reaction to fiscal fundamentals. Hallerberg and Wolff (2008) also find that fiscal conditions impact on bond yields but show that the effect has become weaker following the introduction of the euro. However, when controlling for the quality of fiscal institutions as measured by indices computed by Hallerberg et al. (2007), no weakening effect of fiscal policy on spreads is detected. Bernoth and Wolff (2008) document that sovereign bond markets also react to hidden fiscal policy items, the ”creative accounting” as defined in von Hagen and Wolff (2006) and Koen and van den Noord (2005). Moreover, they document that governments/countries with greater transparency index scores pay lower interest rate premia.

Overall, the existing literature suggests that aggregate risk, liquidity and fiscal variables impact on sovereign risk spreads. However, much of the previous literature has focussed on the effects of the euro introduction, with comparatively short samples, which covered benign economic times. Moreover, the role of banking problems as a driver of governments' fiscal positions and their role as determinants of spreads not only in the crisis but since the introduction of the euro has been neglected so far. This is what we do next.

3 Empirical approach

3.1 The model

As noted above, the literature has established that an aggregate risk factor plays a crucial role in the dynamics of sovereign bond spreads in EMU 12. To illustrate this, we perform a simple principal component analysis on the 10 bond yield spreads, relative to Germany.[4] Consistent with the view that aggregate risk is important, we find that the first component captures almost 96% of the variance. To allow for this feature of the data, we adopt a dynamic adjustment model which allows for persistence in spreads and has a common risk factor.

$$s_{i,t} = \rho_i s_{i,t-1} + (1-\rho_{ii})s^*_{i,t} + u_{i,t} \qquad (1)$$

[4] Luxembourg is excluded, Germany is the benchmark country.

where $s_{i,t} = r_{i,t} - r_{d,t}$ is the yield spread of bonds of country *i* to the benchmark German Bund yield ($r_{d,t}$) at time *t*. It depends on its lagged value and the equilibrium value of the spread, $s^*_{i,t}$. Furthermore, ρ_i is an autoregressive parameter and $u_{i,t}$ is the residual.[5]

We assume that $s^*_{i,t}$ is determined by a common risk factor Z_t, liquidity $L_{i,t}$, default risk $D_{i,t}$ and an interaction term as displayed in equation (2). The latter allows for a different impact of default risk depending on aggregate risk.[6]

$$s_{it} = b_{1,i}Z_t + b_{2,i}L_{i,t} + b_{3,i}D_{i,t} + b_{3,i}Z_tD_{i,t} \qquad (2)$$

Here, $L_{i,t} = \tilde{L}_{i,t} - L_{d,t}$ is the difference of bond specific market liquidity of country *i*'s bonds ($\tilde{L}_{i,t}$) and liquidity of German bonds; default risk is defined equivalently, relative to the benchmark *d* as $D_{i,t} = \tilde{D}_{i,t} - D_{d,t}$.

The estimation equation is therefore

$$s_{i,t} = \rho_i s_{i,t-1} + \beta_{1,i}Z_t + \beta_{2,i}L_{i,t} + \beta_{3,i}D_{i,t} + \beta_{3,i}Z_tD_{i,t} \qquad (3)$$

where $\beta_{j,i} = (1-\rho_i)b_{j,i}$ for j = 1, ... ,4.

We employ several different variables to capture time varying risk factor Z_t and liquidity risk, $L_{i,t}$. Country specific default risk, $D_{i,t}$ is proxied by total assets held by the banking sector relative to GDP, its equity ratio (equity in relation to total assets), government debt-to-GDP ratio and deficit forecasts. The data are described in the next section.

The interaction term allows the impact of banking sector size on sovereign risk to vary with aggregate risk. The idea is that aggregate risk determines the likelihood of banks to require public support and thus influence on the government's fiscal position. We concentrate on the impact of the banking sector as a whole on sovereign risk, hence we do not account for the distribution of assets within a given banking sector.[7]

It should be noted that our variables driving spreads are exogenous or predetermined. Thus, size of the banking sector reflects past decisions of banks and is thus predetermined in

[5] Note, that the short run effect of the equilibrium bond spread $s*_{it}$ on the current spread s_{it} is (1- ρ), while the long run adjustment is 1 by definition.

[6] We vary the specification and report results in Section 5.

equation (3). The same argument applies to our measure of the banking sector vulnerability, the equity ratio. Moreover, measures of common risk, such as the US corporate bond spread, are driven by global shocks and are exogenous.

3.2 Estimation

The estimation of the dynamic panel model raises several issues. Pesaran and Smith (1995) show that pooling the data in a dynamic setting gives inconsistent results if the coefficients differ across sections and the regressors are autocorrelated, which is the case here.[8] Fixed- and random effects models only incorporate panel-specific heterogeneity in the constant term; furthermore, a large time dimension is not sufficient to ensure consistency. We therefore first estimate the model with seemingly unrelated regressions (SUR), in which we obtain estimates for each country.[9] Since a Wald test rejects the hypothesis that the parameters are the same across economies, the homogeneity assumption is violated and pooling is not appropriate.

However, the coefficients appear to be broadly similar across countries. We therefore estimate the random coefficients model proposed by Pesaran and Smith (1995), which allows coefficients to differ across countries but assumes that they are drawn from a common distribution. Pesaran and Smith (1995) show that both an unweighted average of the coefficient estimates for each country as well as the generalized least squares weighted average of Swamy (1971) will yield consistent parameter estimates. We therefore follow their approach in estimating the model and perform various robustness analyses, as outlined in Section 6.

A further problem that arises in estimation is the fact that the series employed are recorded at different frequencies. Financial data are continuously available while macroeconomic information can be obtained at a monthly frequency at most. We reduce this gap by using weekly averages of financial data, which eliminates short term noise, but still captures rapid adjustments in financial markets. When estimating the models, we keep the lower frequency data constant until a new observation occurs (no interpolation). Statistically,

---

[7] While it is beyond the objectives of this paper to study the impact of bank heterogeneity on vulnerability of a banking sector, we recognise that it is an interesting research question.

[8] As shown by Pesaran and Smith (1995, eq. (2.5), p. 83), this effect arises because the error term comprises a component that is given by the deviation of the true, country-specific slope factor and the assumed common mean, times the regressors. If the latter are serially correlated, so will the error be, which, in the presence of a lagged dependent variable, will imply that the parameter estimates are inconsistent.

[9] See Table A-2 in the appendix.

the remaining mismatch is akin to a measurement problem, as, for example, banks balance sheet change at higher frequency than the information recorded on a monthly basis and the repeated values are therefore mis-measured. In what follows we ignore these measurement errors since we believe that they are negligible: one reason some variables are measured at a lower frequency than others is precisely that they do not change rapidly over short spans of time.[10]

4 Data

We use the euro area sovereign bond yields for Austria, Belgium, Germany, Spain, Finland, France, Greece, Ireland, Italy, the Netherlands and Portugal, thus considering all euro area countries except Luxembourg, which has little public debt outstanding and therefore no valuable yield data, and Cyprus, Malta, Slovakia and Slovenia, that is, the last four entrants to the euro.[11] Greece is included in the main sample following its accession in 2001.

We focus on bonds with a maturity of 10 years and use the German Bund as the benchmark, as it is common both in financial markets and in the academic literature.[12] Furthermore, all other variables are expressed in differences to the corresponding German ones.

Rather than using data on constructed yield indices as is common in the literature, we construct time series on yields, bid/ask spreads and the remaining time-to-maturity from single bond observations.[13] Thus, each observation triple is from the same bond. In doing so, only the observations from on-the-run bonds are used, as they are the most traded bonds with the smallest liquidity premia. We collect data for all euro-denominated bonds available on Bloomberg (including yield and bid/ask spreads) with an initial maturity of ten years. We focus only on on-the-run bonds, which carry a fixed coupon. Finally, data from 270 bonds are used for estimation. As explained in the last section, we employ weekly averages of these data.

[10] Greene (2003, pp. 83-90) discusses measurement errors in the multivariate regression model.
[11] The four countries only acceded 2007 or later.
[12] Dunne et al. (2007) provide econometric evidence for the benchmark role of the Bund in the 10 year segment.
[13] Since the remaining time to maturity varies in the sample, we follow Favero et al (2009) and control for the differences in the maturity between the bond of country *i* and the German bond *d* by including this difference in the regression equation.

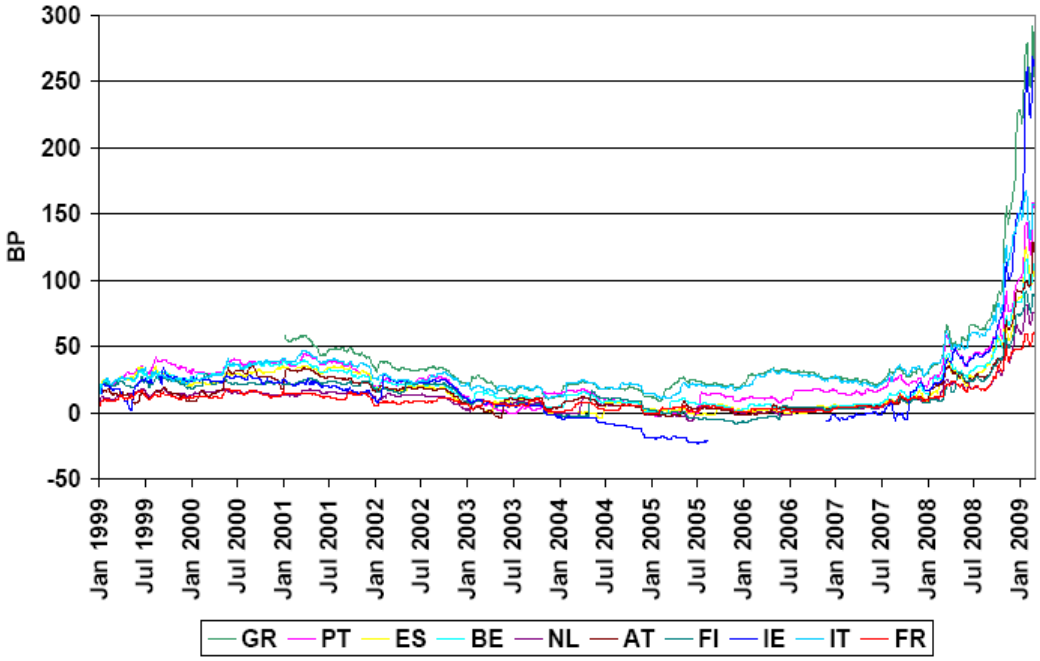


Figure 1: EMU 12 yield spreads to German Bund (without Luxembourg), 10 year bonds. Greece included as of accession in 2001.

The most striking pattern of euro area sovereign bond spreads is the convergence of yields before the inception of the single currency in 1999 and the widening of spreads from 2007 onwards. However, these large movements mask important developments that took place between those events. For example, around 2005 aggregate risk was exceptionally low and in fact the Irish ten year bond traded at lower a yield than the comparable German.[14]

Our main sample starts in January 1999 and ends in February 2009. This comparatively long period allows us to study the impact of macroeconomic variables, many of which are highly inertial, on government bond spreads. To explore the robustness of our findings, we also re-estimate the model with longer time series starting in 1997. In the pre-euro period, we follow Favero et al. (1997) and Gomez-Puig (2006) and control for exchange rates by subtracting the difference between the ten year rates of D-Mark swaps and those of the other currency in question from the sovereign bond spread. There is no swap correction within EMU, as there is no exchange rate risk and thus a single swap rate prevails.

We use four variables to capture sovereign default risk determinants; two are measures of public finances and two aim at potential liabilities related to the banking sector. Sovereign risk is affected by the banking sector by at least two channels. First, the government might be compelled to act as a lender of last resort or to recapitalize banks with public money, as

observed in many cases in 2008 and 2009. Second, Adrian and Shin (2009a) show the importance of financial intermediaries' balance sheet adjustments for aggregate liquidity and financial stability, which affect not only the government's fiscal position directly but also credit availability for the economy as a whole, which, in turn, affects government spending and revenue. Thus, we use the size of the banking sector's aggregate balance sheets (total assets-to-GDP ratio) and the equity ratio (equity-to-assets) as banking-related proxies for sovereign debt. While total assets are the natural upper bound to state rescue packages, the equity ratio is a measure for the vulnerability of the banking sector. The first measure should increase, and the second decrease, sovereign risk. The data are from the ECB's MFI data base, which is adjusted for statistical re-definitions and the inclusion of institutions in- or outside the banking sector. The levels are measured in percent of GDP. Both banking sector variables are measured monthly. An advantage of these statistics is their high degree of consistency both across time and countries (see Figures A-5 and A-6 in the appendix).

Debtors' capacity to repay loans is related to the size of their liabilities. Hence, we also include sovereign debt relative to GDP. However, the debt level of any given country in our sample varied relatively little during 1999-2008 compared to the cross-sectional level differences. This renders it difficult to estimate an effect of debt on yield spreads, as the cross-sectional differences are accounted for in the country-specific constants. Because bond yields are forward looking, we also include three-year-ahead deficit forecasts reported by the national governments to the European Commission,[15] the debt stock is from Eurostat.

