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Sovereign risk premiums in the European government bond market☆

Kerstin Bernoth [a,*], Jürgen von Hagen [b,c,d], Ludger Schuknecht [e,f]

[a] DIW Berlin, Mohrenstrasse 58, D-10117 Berlin, Germany
[b] University of Bonn, Lennestrasse 37, D-53113 Bonn, Germany
[c] Kelley School of Business, Bloomington, IN 47405, USA
[d] CEPR, 77 Bastwick Street, London EC1V 3PZ, UK
[e] European Central Bank, Kaiserstrasse 29, D-60311 Frankfurt am Main, Germany
[f] German Ministry of Finance, Wilhelmstrasse 97, D-10117 Berlin, Germany

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A B S T R A C T

This paper provides a study of bond yield differentials among EU government bonds on the basis of a unique data set of issue spreads in the US and DM (Euro) bond market between 1993 and 2009. Interest differentials between bonds issued by EU countries and Germany or the USA contain risk premiums which increase with fiscal imbalances and depend negatively on the issuer's relative bond market size. The start of the European Monetary Union has shifted market attention to deficit and debt service payments as key measures of fiscal soundness and eliminated liquidity premiums in the euro area. With the financial crisis, the cost of loose fiscal policy has increased considerably.

1. Introduction

The potential effect of public debt on government bond yields is an important issue for economists and policy makers. If government bond yields include risk premiums, increasing indebtedness may cause bond yields to go up, thus raising the cost of borrowing and imposing discipline on governments.

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* Corresponding author.
E-mail addresses: kbernoth@diw.de (K. Bernoth), vonhagen@uni-bonn.de (J. von Hagen), ludger.schuknecht@bmf.bund.de (L. Schuknecht).

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Market discipline of this kind is especially relevant and important in the European Monetary Union (EMU), in which the governments of the member states can issue debt, but do not have the possibility to monetize and inflate away excessive debts.

Whether such risk premiums can be identified empirically and how large they are has attracted considerable interest of policy makers as well as academics. This paper makes four contributions to the existing literature. First, we use a new data set consisting of yield-at-issue spreads between DM (Euro after 1999) and US$ denominated bonds issued between 1993 and 2009 by several EU governments and Germany or the US government, respectively. European countries issued substantial amounts of DM and US$ denominated debt before the start of EMU in 1999; since then, they issue most debt in euros and still substantial amounts in US$. Using primary market spreads has the advantage that the data reflect the cost of actual borrowing for the sovereign issuer.[1] Furthermore, using primary spreads assures the comparability of observations at different points in time, since, in contrast to average yields on debt outstanding, the residual maturity is always the full maturity. Using euro-denominated bonds, we treat public debt issued by member states of the euro area as foreign-currency debt. This is justified by the fact that no national government controls the monetary policy of the euro area, and no government can use monetary policy to inflate away its own debt. Our data set has several advantages compared to those used in earlier studies. Looking at DM (Euro) and US$ denominated bonds avoids the problem of exchange rate risk that arises in the comparison of bonds denominated by governments in their national currencies. Furthermore, the comparison of spreads on such issues is not distorted by differences in national tax regimes. Finally, we consider bonds issued by national governments, which allows us to consider sovereign risk at the national rather than the sub-national level.

Our second contribution is that we use data from before and after the start of EMU. This allows us to estimate directly the effects of monetary union on the risk premiums paid by European governments. A priori, these effects are ambiguous. Monetary union may increase the default risk of member governments, since the latter have surrendered their monetary sovereignty and, therefore, the possibility to monetize their debts, and other governments and the monetary union's central bank may not be compelled to rescue governments in financial crises. However, monetary union may also have reduced the perceived default risk, if markets anticipate that member governments in fiscal troubles will be bailed out by other governments or the central bank.

Our third contribution is that our empirical analysis distinguishes between risk premiums and liquidity effects in the bond market. Identifying the liquidity component of yield spreads is important, because it points to a lack of financial market integration rather than differences in fiscal positions as a source of yield differentials.[2] Empirically, we observe that German government bond yields are still below those of bonds issued by governments with much better debt positions. This has been interpreted as showing that bond yields do not reflect fiscal performance appropriately (Reuters, June 2002). But the fact that German bonds enjoy a yield advantage compared to others may instead be due to the size of the German bond market and the fact that German bonds can be traded immediately at lower transaction costs and with a smaller risk of price changes due to individual transactions.

Our fourth contribution is that we analyze in detail the impact of the global financial crisis on government bond pricing. Government bond spreads in the euro area have risen sharply since the collapse of the investment bank Lehman brothers. We investigate, whether this sharp increase can be explained by a mere deterioration of the fiscal position of European governments or whether financial markets corrected their risk perception of sovereign defaults by changing the market price of government credit risk.

Our paper proceeds as follows. Section 2 gives an overview of the related literature. Section 3 motivates the empirical approach and sets up a reduced-form equation of the yield spread. Section 4 describes the data we use for the estimation. Section 5 reports the estimation results, and Section 6 concludes.

[1] See Eichengreen and Mody (2000) who use similar data for emerging market economies.

[2] For evidence on liquidity premiums in European bond markets see Beber et al. (2009), Blanco (2001), Codogno et al. (2003), Gomez-Puig (2006), Favero et al. (2010).

