Banking and Sovereign Risk in the Euro Area

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Abstract

We study the determinants of sovereign bond spreads in the euro area since the introduction of the common currency. We show that an aggregate risk factor is a main driver of spreads. Aggregate risk is also key in determining the impact of the size and structure of a country's banking sector on sovereign risk. In episodes of high aggregate risk countries with large banking sectors and low equity ratios of the banking sector exhibit larger yield spreads. Government debt levels and forecasts of future fiscal deficits are also significant determinants of sovereign spreads.

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1 Introduction

Much attention has been given to the recent surge in sovereign bond spreads within the euro area. The average yield spread of ten year bonds against Germany was a narrow 15 basis points between the introduction of the euro in 1999 and late August 2008, increasing by more than the factor five to almost 80 basis points between September 2008 and February 2009. At the peak, Irish and Greek government bonds even traded more than 250 basis points above the German Bund, a level previously associated with emerging market debt. At the same time, the present crisis is centered on the financial sector and the banking sector in particular. Banking risk and sovereign risk can therefore be connected and it is this link that the present paper studies.

In the fall of 2008, shortly after the collapse of Lehman Brothers, most governments set up rescue packages for the financial system of unprecedented size. Explicit liabilities from these programs come mostly in the form of cash transfers (eg recapitalization) or guarantees (eg for bond issues) and increase sovereign obligations. Ireland might be the best example for that link, as its issued guarantees are worth more than 200 percent of GDP. Besides explicit guarantees and liabilities given to the banking sectors, governments implicitly guarantee the banking sector. Indeed, the banking sector in European economies plays a central role for the real economies. It is clear, that government cannot allow major banks to fail as the real implications would be disastrous. It can therefore be argued that already before the crisis, the financial sector implicitly enjoyed a state guarantee. This implicit liability could therefore weigh on sovereign risk. It should be particularly pronounced when the likelihood of the implicit guarantee to become an actual liability is high.

One cannot exactly calculate the extent of market-perceived government liabilities. However, they clearly relate to the size of the banking sector which can be measured by total assets. Thus, a key question of this paper is, whether the banking sector size is a determinant of sovereign spreads. Furthermore, the potential impact on public coffers depends on the vulnerability of the banking sector. We use the equity ratio as a measure, since equity is a buffer that is used before governments need to step in. Furthermore, the equity ratio is a proxy for the ability of credit institutions to give loans, which feeds back into the real economy and thus indirectly into state finances.

Viewing the banking sector as a liability appears to be straightforward at

present. However, it is - under normal conditions - an important source of government revenue and economic growth. A well developed banking sector should therefore reduce sovereign spreads as it contributes to revenues and the well-being of the economy in general. Thus, we expect that a large banking sector should reduce sovereign spreads, when it is unlikely that governments will have to step in for its liabilities.

We find that when it is likely that governments will have to step in for banking liabilities, sovereign risk increases. In contrast, when this is very unlikely, larger banking sectors reduce sovereign risk. More specifically, with higher aggregate risk, banking sectors indeed become a liability to governments. Specifically, countries with large banking sectors face a higher sovereign spread. The same holds for banking sectors with comparatively low capitalization. At the peak of the crisis (to date), up to almost one percentage point of euro area sovereign spreads can be explained by banking sector related risk. However, in a very favorable state of aggregate risk the impact of bank risk on sovereign spreads reverses demonstrating the beneficial effects of banking. The effect of banking on sovereign risk is thus related to a measure of aggregate risk. This captures the importance of systemic risk, which can swiftly turn an apparently healthy banking sector to a burden for taxpayers.

We also show that fiscal policy and liquidity factors are a determinant of sovereign spreads. Moreover, we pay particular attention both to the importance of liquidity in sovereign bond markets and the measurement of the aggregate risk factor. Our results are robust to various measures for liquidity and risk, as well as to different specifications of our econometric approach. All in all, we are able to establish that country specific risk factors, apart from liquidity risk, contribute to sovereign spreads. In identifying the role of the banking sector we add another source of risk to the canon of sovereign spread determinants, which so far mainly consists of aggregate risk, liquidity risk and fiscal conditions.

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. We then discuss the data set featuring the construction of a number of variables, in particular with a view of capturing liquidity effects. Section 5 presents the main estimation results. Section 6 provides an extensive robustness analysis while the last section concludes.

2 Related Literature

A firmly established result in the literature on (European) sovereign bond spreads is the importance of an aggregate or global risk factor, which measures general perception of risk and investors willingness to bear it. Favero, Giavazzi, and Spaventa (1997) identify a common trend for Spanish and Italian spreads to Germany which is driven by an international risk factor and explains a large percentage of the variation of spreads. Codogno, Favero, and Missale (2003), using data from 1992 to 2002, confirm, that an international risk factor, proxied by the US swap spread or the US corporate bond spread, is a main driver of European bond spreads. In contrast, liquidity only plays a minor role. This result is robust both to varying samples and estimation strategies: Geyer, Kossmeier, and Pichler (2004) come to similar results using a different estimation technique. Longstaff, Pan, Pedersen, and Singleton (2007), who study sovereign CDS instead of bond markets find that excess returns from investing in sovereign credit stem primarily from bearing global risk, while country-specific risk factors are hardly remunerated. Mangenelli and Wolswijk (2009) use the short term interest rate to identify aggregate risk and argue that low interest rates result in spread compression if investors have absolute return objectives.

Regarding liquidity, Gómez-Puig (2006) finds a positive contribution of liquidity on sovereign spreads during 1996-2001. Favero, Pagano, and von Thadden (forthcoming) provide both theoretical and empirical evidence for the role of liquidity and its interaction 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. The total effect of liquidity risk on sovereign risk is negative, which is explained by a reduced set of alternative investment opportunities in periods of high aggregate risk. In contrast, Beber, Brandt, and Kavajecz (2009) find that liquidity matters especially in episodes of market stress in a sample covering 2003 and 2004. [1]

With regard to the fiscal literature, Bernoth, von Hagen, and Schuknecht (2004) study changes in the European bond market after the introduction of the euro (observation period 1991-2002). They establish that debt, deficits

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

and debt-service ratios increase sovereign spreads. Schuknecht, von Hagen and Wolswijk (2009) extend the study to regional government debt. Hallerberg and Wolff (2008) confirm the impact of fiscal conditions on bond prices and show that it has become weaker following the introduction of the euro. However, when controlling for the quality of fiscal institutions, no weakening effect of fiscal policy on spreads can be measured. 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).