[14] Figure A-3 in the Appendix depicts the Irish spread to the Bund and the aggregate risk factor. Results neither depend on Ireland nor Greece, as we show in the robustness section.

[15] The expected deficit can be interpreted as either a proxy for the change of debt or the ability of the government to meet obligations.

Table 1: Banking Assets

Country	Total assets held by banking sector relative to GDP
AT	380 %
BE	371 %
DE	317 %
ES	311 %
FI	213 %
FR	395 %
GR	191 %
IE	939 %
IT	235 %
NL	374 %
PT	290 %

Note: Data at the end of 2008. A time series representation is available in Figure A-5 in the appendix. Source: ECB / Eurostat.

Finding a good proxy for the aggregate risk factor is critical. Our main measure is the seven-to-ten year US corporate bond spread for the rating category BBB from Merill Lynch. The corporate bond spread is the yield differential to US treasuries (see Figure 1). We use the US spread since this is the most liquid corporate bond market, thus the tightness of financing conditions there gives a good indication of investors' willingness to fund projects and to take on risk (Codogno et al. 2003 and Geyer et al. 2004).

Besides the corporate bond spread, the swap spread and equity market volatility have been used in previous work to capture an aggregate risk factor. We inspect the robustness of our findings with these measures. In addition, we employ two alternative variables, the Ted spread, which is defined as three-month LIBOR vs. T-bill rate, and the Refcorp spread, which is defined as the spread between ten-year agency securities and treasuries; a detailed description is in the appendix.

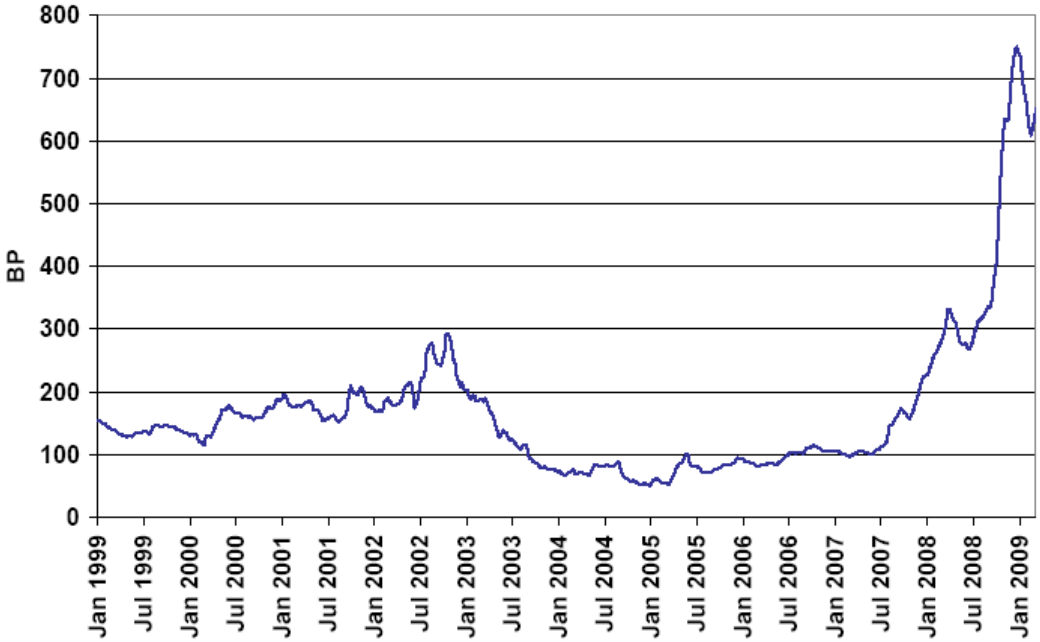


Figure 2: US corporate bond spread to government bonds for rating category BBB.

Finally, our main measure of liquidity is the bid/ask spread, which correspond directly to the sovereign bond yields. In addition, we proxy the liquidity of a country's sovereign bond market with the total amount of outstanding bonds by that issuer. Finally, we target trading activity directly. From September 2007 on, we obtain actual turnover from the electronic trading platform system MTS. A more detailed discussion of liquidity measures is provided in the appendix.

5 Results

5.1 Main findings

Table 2 presents our main regression results. These warrant several comments. First, the parameter on the common risk factor, as measured by the US corporate bond spread, is highly significant and of plausible magnitude. Regression A indicates that if the corporate bond spread increases by 1 basis point, the average spread of sovereign bonds in EMU increases by 0.01 basis points. Furthermore, an increase of the bid/ask spread by 1 basis point in bid/ask spread of country *i* relative to the German benchmark spread increases of the yield spread by 0.43 basis points, indicating that liquidity effects are relevant in EMU. Even though the coefficient on liquidity is larger by an order of magnitude, the risk factor is overall of far greater importance: whereas the standard deviation of the bid/ask spread in the sample is 0.75

basis points, it is 120 basis points for the corporate bond spread. All regressions include a lagged dependent variable and controls for time to maturity. The yield spreads are highly persistent as evidence by an autoregressive coefficient of 0.95, which is highly significant in all specifications.

In Regressions B and C we introduce the size of the banking sector relative to GDP, which on its own is not a determinant of spreads. However, when interacted with aggregate risk, it is significant. An F-test shows that the use of the interactive terms adds significant explanatory power to the model. Thus, economies with large banking sectors are more sensitive to the aggregate risk factor.

The interaction of the risk factor and banking sector size is both statistically and economically highly significant (Regression C). The direct effect of the size of banking sector balance sheets on sovereign spreads is negative. Thus, economies with large banking sectors tend of have lower yield spreads. However, the marginal effect of the size of bank assets to GDP on sovereign spreads is a function of the level of the aggregate risk factor (see Figure 3).

The fact that a large bank sector reduces spreads but exacerbates the impact of the risk factor on borrowing costs raises the question at what level of risk a larger banking sector increases the country's sovereign spreads. According to the point estimates, the marginal effect turns positive when the corporate bond spreads exceeds 200 basis points. Interestingly, this condition is frequently satisfied: the corporate bond spread is above this level during 38% of the sample period. The effect of banking on spreads is significantly different from zero for corporate bond spreads below 145 basis points or above 250 basis points. At an aggregate risk spread of 750 basis points, the highest observed in the recent period, a one percentage point larger banking sector relative to Germany translated into a widening of the sovereign spread by 0.13 basis points. While numerically small, this coefficient is of substantial economic magnitude since the size of the banking sector varies considerably across euro area member states. For Ireland, the country with the largest banking sector, up to 80 basis points of the sovereign spread would be attributable to the risk arising from the banking sector.

Table 2: Main estimation results

Regression	A	B	C	D	E	F	G
Yield Spread (-1)	**0.94*** **	**0.98*** **	**0.96*** **	**0.96*** **	**0.96*** **	**0.97*** **	**0.88*** **
	105.73	61.45	58.72	54.42	59.48	135.29	22.51
Time to maturity	**0.22**	**0.07**	**0.18**	**0.25**	**0.21**	**0.21** **	**0.65**
	1.51	0.66	1.17	1.61	1.48	2.27	0.98
Bid/ ask spread	**0.43*** **	**0.31** **	**0.23***	**0.32** **	**0.37*** **	**0.28*** **	**0.39**
	2.81	2.43	1.68	2.12	2.99	2.81	0.41
US Corp	**0.01*** **	**0.01*** **	**0.03***	**0.03**	**0.02**	**0.01**	**0.05***
	5.6	5.04	1.65	1.45	1.61	1.20	1.72
Bank assets[a]		**0.19**	**-3.51** **	**-2.81*** **	**-1.47** **	**-1.45***	**-6.79**
		0.64	-2.60	-2.84	-2.01	-1.75	-1.46
US Corp*bank assets[a]			**0.02** **	**0.02** **	**0.01** **	**0.01***	**0.03***
			2.37	2.02	1.99	1.65	1.69
Crisis (2007) dummy				**-1.98**			
				-0.45			
Crisis (2007) dummy *bank assets				**-0.04**			
				-1.5			
Crisis (Lehman) dummy					**36.74**		
					1.4		
Crisis (Lehman) dummy * bank assets					**0.09**		
					0.83		
N	4969	4969	4969	4969	4969	4122	827
Sample	full	full	full	full	full	pre-crisis	crisis

Notes: Dependent variable is the yield spread to German Bunds. EMU 12, without Luxembourg, Germany is benchmark. Greece included from 2001 on. Estimations A-E: 01 Jan 1999 to 28 Feb 2009, F: 01 Jan 1999 to 30 Jun 2007, G: 01 Jul 2007 to 28 Feb 2009. Data have weekly frequency, unless overstated otherwise. Bank assets are total assets held by the banking sector in each country (monthly frequency). The crisis dummy takes the value one as of 2007, the early onset of the financial crisis. The Lehman dummy is equal to unity from September 2008 on. Estimation method: Pesaran and Smith (1995) using Swamy (1971). t-values are below the coefficient estimates in bold. * (**,***) indicates significance at a 10 (5, 1) percent level. Estimation is with country fixed effects.

[a] Coefficients scaled up by factor 100.

As noted above, sovereign bonds spreads are highly persistent, implying that the long-run effects of permanent changes in the regressors are substantial.[16] From Regression C it follows that an increase of the size of a country's banking sector by one percentage point widens the sovereign spread by 3.4 basis points at an US corporate bond spread of 750 basis points (or still 1.4 basis points at an US corporate bond spread of 400 basis points). Even for a country with an average banking sector size this translates into a long term spread widening of 200 basis points. The government's funding conditions can thus worsen severely through the combination of aggregate and banking related risk.

[16] Given the dynamic nature of our model, the long-run coefficient is calculated by dividing the marginal coefficient by the difference of one and the lagged dependent variable's coefficient.

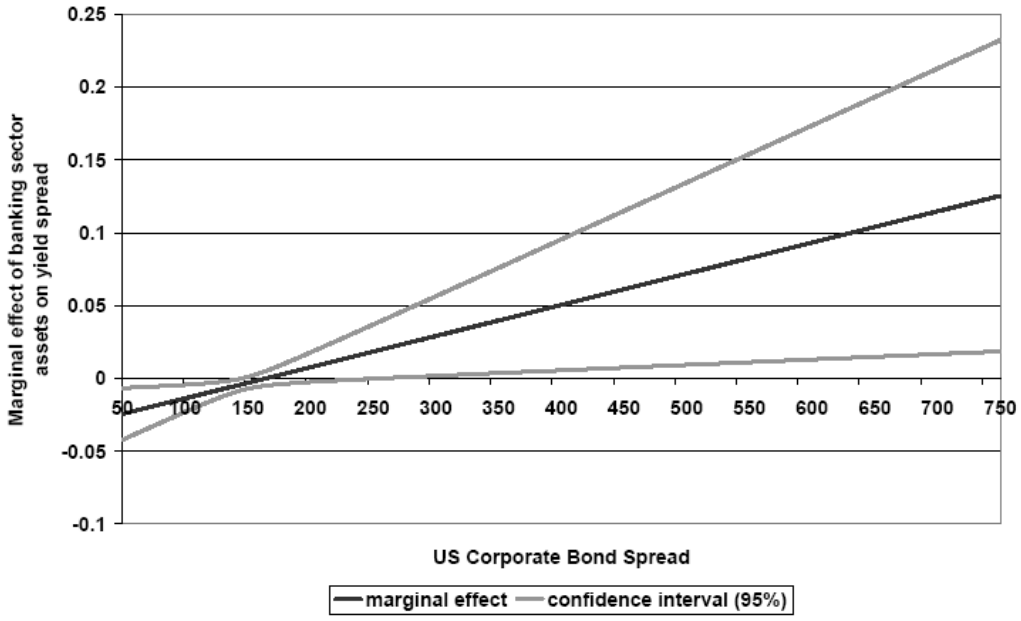


Figure 3: Marginal Effect. Computations are based on Regression C of Table 2. A 95% confidence band is shown; the marginal effect is statistically insignificantly different from zero when the US corporate bond spread is between 145 and 250 basis points.

In light of the severe recession and the large rise in sovereign spreads following the onset of the current financial crisis, it seems obvious that instability in the banking sector can have implications for the government's ability to service the public debt. However, to demonstrate that our results are not only an artefact of the current exceptional circumstances, we introduce in Regression D a dummy variable that equals unity from the first week of 2007 onward.[17] We interact this crisis dummy with the banking-related variables to assess the importance of banks size. The results are encouraging in that the interaction effects discussed previously remain significant while the crisis dummy and the interaction term are not significant. The same holds true when the crisis dummy is set to unity from the Lehman bankruptcy onwards (Regression E).