2. Literature overview

The question, whether government bond yields include risk premiums has attracted considerable interest in the literature. A first line of research estimates the effect of fiscal variables on interest rate levels. Gale and Orszag (2003), in a comprehensive review of the evidence for the US, conclude that expected deficits affect long-term interest rates positively, a result confirmed by Gale and Orszag (2004), Laubach (2004, 2009) and Thomas and Wu (2009). In a similar vein, Canzoneri et al. (2002) show that expected deficits affect the spread between long and short-term interest rates in the US. Faini (2004) estimates a positive impact of government debt on ex-post real interest rates in 10 European countries. Ardagna et al. (2007) use a panel of 16 OECD countries over several decades and both static and dynamic econometric models. They find a significant positive effect of primary deficits on long-term interest rates. They also find a non-linear effect of government debt on interest rates: Only when countries have above-average debt ratios does an increase in the debt ratio cause the interest rate to rise. As explained by Gale and Orszag (2003), however, there are many reasons why interest rates may respond positively to rising government debts and deficits, and an increase in sovereign risk premiums is just one of them. Therefore, looking at the response of interest rate levels does not necessarily yield evidence of how markets price sovereign risk.

In view of this, a second line of research uses interest rate spreads between government bonds and suitable benchmark assets to estimate risk premiums related to fiscal performance. Goldstein and Woglom (2004), Bayoumi et al. (1995) and Poterba and Rueben (1999) find that the yield differentials of 39 US states relative to New Jersey depend positively on their levels of debt. Lemmen (1999) uses yields of bonds issued by state governments in Australia, Canada, and Germany and shows that yield spreads over central government bond yields depend positively on the ratio of government debt-to-GDP. Booth et al. (2007) find that bond yield spreads of Canadian provinces over the federal government respond positively to measures of provincial indebtedness. Since these papers relate to sub-national government debt, however, it is not clear what they tell us about the sovereign risk of national governments. Balassone et al. (2004) show that yields spreads against Germany of government bonds issued by the other EU countries in their national currencies between 1980 and 2003 depend positively on the change in the government debt-to-GDP ratio. Using issues in national currencies, however, they cannot distinguish between credit risk and exchange rate risk, which is no longer relevant in the European Monetary Union. To avoid this problem, Lonning (2000) compares the yields of a very small sample of DM issues of 11 EU governments with equivalent German government bonds in the mid-1990s and finds a positive, though not always significant impact of government debt and deficits. Gomez-Puig (2008) uses adjusted spreads of the yields on bonds issued by 10 European countries over DM bonds, where the adjustment uses appropriate swap rates to eliminate exchange rate uncertainty, and finds that the spreads increase with increasing debt relative to Germany.

Alesina et al. (1992) use data from 12 OECD countries and show that the differential between public and private bond yields is positively related to the level of public debt. It is not clear, however, that this differential properly reflects sovereign risk, since the credit risk of private issuers is likely to be correlated with the credit risk of their governments. Focusing on the differential between government bond yields and the corresponding swap yield of the same maturity Lemmen and Goodhart (1999) and Codogno et al. (2003) show that this differential depends positively on the level of public debt, while Heppke-Falk and Hüfner (2004) find that expected deficits have a positive impact on this yield spread in Germany, France, and Italy.

A small but growing number of papers have investigated the effect of the current financial and economic crisis on government bond yield pricing. Haugh et al. (2009) analyze the yield spreads between ten euro area countries and Germany covering the period December 2005–June 2009. They confirm that future deficits and the debt service ratio have an important role in explaining bond yield spreads in the euro area. They find further that the effect of each of the fiscal variables on the yield spreads is amplified by its interaction with general risk aversion. They conclude that this suggests that governments will face greater financial market discipline in the coming years than they used to prior to the crisis because general risk aversion is likely to be higher. Barrios et al. (2009), using a panel of seven EMU countries covering the period 2003q1–2009q2, find that euro area sovereign bond spreads are strongly influenced by domestic factors like liquidity and credit risk and that this effect became more

important in the financial crisis. More specifically, the role of fiscal deficits is shown to increase with the level of general risk aversion and high debt countries are found to experience the highest bond yield increases during the financial crisis. Sgherri and Zoli (2009) estimate a panel model covering monthly government bond yield spreads between ten euro area countries and Germany over the period January 2003–March 2009. They also find that financial markets seem to have responded to the significant deterioration in fiscal position after the outburst of the financial crisis by requiring higher sovereign risk premiums for most countries and differentiating across sovereign issuers much more than before.

3. Determinants of bond yield spreads

Since we are mainly interested in the empirical analysis, we only sketch a model of portfolio choice underlying the estimates below.[3] Consider a risk-averse investor choosing between two securities issued in the same currency, one by the 'domestic' and the other by the 'foreign' government. The investor's rate of return depends positively on the expected yield and negatively on the expected transaction costs he might incur if he wants to sell the security before it matures. We assume that the expected transactions costs are proportional to the value of the security and a declining function of the liquidity of the security in the market. Taking the security issued by the foreign government as the benchmark in the market, we normalize the transactions costs related to it to zero.

We assume that, with a positive probability, the domestic government will be unable to fully serve its obligations. If that happens, the government may take actions, such as a tax on interest income withheld at the source, that reduce the investor's return on the security, and the investor receives a fraction of his gross interest payment on the domestic bond. Thus, the domestic security is subject to partial default risk. In contrast, the foreign asset is considered risk-free.

Standard portfolio theory implies that the optimal amount invested in the domestic security depends positively on the yield on the domestic security, and negatively on the foreign yield, the domestic government's probability of partial default, a liquidity premium reflecting the higher expected transaction cost connected with the domestic bond, and the investor's degree of risk aversion. Equilibrium in the securities market then implies that the yield spread of the domestic over the foreign bond depends positively on the domestic government's probability of partial default, the liquidity premium, the investor's degree of risk aversion, and the variance of the government's stochastic default process. This motivates the following, reduced-form equation, derived in more detail in the appendix:

$$\frac{r_{it}-r_{jt}^{*}}{1+r_{it}} = \beta_0 + \beta_1' z_{it} + \gamma \Phi_t + EMU\left(\delta_0 + \delta_1' z_{it}\right) + Crisis\left(\alpha_0 + \alpha_1' z_{it}\right) + \lambda_t + \mu_i + \varepsilon_{it} \tag{1}$$

The dependent variable is the yield spread between a bond issued in EU country i and the benchmark country j. The vector z_{it} contains a set of explanatory variables, Φ_t is a measure of the investors' degree of risk aversion in the market. *EMU* is a dummy variable for the period after the beginning of the European Monetary Union in January 1999 and *Crisis* is a dummy for the period after the Lehman default in September 2008. Interacting these two dummies with the explanatory variables allows us to test for structural breaks due to the introduction of the euro and the financial crisis 2008/09.[4] μ_i and λ_t are country and time dummies to capture the impact of common trends, business cycles and other unobserved factors, respectively, and ε_{it} is a random error term.