In this paper, we estimate a model, in which an aggregate risk factor helps to determine sovereign spreads. Furthermore, we consider the influence of liquidity as well as fiscal policy. In addition, the central novelty of our paper relates to the impact a banking sector may have on sovereign spreads.

3 Empirical approach

An aggregate risk factor plays a crucial role for the dynamics of sovereign bond spreads in EMU, as is established in the literature, for example Codogno, Favero, and Missale (2003). A simple principal components analysis supports this view: the first component captures already almost 96% of the variation, while the first three components explain nearly 98%. Moreover, euro area yield spreads are very persistent. We therefore adopt a dynamic adjustment model, which allows for persistence in spreads and has a common risk factor.

$$\tilde{r}_{i,t} = \rho_i \tilde{r}_{i,t-1} + (1-\rho_i)\tilde{r}^*_{i,t} + u_{i,t} \tag{1}$$

where $\tilde{r}_{i,t} = r_{i,t} - r_{d,t}$ 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 yield differential $\tilde{r}^*_{i,t}$. ρ_i is a weight parameter and $u_{i,t}$ the residual.

The equilibrium level of spreads, $\tilde{r}^*_{i,t}$, is determined by a common risk factor Z_t, bond specific liquidity $L_{i,t}$, issuer 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.[2]

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

$$\tilde{r}^*_{i,t} = b_{1,i}Z_t + b_{2,i}\tilde{L}_{i,t} + b_{3,i}\tilde{D}_{i,t} + b_{4,i}Z_t * \tilde{D}_{i,t}. \quad (2)$$

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

The estimation equation is therefore

$$\tilde{r}_{i,t} = \rho_i \tilde{r}_{i,t-1} + \beta_{1,i}Z_t + \beta_{2,i}\tilde{L}_{i,t} + \beta_{3,i}\tilde{D}_{i,t} + \beta_{4,i}Z_t * \tilde{D}_{i,t} + u_{i,t} \quad (3)$$

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

We employ several different variables to capture time varying risk factor Z and to proxy liquidity risk L. Our central variables for country specific default risk D are total assets held by the respective banking sector, its equity ratio[3] as well as government debt-to-GDP ratios and deficit forecasts. The data are described in the next section.

The interaction term allows the size of the banking sector's effect on sovereign risk to vary with aggregate risk. The underlying idea is that aggregate risk determines the likelihood of banks to become a liability for governments as the banking sector is perceived to be less stable when aggregate risk is high. In this way, the interaction term captures systemic effects. We concentrate on this systemic impact to the banking industry of a country, hence we do not account for the distribution of assets in a given banking sector.[4]

An important advantage of our approach is that the central explanatory variables are exogenous to euro area sovereign spreads. The size of the banking sector reflects past decisions of banks. A change in current sovereign risk premia is unlikely to have an immediate effect on this stock variable. The same argument applies to our measure of vulnerability of the banking sector, the equity ratio. Moreover, measures of the common risk factor, such as the corporate bond spread in the US, are driven by global shocks.

The estimation of this dynamic panel model raises several issues. Pesaran and Smith (1995) show that pooling the data in a dynamic setting can give inconsistent results if coefficients differ across sections. Fixed- and random

[3]Equity in relation to total assets.

[4]The impact of heterogeneity on vulnerability of a banking sector would be an interesting research question of its own.

effects models can 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 coefficients for each country. Indeed, a Wald test indicates that coefficients differ across countries, which rules out pooling in our dynamic panel.[5] At the same time, coefficients appear to be sufficiently similar for the hypothesis of a common distribution needed for the random coefficients model adopted.

We therefore opt for the estimation of a random coefficients model as proposed by Pesaran and Smith (1995), which allows coefficients to differ but assumes that these are drawn from a common distribution. They 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 estimates.

We perform various robustness analyses. Among these are SUR estimates for each country and a simple fixed effects estimation of our model, which we present for comparison purposes in the appendix.

Financial data are continuously availale and we use weekly averages of financial data instead of aggregating information further to lower frequencies. Since our banking variable is measured at a monthly frequency, we consider weekly spread data to be a compromise that allows to capture on the one hand the medium term fluctuations in spreads and on the other hand lower moving variables. For data with lower frequency, the data remain constant until a new observation occurs. Statistically, this 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 mismeasured. Such a measurement problem leads to an attenuation bias, which biases the coefficients towards zero. The estimated statistically significant effects on variables measured at lower frequency can therefore be considered to reflect a lower bound of the actual effects.

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

4 Data

We study the euro area sovereign bond market, excluding only Luxembourg, which has little public debt outstanding and therefore no valuable yield data and the last four entrants to the euro, as their accession to the common currency is recent.[6] 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 the financial markets and in the academic literature.[7] As we analyze the yield spread to Germany, all other variables are expressed in differences to the corresponding German ones.

We rely on all bonds available on Bloomberg, issued by the 11 countries which have an initial maturity of ten years. From those, we use only on-the-run bonds, which carry a fixed coupon (straight bonds without structuring features), are issued in euro and are quoted.[8] Thus, from about 850 initially identified single bonds approximately 270 remain in the sample.

We use these to calculate time series for yield to maturity, the (yield) bid-/ask spread and the remaining time to maturity for every country in the sample. To do so, only the observations from on-the-run bonds are used, as they are the most traded bonds with the smallest liquidity premia. Each observation triple - yield, bid-/ask spread and time to maturity - is from the same bond. Since the remaining time to maturity varies in the sample, we follow Favero, Pagano, and von Thadden (forthcoming) 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.[9] We employ weekly averages of these data. Yields and bid/ask spreads are also taken from Bloomberg.

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 in the present crisis. However, these large movements mask

[6] Cyprus, Malta, Slovakia and Slovenia acceded 2007 or later.

[7] Dunne, Moore, and Portes (2007) provide econometric evidence for the benchmark role of the Bund in the 10 year segment.

[8] We exclude stale quotes, however this is hardly an issue as we rely on on-the-run bonds.

[9] We cannot revert to zero coupon rates, as the breadth and depth of several EMU participants sovereign bond markets is not sufficient to estimate reliable yield curves.