Moreover, we estimate the model separately for the period before the beginning of the crisis (up to June 2007) and for the period of the financial crisis only, i.e. from July 2007 to February 2009 (Regressions F and G). As can be seen, the coefficients are quite similar. We find, as expected, a larger coefficient on our central interaction for the second period. However, also in the first period, a positive interaction between the aggregate risk factor and the assets of the banking sector is found, significant at a 10 percent level. Thus, the finding

[17] Note, that we also used mid 2007 as an alternative starting date of the crisis, when central banks started unprecedented liquidity injections. Results did not change substantively.

that the size of the banking sector is a determinant of sovereign spreads, whose impact crucially depends on the interaction with aggregate risk, is not exclusively driven by the present crisis. When aggregate risk is low, investors deem a large sector as an asset to the state; high aggregate risk goes along with an increasing likelihood of costs to the government, contributing to the sovereign spread before as well as during the crisis.[18]

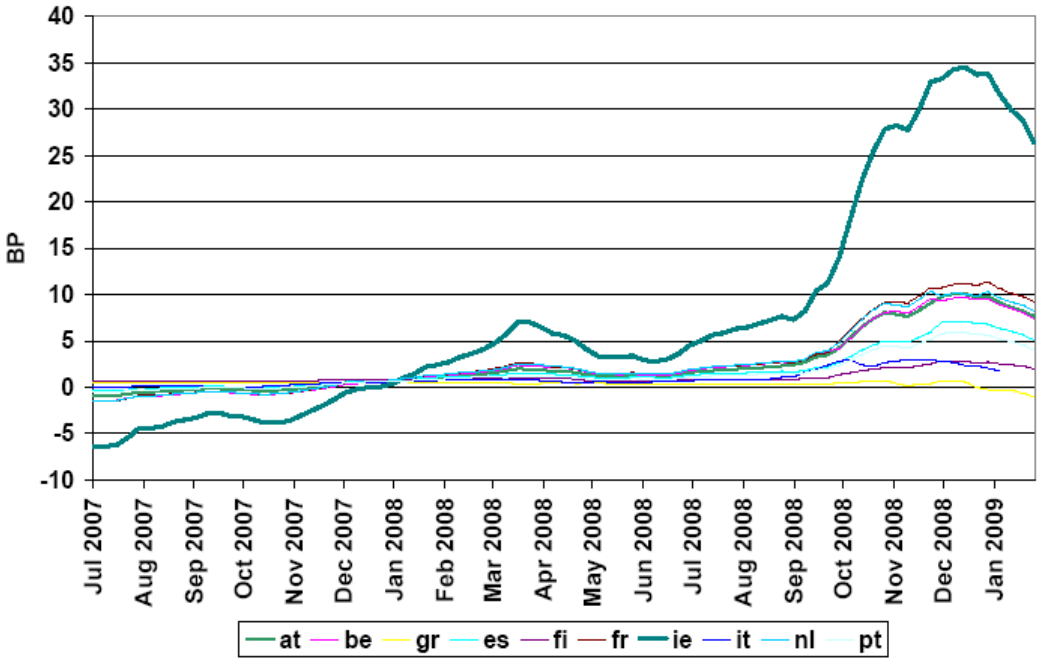


Figure 4: Difference of fit between model estimated on entire sample and model estimated on pre-crisis data (Jan 1999 to Jun 2007). See Regressions F and G in Table 2.

In Figure 4, we further gauge the difference between the model estimated for the full sample, including the financial crisis, and the sample that ends before the crisis. The figure compares the difference between the predicted spread of the full model and the spread predicted by the model based on the estimated coefficients until 2007Q2 but using current data for the explanatory variables. As can be seen, for virtually all countries, the difference between the two models is negligible. The coefficients therefore do not hinge on whether the financial crisis is included in the estimation period. For Ireland, we find a significant difference between the two models. However, the difference amounts to less than 35 basis

[18] We also tested for a structural break in all variables after the second quarter of 2007. We only found a break (at a 10 percent level) in the interaction effect on banking and the aggregate risk factor and the banking variable as such. In the later part of the sample, banks were considered to be a larger liability, when risk aversion is high. For the other variables, no structural break could be detected. The model is therefore stable in time.

points, which is small compared to the large increase of the Irish spread. Thus, even in the case of Ireland, the estimates of the two models are broadly similar.

To assess further the influence of the banking sector risk on sovereign spreads, we incorporate the banking sector equity ratio in the analysis. We define the equity ratio as equity over total assets. A decrease in this ratio corresponds to increasing banking sector risk since less equity is available. Accordingly, it is more likely that banks become illiquid or insolvent, raising the risk of a costly government rescue, possibly triggering sovereign risk.

Table 3: Capitalization

Regression	A	B	C
Yield Spread (-1)	**0.98***** 60.27	**0.96***** 51.7	**0.96***** 50.39
Time to maturity	**0.11** 0.91	**0.11** 0.93	**0.13** 0.99
Bid/ ask spread	**0.31**** 2.48	**0.32**** 2.22	**0.30**** 2.23
US Corp	**0.01***** 4.96	**0.02**** 2.37	**0.02**** 2.41
Equity	**-0.2**** -2.45	**1.1**** 2.51	**1.1**** 2.34
US Corp*equity[a]		**-0.75***** -2.87	**-0.78***** -2.97
Bank assets[a]			**0.14** 0.34
N	4969	4969	4969

Notes: Dependent variable is the yield spread to German Bunds. Sample: EMU 12, without Luxembourg, Germany is benchmark, Greece included from 2001 on. Estimation period 01 Jan 1999 to 28 Feb 2009. Data have weekly frequency, unless stated otherwise. Bank assets are total assets held by the banking sector in each country, equity is the banking sectors aggregate equity relative to assets (monthly frequency). Estimation method: Pesaran and Smith (1995) using Swamy (1971). t-values are below the coefficient estimates in bold. * (**,***) indicates significance at a 10 (5, 1) percent level. Estimation is with country fixed effects.
[a] Coefficients scaled up by factor 100.

In Regression A of Table 3, we show that indeed a decrease in banks' equity ratio leads to an increase in sovereign spreads. Again, the overall effect depends on the state of the aggregate risk factor (Regression B). Markets apparently regard low equity holdings as pointing towards higher sovereign risk if the risk factor is sufficiently high. In Regression C, we control also for the size of the banking sector. The core capitalization of banks, measured by the equity ratio, continues to be priced-in on sovereign bond markets.

So far we have demonstrated that the banking sector is a determinant of sovereign spreads. While banking sector size relative to GDP indicates the cost of a potential government rescue of the banking system, the equity ratio captures the resilience of banks. The size of the effect depends on the interaction with aggregate risk. High aggregate risk translates ceteris paribus into a greater probability of bank default and thus constitutes a risk for public budgets. Furthermore, a high aggregate risk factor coincides with higher risk premia, i.e., bond holders demand higher compensation for a given risk. The effects can also be found in a sample ending prior to the crisis.

5.2 The importance of fiscal policy

After establishing the influence of the banking sector we turn to the classical determinant of sovereign risk, fiscal policy. We augment our baseline regression from Table 2 with measures of fiscal policy. In regression A and B of Table 4, we expand the model by including the debt-to-GDP ratio relative to Germany as an additional regressor.

We do not find a significant impact of debt measured at annual frequency on sovereign spreads. In contrast, debt measured at quarterly frequency leads to the expected larger sovereign spread. In economic terms, the marginal effect is meaningful, but small: a 10 percent of GDP increase of public debt relative to Germany increases the spread by 0.4 basis points instantaneously.[19] Given that our model is dynamic, the long-run effect is much larger: A relative debt increase of 10 percentage points of GDP translates into a spread widening of 5 basis points. It is, however, important to note that the substantial increase of debt in 2009 due to financial stability programs, economic stimulus packages and higher unemployment rates is not covered by our sample. Furthermore, there is a statistical caveat, as mere level differences are accounted for by the constant and thus do not show up in the slope coefficients. The size of the banking sector and the interaction of the size of the banking sector with the aggregate risk factor remain clearly significant.

Laubach (2009) and Evans (1987) highlight the importance of expected future budget deficits for interest rates in the US. We therefore introduce a measure of three-year forecast of deficits as reported by euro area Member States to the European Commission at the end of each year (Regression C).

[19] For example, Schuknecht et al. (2009) find an effect of similar size.

We find a highly significant effect of forecasted deficits on sovereign bond spreads. A forecasted 10 percentage point increase in the deficit in three years relative to Germany leads to a marginal increase of the spread by 2.4 basis points or a long term yield widening of almost 30 basis points. There are two potential explanations for this finding. First, expected deficits are news to the market. Second, the long term effect of a permanent increase in deficit is more substantial as it entails a far larger permanent increase of debt to GDP ratio compared to a permanent increase in the debt level as such. Moreover, also in this regression is our central results unchanged. This is consistent with the view that budget forecasts, also in the recent past, either did not reflect the cost of potential rescue packages or market participants regarded banking related risk as a continuing risk, in spite of public actions.

Table 4: Debt and Deficit

Regression	A	B	C	D	E	F
Yield Spread (-1)	**0.96*** **	**0.92*** **	**0.91*** **	**0.96*** **	**0.92*** **	**0.91*** **
	50.02	97.54	77.14	58.83	81.69	66.1
Time to maturity	**0.18**	**0.31***	**0.36** **	**0.16**	**0.29**	**0.34***
	1.15	1.76	1.98	1.07	1.60	1.85
Bid/ ask spread	**0.33***	**0.34** **	**0.28***	**0.18**	**0.34** **	**0.29***
	1.93	2.45	1.81	1.31	2.36	1.94
US Corp	**0.03***	**0.03***	**0.03***	**0.03***	**0.03***	**0.04***
	1.61	1.67	1.79	1.66	1.70	1.78
Bank assets	**-0.03** **	**-0.03***	**-0.04** **	**-0.03** **	**-0.03***	**-0.04***
	-2.25	-1.8	-2.19	-2.38	-1.78	-2.07
US Corp*bank assets[a]	**0.23** **	**0.02** **	**0.03** **	**0.02** **	**0.02** **	**0.26** **
	2.25	1.97	2.24	2.21	1.99	2.17
Debt (quarterly)		**0.04** **	**0.04** **		**0.05** **	**0.05** **
		2.21	2.23		2.27	2.27
Debt (annual)	**0.02**					
	0.89					
Deficit forecast			**0.24** **			**0.25** **
			1.98			2.16
Output gap[a]				**-0.012** **	**-0.001**	**-0.01**
				-2.07	-0.27	-0.28
N	4455	4455	4455	4949	4455	4455

Notes: Dependent variable is the yield spread to German Bunds. Sample: EMU 12, without Luxembourg, Germany is benchmark. Greece included from 2001 on. Estimations A, B, D: 01 Jan 2000 to 28 Feb 2009, Estimations C: 01 Jan 1999 to 28 Feb 2009. Data have weekly frequency, unless overstated otherwise. The deficit forecast is taken forecast is taken from the annual member countries' Stability and Convergence Program reports to the European Commission; a higher value indicates a larger expected deficit. Debt has annual or quarterly frequency (available from 2000). Output gap is deviation of GDP from HP-filtered trend (quarterly), bank assets are monthly. Estimation method: Pesaran and Smith (1995) using Swamy (1971). t-values are below the coefficient estimates in bold. * (**,***) indicates significance at a 10 (5, 1) percent level. Estimation is with country fixed effects.

[a] Coefficients scaled up by factor 100.

Finally, we evaluate whether our results are driven by the state of the business cycle. We use the deviation of a country's quarterly real GDP from a HP-filtered trend as a simple control variable. Our results concerning the risk from the banking sector and the interaction with the aggregate risk factor are not affected by this variable (Regression C). Controlling for debt and the output gap has no effect on these results, either (Regression D). However, the output gap has no explanatory power if debt outstanding is included in the model. Also deficit forecasts remain significant determinants of sovereign spreads (Regression F).

All-in-all, fiscal variables are determinants of sovereign spreads and the identified effects of the banking sectors to European sovereign risk essentially remain unaffected. Thus, markets do distinguish the solvency of euro area national governments individually.

6 Robustness analysis

6.1 Aggregate risk

In this section, we inspect the robustness of the findings reported above. The literature employs different measures to capture changes in the aggregate risk factor. As we have documented in Section 4, all but the US swap spread show a strong increase in the present financial crisis. Table 5 presents our central robustness checks regarding the different measures of aggregate risk. In Regressions A-C, we employ the VIX (implied equity market volatility) as the measure for the risk factor. Regressions D-F use the Refcorp spread (guaranteed US agency spread) while the last three regressions resort to the Ted money market spread.

Sovereign bond spreads in the euro area are positively related to all three risk measures. This underscores the result that sovereign spreads in the euro area are significantly driven by international aggregate risk (Regressions A, D, G). The second regression for each risk measure shows that banking sector size is a significant determinant of sovereign spreads on its own (Regressions B, E, H). This is a stronger finding than our main result (presented in Table 2, in which banking sector balance sheets are only significant when interacted with aggregate risk.

In the third regression of that table, we include the measure for aggregate risk interacted with the banking sector size. In all three cases we find the interaction variable to be positive (Regressions C, F, I). However, the parameters are only significant when the VIX and the

Refcorp spread are used to capture aggregate risk.[20] Moreover, the coefficient on the banking sector size is in this case negative as in our main findings.