Our set of explanatory variables, z_{it}, contains three variables related to a governments fiscal performance, which reflect its quality as a borrower. The first two, the debt/GDP ratio and the deficit/GDP ratio, are commonly used in the literature, in policy debates, and in the Maastricht Treaty to assess a government's fiscal soundness. We use the projected (12-month ahead) rather the current deficit/GDP ratio. This has two advantages. First, it takes the forward-looking behavior of financial markets

[3] See Appendix A1 for an exposition of the underlying model.

[4] We have also tested for a structural break during the early phase of the financial crisis between August 2007 and August 2008. However, this is not the case.

into account. Second, it avoids a potential endogeneity bias in the estimation results, which could arise from the fact that the current deficit figure contains government interest payments. In addition, we use the ratio of government debt service to current government revenues. This variable is closer in spirit to measures of borrower quality used in corporate finance, such as the ratio of debt service to cash flow. It allows for the fact, neglected in the use of GDP as the denominator, that governments in different countries may differ in their ability to raise taxes from a given volume of GDP, and it focuses on the constraint high debt burdens impose on the annual budgetary flows. All three fiscal variables relate to the general government. They are measured as differences to the benchmark country, Germany in the case of DM and Euro bonds, and the US in the case of US$ bonds. We include levels and quadratic terms of the fiscal variables to allow for non-linear relationships.[5]

The next explanatory variable approximates the liquidity premium in the yield spread. Due to the lack of direct liquidity measures such as bid-ask spreads or trading volume for primary markets, we focus on two indirect liquidity measures, i.e the outstanding amount of debt securities and the issue size of the specific bond.[6] The liquidity premium should be a decreasing function of the issue size, as bonds with large issues may have lower information costs.[7] Further, we expect that the size of the market for a given security has a positive effect on its liquidity (compare e.g. Gomez-Puig (2006)). In view of this, and assuming that all debt issued by a government in a given currency is homogeneous up to maturity, the liquidity premium can be expected to be proportional to the outstanding amount of debt issued by a government in DM (Euro) or US$. Thus, we measure liquidity by the amount of DM (Euro) and US$ denominated securities traded on international capital markets and ignore securities traded solely on the domestic capital market. The reason is that, with the start of EMU, the market for US$ denominated bonds stays concentrated on international capital markets, but Euro-denominated bonds are issued on domestic and international capital markets, which would cause a sudden jump in our liquidity variable.[8] Tables A.1 and A.2 in the Appendix summarize our liquidity proxy. Note that an increase in the outstanding amount of government bonds increases not only the liquidity of this market, but also the default risk of the issuer country. By including total debt/GDP in our estimation equation, we assure that the coefficient on our liquidity variable will not be biased towards zero.

The final explanatory variable contained in vector z_{it} measures the time to maturity of the bonds at the time of issue and controls for the possibility that risk premiums vary with the length of the contract. As argued by Bhojraj and Sengupta (2003), bonds with longer maturities are expected to have higher yields because of their greater (interest) risk exposure. Thus, an investor receives a compensation for investing in long-term bonds instead of buying short-term bonds and rolling them.

Previous research suggests that sovereign yield spreads between countries are significantly affected by international factors such as general investors' risk aversion. Dungey et al. (2000), Codogno et al. (2003) show strong evidence of a common international factor in several yield differentials. Lemmen (1999) observes that the difference between provincial and federal yields in Australia, Canada, Germany, Switzerland and the US widened considerably after the outbreak of the Asian crisis in 1997 and the Russian default of August 1998. Similarly, Barrios et al. (2009) and Sgherri and Zoli (2009) focus on recent financial crisis and also find that a substantial part of the observed increase in government bond yields across EMU countries can be attributed to a common international factor reflecting investors' risk aversion. Thus, it seems that in periods of global financial crises or uncertainty investors move to safer and more liquid assets and that bond yield spreads increase as a result.

[5] Bayoumi et al. (1995) and Flandreau et al. (1998) talk about a 'credit punishing' effect, when interest rate spreads grow non-linearly with the level of fiscal variables.

[6] Several studies show that indirect and direct liquidity measures are closely related to each other. Ejsing and Sihvonen (2009) analyze data from the secondary market for German and French sovereign bonds and find a highly significant relationship between e.g. bid-ask spreads, the trading volume or the log issue size. Gravelle (1999) finds for the Canadian government securities market that the correlation between bid-ask spreads total supply of debt is significantly negative.

[7] For empirical evidence for this hypothesis see Jankowitsch et al. (2006) and Fleming (2003).

[8] The correlation between the outstanding amount of Euro-denominated securities issued on domestic and international capital markets is very close to one. Thus, this suggests that focusing on securities issued on international markets avoids this level jump in our liquidity without having an impact on the estimation results.