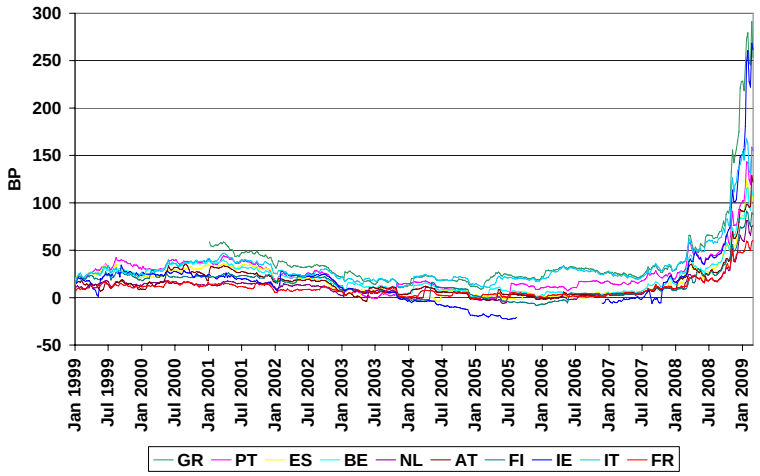


Figure 1: EMU 12 yield spreads to German Bund (without Luxembourg), 10 year bonds. Greece included as of accession in 2001.

developments in between. For example, around 2005 Ireland was considered to be a fast growing, fiscally sound economy, fuelled not the least by a large financial sector.[10] At that time, aggregate risk was exceptionally low and in fact the Irish ten year bond bond traded at lower a yield than the comparable German.[11]

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 on government bond spreads. To explore the robustness of our findings, we also re-estimate the model with longer time series. In the pre-euro period, we follow Favero, Giavazzi, and Spaventa (1997) and Gómez-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 (2009) show the importance

[10]Ireland even stopped issuing ten year bonds for some time.

[11]Graph A-3 in the Appendix depicts the Irish spread to the Bund and the aggregate risk factor.

of financial intermediaries' balance sheet adjustments for aggregate liquidity and financial stability, which affect not only public coffers directly but also credit availability for the economy as a whole, which feeds back into the fiscal stance. Thus, we use the size of the banking sector aggregate balance sheets (total assets to GDP ratio) and the equity ratio (equity relative 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 therefore increase sovereign risk while the second one should be associated with lower sovereign risk. Data is from the ECB's MFI data base, which is adjusted for statistical re-definitions and the inclusion of institutes in- or outside the banking sector. The levels are measured in percent of GDP. Since the yield spread is relative to Germany, we take the variable in difference to the German ones. 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' capability to repay a loan 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, [12] the debt stock is from 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 2). We use the US spread since this market is the largest and most liquid corporate bond market, thus the tightness of financing conditions there gives a good indication of investors' willingness to fund projects and thus to take on risk (Codogno, Favero, and Missale (2003) and Geyer, Kossmeier, and Pichler (2004)).

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

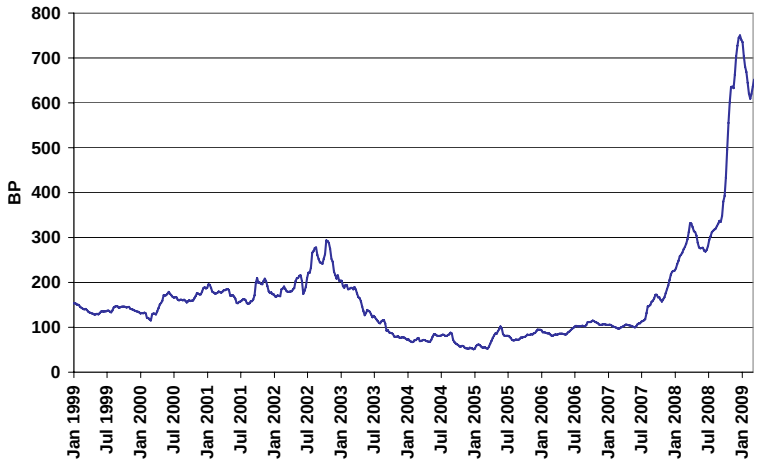


Figure 2: US corporate bond spread to government bonds for rating category BBB.

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 (3 month LIBOR vs. T-Bill rate) and the Refcorp spread (10 year agency vs. treasury yield); a detailed description is in the appendix.

Finally, we capture the liquidity of bonds. Our main measure are yield bid-/ask spreads, 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, again, in the appendix.

5 Results

5.1 Main findings

Table 1 presents our main regression results and yields several insights. First, sovereign bond spreads in the euro area react significantly to the common risk factor, measured by the US corporate bond spread. If the corporate bond spread increases by 1 basis point, the average spread of sovereign bonds in EMU increases by 0.01 basis points according to Regression A. Furthermore,

an increase of the bid-ask spread by 1 basis point relative to the German benchmark spread leads to an increase 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 the order of a magnitude, the risk factor is overall of far greater importance: the standard deviation of the bid-/ask spread in the sample is 0.75 basis points, whereas it is 120 basis points for the corporate bond spread. All regressions include the lagged dependent variable and a control for time to maturity. The high persistence of yield spreads emerges clearly with a coefficient of about 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, in times of higher aggregate risk, economies with large banking sectors see relatively sizeable increases in spreads.

The interaction of the risk factor and banking sector size is both statistically and economically highly significant (Regression C). The direct effect of banking sector balance sheets on sovereign spreads is negative. 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). From a corporate bond spread of 163 basis points on, coinciding with its mean, a larger banking sector increases the country's sovereign spreads. The corporate bond spread is indeed during 38% of our sample above that threshold. Given that we have opted for the conservative Pesaran/Smith/Swamy estimator, the confidence band is comparatively broad. 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 present financial crisis, a one percentage point larger banking sector relative to Germany, translated into a sovereign spread widening of 0.13 basis points. These numerically small coefficients are 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, 80 basis points of the sovereign spread would be attributable to the risk from the countries' credit institutions.

Sovereign bonds spreads prove to be very persistent; the long-run effects are

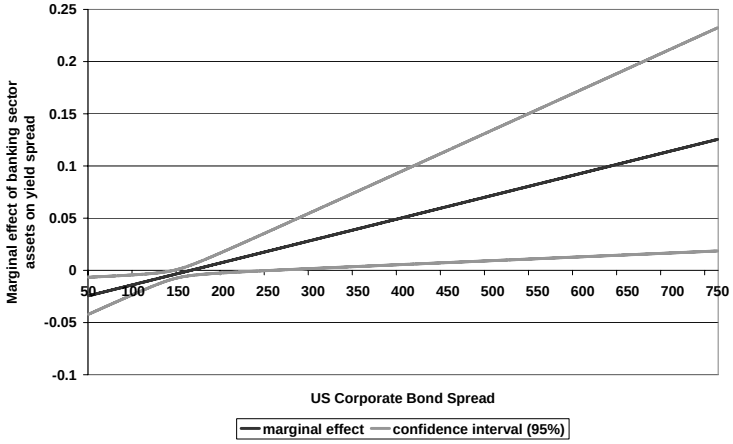
Table 1: Main estimation results

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	4949	4949	4949	4949	4122	827
Sample	full	full	full	full	full	pre-crisis	crisis

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 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 stated 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.