Overall, irrespectively of the precise measure of aggregate risk we find that sovereign spreads depend positively on aggregate risk and aggregate risk interacted with banking sector size.

Table 5: Robustness with regard to measures of aggregate risk

Regression	A	B	C	D	E	F	G	H	I
Yield Spread (-1)	**0.99*** **	**1.01*** **	**1.01*** **	**0.94*** **	**0.97*** **	**0.96*** **	**1.00*** **	**1.02*** **	**1.02*** **
	162.37	90.61	93.7	106.95	86.63	78.14	190.1	108.94	107.79
Time to maturity	**0.03**	**0.02**	**0.08**	**0.27***	**0.17**	**0.25***	**0.15**	**0.03**	**0.01**
	0.33	0.23	0.7	1.88	1.43	1.74	1.38	0.29	0.07
Bid/ ask spread	**0.40*** **	**0.23** **	**0.22***	**0.55*** **	**0.34*** **	**0.30** **	**0.25** **	**0.18**	**0.17**
	2.98	2.09	1.83	5.25	2.65	2.14	2.06	1.48	1.26
VIX[a]	**5.79*** **	**3.07*** **	**14.67**						
	5.31	3.96	1.3						
Bank assets[a]		**1.20*** **	**-1.78**		**0.63***	**-0.66***		**0.8***	**0.05**
		3.89	-1.47		1.78	-1.65		1.95	0.08
VIX*bank assets[a]			**0.14***						
			1.93						
Refcorp[a]				**8.38*** **	**6.22*** **	**13.77**			
				3.87	4.94	1.55			
Refcorp						**0.09***			
*bank assets[a]						1.68			
Ted[a]							**0.77*** **	**0.25***	**1.81**
							5.13	1.74	0.99
Ted*bank assets[a]									**0.02**
									1.45
N	4989	4949	4949	4969	4949	4949	4989	4949	4949

Notes: Dependent variable is the yield spread to German Bunds. Sample: EMU 12, without Luxembourg, Germany is benchmark. Greece included from 2001 on. Estimation period: 01 Jan 1999 to 28 Feb 2009. Data have weekly frequency, except for bank assets (monthly). The implied equity volatility VIX, the US agency spread Refcorp and the Treasury-to-T-Bill spread (Ted) are alternatives to the US Corporate Bond Spread as measure for aggregate risk (see Section 4). Estimation method: Pesaran and Smith (1995) using Swamy (1971). t-values are below the coefficient estimates in bold. * (**,***) indicates significance at a 10 (5, 1) percent level. Estimation is with country fixed effects.

[a] Coefficients scaled up by factor 100.

[20] This is not surprising given the high correlation of the US corporate bond spread, the VIX and the Refcorp spread on the one hand and the hardly detectible correlation of the Ted spread with the other three prior to the financial crisis (see Figure A-2 in the Appendix).

6.2 Robustness to alternative measures of liquidity

To ensure that our findings are not the result of an inappropriate modelling of liquidity, we present both variations of our econometric approach as well as different measures of liquidity. First, we allow for endogeneity of liquidity in an instrumental variable framework. Second, we interact liquidity with aggregate risk. Third, we use actual trading activity on the electronic platform MTS and bond volume outstanding as alternative measures of liquidity.

Sovereign bond spreads and bid/ask spreads could both depend on a third exogenous factor such as financial turbulence. Moreover, reverse causality from sovereign spreads to market liquidity is possible.

To study the potential importance of reverse causality, we perform instrumental variable regressions. We employ two different instruments for the bid/ask spread. First, we use the first lag of the bid/ask spread as an instrument for the contemporaneous bid/ask spread. Second, we employ the trading volume of the Bund Future as an instrument. The Bund Future is the dominant euro area bond future and is the most observed single price signal for the euro area fixed income market.[21] Against this backdrop and given that some trading strategies require involvement on both the cash and the derivative market, for example hedging, trading activity in the futures market could be an instrument for the bid/ask spread. First-stage regressions show that the lagged value is a valid instrument for the bid/ask spread as it is a significant determinant of the spread, while Bund Future trading volume performs considerably worse (see Table A-5 in the appendix).

In Regression A of Table 6, we present the results for the first lag of the bid/ask spread as the instrument. In the non-dynamic panel, liquidity remains significant. Indeed, the first stage regression shows that the lag of the bid/ask spread is significantly related to the contemporaneous bid/ask spread. However, since the sovereign spread is autocorrelated, it is unlikely that the lag is orthogonal to the residual of the regression. Therefore in Regression B, we estimate a dynamic model. Actually, in the dynamic model the instrumented bid/ask spread turns insignificant. This is consistent with information efficient markets in which the change of the bid/ask spread in the previous period is fully incorporated in the same period's yield spread. Since the lagged yield spread is included as a regressor, there is no additional information coming from the bid/ask spread instrumented with its first lag.

In Regression C, we therefore use contemporaneous Bund futures trading volume as an instrument for the bid/ask spread. The instrumented liquidity measure now remains a

[21] Apart from the Bund Future, there is only a Spanish bond future, with substantially lower trading volume.

significant determinant of spreads. In Regression D and E we show that our central result regarding the effect of banking sector size on sovereign bond spreads remains unaffected by the instrumenting the bid/ask spread. For both instruments, the interaction between the corporate bond spreads and the size of the banking sector remains highly significant.[22] Overall, the instrumental variable regressions confirm our previous findings, in particular on the effect of banking sector size and its interaction with the common risk factor.

So far, we have presented several estimates of equation (3). In a variation, we analyze the importance of the aggregate risk factor not only for default risk but also for liquidity risk. Favero et al. (2009) find that liquidity risk, proxied by the bid/ask spread, only is detectable in the European sovereign bond market when interacted with the aggregate risk factor. To be sure that our central results are not affected by liquidity effects as identified in Favero et al. (2009), we replicate their approach and test, whether our banking-related results are affected. We find that they are not affected and we can also replicate Favero et al's central result.

In Regression A we restrict the sample to the 2002/2003 period studied by Favero et al. (2009). The bid/ask spread is in this case on its own highly significant. The bid/ask spread interacted with the US swap spread, which is the proxy for aggregate risk used by Favero et al. (2009), is negative and also highly significant. Their model-based explanation is, that a higher aggregate risk factor is equivalent to a diminished set of alternative investment opportunities, which translates into a lower demand for liquidity. In Regression B, we replicate this result using our preferred measure of the common risk factor, the US corporate bond spread. In Regression C, we interact the bid/ask spread with both the US swap spread and the corporate spread. For both terms, we find a significantly negative coefficient.

In Regression D, we extend the sample to our full sample. Again, we find a negative interaction as predicted by Favero et al. (2009). In Regression E, we assess, whether our central result on the importance of the banking sector for sovereign spreads holds, if we allow for an additional interaction between aggregate risk and liquidity as proposed by Favero et al. (2009). Indeed, we find that larger banking sectors are associated with increasing sovereign risk when aggregate risk is sufficiently high. Thus aggregate risk does not only affect sovereign risk via banking sector risk but also via liquidity. However these liquidity effects do not alter our main results regarding the banking sector.

[22] These results remain robust to a change of the aggregate risk measure. Table A-4 presents results using the VIX instead of the corporate bond spread.

Finally, we use the depth of the market, measured as the total volume of each country's sovereign bonds outstanding, as a proxy for liquidity. Table A-9 in the Appendix presents the results. Essentially, our central result regarding the effect of the banking sector on yield spreads remains unaffected.

Table 6: IV regressions for liquidity

Regression	A	B	C	E	G
Insrument for liquidity	Bid-/ ask spread (-1)	Bid-/ ask spread (-1)	Future Volume	Bid-/ ask spread (-1)	Future Volume
Yield Spread (-1)		**0.99*** **	**0.89*** **	**1.02*** **	**0.90*** **
		297.44	20.87	299.95	23.8
Liquidity	**5.37*** **	**0.03**	**10.85** **	**-0.08**	**11.08*** **
	14.87	0.39	2.28	-1.02	3.25
Time to maturity	**2.69*** **	**0.10***	**0.15**	**-0.05**	**-0.09**
	10.15	1.68	1.06	-0.9	-0.62
US Corp[a]	**13.05*** **	**0.71*** **	**0.19**	**0.41*** **	**0.14**
	84.15	12.98	0.72	7.72	0.9
Bank assets[a]				**0.06**	**-0.30**
				0.6	-1.09
US Corp*bank assets[a]				**0.0010*** **	**0.0026*** **
				5.47	3.94
N	4968	4968	4969	4948	4949

Notes: Dependent variable is the yield spread to German Bunds. Sample: EMU 12, without Luxembourg, Germany is benchmark. Greece included from 2001 on. Estimation period: 01 Jan 1999 to 28 Feb 2009. Data have weekly frequency, except for bank assets (monthly). The first instrument for liquidity, ie the bid/ask spread, is its first lag, the second one is the trading volume of the Bund Future. Estimation method: Instrumental variable panel regression. For first stage regressions, see Table A-5 in the Appendix. t-values are below the coefficient estimates in bold. * (**,***) indicates significance at a 10 (5, 1) percent level. Estimation is with country fixed effects.
[a] Coefficients scaled up by factor 100.

In Tables A-10 and A-11, we use actual trading volume in the electronic trading market MTS as a proxy to gauge liquidity effects. Actual trading is a self-evident measure for liquidity, since trades in a frequently dealt asset should move the market price less than trades in a stale market. We can only estimate this specification on a short sample, as MTS data is available to us only from September 2007 on. Again, we find our central estimation result confirmed.

Overall, we conclude that our estimation results are not driven by spurious liquidity effects but rather reflect the true pricing of sovereign bonds as a function of increasing risk in the banking sector. This shows that markets do not regard European sovereign bonds as equal except for liquidity effects, but that factors concerning country specific default risk are actually priced in.

Table 7: Aggregate risk and liquidity

Regression	A	B	C	D	E
Yield Spread (-1)	**0.58*** **	**0.50*** **	**0.45*** **	**1.01*** **	**0.93*** **
	9.3	8.5	6.76	137.24	40.76
Maturity	**3.66*** **	**4.40*** **	**4.78** **	**0.03**	**0.03** **
	8.75	9.34	8.81	0.33	2.21
Bid/ ask spread	**4.44*** **	**2.99*** **	**6.59*** **	**1.53*** **	**1.54*** **
	3.28	4.78	4.52	3.37	2.89
Swap spread	**0.01**		**0.02** **	**-0.01**	**0.01**
	1.05		2.17	-1.3	1.58
Swap spread * bid/ ask spread[a]	**-10.19*** **		**-8.94*** **	**-1.60** **	**-1.99*** **
	-3.13		-3.07	-2.52	-2.79
US Corp		**0.00**	**0.00**		**0.03***
		0.37	0.76		1.77
US Corp* bid/ ask spread[a]		**-3.03*** **	**-2.87*** **		
		-3.61	-4.05		
Bank assets					**-0.05*** **
					-2.84
US Corp * bank assets[a]					**0.03** **
					2.62
N	1050	1050	1050	4989	4949

Notes: Dependent variable is the yield spread to German Bunds. Sample: EMU 12, without Luxembourg, Germany is benchmark. Greece included from 2001 on. Estimations A, B, C: 01 Jan 2003 to 31 Dec 2004, Estimations D, E: 01 Jan 1999 to 28 Feb 2009. Data have weekly frequency, except for bank assets (monthly). Swap spread is the difference between ten year US swap rates and T-Note yields. Estimation method: Pesaran and Smith (1995) using Swamy (1971). t-values are below the coefficient estimates in bold. * (**,***) indicates significance at a 10 (5, 1) percent level. Estimation is with country fixed effects.

[a] Coefficients scaled up by factor 100.

6.3 Further robustness tests

We perform a number of additional robustness checks. The respective tables are included in the Appendix. First, we extend the sample to start in 1997, stretching out to the pre-euro period. To do so, we control for exchange rate effects by subtracting the swap spread from the yield spread to account for exchange rate expectations. Our central results remain unaffected.

In a second step, we discard Ireland and Greece from the sample. Both countries have been special in the period in the sense that Ireland has seen its banking sector grow significantly while Greece has the most pronounced spreads. However, our results are not driven by these two countries. In an opposite exercise, we restrict our sample to the four large euro area economies, France, Germany, Italy and Spain. Our central results are stable also to that specification.

We furthermore test for possibly non-linear effects, where the yield spread depends on the German yield. To do so, we include the German yield on the right hand side of the estimation equation. However, we find a coefficient of zero and that the other results are unaffected. Spreads are thus not varying with the absolute level of yields in the EMU sample. Furthermore, markets might react disproportionately to changes in risk factors. However, we do not find a non-linear impact, for example measured by the squares of the aggregate risk factor and assets in the banking sectors.