Since investors' risk aversion is not directly observable, we follow Codogno et al. (2003) and Favero et al. (2010) and use the yield spread between low grade US corporate bonds (Baa) and benchmark US government bonds as an empirical proxy for global risk aversion.[9,10]

Fig. A.1 illustrates the development of the yield spread between US corporate bonds and benchmark US government bonds between January 1993 and May 2009 in daily frequency. The yield spread hovered around 130 percentage points during the early years of the 90's. With the burst of the asset price bubble in 1999, and again in 2000, it increased sharply, illustrating the markets' increasing skepticism and risk aversion during those periods. After peaking in November 2002, the yield spread decreased and reached its level of the early 1990s again in March 2005. From mid 2007, when the first signs of increasing turmoil in global financial markets became visible, until early 2008, the spread tripled and, after the collapse of Lehman Brothers, it reached values exceeding 600 basis points. Between January and May 2009, it decreased substantially, probably due to the massive central bank and government interventions around the globe.

Several papers have documented the effect of an international risk factor on government bond yields. Codogno et al. (2003) finds that it is larger in countries with high government debt ratios. Haugh et al. (2009) show that it amplifies the effect of the debt service ratio on bond yields. Beber et al. (2009) and Favero et al. (2010) provide evidence that the level of the aggregated risk factor has also a significant impact on the effect of liquidity on bond yields. To test for such amplification effects we interact the Baa–spread with our fiscal and liquidity variables.

To estimate the effects of EMU on yield spreads, the EMU dummy takes the value of one for the initial 11 EMU member countries starting in 1999, for Greece starting in 2001, and zero otherwise. A significant coefficient on this dummy points to a general effect of EMU on yield spreads of all member countries. Furthermore, we interact the EMU dummy with the fiscal variables and the liquidity variable to see whether EMU has changed their effect on interest rates.

The *Crisis* dummy takes the value of one for all observations after September 2008 and zero otherwise. We interact this dummy with the fiscal variables, the liquidity variable and the Baa–spread to test for a structural break in our coefficients after the financial crisis intensified.[11,12]

4. Data description

The data on the yield spreads were provided by Capital DATA Bondware, now part of the Dealogic Group. We compare central government bonds issued by the 15 countries forming the EU before 2004 except Luxembourg and by the US federal government. The sample period runs from January 1993 to May 2009. All bonds considered are denominated either in DM (before 1999) and Euro (since 1999), or

[9] A variable that measures the respective corporate bond spread for the complete euro area is not available, but the empirical literature on sovereign bond spreads of emerging markets shows that spreads are sensitive to US risk factors (see, e.g., Barnes and Cline (1997), Kamin and von Kleist (1999), Eichengreen and Mody (2000)). Therefore, data on US corporate-government bond yield spreads can be used as a good proxy for the overall investors' risk attitude.

[10] An additional proxy for general risk aversion used in the related literature is the general level of yields offered in other financial markets. The argument is that if long-term rates are generally low compared to short-term rates, investors ask for lower risk premiums as they are eager to find investment opportunities offering attractive spreads over short-term interest rates (compare e.g. Schuknecht et al. (2009)). Similarly, Manganelli and Wolswijk (2009) argue that when short-term interest rates are low, investors have greater incentives to take on risk, in order to improve the expected return. We have added the short-term interest rate in the relevant currency market to the set of regressors, however, this variable always turned out to be highly insignificant, therefore we have dropped this variable again from our regressions.

[11] Canzoneri et al. (2002) point out that is it important to condition on the stance of monetary policy when estimating the effects of fiscal policy on interest rates, since monetary policy might react to fiscal policy. Since we do not have time series data, as they do, we cannot follow their approach of estimating a VAR including monetary policy variables. At the same time, our use of yield spreads on foreign-currency issues makes this point less relevant, as it seems much less likely that the Bundesbank or the Fed would react to the fiscal policy of a different country issuing DM or US dollar denominated debt, and the ECB has often stated that it does not react to the fiscal policy of an EMU member state.

[12] Following a suggestion of Alesina et al. (1992) that default risk depends on the overall economic situation of a country, we also used an indicator of the relative cyclical position of a country vis-a-vis the benchmark country. However, this indicator turned out not to be statistically significant in any of our regressions. In view of that, we dropped the variable and do not report the results here. We also included nominal GDP as an explanatory variable, which also turned out to be insignificant.

in US$. This assures that interest differentials will be net of expected changes in exchange rates and exchange rate risk between currencies.

The interest differential for the DM (Euro) denominated bonds is measured as the difference in the yield to maturity at the time of issue between the national bond under consideration and an equivalent German government bond. Similarly, the differential for the bonds issued in US$ is the difference to an equivalent US government bond. Capital DATA Bondware defines equivalence as meaning that the German or US benchmark bond is similar to the government bond under consideration with respect to the time of issuance, the coupon payment structure, the underlying currency, and the time to maturity. Altogether, our sample consists of 311 observations, of which 149 were issued in DM (Euro) and 162 in US$. 53 of these DM (Euro) denominated bonds and 92 of the US$ denominated bonds were issued before the start of EMU. 266 bonds were issued before August 2007 and 45 bonds thereafter.

Fig. A.2 in the Appendix plots the yield spreads of the government bond issues over time. The figure shows a cyclical pattern of European bond yields. Between 1993 and 1997, the bond yields of all EU-15 countries except Greece converged to German and US levels. Between 1997 and 2001, one observes a general divergence of EU-15 interest rates relative to German and US levels, the only exception is again Greece, where interest rates continued to decline after 1997. After 2001, interest differentials across EU-15 countries seemed to decrease again reaching the trough in 2007. With the beginning of the financial crisis in August 2007, yield spreads began to rise. Until mid 2008, they were still comparable to their level in the 1999/2001 recession. However, in the second half of 2008, when the financial crisis intensified, yield spreads increased further reaching record highs of more than 300 basis points at the end of the observed time period.