Figure 3: Marginal impact of the size of the banking sector on sovereign spreads as a function of the level of the common risk factor.



Note: Computations are based on Regression C of Table 1. The confidence band is on 95% level, the marginal effect is statistically not significantly different from zero when the US corporate bond spread is between 145 and 250 basis points.

thus very substantial.[13] 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, if the aggregate risk factor would permanently remain at such an elevated level. This figure demonstrates that public financing conditions can severely deteriorate through the combination of aggregate and banking related risk.

In the light of the severe recession following the financial market crisis, a negative impact of the banking sector on state solvency appears rather straightforward. However, to demonstrate that our results are not only an artefact of exceptional circumstances in the financial crisis, we introduce in Regression D a dummy variable that equals 1 from the first week of 2007.[14] We interact this crisis dummy with the banking related variables to assess whether the importance of banks size merely derives from the fact that the current crisis has

[13]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.

[14]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.

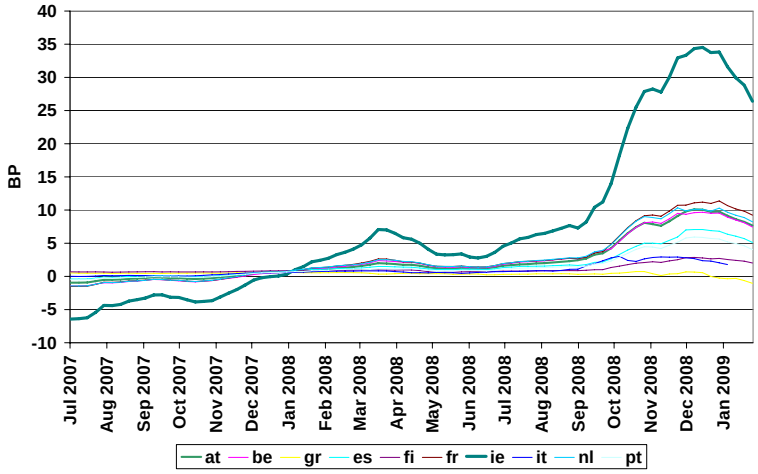


Figure 4: Difference of fit between model estimated on entire sample and model estimated on pre-crisis data (Jan 1999 to Jun 2007). See Regressions F and G in Table 1.

had a large impact on the stability of the banking system in many countries. 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 switched on at the Lehman bankruptcy (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 do find, as would be 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 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.[15]

[15]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 risk aversion 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.

In Graph 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 the financial crisis to be included in the estimated model. For Ireland, we find a significant difference between the two models. However, the difference amounts to less than 35 basis points, which is still small compared to the strong increase of the Irish spread. So even for the extreme case of Ireland, the estimates of the two models are not particularly different.

To further assess 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, possibly triggering a bail-out by the government which is a source of sovereign risk.

In Regression A of Table 2, we show that indeed a decrease in banks' equity ratio leads to an increase in sovereign spread. 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.

We have demonstrated that the banking sector is a determinant of sovereign spreads, measured as the effect of balance sheet sizes and equity ratios on sovereign spreads. While banking sector size relative to GDP indicates the cost of the government to bail-out the banking system, the equity ratio targets 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, ie, bond holders demand higher compensation for a given risk. The effects can also be found in a sample ending prior to the crisis.

Table 2: Capitalization

Regression	A	B	C
Yield spread (-1)	**0.98*** **	**0.96*** **	**0.96*** **
	60.27	51.7	50.39
Time to maturity	**0.11**	**0.11**	**0.13**
	0.91	0.93	0.99
Bid/ask spread	**0.31****	**0.32****	**0.30****
	2.48	2.22	2.23
US Corp	**0.01*** **	**0.02****	**0.02****
	4.96	2.37	2.41
Equity	**-0.2****	**1.1****	**1.1****
	-2.45	2.51	2.34
US Corp * equity[a]		**-0.75*** **	**-0.78*** **
		-2.87	-2.97
Bank assets[a]			**0.14**
			0.34
N	4949	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, 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.

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 1 with measures of fiscal policy. In regression A and B of Table 3, 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. This illustrates the attenuation bias outlined in section 3. 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.[16] 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. Regarding our central result, 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) as well as already Evans (1987) highlight the importance of expected future budget deficits for the interest rate in the US. We therefore revert in a further regression to a measure of expected changes in the debt level. More specifically, we employ the medium-term (3 year) forecast of deficits as reported by euro area Member States to the European Commission at the end of each year(Regression C).

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 will lead to a marginal increase of the spread by 2.4 basis points or a long term yield widening of almost 30 basis points. The higher sensitivity of sovereign spreads to deficit forecasts - in comparision to debt outstanding - has two explanations. First, expected deficits are news to the market. Second, the long term effect of a permanent increase in deficit more substantial as it entails a far larger permanent increase of debt to GDP ratio

[16] For example, Schuknecht, von Hagen and Wolswijk (2009) find an effect of similar size.

Table 3: 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, Estimation C: 01 Jan 1999 to 28 Feb 2009. Data have weekly frequency, unless stated otherwise. The deficit 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 1000.

compared to a permanent increases in the debt level as such. Moreover, also in this regression our central results regarding bank-related variables remains unchanged. This is consistent with the view that budget forecast, also in the recent past, either did not factor in the cost of potential bail-outs or market participants regarded banking related risk as a continuing risk, in spite of public actions.

Finally, we evaluate whether our results are driven by the state of the business cycle. We use a simple measure of the output gap as a control: the deviation of a country's quarterly real GDP from its HP-filtered trend. Our results concerning the risk from the banking sector and the interaction with the aggregate risk factor are not affected by the additional control (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 on top of debt outstanding. Also deficit forecasts maintain their contribution to sovereign spreads (Regression F).

All in all, key 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 the previous section, we established our central results on determinants of sovereign spreads. In this section, we inspect the robustness of our findings.

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 4 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 1, in which banking sector balance sheets are significant, only in the interaction with aggregate risk.

In the third respective regression, we include the measure for aggregate risk interacted with the banking sector size. In all three cases we find that the interaction to be positive (Regressions C, F, I). However, results are significant only for the regressions approximating aggregate risk with the VIX and the Refcorp spread.[17] Moreover, the coefficient on the banking sector size on on its own now turns negative as in our main findings.