We also include the short term interest rate on the right hand side. The short-term interest rate turns out to be insignificant after controlling for aggregate risk. Obviously, aggregate risk is influenced by short-term interest rates (see Rajan 2006). However, it is the aggregate risk factor that matters for the spread, not the absolute level of the short term interest rate. Indeed, the proxy for aggregate risk stays significant, while the short term interest rate is not.

We have motivated our choice for the random coefficients model following Pesaran and Smith (1995) and Swamy (1971) carefully, by demonstrating that coefficient heterogeneity rules out the use of common pooling methods. However, for comparison with previous contributions to the literature, we present an estimation using panel fixed effects in the appendix (Table A-6). Our results can be replicated also in this framework.

7 Conclusions

In this paper we have shown that the size of the banking sector, as measured by the aggregate balance sheet to GDP ratio, is an important determinant of sovereign risk spreads relative to Germany in the euro area. In normal times, financial markets do not demand a premium from governments of countries with large banking sectors. However, if and when perceptions of aggregate risk increase, yields rise more strongly in economies with large banking sectors. These differences can be economically significant: at the height of the current crisis, as much as one percentage point of euro area sovereign spreads can be explained by this factor. In periods of low aggregate risk, economies with larger banking sectors enjoy lower sovereign risk spreads. Furthermore, we provide evidence that the effect of banking sectors on sovereign spreads is related to their relative vulnerability. Countries where bank equity buffers are relatively small have to pay a larger sovereign risk premium as aggregate risk increases.

One important consequence of our finding is that changes of global risk perception can have large and rapid effects on sovereign risk spreads, particularly when underlying country fundamentals are comparatively weak. Moreover, the increase in aggregate risk is in itself increasing banking risk. Heightened aggregated risk can quickly lead to a fragile banking sector as banks' balance sheets come under pressure, potentially triggering a government rescue. Since such interventions are typically very costly, they can have a first-order impact on the government's fiscal position and therefore trigger concerns about sovereign risk.

We also document that liquidity is priced in sovereign bond markets, although its quantitative importance is small. Moreover, we confirm previous findings that sovereign bond markets price in forward-looking fiscal variables as well as national public debt level. We demonstrate the robustness of central findings to a wide range of alternative specifications and control variables.

To reduce the risk for the taxpayer arising from banking fragility, governments could require banks to hold more equity as we have shown that sovereign spreads decrease with the equity ratio. Furthermore, emphasis should be given to the resilience of the financial system against aggregate risk, as our study identified this as the crucial link of bank risk to sovereign risk.

An interesting avenue for further research is to study the impact on sovereign risk spreads resulting from large international banks. In particular, do implicit and explicit burden sharing agreements and associated premia have an effect on relative sovereign risk?

References

Adrian, T., and H. S. Shin (2009): "Money, Liquidity and Monetary Policy," *American Economic Review, Papers and Proceedings*, 99(2), 600–605.

Maria-Grazia Attinasi, M.G., C. Checherita and C. Nickel (2009): "What explains the surge in euro area sovereign spreads during the financial crisis of 2007-2009?", *ECB Working Paper*, 1131.

Beber, A., M. W. Brandt, and K. A. Kavajecz (2009): "Flight-to-Quality or Flight-to-Liquidity? Evidence from the Euro-Area Bond Market," *The Review of Financial Studies*, 22(3), 925–957.

Bernoth, K., J. von Hagen, and L. Schuknecht (2004): "Sovereign Risk Premia in the European Government Bond Market," *ECB Working paper*, 369.

Bernoth, K., and G. B. Wolff (2008): "Fool the Markets? Creative Accounting, Fiscal Transparency and Sovereign Risk Premia," *Scottish Journal of Political Economy*, 55(4), 465–487.

Buraschi, A., and D. Menini (2002): "Liquidity risk and specialness," *Journal of Financial Economics*, 64, 243–284.

Codogno, L., C. Favero, and A. Missale (2003): "Yield Spreads on EMU Government Bonds," *Economic Policy*, 18(37), 503–32.

Dunne, P., M. Moore, and R. Portes (2007): "Benchmark Status in Fixed-Income AssetMarkets," *Journal of Business, Finance and Accounting*, 34, 1615 – 1634.

ECB (2009): "The impact of government support to the banking sector on euro area public finances," Frankfurt: Monthly Bulletin of July.

Evans, P. (1987): "Interest Rates and Expected Future Budget Deficits in the United States," *Journal of Political Economy*, 95, 34–58.

Favero, C., F. Giavazzi, and L. Spaventa (1997): "High Yields: The Spread on German Interest Rates," *The Economic Journal*, 107, 956–85.

Favero, C. A., M. Pagano, and E.-L. von Thadden (forthcoming): "How Does Liquidity Affect Government Bond Yields?," *Journal of Financial and Quantitative Analysis*.

Geyer, A., S. Kossmeier, and S. Pichler (2004): "Measuring Systematic Risk in EMU Government Yield Spreads," *Review of Finance*, 8, 171–197.

Gómez-Puig, M. (2006): "Size Matters for Liquidity: Evidence from EMU Sovereign Yield Spreads," *Economics Letters*, 90, 156–162.

Greene, W. (2003): Econometric Analysis, 5th ed., Prentice Hall, Upper Saddle River, NJ.]

Haldane, A. (2009): Banking on the state, mimeo, Bank of England.

Hallerberg, M., and G. B. Wolff (2008): "Fiscal Institutions, Fiscal Policy and Sovereign Risk Premia in EMU," *Public Choice*, 136(3-4), 379–396.

Hallerberg, M., R. Strauch, and J. von Hagen (2007), The design of fiscal rules and forms of governance in European Union countries. *European Journal of Political Economy*, 23(2), 338–359.

Heppke-Falk, K., G.B.Wolff (2008), MoralHazard and Bail-Out in Fiscal Federations: Evidence for the German Länder. *Kyklos*, 61, 425–446.

Koen, V., and P. van den Noord (2005): "Fiscal Gimmickry in Europe: One-Off Meausres and Creative Accounting," *OECD Economics Department Working Paper*, 2005(4).

Laubach, T. (2009): "New Evidence on the Interest Rate Effects of Budget Deficits and Debt," *Journal of the European Economic Association*, 7(4), 858–885.

Longstaff, F. (2004): "The Flight-to-Liquidity Premium in U.S. Treasury Bond Prices," *Journal of Business*, 77(3), 511–526.

Longstaff, F., J. Pan, L. Pedersen, and K. Singleton (2007): "How Sovereign is Sovereign Credit Risk," *NBER Working Paper*, 13658.

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

Pesaran, H., and R. Smith (1995): "Estimating long-run relationships from dynamic heterogenous panels," *Journal of Econometrics*, 68, 79–113.

Rajan, R. (2006): "Has Finance Made the World Riskier?," *European Financial Management*, 12(4), 499–533.

Schuknecht, L., J. von Hagen, and G. Wolswijk (2009): "Government risk premiums in the bond market: EMU and Canada," *European Journal of Political Economy*, 25(3), 371–384.

Schulz, A. and G.B. Wolff (2009): The German Sub-national Government Bond Market: Structure, Determinants of Yield Spreads and Berlin's Forgone Bail-out, *Journal of Economics and Statistics*, 229(1), 61-83

Shleifer, A., and R. Vishny (1997): "The Limits of Arbitrage," *Journal of Finance*, 52(1), 35–55.

Swamy, P. (1971): Statistical inference in random coefficient regression models. Springer, Berlin.

Vayanos, D. (2004): "Flight to quality, flight to liquidity, and the pricing of risk," *NBER Working Paper*, 10327.

Vayanos, D., and P.-O. Weill (2008): "A Search-Based Theory of the On-the-Run Phenomenon," *Journal of Finance*, 63(3), 1361–1398.

von Hagen, J., and G. B. Wolff (2006): "What Do Deficits Tell Us About Debt? Empirical Evidence on Creative Accounting with Fiscal Rules in the EU," *Journal of Banking and Finance*, 30 (12), 3259–3279.

Whaley, R. (1993): "Derivatives on market volatility: Hedging tools long overdue," *Journal of Derivatives*, 1, 71 – 84.

Whaley, R. (2008): "Understanding VIX," *SSRN Working Paper*.

Appendix

Related literature

Table A-1: Synopsis of related literature

Authors	Data Range	Sample	Main Method	Major Findings
Favero, Giavazzi, Spaventa (1997)	Jan 1993 – Dec 1995, daily	DE, IT, ES, SW	OLS, VAR	Major factors are: exchange rate risk, Italian tax effect and default risk, Common trend driven by international factor (structural shock to exchange rate factors).
Codogno, Favero, Missale (2003)	monthly: 1991 – 2002, daily: Oct 2001 – Mar 2002	EMU 12	SUR	Bond Spreads driven by international risk factor (US swap spread, US corp bond spread), liquidity factors play minor role.
Favero, Pagano, von Thadden (2009)	Jan 2002 – Dec 2003, daily	EMU 12, without IE, GR	SUR	Common trend in yield spreads, highly correlated with measures of aggregate risk (US swap spread). Liquidity matters in interaction with aggregate risk factor.
Geyer, Kossmeier Pichler (2004)	Jan 1999 – May 2002, daily	AT, BE, IT, SP	State space, Kalman Filter	Global risk factor is main determinant of EMU spreads; it is best explained by EMU corporate bond spread and German swap spread.
Gomez Puig (2006)	1996 – 2001, daily	EMU 12	Static panel	Liquidity and market size influence yields; risk control with ratings.
Beber, Brandt, Kavajecz (2009)	Apr 2003 – Dec 2004, daily	EMU 12 without IE	Pooling	Spreads explained by credit risk, liquidity plays a role for low risk countries. Large (stress related) flows are determined by liquidity.
Mangenelli, Wolswijk (2009)	Jan 1999 – Apr 2008, daily	EMU 12	Several panel specification	Common risk factor drives EMU spreads. It is influenced by the short term interest rate, as this relates to risk aversion in two ways: funding liquidity and state of the economy.

Note: Luxembourg is excluded from all samples.

Data

All in all, we use five measures for the aggregate risk factor: next to our preferred **measure, the US corporate bond spread, we also use US equity market implied volatility (the** VIX index), the US swap spread, the Refcorp agency spread and the money market Ted spread, which are described in detail below. Simple correlations of the different measures show, that in line with existing literature, equity market volatility is a good alternative specification for the US corporate bond spread. The Refcorp spread, which has hardly been used so far, is a close substitute in the financial crisis, but also correlates with the corporate bond spread before the crisis, so does the swap spread. The swap spread gives misleading information from fall 2008 on, as discussed below. The Ted-spread, in turn, has practically no correlation to the corporate bond spread before the crisis, but picks up the current crisis reliably. The data is plotted in Figure A-1, correlations are depicted in Figure A-2.

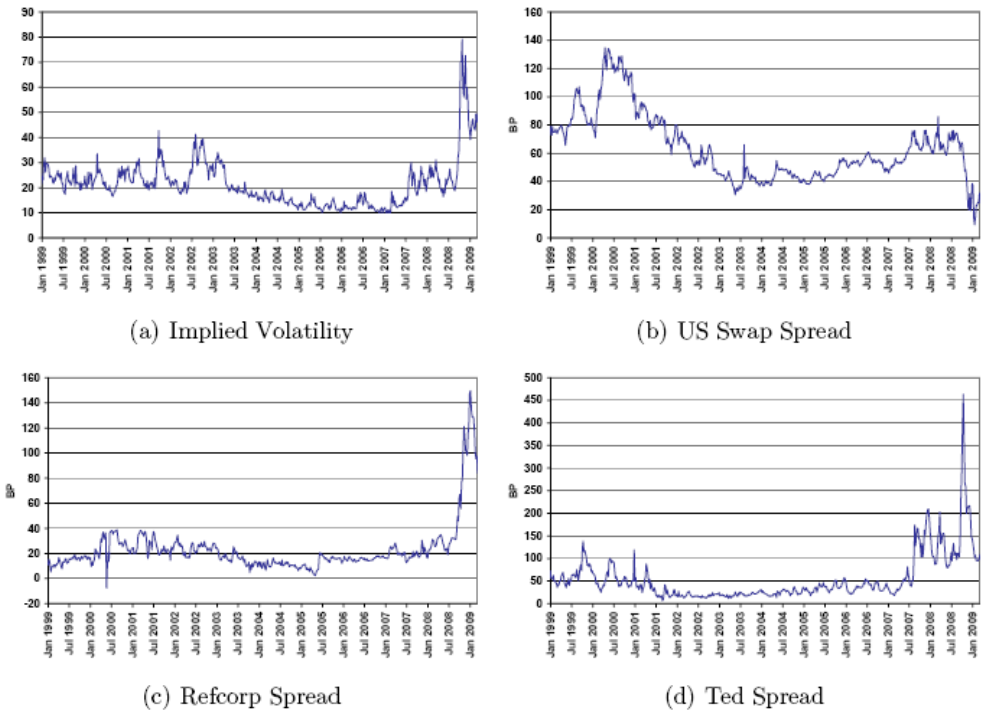


Figure A-1: Measures for the common risk factor. Implied volatility is measured by the VIX index; the US Swap spread is the difference between the ten-year swap rate and T-Notes with equal maturity, the Ted spread is the difference between the 3-month LIBOR rate and T-bills. The Refcorp spread is a measure for the liquidity premium advantage of US Treasury bonds, calculated as the spread between bonds of the US Refcorp agency and T-Notes (Longstaff 2004).