For an impression of how important foreign-currency debt is for EU countries, Tables A.3 and A.4 in the Appendix give an overview of the foreign-currency denominated bond market in the EU and reports the shares of DM, Euro, and US$ denominated debt outstanding. The data are provided by the DBS-online data bank of the Bank of International Settlements (BIS). Table A.3 shows that small countries tend to have larger shares of government debt issued in a foreign currency than large countries. In 1993, the outstanding amount of foreign-currency denominated debt ranged between zero percent in Germany and the Netherlands and 60 percent in Finland. With the introduction of the Euro, the share of debt issued in other currencies decreased substantially for all countries except Austria, Germany, Denmark, Spain and Italy. Since 2007, Belgium, Denmark and Ireland increased their non-Euro debt issuance. At the end of 2008, two EMU countries, Austria and Ireland, had more than thirteen percent of their total public debt denominated in a currency other than the Euro, while Denmark and Sweden had more than ten percent of their total public debt denominated in a foreign currency including the Euro.

Table A.4 shows that the DM (Euro) and the US$ are the most important currencies in which the sample countries issued foreign-currency denominated debt during the period under consideration. In 1993, more than 40 percent of the foreign-currency debt of the EU countries except Germany, France and Greece was denominated in one of these two currencies. In Belgium, the UK, and Italy, the share of DM and US$ denominated debt securities in total foreign-currency debt was larger than 60 percent. This is in line with Cohen (2005), who shows that, before 1999, the US$ and DM represented the largest and third largest currency shares in international bond and note issuance. As shown in Table A.4, the share of US$ denominated government securities outstanding increased with the introduction of the Euro in almost all countries except Belgium, France and Portugal. Regarding the non-EMU countries, the UK had switched entirely to US$ denominated debt and Denmark almost entirely to Euro-denominated debt by May 2008. Sweden maintained large shares of her foreign-currency denominated debt in both Euro and US$.

All fiscal variables are taken from the European Commission's AMECO data bank. Note that deficits are defined as positive numbers.

The corporate bond yield spread (*Baa–Spread*) is provided by Datastream (compare Fig. A.1). Thus, we can attribute to every bond the corresponding corporate-government bond yield spread reported at the date of issuance. All other macro variables like the debt/GDP, deficit/GDP, debt service/revenue are from the European Commission's annual database, Ameco.

Detailed summary statistics of all variables used in the regressions are reported in Table A.5 in the Appendix.

5. Estimation setup and results

We estimate the determinants of government bond yield spreads for two different data samples. We first regress Equation (1) for the pre-crisis period covering bonds issued between January 1993 and July 2007. Thereafter, we add the bonds issued after August 2007 until May 2009 to investigate in detail the effect of the financial crisis on risk pricing in sovereign bond markets.

5.1. Pre-crisis period

We estimate Equation (1) with ordinary least squares and robust standard errors. Table A.7 shows the estimation results with time-fixed effects and Table A.8 shows the results after adding country fixed effects to the regressions. It turns out that the inclusion of country dummies has almost no impact on the sign and significance of the estimated coefficients. The only exception are the coefficients on the debt variable, which turn insignificant. This is not surprising given the relatively high persistence of government debt over time. Most of the variation in government debt was therefore absorbed by the country dummies. In what follows, we will therefore focus on the estimation results excluding country fixed effects shown in Table A.7.

Since we use data from two different markets, DM (Euro) and US$ denominated bonds, we first check whether we can pool these data to increase the number of observations available for the estimation of the model and, thus, improve the quality of the estimates. We use a standard poolability test for that purpose. That is, we interact all independent variables of equation (1) with a dummy taking the value of one, if a bond is issued in US$, and zero otherwise. Next, we estimate the model using data from both markets and include all explanatory variables considered together with these interacted terms. In this regression, the *p*-values on the interacted terms can be regarded as significance tests of the hypothesis that the relevant coefficients are equal in both markets. Table A.6 in the appendix reports the *p*-values of these interacted variables together with the results of an *F*-test of the hypothesis that all interactive variables are jointly insignificant. The test results confirm that the restriction of equal coefficients in both markets is valid. We reject the hypothesis of poolability only for our measure of international risk aversion (*Baa–spread*). In the subsequent regressions, we keep this variable together with its interactive term in the model.[13] Below, variables interacted with the EMU dummy are denoted as "**EMU*".[14]

Our estimation results indicate that a positive relationship exists between yield spreads and fiscal variables. This suggests that markets perceive and price sovereign risk in the European bond market. According to the results in column (A), bond yield spreads significantly increase with the level of the debt differential between the issuer country and the benchmark country. However, the small but significant negative coefficient on the squared debt variable suggest that the marginal effect for higher public debt ratios is slightly declining with higher fiscal imbalances.[15] A debt ratio exceeding that of the benchmark countries Germany or the USA by 10 percent causes a yield spread of around 7 basis points, while a debt differential of 50 percent results in a yield spread of 23 basis points. The results shown in column (B) of Table A.7 suggest that the bond yield differential also increases with the projected deficit ratio. The coefficient of the squared deficit term is positive and significant. Thus, rising deficit ratios relative to Germany increase yield spreads with an increasing marginal effect. A projected deficit exceeding the benchmark country's (Germany and the USA) by three percent results in a yield spread of 16.9 basis points, while a deficit differential of five percent results in a yield spread of 34.2 basis points. Regressions (C) uses the debt service ratio as indicators of fiscal performance. We find that only the squared debt service ratio has a positive and significant coefficient. A

[13] Estimation results for both currencies individually are available from the authors upon request. The results did not differ substantially from the results of the pooled data set, only a few variables turned insignificant due to a smaller set of observations.

[14] Note that the interacted variables are constructed in an additive way, thus, the effect of the deficit/GDP differential on bond yield spreads for an EMU member state is the sum of the coefficients on *Deficit* and *Deficit*EMU*.