Overall, the variation of the measure for aggregate risk in the analysis yields stable results: sovereign spreads increase in aggregate risk and higher aggregate risk interacts positively with a country's banking sector size.

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 be determined by some exogenous factor. More specifically, sovereign spreads as well as bid/ask spreads could raise during times of financial turbulence. At the same time, it is possible that the liquidity situation of sovereign bond markets is influenced by the sovereign spread.

To study the potential importance of reverse causality, we perform instrumental variable regressions. We employ two different instruments for the

[17] This is not very 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 Graph A-2 in the Appendix).

Table 4: 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**						
	5.13	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*bank assets[a]						**0.09***			
						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.

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.[18] 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 Future 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, while Bund Future trading volume performs considerably worse (see Table A-5 in the appendix).

In Regression A of Table 5, 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 Future trading volume as an instrument for the bid/ask spread. The instrumented liquidity measure now remains a 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 instrumentation of the bid-/ask spread. For both instruments, the interaction between the corporate bond spreads and the size of the banking sector remains a highly significant variable.[19] 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.

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

[19] 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.

Table 5: IV regressions for liquidity

Regression	A	B	C	E	G
Instrument 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	-1.19
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.

So far, we have presented several estimations 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, Pagano, and von Thadden (forthcoming) find that liquidity risk, proxied by the bid/ask spread, only is detectable in the European sovereign bond market if an interaction with the aggregate risk factor is accounted for. In Table 6 we therefore replicate the result of Favero et al. using our data set and show that such an interaction does not affect our central results.

More specifically, in Regression A we restrict our sample to the two years of Favero et al. The bid/ask spread as such is highly significant. Moreover, the interaction between the bid/ask spread and the US swap spread, which is their proxy for aggregate risk 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 reduces the 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. 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. Indeed, we find that larger banking sectors are associated with increasing sovereign risk when aggregate risk is sufficiently high. Thus the role of aggregate risk is manifold, but its influence also on liquidity does not alter our central result.

As a final robustness regarding liquidity, 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.

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

Table 6: Risk aversion 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**	**0.33** **
	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.

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 are therefore confident 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.

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. Therefore, we control for exchange rate effects by substracting 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 the other results to be 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,

for a discussion 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 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

We have shown that the size of the banking sector balance sheet matters for the assessment of European sovereign risk, measured with the bond yield spread to the German Bund. In normal times, financial markets do not demand a premium from governments of countries with large banking sectors; however with increasing aggregate risk the size of the banking sector is a positive determinant of a country's yield spread and such a premium can be economically significant. During the height of the current crisis, up to almost one percentage point of euro area sovereign spreads can be explained by this banking related factor. This effect can reverse in periods of low aggregate risk and larger banking sectors are seen as beneficial for sovereign risk. Systemic risk could explain this result as heightened aggregated risk can quickly turn a banking sector that is healthy in normal times into a strong risk to governments. 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 with increasing aggregate risk.

We also document that liquidity is priced in the sovereign bond market. Its quantitative importance is, however, comparatively small. Moreover, we also confirm previous findings that sovereign bond markets price in forward looking fiscal variables as well as the debt level of countries. We demonstrate the robustness of our findings to a wide range of alternative specifications and control variables.

The results therefore highlight the importance of the vulnerability and size of the banking sector for sovereign risk. Thus we are able to identify interpretable, country specific factors relating to default risk which affect sovereign bond spreads. Furthermore, the impact of banking sectors on sovereign spreads supports the notion that governments, ie taxpayers, are ultimately lenders and capital providers of last resort in a systemic crisis. This is reflected in sovereign risk.

To reduce the risk for the taxpayer, 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 of further research could be the study of government risk resulting from large international banks operating in two or more countries. Implicit and explicit burden sharing agreements and associated premia should clearly have an effect on relative sovereign risk.

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Appendix

Related Literature

See synopsis in Table A-1.

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.

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, Brandt, and Kavajecz 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.[20]

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, Pagano, and von Thadden forthcoming). The swap market is usually almost perfectly liquid, thus the spread to treasuries could be relied on as a

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

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 only 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	EWU 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 specifications	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.

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.

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.[21] 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.[22] 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.[23]

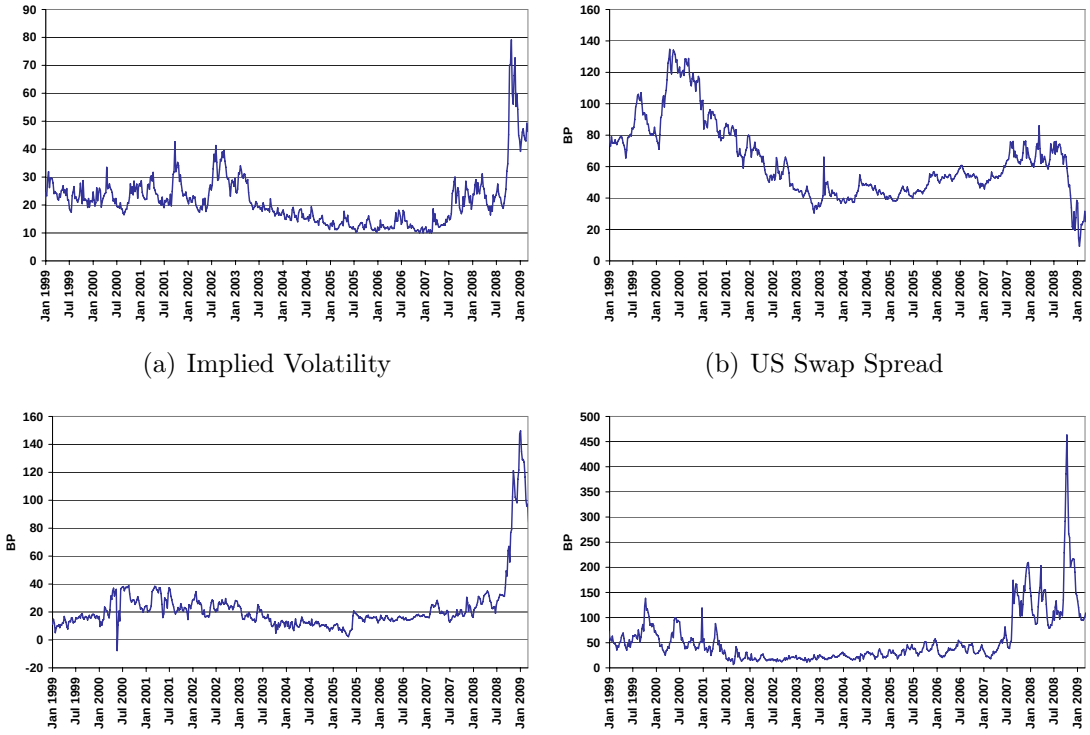
Furthermore, we capture time varying risk premia with a hybrid measure of liquidity and default risk, proposed by Longstaff (2004). Agency bonds with an explicit US federal government guarantee (Refcorp) and treasuries should have the same credit quality. Remaining yield spreads may be attributed to 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.[24]

[21] Shleifer and Vishny (1997).