A frequently used alternative to the corporate bond spread as a measure for aggregated risk is the implied volatility of the US stock market, the VIX index, often labelled as "investor fear gauge" (Beber et al. 2009). It is a forward looking measure representing today's expected volatility over the following thirty days as it is implied by current prices of options with different strike prices on the S&P 500 index.[23]

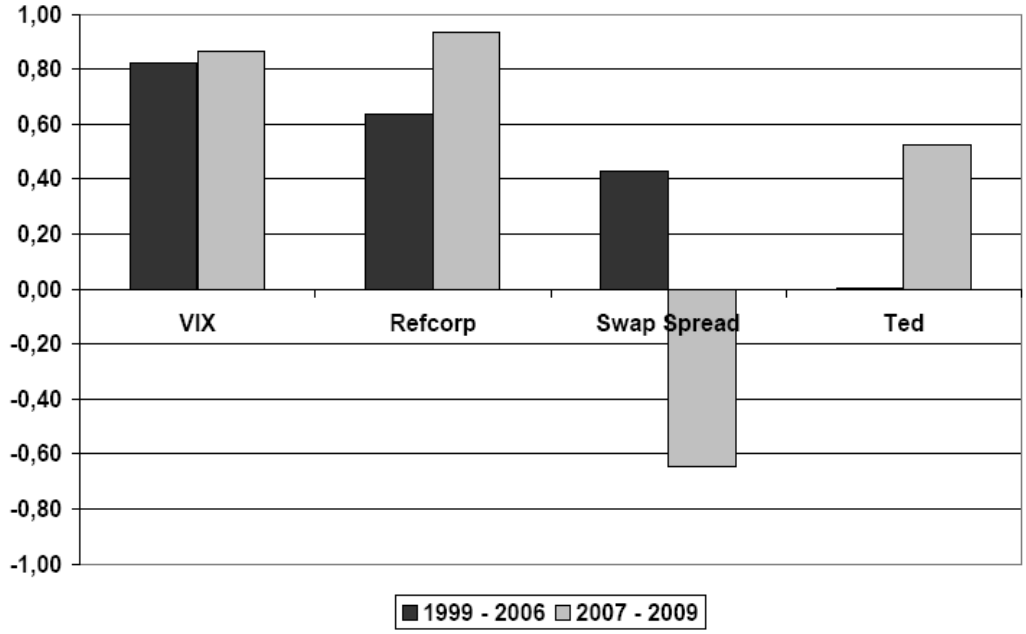


Figure A-2: Correlations of four alternative measures for the aggregate risk factor to our preferred measure, the US corporate bond spread.

We also demonstrate robustness with regard to the US swap spread, ie the difference of the 10-year swap rate and treasury yields (T-Note). Swaps are traded in the interbank market and thus the swap rate includes a time varying premium for counterparty risk, which drives the spread to risk free treasury bonds, and thus also approximates the pricing of risk in the market Favero et al. (2009). The swap market is usually almost perfectly liquid, thus the spread to treasuries could be relied on as a risk measure. However, with the present financial crisis in the fall of 2008, the swap spread plunged, while all other risk indicators displayed record levels.

[23] Before 2003, the underlying index was the S&P 100. For a comprehensive discussion of the VIX index, see Whaley (1993, 2008).

The anomaly can be best described with the 30 year swap spread, which has been negative most of the time since November 2008. The key insights apply also to the 10 year swap spread, which we use. Such a pattern appears to be an arbitrage opportunity, as one would assume, that the government is a more creditworthy borrower than a bank. However, at least three factors hinder arbitrage trades at present: arbitrage requires capital, which is currently in short supply.[24] Repo and asset swap markets are disturbed, which in turn impedes the set up of arbitrage portfolios. Finally, a negative swap spread might not be an arbitrage opportunity at all, as counterparty risk may prevail, deterring investors from engaging in long running contracts.[25] Thus the swap spread, frequently used in the literature, is not a good proxy for aggregate risk in the current crisis.

The Ted-spread depicts the difference between a risky and a risk-free rate, this time on the money market (3-month LIBOR vs. US T-Bill). Again, the pure interest rate component should be identical, while default premia and save haven flows cause a positive spread. The Ted-spread is the money market-analogon to the swap spread.[26]

Furthermore, we capture time varying risk premia with a hybrid measure of liquidity and default risk, proposed by Longstaff (2004). Agency bonds with an explicit US federal government guarantee (Refcorp) and treasuries should have the same credit quality. Remaining yield spreads may be attributed to an investor's wish to hold a standard Treasury bond. These are especially in demand when investors are looking for a liquid asset. Such a flight a quality or liquidity occurs exactly when aggregate risk swiftly increases. The measure therefore captures both, a preference for liquidity as well as aggregate risk.[27]

We use three measures of liquidity: bid/ask spreads, volume outstanding and actual turnover. Bid/ask spreads are typically narrow, especially for on-the-run bonds. Figure A-4 shows the relative spreads to Germany. Most notably, Germany has not always had the most liquid market as evident by the fact that negative spreads occur. This fact has already been pointed out in previous studies, eg Favero et al. (2009). This may partly relate to trading

[24] See Shleifer and Vishny (1997).

[25] The crash of Lehman Brothers made clear that full collateralization is impossible. At least the default-to-replacement risk remains, which has two dimensions. Collateral is valued at the margin and the default of a major counterparty will impose non-marginal price changes. Thus, the value of collateral - even if posted in cash - will not suffice to close open positions. Furthermore, transaction cost matter, as even a well developed financial system will need some time to replace contracts with a failed party, while in the meantime investors are exposed to common market risk.

[26] An alternative measure is the overnight indexed swap (OIS) spread. However, OIS are a fairly recent innovation and data does not reach back to 1999.

[27] In addition, technical factors as repo-specialness and the deliverability for futures contracts play in favor of standard government bonds. See, Vayanos and Weill (2008), Vayanos(2004) and Buraschi and Menini (2002).

technicalities: trading in a bond is most active shortly after issue and declines subsequently, thus variable issue dates and different issue frequencies may effect bid/ask spread relative to Germany. Absolute variation of bid/ask spreads is rather limited, reflecting the high degree of trading in on-the-run bonds.

Furthermore, we are interested in the depth of the market which we proxy with the total amount of sovereign bonds outstanding in each country. Data is quarterly and taken from the Bank for International Settlements securities database. We use the sum of domestic and international issues, to capture the total volume outstanding.

As of September 2007, we obtain from the electronic trading system MTS the actual daily trading volume on their inter dealer platforms, yielding a direct measure of market activity. Figures A-7 to A-9 in the appendix depict the evolution of trading volume. Next to the obvious seasonality pattern around Christmas, a sharp decrease in trading volume is observed at the time of the emergency sale of Bear Stearns. In contrast, trading volume reacted little to the failure of Lehman Brothers in September 2008. Trading on MTS is heavily dominated by Italian government bonds, although the pattern of trading activity is very similar across countries.

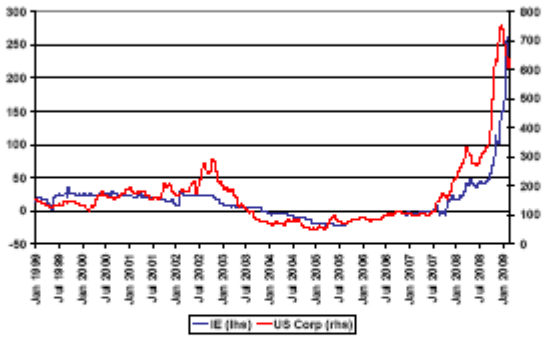


Figure A-3: Irish yield spread to German Bund, 10 year bonds and US corporate bond spread.

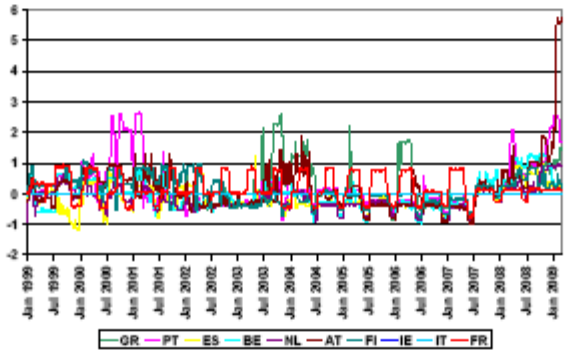


Figure A-4: Bid-/ask spreads relative to German Bund. Greece included as of accession in 2001.

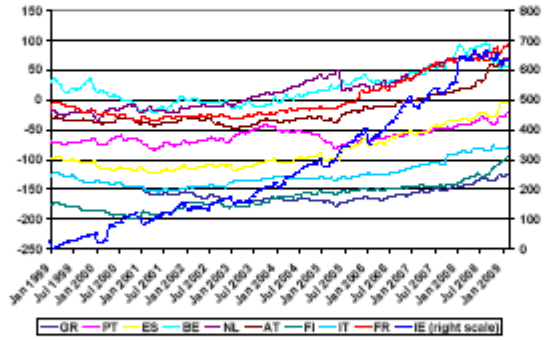


Figure A-5: Total banking assets relative to GDP, difference to Germany.

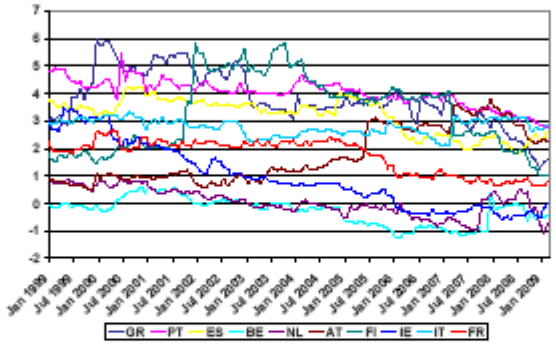


Figure A-6: Banking equity relative to total assets, difference to Germany.

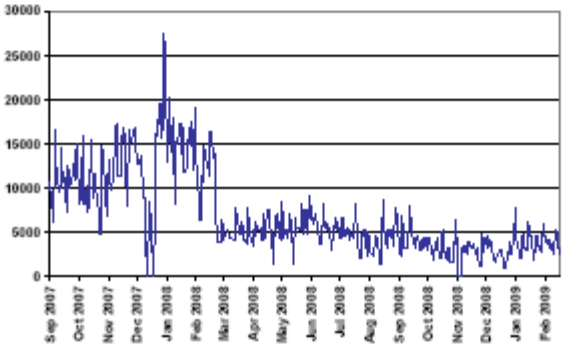


Figure A-7: Actual trading volume of EMU sovereign debt on the MTS trading platforms.

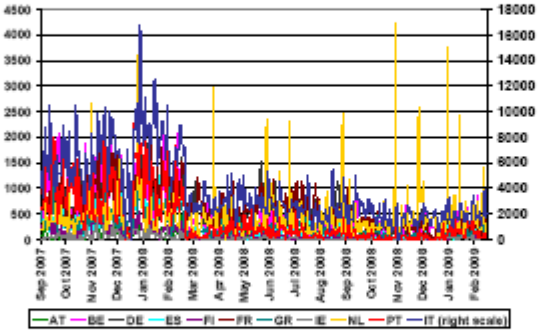


Figure A-8: Actual trading volume of EMU sovereign debt on the MTS trading platforms.

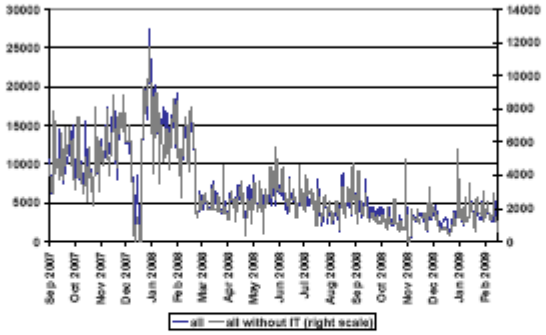


Figure A-9: Actual trading volume of EMU sovereign debt on the MTS trading platforms.

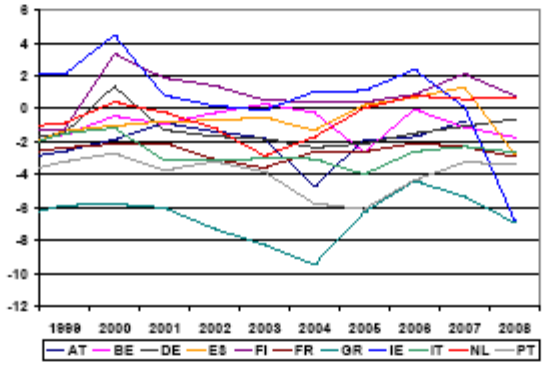


Figure A-10: Budget deficit as per cent of GDP.