[15] The overall effect of the debt differential on bond yield spreads turns negative, when the value exceeds 97%, which is substantially higher then past realised debt differentials between EU countries and Germany or the USA.

debt service ratio of five percent above Germany or the USA results in a yield spread of 4.25 basis points, while a debt service ratio exceeding the benchmark country's by 10 percent results in a yield spread of 17 percentage points.[16]

The lower panel of Table A.7 shows the results for the variables that are interacted with the EMU dummy to test for structural breaks in the coefficients after the start of EMU.[17] While the pricing of risk related to an increase in the deficit or debt service ratio remained unchanged with EMU membership, the relationship between the debt ratio and bond yield spreads has changed significantly. The coefficient on the debt ratio is significantly negative and the coefficient on the squared debt ratio is significantly positive. The results of a Wald-test of the hypothesis that the sum of the coefficients on *debt* and *debt* EMU* and on $debt^2$ and $debt^{2}$* *EMU* is zero is rejected at standard significance levels as shown in Table A.10. This indicates that markets price fiscal indebtness less than before the start of EMU, but still in a statistically significant way. An EU government whose debt level exceeds that of Germany or the USA by 10 percent saves roughly 5.8 basis points in the interest payment on its debt relative to the period before the start of EMU. We conclude that market discipline still works after the start of EMU, but markets pay less attention to the debt level of an issuer country. A suggestive reason is that public debates and economic analysis of the fiscal performance of EMU countries has generally focused on deficits and disregarded debt ratios since 1999.

Since the issue size turned out to be highly insignificant in all estimates, we dropped this variable from our regressions and focus entirely on the bond market size to proxy liquidity risk. Our estimates in Table A.7 show that yield spreads were significantly affected by liquidity premiums before the start of EMU. An increase in the market size by one billion US$ caused a reduction of the issuer country's interest rate by around one basis point. This liquidity effect largely vanished with EMU, as shown by the positive and significant coefficients on *Liquidity* EMU*. A Wald-test does not reject the hypothesis that the sum of the coefficients on *Liquidity* and *Liquidity* EMU* is zero (compare Table A.10). This result is in line with the findings of Pagano and von Thadden (2004), Favero et al. (2010) and Beber et al. (2009). We attribute it to the fact that, after the conversion of all existing government debt of the EMU member states into Euros, the market for Euro-denominated debt became much larger for all countries. The result is also consistent with an increasing degree of financial market integration in Europe. Note that, for non-EMU countries, the liquidity premium remains unchanged after the start of EMU.[18]

The negative coefficient on the EMU dummy indicates that average yield differentials of EMU member states declined with the start of EMU, although this effect is significant only in regressions (A) and (B).

An increase in investors risk aversion, as reflected by an increase in the *Baa–spread*, increases the spread on US$ denominated bond issues, but not on DM or Euro-denominated issues. Accordingly, in periods of high global risk aversion, the interest differentials of EU countries versus the USA rise. This underlines the 'safe haven' status of the US government bond market, which the DM (Euro) market does not enjoy during our sample period.

We have repeated our regressions interacting our fiscal variables additionally with the variable *Baa–spread* to investigate whether the impact of the deficit or debt ratio on bond yield spreads is amplified by the degree of general risk aversion. We do not find this to be the case and have therefore dropped these variables from our regressions.

Finally, we find that the time to maturity matters for the interest differential. With every additional year to maturity, the interest rate increases by around 0.7 basis points.

[16] We have repeated the regressions including all possible combinations of the three fiscal variables considered. The results were very robust and are not reported here for space reasons.

[17] As a robustness test, we have also estimated regression (1) for the EMU and non-EMU period separately. The estimation results did not differ with respect of signs and significance from the pooled data set.

[18] Following Beber et al. (2009) and Favero et al. (2010) we also interacted our variable measuring general risk aversion with our liquidity variable. However, these interacted variables always turned out to be insignificant except in regression (C), where the coefficient was significantly negative for the bonds issued prior to EMU and significantly positive thereafter. These results can be provided by the authors on demand.

5.2. Crisis period

Table A.9 shows the result when estimating regression (1) for the extended data sample including also the crisis observations until mid-May 2009. For sake of clarity we have this time dropped the insignificant interaction terms with the EMU dummy from our regressions. To test for crisis-related effects, we have interacted the fiscal and risk aversion variables with a dummy for the crisis period.[19] The additional variables are listed in the lower panel of the table.[20,21]

The significance and size of the coefficients estimated for the fiscal and other explanatory variables for the time before and after EMU up to September 2008 broadly confirm our results shown in Table A.7. After the collapse of Lehman Brothers in mid September 2008, however, the pricing of sovereign default risk has changed markedly as indicated by the estimation results listed in the lower panel of Table A.9. All fiscal variables interacted with the crisis dummy are highly significant and positive. While, before the financial crisis, an increase of the debt-to-GDP differential of an EMU member country from 10% to 20% resulted in an increase of the yield spread of 2.2 basis points, it results in an increase of around 28 basis points after the collapse of Lehman Brothers. For the deficit ratio the increase of the coefficient is even more pronounced. Before September 2008, an increase in the deficit differential from two to three percent between the issuer country and Germany or the USA, respectively, caused an increase of the bond yield differential of 5.5 basis points. However, after the intensification of the financial crisis, the effect almost tripled and results in an increase of the yield spread of around 14 basis points. Also, the impact of the debt service differential on the yield spread has increased markedly. While, before September 2008, a debt service differential of three percent between the issuer country and the benchmark country explained only around 1.5 basis points of the yield spread, it explained a yield differential of around 37 basis points afterward. Thus, the cost of fiscal loosening has increased considerably with the financial crisis.

Moreover, we find that the impact of investors' risk aversion on US$ denominated bonds has decreased after September 2008, as indicated by the significantly negative coefficient on *Baa–spread***US** *Crisis*. A Wald-test does not reject the hypothesis that there is no significant difference between Euro and US$ denominated bonds in this regard (compare Table A.10). For every percentage point increase in the *Baa–spread*, the government bond yield spread of both currencies increases by 15–24 basis points. Importantly, Germany seems to have gained a safe-haven status in the European bond market in the crisis, a position it did not have before.