[22] 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.

[23] 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.

[24] In addition, technical factors as repo-specialness and the deliverability for futures con-



(a) Implied Volatility

(b) US Swap Spread

(c) Refcorp Spread

(d) Ted Spread

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).

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, Pagano, and von Thadden (forthcoming). This may partly relate to trading 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.

tracts play in favor of standard government bonds. See, Vayanos and Weill (2008), Vayanos (2004) and Buraschi and Menini (2002).

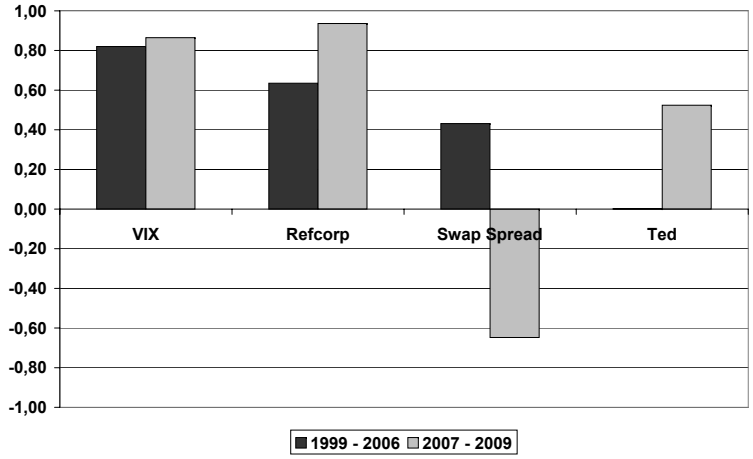


Figure A-2: Correlations of four alternative measures for the aggregate risk factor to our preferred measure, the US corporate bond spread.

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 - 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.

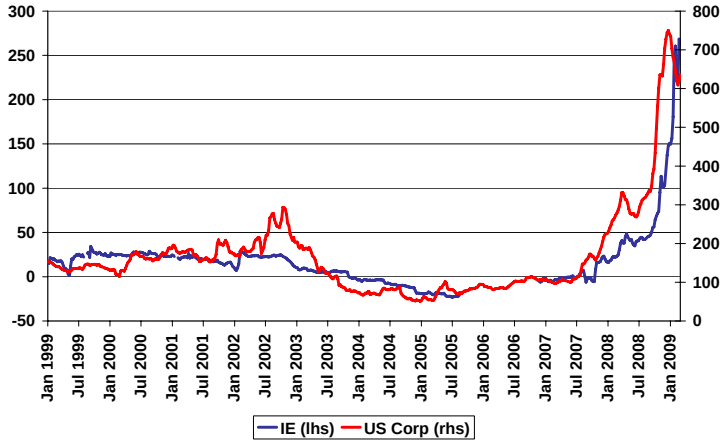


Figure A-3: Irish yield spread to German Bund, 10 year bonds and US corporate bond spread.

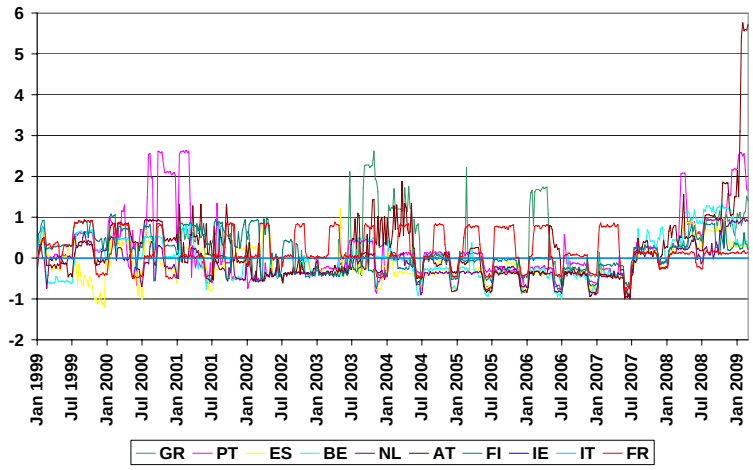


Figure A-4: Bid-/ask spreads relative to German Bund. Greece included as of accession in 2001.

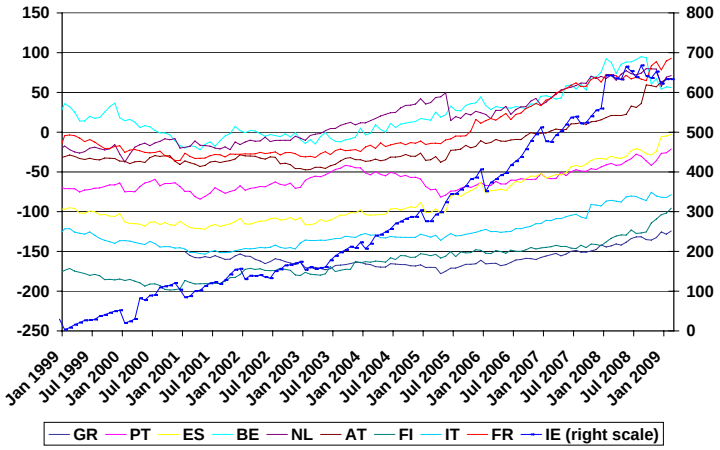


Figure A-5: Total banking assets relative to GDP, difference to Germany.

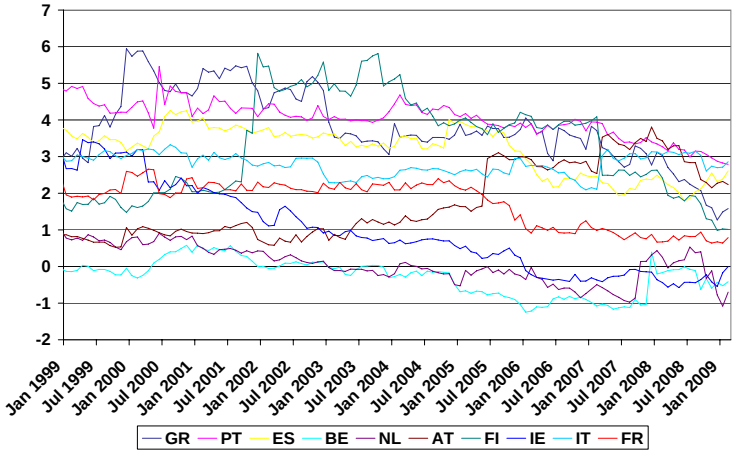


Figure A-6: Banking equity relative to total assets, difference to Germany.