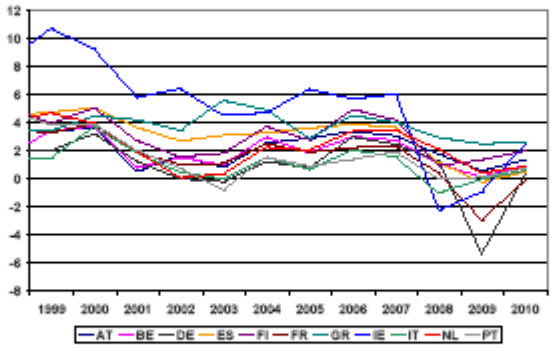


Figure A-11: Real GDP growth. Values for 2009 and 2010 are projections by the European Commission.

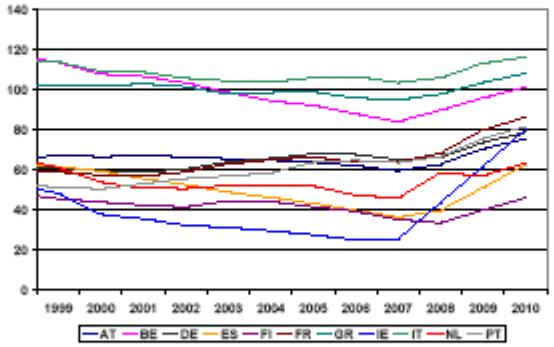


Figure A-12: Debt to GDP. Values for 2009 and 2010 are projections by the European Commission.

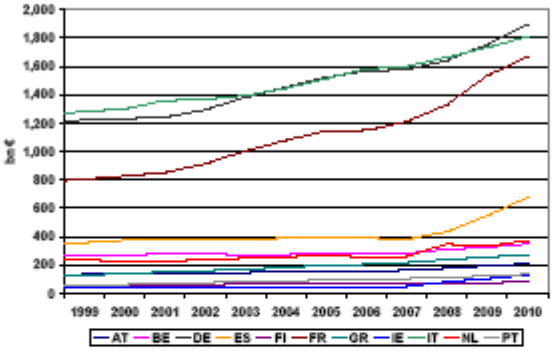


Figure A-13: Absolute debt outstanding, general government. Values for 2009 and 2010 are projections by the European Commission.

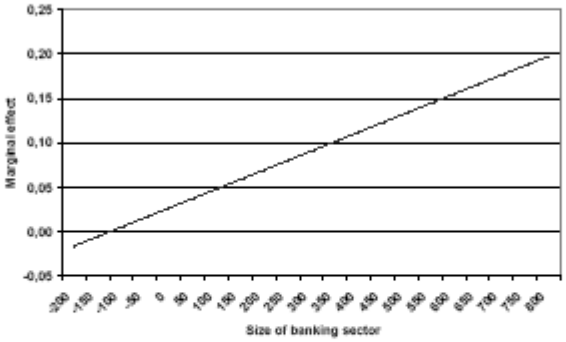
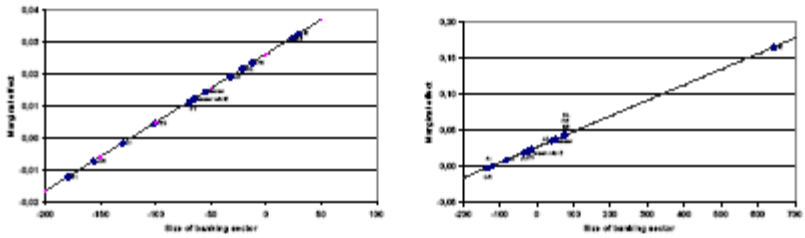


Figure A-14: Marginal effect of risk factor on yield spread, depending on size of banking sector.

Main findings and robustness analysis



(a) 1999 (GR 2001) (b) 2008/2009

Figure A-15: Marginal effect of risk factor on yield spread, depending on size of banking sector relative to Germany, estimated on whole sample. For illustration, individual countries' size of banking sector at the beginning and end of the sample is displayed.

Table A-2: SUR

Regression	A	B	C	D	E	F	G	H	I	J	
	BE	IE	GR	ES	FR	IT	NL	AT	PT	FI	Mean
Yield Spread	**0.99*** **	**1.08*** **	**0.96*** **	**0.98*** **	**0.92*** **	**0.91*** **	**0.92*** **	**0.94*** **	**0.97*** **	**0.93*** **	**0.96**
(-1)	52.56	14.02	23.2	39.62	39.81	19.06	22.63	48.5	39.89	41.1	0.00
Time to	**-0.03**	**-0.48***	**0.97** **	**0.28**	**-0.25**	**0.31**	**0.21**	**-0.11**	**0.61***	**0.38** **	**0.19**
maturity	-0.14	-1.68	2.17	0.89	-1.19	0.92	1.05	-1.16	1.68	2.38	0.0323
Bid / ask	**-0.15**	**0.58**	**-0.13**	**-0.13**	**0.49*** **	**-0.07**	**0.58***	**0.40***	**0.28**	**0.79*** **	**0.27**
spread	-0.42	0.94	-0.56	-0.46	3.26	-0.25	1.75	1.86	1.48	2.92	0.0077
US Corp[a]	**0.13**	**-1.69**	**15.73*** **	**1.23*** **	**0.48*** **	**6.05** **	**0.40**	**0.81*** **	**2.31*** **	**3.28*** **	**2.87**
	0.55	-1.34	3.03	2.81	3.15	2.16	1.25	3.09	3.72	4.35	0.00
Bank assets[a]	**-1.45**	**-0.69** **	**-14.10** **	**-1.88** **	**-0.79***	**-6.92***	**-2.08**	**-1.50**	**-5.88*** **	**-4.23*** **	**-3.95**
	-1.24	-1.90	-2.51	-1.97	-1.68	-1.72	-1.47	-1.47	-2.71	-3.3	0.00
US Corp *	**0.010***	**0.004*** **	**0.095*** **	**0.013** **	**0.005** **	**0.041** **	**0.010**	**0.008***	**0.036*** **	**0.018*** **	**0.024**
bank assets[a]	1.81	2.59	3.10	2.54	2.1	2.06	1.33	1.87	2.68	3.67	0.00
N	527	320	422	527	527	518	527	527	527	527	4949
R2	0.99	0.99	0.99	0.98	0.98	0.98	0.99	0.99	0.98	0.99	

Notes: Dependent variable is the yield spread to German Bunds. Sample: EMU 12, without Luxembourg, Germany is benchmark. Greece included from 2001 on. Estimation period: 01 Jan 1999 to 28 Feb 2009. Data have weekly frequency, except for bank assets (monthly). Estimation method: Instrumental variable panel regression. t-values are below the coefficient estimates in bold; below mean coefficients, p-values are reported. * (**,***) indicates significance at a 10 (5, 1) percent level. Estimation is with country fixed effects.

[a] Coefficients scaled up by factor 100.

Table A-3: Capitalization (robustness)

Regression	A	B	C	D	E	F
Yield Spread (-1)	**0.95*** **	**0.93*** **	**0.92*** **	**0.90*** **	**0.91*** **	**0.95*** **
	69.58	74.47	71.11	69.91	68.39	52.03
Time to maturity	**0.21**	**0.19**	**0.27**	**0.34***	**0.31**	**0.18**
	1.56	1.25	1.51	1.92	1.47	1.13
Bid/ ask spread	**0.46*** **	**0.45** **	**0.39** **	**0.43** **	**0.29** **	**0.31** **
	2.91	2.51	2.2	2.61	2.23	2.47
US Corp[a]	**1.03*** **	**2.66*** **	**2.75*** **	**1.89** **	**3.51***	**2.24**
	5.88	2.88	2.77	2.26	1.69	1.27
Debt[a]	**2.22** **	**2.60***	**3.51***	**4.18** **	**4.75** **	
	2.05	1.92	1.89	2.14	2.2	
Equity	**-0.3** **	**1.2** **	**1.3** **	**1.00** **	**0.9**	**0.2**
	-2.37	2.49	2.51	2.06	1.62	0.34
US Corp * equity[a]		**-0.79*** **	**-0.84*** **	**-0.59** **	**-0.42**	**-0.09**
		-3.01	-3.04	-2.46	-1.32	-0.21
Bank assets			**0.01**	**0.01***	**-0.01**	**-0.03*** **
			1.44	1.83	1.58	-3.19
Refcorp[a]				**4.20*** **		
				4.56		
US Corp * bank assets[a]					**0.02** **	**0.02*** **
					2.06	3.21
N	4455	4455	4455	4455	4455	4949

Notes: Dependent variable is the yield spread to German Bunds. Sample: EMU 12, without Luxembourg, Germany is benchmark. Greece included from 2001 on. Estimations A-E 01 Jan 2000 to 28 Feb 2009, Estimation F: 01 Jan 1999 to 28 Feb 2009. Data have weekly frequency, unless stated otherwise. Equity is banking equity in relation to total assets; thus a lower value indicates greater risk. Equity and bank assets have monthly frequency, debt is quarterly (available from 2000). Estimation method: Pesaran and Smith (1995) using Swamy (1971). t-values are below the coefficient estimates in bold. * (**,***) indicates significance at a 10 (5, 1) percent level. Estimation is with country fixed effects.

[a] Coefficients scaled up by factor 100.

Table A-4: Instrumental variables regression: robustness

Regression	A	B	C	E	G
Insrument for liquidity	Bid-/ ask spread (-1)	Bid-/ ask spread (-1)	Future Volume	Bid-/ ask spread (-1)	Future Volume
Yield Spread (-1)		**1.01*** **	**0.89*** **	**1.04*** **	**0.93*** **
		363.92	18.5	370.57	31.51
Liquidity	**9.86*** **	**0.11**	**13.48*** **	**-0.09**	**9.22*** **
	21.03	1.22	2.70	-1.08	3.64
Time to maturity	**4.11*** **	**0.09**	**0.11**	**-0.01**	**0.05**
	11.4	1.36	0.63	-0.12	0.38
VIX[a]	**131.26*** **	**4.16*** **	**-1.13**	**1.71*** **	**0.29**
	51.37	7.02	-0.46	3.43	0.26
Bank assets[a]				**0.25** **	**0.13**
				2.62	0.63
VIX*bank assets[a]				**0.01*** **	**0.02*** **
				4.27	3.25
N	4988	4988	4989	4948	4949

Notes: Dependent variable is the yield spread to German Bunds. Sample: EMU 12, without Luxembourg, Germany is benchmark. Greece included from 2001 on. Estimation period: 01 Jan 1999 to 28 Feb 2009. Data have weekly frequency, except for bank assets (monthly). The first instrument for liquidity, ie the bid/ask spread, is its first lag, the second one is the trading volume of the Bund Future. Estimation method: Instrumental variable panel regression. t-values are below the coefficient estimates in bold. * (**,***) indicates significance at a 10 (5, 1) percent level. Estimation is with country fixed effects.

[a] Coefficients scaled up by factor 100.

Table A-5: Instrumental variables regressions: first stage

Regression	A	B	C	D	E
Bid/ ask spread (-1) (Instrument 1)	**0.91*** **	**0.90*** **		**0.90*** **	
	144.8	141.12		136.91	
Bund Future Volume (Instrument 2)			**1.19** **		**1.78*** **
			2.51		3.55
Time to maturity[a]	**-0.33**	**-0.49**	**-0.52**	**-0.43**	**-0.25**
	-0.66	-0.97	-0.45	-0.78	-0.21
US Corp[a]	**0.02*** **	**0.01** **	**0.05*** **	**0.01** **	**0.02** **
	6.78	2.63	4.61	2.04	2.33
Yield spread (-1)[a]		**0.06** **	**0.92*** **	**0.09*** **	**1.15*** **
		2.26	14.82	2.75	16.75
Bank assets[a]				**0.004**	**0.008**
				0.43	0.4
US Corp * bank assets[a]				**-0.00001**	**-0.00013*** **
				-0.63	-3.39
N	4968	4968	4969	4948	4949
R2	0.83	0.83	0.17	0.83	0.17

Notes: Dependent variable is the bid / ask spread. Sample: EMU 12, without Luxembourg, Germany is benchmark. Greece included from 2001 on. Estimation period: 01 Jan 1999 to 28 Feb 2009. Data have weekly frequency, except for bank assets (monthly). The first instrument for liquidity, ie the bid/ask spread, is its first lag, the second one is the trading volume of the Bund Future (in million euro). Estimation method: Instrumental variable panel regression. t-values are below the coefficient estimates in bold. * (**,***) indicates significance at a 10 (5, 1) percent level. Estimation is with country fixed effects.

[a] Coefficients scaled up by factor 100.