For the current policy discussion, it is important to analyze what is the main driving force for the observed increase of sovereign yield spreads after the fall of Lehman Brothers. If the increase of yield spreads is mainly explained by an increase in the general investors' risk aversion, it is likely that yield spreads converge again as soon as the financial crisis fades off. However, if the fiscal situation of a government is the main reason for this development, we would expect that it will last longer and that only fiscal convergence to the benchmark country will reduce yield spreads in the future. Fig. A.3 shows the estimated contribution of both factors to the yield spreads of all bonds issued since the collapse of Lehman Brothers until mid-May 2009 together with the actual observed spread. General risk aversion and the fiscal variables explain large parts of the actually observed spreads.[22] About 120 basis points of the observed yields spreads of all countries can be explained by general investor's risk aversion. For

[19] We have also interacted our liquidity variable with the crisis dummy, however, the coefficients on this interacted variable were insignificant. We also restrain from including the crisis dummy itself to the set of regressors, since the year dummies included in our regression will capture most of the general crisis effect.

[20] Again, we have estimated two versions of equation (1), one time with year fixed effects, another time with year and country fixed effects. However, as before, the estimation results did not differ substantially except for the debt-to-GDP differential so that we focus in what follows on the regressions with year dummies only. The estimation results controlling also for country fixed effects are available from the authors on request.

[21] Note, that again the interaction variables are constructed in an additive way. Thus, the effect of a one percent differential of the deficit/GDP between the issuer and the benchmark country after the start of the crisis is the sum of the coefficients on *Deficit*, *Deficit***EMU* and *Deficit***Crisis*, if all three variables were significant.

[22] The difference between the actual level of yield spreads and the estimated contribution of these two risk factors can attributed to the model residual and the contribution of all other variables considered in the estimations.

Greece and Ireland, the relatively bad fiscal performance explains about two and one third of the observed yield spreads, respectively. These contributions will probably persist even if investors generally become less risk averse in the post-crisis period again. The graph shows that Denmark, Finland, and Sweden benefited from the stronger market reaction to fiscal variables due to their relatively favorable fiscal performance in recent years.

6. Conclusion

This paper contributes to the literature on the impact of fiscal policies on interest rates by analyzing the effect of government debt and deficits on sovereign bond yields in Europe. We exploit a unique data set of US$, DM, and, after 1998, Euro-denominated government bond issue spreads between 1993 and 2009, which has the advantage that we can ignore exchange risks and distortions by differences in national tax regimes. We examine whether government bond yield differentials across EU countries are determined by credit risk and liquidity effects, and whether EMU and the financial crisis in 2008/09 had a significant impact on bond pricing.

Our results show that yield spreads respond significantly to measures of government indebtedness both before and after the start of EMU. Interestingly, after the start of EMU, markets seem to pay less attention to government debt levels than they did before, while deficits and debt service ratios continue to be monitored as indicators of creditworthiness. This result may reflect the fact that public debates of the fiscal performance of EMU countries have generally focused on deficits and disregarded debt ratios since 1999. With the financial crisis, Germany seems to have gained a safe-haven status in international financial markets in the crisis, a position it did not have before. Market reaction to fiscal loosening has increased considerably, with the result that market discipline has become stronger.

Before EMU, yield spreads were also affected by liquidity premiums. In the euro-denominated debt market, however, these premiums have vanished after the start of EMU.

Appendix A

Appendix A.1. The sovereign risk premium in a simple portfolio model

In this appendix, we present a simple mean-variance model of portfolio choice to motivate the reduced-form equation estimated above. Consider a domestic investor maximizing a utility function that depends positively on expected real wealth, $E_t[w_{t+1}]$ and negatively on its variance, $Var_t[w_{t+1}]$:

$$MaxU\{E_t[w_{t+1}], Var_t[w_{t+1}]\}, U_1 > 0, U_2 < 0. \tag{A.1}$$

The investor allocates a fraction θ of his real wealth w_t to a domestic security D and a fraction of $1-\theta$ to a foreign security F. Both securities and real wealth are priced in the foreign currency, so that:

$$\theta_t w_t = D_t \tag{A.2}$$

$$(1-\theta_t) w_t = F_t \tag{A.3}$$

We assume that the domestic security is subject to the risk of partial default, while the foreign asset is considered risk-free. Thus, with a positive probability of $1 - P(x_t)$, $0 \leq P(x_t) \leq 1$, the domestic government will be unable to fully serve its debt. In that case, the investor receives only a fraction τ of his gross payment, $\tau \in (0, 1+r)$, where r is the interest rate on the domestic bond. While outright and full default seems unlikely in the case of European governments today, partial default includes unexpected fiscal measures a government might undertake in the case of a fiscal crisis to reduce its debt service, such as the imposition of a new tax on interest payments taken at the source. The vector x_t indicates a set of variables affecting this probability.

Investors incur transaction costs, l, proportional to their investment in bonds. We assume that the foreign bond has benchmark status in the bond market, i.e., the foreign bond is considered to be more liquid than the domestic bond. Transactions costs decrease with the liquidity of the bond market. Expected wealth then is:

$$E(w_{t+1}) = (1+r_t)\theta_t w_t P(x_t) + \tau_t \theta_t w_t (1-P(x_t)) - \theta_t w_t l_t + (1+r^*)(1-\theta_t)w_t, \tag{A.4}$$

where an asterix indicates the corresponding foreign variables. We normalize the transaction costs for the foreign bond to zero. The objective function and the budget constraint for a representative investor in the foreign country are the same as those of the domestic investor. There is no discrimination between domestic and foreign investors in the case of default, $\tau = \tau^*$. The foreign investor's expected real wealth is:

$$E(w^*_{t+1}) = (1+r_t)\theta^*_t w^*_t P(x_t) + \tau_t \theta^*_t w^*_t (1-P(x_t)) - \theta^*_t w^*_t l_t + (1+r^*)(1-\theta^*_t)w^*_t, \tag{A.5}$$