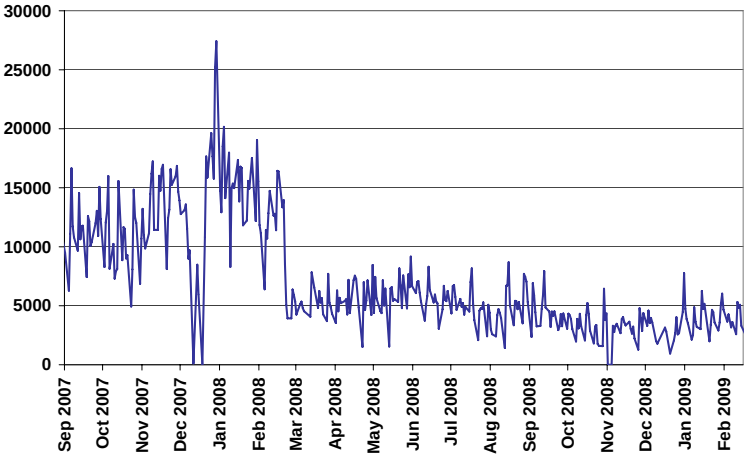


Figure A-7: Actual trading volume of EMU sovereign debt on the MTS trading platforms.

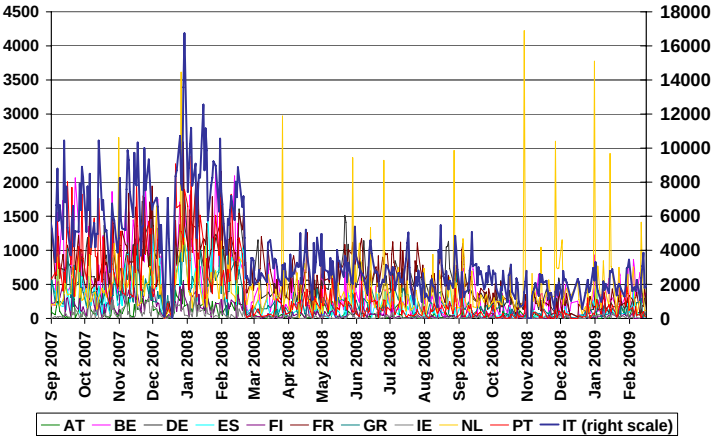


Figure A-8: Actual trading volume of EMU sovereign debt on the MTS trading platforms.

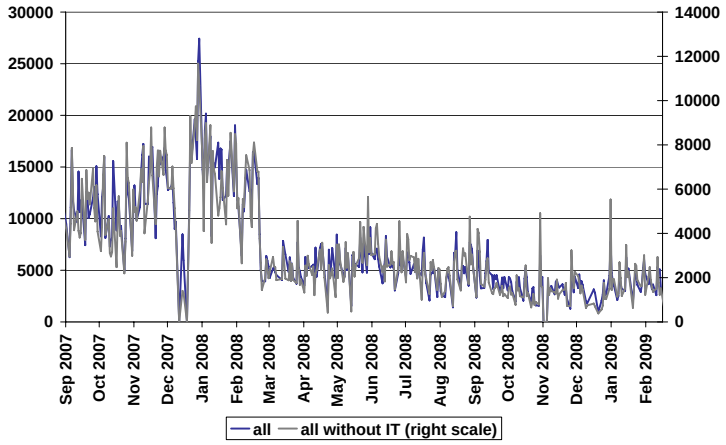


Figure A-9: Actual trading volume of EMU sovereign debt on the MTS trading platforms.

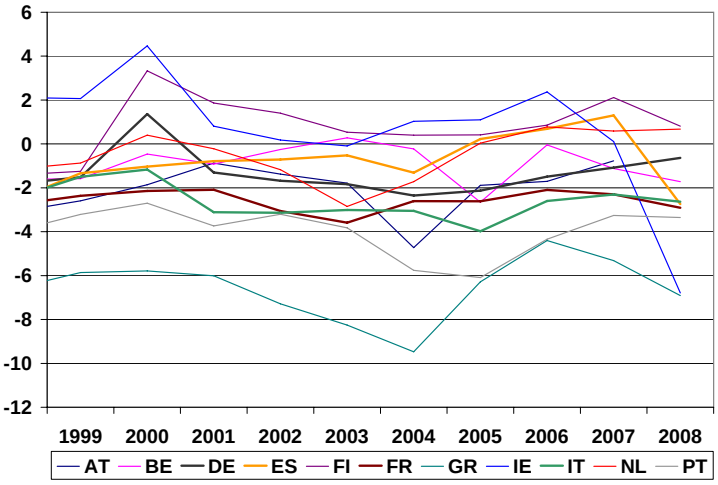


Figure A-10: Budget deficit as per cent of GDP.

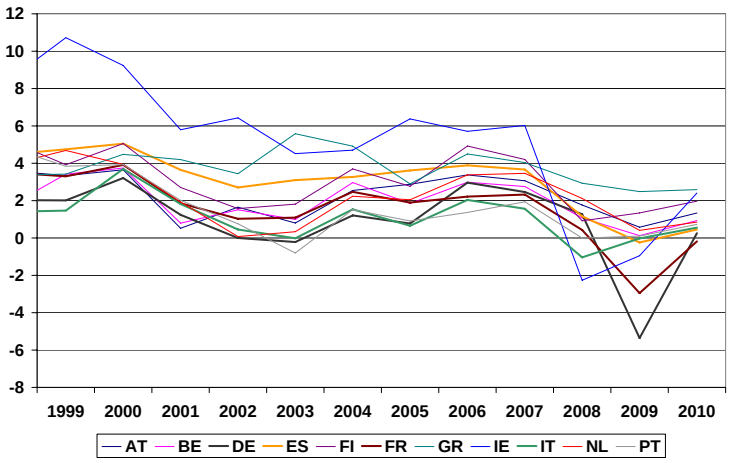


Figure A-11: Real GDP growth. Values for 2009 and 2010 are projections by the European Commission.