Table A-6: Panel fixed effects regression

Regression	A	B	C	D	E	F	G	H
Yield Spread (-1)	**0.99*** **	**1.02*** **	**1.02*** **	**1.02*** **	**1.02*** **	**1.03*** **	**1.02** **	**0.99*** **
	298.7	305.37	301.58	299.85	300.74	285.6	274.15	298.57
Time to maturity	**0.10***	**0.05**	**-0.06**	**-0.08**	**-0.05**	**-0.09**	**-0.06**	**0.99**
	1.67	0.9	-0.95	-1.29	-0.83	-1.51	-1.04	1.47
Bid/ ask spread	**0.14***	**0.03**	**0.05**	**0.05**	**-0.31*** **	**0.00**	**0.03**	**0.15***
	1.81	0.37	0.68	0.64	-3.04	-0.04	0.37	1.9
US Corp[a]	**0.70*** **	**0.37*** **	**0.41*** **	**0.39*** **	**0.32*** **	**0.35*** **	**0.39*** **	**0.72*** **
	12.9	6.93	7.69	6.85	5.55	6.45	7.04	12.87
Bank assets[a]		**0.41*** **	**0.04**	**0.49*** **	**0.00001**	**-0.19***	**-0.23** **	
		6.17	0.46	3.52	-0.01	-1.92	-2.28	
US Corp * bank assets[a]			**0.0011*** **	**0.0015*** **	**0.0012*** **	**0.0012*** **	**0.0015*** **	
			5.61	7.24	6.16	6.53	7.43	
Crisis dummy (2007)				**-0.22***				
				-1.67				
Crisis dummy * bank assets[a]				**-0.48*** **				
				-5.67				
US Corp * bid/ ask spread[a]					**0.19*** **			
					4.81			
Annual debt						**-0.03*** **	**-0.04*** **	
						-5.96	-6.8	
US Corp * annual debt[a]							**0.0052*** **	
							3.63	
Short term interest rate[a]								**-5.98**
								-1.39
N	4969	4949	4949	4949	4949	4949	4949	4969
R2	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98

Notes: Dependent variable is the yield spread to German Bunds. Sample: EMU 12, without Luxembourg, Germany is benchmark. Greece included from 2001 on. Estimation period: 01 Jan 1999 to 28 Feb 2009. Data have weekly frequency, except for bank assets (monthly) and debt (annual). The crisis dummy takes the value 1 from 2007 on. Estimation method: Pesaran and Smith (1995) using Swamy (1971). t-values are below the coefficient estimates in bold. * (**,***) indicates significance at a 10 (5, 1) percent level. Estimation is with country fixed effects.

[a] Coefficients scaled up by factor 100.

Table A-7: Further robustness checks: Full sample not restricted to EMU

Regression	A	B	C	D	E	F	G	H
Yield Spread (-1)	**0.96*** **	**0.97*** **	**0.96*** **	**0.95*** **	**0.95*** **	**0.95*** **	**0.94** **	**0.96*** **
	161.98	79.05	82.28	72.28	75.47	60.41	65.4	155.49
Time to maturity	**0.19**	**0.16**	**0.19**	**0.19**	**0.27**	**0.17**	**0.20**	**0.18**
	0.64	1.05	1.12	1.11	1.56	0.92	1.08	0.58
Bid/ ask spread	**0.20**	**0.35*** **	**0.26** *	**0.09**	**0.36** **	**0.36** **	**0.41** **	**0.24**
	1.03	2.70	1.71	0.23	2.25	2.03	2.35	0.92
US Corp[a]	**0.88*** **	**0.94*** **	**2.62** *	**2.51**	**3.29**	**2.96** *	**3.51** **	**0.89*** **
	4.85	6.34	1.94	1.52	1.58	1.76	2.22	4.7
Bank assets[a]		**0.00**	**-0.03*** **	**-0.03** **	**-0.03*** **	**-0.03** **	**-0.03** **	
		0.27	-2.92	-2.36	-3.03	-2.57	-2.42	
US Corp * bank assets[a]			**0.0021*** **	**0.019** *	**0.026** **	**0.024** **	**0.023** **	
			2.61	1.88	2.13	2.4	2.28	
US Corp * bid/ ask spread[a]				**0.14**				
				0.45				
Crisis dummy (2007)					**-2.47**			
					-0.53			
Crisis dummy * bank assets[a]					**-0.04**			
					-1.58			
Annual debt						**0.03**	**-0.01**	
						1.01	-0.17	
US Corp * annual debt[a]							**0.03**	
							1.44	
Short term interest rate[a]								**2.35**
								0.21
N	7876	5622	5622	5622	5622	5622	5622	7876

Notes: Dependent variable is the yield spread to German Bunds. Sample: EMU 12, without Luxembourg, Germany is benchmark. Greece included from 2001 on. Estimations A, H: 01 May 1990 to 28 Feb 2009, B-G: 01 Mar 1997 to 28 Feb 2009. Data have weekly frequency, except for bank assets (monthly) and debt (annual). Crisis dummy takes the value 1 from 2007 on. Yield spreads prior to 1999 are adjusted for ten year swap rate differential, thus controlling for exchange rates. Estimation method: Panel fixed effects. t-values are below the coefficient estimates in bold. * (**,***) indicates significance at a 10 (5, 1) percent level. Estimation is with country fixed effects.

[a] Coefficients scaled up by factor 100.

Table A-8: Sub-sample stability and Bund yield as explanatory variable

Regression	A	B	C	D
Yield Spread (-1)	**0.95*** **	**0.96*** **	**0.95*** **	**0.96*** **
	86.89	52.74	77.91	52.9
Time to maturity	**0.22**	**0.10**	**0.15**	**0.16**
	1.57	0.74	1.21	1.15
Bid/ ask spread	**0.23***	**0.28** **	**0.28** **	**0.27** **
	1.67	2.05	1.96	2.05
US Corp[a]	**3.06***	**1.35***	**1.69** **	**2.68***
	1.83	1.81	2.36	1.71
Bank assets[a]	**-0.04** **	**-0.02*** **	**-0.03*** **	**-0.03** **
	-2.61	-3.1	-3.16	-2.47
US Corp*bank assets[a]	**0.023** **	**0.014*** **	**0.015*** **	**0.021** **
	2.39	3.04	3.13	2.29
Yield Germany				**-0.08**
				-0.4
sample omits	IE	GR	IE, GR	
N	4629	4527	4207	4949

Notes: Dependent variable is the yield spread to German Bunds. Sample: EMU 12, without Luxembourg, Germany is benchmark. Greece included from 2001 on. Estimation period: 01 Jan 1999 to 28 Feb 2009. Data have weekly frequency, except for bank assets (monthly). Estimation method: Pesaran and Smith (1995) using Swamy (1971). t-values are below the coefficient estimates in bold. * (**,***) indicates significance at a 10 (5, 1) percent level. Estimation is with country fixed effects.

[a] Coefficients scaled up by factor 100.

Table A-9: Depth of Market

Regression	A	B	C	D	E	F
Yield Spread (-1)	**0.96*** **	**0.96*** **	**0.95*** **	**0.94*** **	**0.93*** **	**0.94*** **
	112.13	104.79	107.69	97.70	77.39	86.00
Time to maturity	**0.13**	**0.13**	**0.14**	**0.27*** **	**0.31*** **	**0.30*** **
	1.27	1.29	1.42	2.84	3.41	2.87
Bid/ ask spread	**0.45*** **	**0.35*** **	**0.37*** **	**0.37*** **	**0.32*** **	**0.34*** **
	4.1	3.07	2.99	3.73	3.35	3.61
US Corp[a]	**0.45*** **	**-1.14** **	**-1.03***	**-0.76**	**0.90**	**1.36** **
	5.81	-2.03	-1.74	-1.16	1.34	2.12
Outstanding volume[a]	**0.03**	**0.51*** **	**0.57*** **	**0.52*** **	**0.22**	**0.34*** **
	0.42	3.94	4.16	4.58	1.47	3.09
US Corp * outstanding volume[a]		**-0.0028*** **	**-0.0026*** **	**-0.0016*** **	**0.0010**	
		-3.72	-3.4	-1.83	0.71	
Annual debt[a]			**-1.37**			
			-0.59			
Bank assets[a]				**1.11** **	**-0.30**	**-0.21**
				2.26	-0.54	-0.37
US Corp*bank assets[a]					**0.0107*** **	**0.0101** **
					2.76	2.51
N	4769	4769	4769	4769	4769	4769

Notes: Dependent variable is the yield spread to German Bunds. Sample: EMU 12, without Luxembourg, Germany is benchmark. Greece included from 2001 on. Estimation period: 01 Jan 1999 to 30 Sept 2008. Data have weekly frequency, except for bank assets (monthly) and debt (annual). Depth of market measured by country's total market debt, relative to German market debt outstanding (quarterly data, Bank for International Settlements). Estimation method: Pesaran and Smith (1995) using Swamy (1971). t-values are below the coefficient estimates in bold. * (**,***) indicates significance at a 10 (5, 1) percent level. Estimation is with country fixed effects.

[a] Coefficients scaled up by factor 100.

Table A-10: Controlling for actual trade.

Regression	A	B	C	D	E	F
Yield Spread (-1)	**0.82*** **	**0.81*** **	**0.77*** **	**0.90*** **	**0.88*** **	**0.88*** **
	27.11	25.2	17.85	21.53	20.95	21.98
Time to maturity	**1.05**	**1.63**	**1.73***	**0.82**	**0.91**	**0.70**
	1.00	1.39	1.77	0.73	0.9	0.82
Bid/ ask spread	**0.06**	**0.05**	**0.11**	**0.09**	**0.38**	**0.47**
	0.05	0.04	0.09	0.08	0.37	0.47
US Corp[a]	**3.21*** **	**3.34*** **	**3.63*** **	**1.77*** **	**3.78** **	**4.16**
	5.34	6.88	5.46	3.77	1.98	1.60
Trading volume[a]	**0.02**	**-0.03**	**-0.03**	**0.04**	**-0.01**	**-0.04**
	0.34	-1.03	-0.93	0.1	-0.02	-0.5
US Corp * trading volume[a]		**0.0012**	**0.0011**	**-0.0002**	**-0.0002**	
		1.00	0.86	-0.15	-0.12	
Annual debt[a]			**0.9645**			
			1.28			
Bank assets[a]				**0.33**	**-6.59**	**-4.94**
				0.07	-1.11	-0.92
US Corp*bank assets[a]					**0.0244**	**0.0249**
					1.65	1.41
N	750	750	750	730	730	730

Notes: Dependent variable is the yield spread to German Bunds. Sample: EMU 12, without Luxembourg, Germany is benchmark. Greece included from 2001 on. Estimation period: 01 Sept 2007 to 28 Feb 2009. Data have weekly frequency, except for bank assets (monthly) and debt (annual). Liquidity measured with actual trading volume on all platforms of the electronic trading system MTS combined. Estimation method: Pesaran and Smith (1995) using Swamy (1971). t-values are below the coefficient estimates in bold. * (**,***) indicates significance at a 10 (5, 1) percent level. Estimation is with country fixed effects.
[a] Coefficients scaled up by factor 100.

Table A-11: Controlling for actual trade (without Italy)

Regression	A	B	C	D	E	F
Yield Spread (-1)	**0.83*** **	**0.82*** **	**0.79*** **	**0.91*** **	**0.89*** **	**0.89*** **
	28.79	25.95	20.58	20.82	19.77	20.76
Time to maturity	**0.78**	**1.02**	**1.45**	**0.48**	**0.67**	**0.59**
	0.71	0.98	1.56	0.49	0.79	0.71
Bid/ ask spread	**-0.21**	**-0.13**	**-0.13**	**0.07**	**0.28**	**0.34**
	-0.16	-0.09	-0.11	0.06	0.26	0.32
US Corp[a]	**2.90*** **	**3.18*** **	**3.33*** **	**1.55*** **	**3.55***	**3.93**
	5.66	6.60	6.70	3.59	1.71	1.36
Trading volume[a]	**0.02**	**-0.33**	**-0.32**	**0.11**	**0.06**	**-0.05**
	0.2	-0.96	-0.88	0.26	0.13	-0.51
US Corp * trading volume[a]		**0.0013**	**0.0012**	**-0.0005**	**-0.0004**	
		0.94	0.81	-0.31	-0.25	
Annual debt			**0.50**			
			1.28			
Bank assets[a]				**0.19**	**-7.49**	**-5.45**
				0.04	-1.15	-0.96
US Corp * bank assets[a]					**0.0263**	**0.0257**
					1.65	1.36
N	675	675	675	657	657	657

Notes: Dependent variable is the yield spread to German Bunds. Sample: EMU 12, without Luxembourg, Germany is benchmark. Greece included from 2001 on. Estimation period: 01 Sept 2007 to 28 Feb 2009. Data have weekly frequency, except for bank assets (monthly) and debt (annual). Liquidity measured with actual trading volume on all platforms of the electronic trading system MTS combined. Italy is dropped from the estimation because its bonds dominate trading on MTS. Estimation method: Pesaran and Smith (1995) using Swamy (1971). t-values are below the coefficient estimates in bold. * (**,***) indicates significance at a 10 (5, 1) percent level. Estimation is with country fixed effects.

[a] Coefficients scaled up by factor 100.