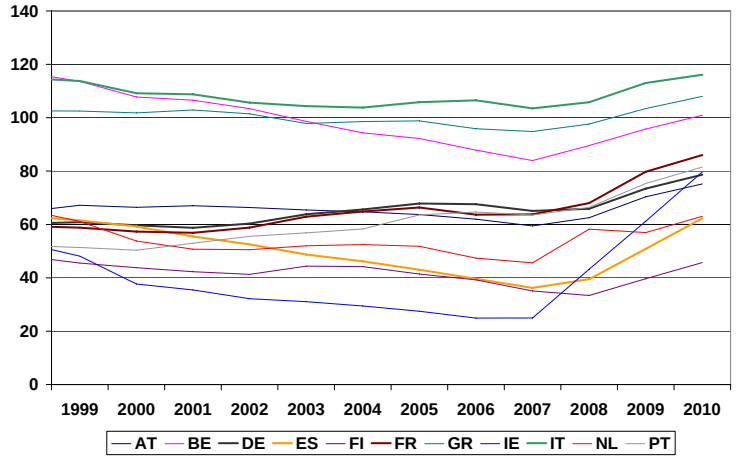


Figure A-12: Debt to GDP. Values for 2009 and 2010 are projections by the European Commission.

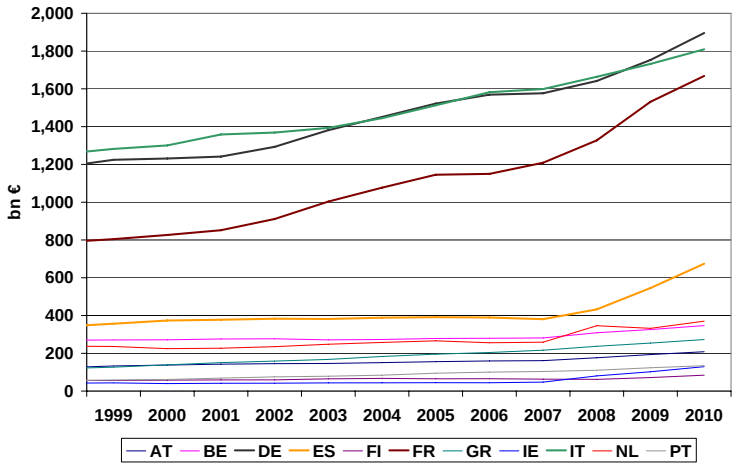


Figure A-13: Absolute debt outstanding, general government. Values for 2009 and 2010 are projections by the European Commission.

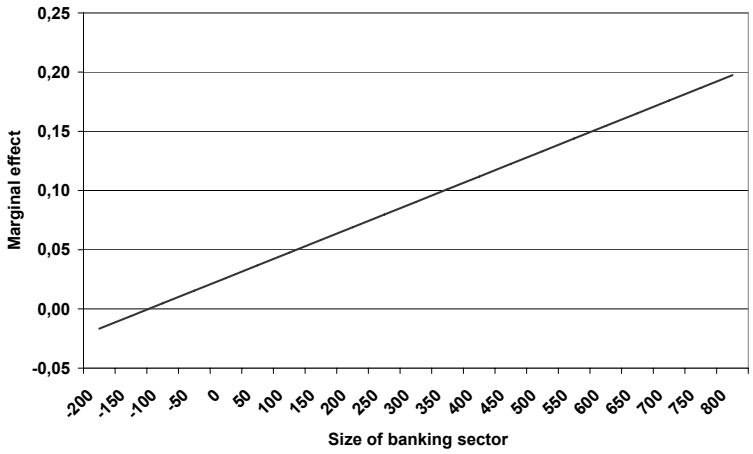
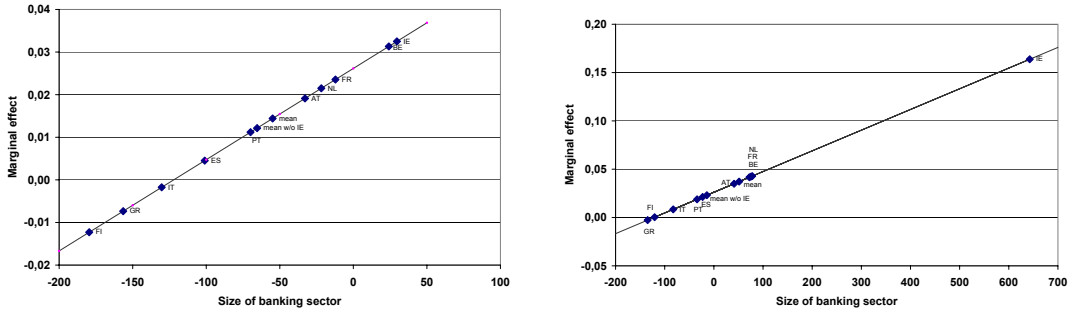


Figure A-14: Marginal effect of risk factor on yield spread, depending on size of banking sector.

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 (-1)	**0.99*** **	**1.08*** **	**0.96*** **	**0.98*** **	**0.92*** **	**0.91*** **	**0.92*** **	**0.94*** **	**0.97*** **	**0.93*** **	**0.96**
	52.56	14.02	23.2	39.62	39.81	19.06	22.63	48.5	39.89	41.1	0.00
Time to maturity	**-0.03**	**-0.48***	**0.97** **	**0.28**	**-0.25**	**0.31**	**0.21**	**-0.11**	**0.61***	**0.38** **	**0.19**
	-0.14	-1.68	2.17	0.89	-1.19	0.92	1.05	-1.16	1.68	2.38	0.0323
Bid/ask spread	**-0.15**	**0.58**	**-0.13**	**-0.13**	**0.49*** **	**-0.07**	**0.58***	**0.40***	**0.28**	**0.79*** **	**0.27**
	-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 * bank assets[a]	**0.010***	**0.004*** **	**0.095*** **	**0.013** **	**0.005** **	**0.041** **	**0.010**	**0.008***	**0.036*** **	**0.018*** **	**0.024**
	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	0.98	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** **	**1.0** **	**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 has 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
Instrument 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				**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 regression: 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 100 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**	**0.09**
	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: Panel fixed effects. t-values are below the coefficient estimates in bold. * (**, ***) indicates significance at a 10 (5, 1) percent level.
[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		**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]			**0.021*** **	**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 (2007) * bank assets					**-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, Estimations B-G: 01 Mar 1997 to 28 Feb 2009. Data have weekly frequency, except for bank assets (monthly) and debt (annual). Crisis dummy takes 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: 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-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	**-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			**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.