The variance of next period's real wealth of the domestic and the foreign investor is non-zero and given by:

$$Var(w_{t+1}) = \theta_t^2 w_t^2 (1+r_t-\tau_t)^2 P(x_t)(1-P(x_t)), \tag{A.6}$$

for the domestic investor and

$$Var(w^*_{t+1}) = \theta_t^{*2} w_t^{*2} (1+r_t-\tau_t)^2 P(x_t)(1-P(x_t)) \tag{A.7}$$

for the foreign investor. Utility maximization yields the optimal shares invested in domestic securities, $\hat{\theta}_t$ and $\hat{\theta}^*_t$:

$$\hat{\theta}_t = \frac{P(x_t)(1+r_t) + \tau_t(1-P(x_t)) - l_t - (1+r^*_t)}{\Phi(1+r_t-\tau_t)^2 P(x_t)(1-P(x_t))} \tag{A.8}$$

$$\hat{\theta}^*_t = \frac{P(x_t)(1+r_t) + \tau_t(1-P(x_t)) - l_t - (1+r^*_t)}{\Phi^*(1+r_t-\tau_t)^2 P(x_t)(1-P(x_t))} \tag{A.9}$$

where $\Phi_t = -2w_t U_2/U_1$ and $\Phi^*_t = -2w^*_t U^*_2/U^*_1$ are the coefficients of relative risk aversion for the domestic and the foreign investor.

Let S be the total supply of bonds issued by the domestic government. Bond market equilibrium requires:

$$S_t = D_t + D^*_t = \frac{P(x_t)(1+r_t) + \tau_t(1-P(x_t)) - l_t - (1+r^*_t)}{(1+r_t-\tau_t)^2 P(x_t)(1-P(x_t))}\left(\frac{w_t}{\Phi_t} + \frac{w^*_t}{\Phi^*_t}\right), \tag{A.10}$$

where D^*_t denotes the amount of domestic bonds held by the foreign investor. This can be solved for the interest rate differential:

$$\frac{r_t - r^*_t}{1+r_t} = (1-P(x_t))\left(1 - \frac{\tau_t}{1+r_t}\right) + \frac{l_t}{1+r_t} + \frac{S(1+r_t-\tau_t)^2 P(x_t)(1-P(x_t))}{(w_t/\Phi_t + w^*_t/\Phi^*_t)(1+r_t)}. \tag{A.11}$$

In what follows, by the interest rate spread or differential, we mean the term on the left hand side of the equation.

Equation (A.11) separates the yield spread between the two bonds into three terms. The first term on the right hand side reflects the default risk premium. It depends positively on the default probability of the risky issuer country, $(1-P(x_t))$, and decreases with an increase in the repayment ratio, τ. Thus, the effect of the default probability on the interest differential may be small, if investors expect that the government will repay a significant part of its debt. Since τ ranges between 0 and $(1+r_t)$, the default risk premium is always positive.

The second term in the yield differential depends on the liquidity premium. The more liquid the domestic bond, the smaller will be this premium.

The third term is the country-specific risk premium. It depends negatively on τ and positively on the variance of the default probability $P(x_t)(1-P(x_t))$, the gross nominal return $(1+r_t)$, and the level of the relative risk aversion of investor Φ and Φ^*. The more investors care about the variance of their

future wealth w_{t+1} (the larger U_2), the larger will be the interest rate differential between the risky and the risk-free country. Furthermore, the country-specific risk premium increases with the total supply of domestic bonds, S, relative to total wealth.

Appendix A.2. Figures

Fig. A.1. Yield spread between US low graded corporate bonds and US government bonds.

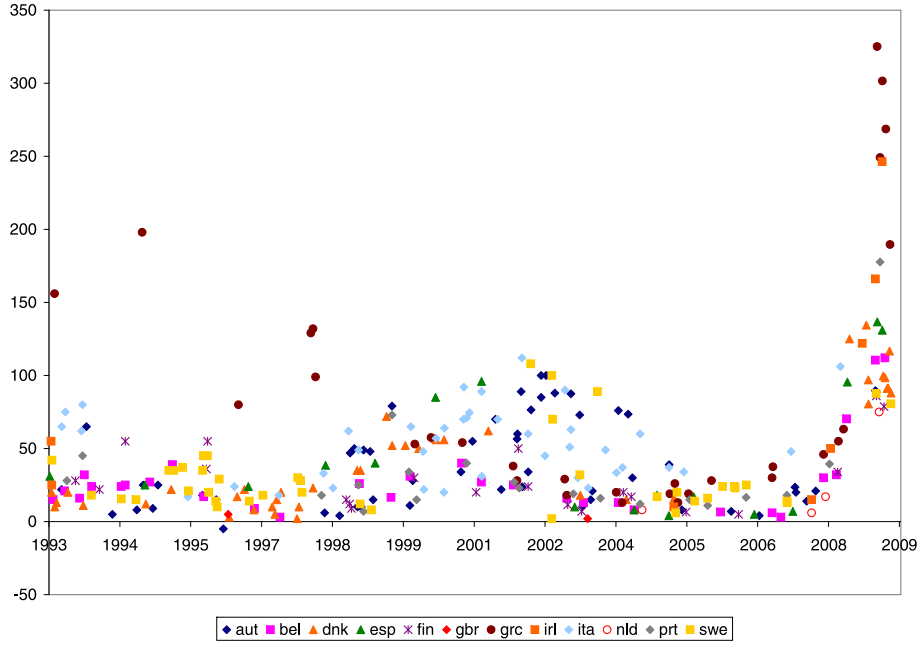

Fig. A.2. DM (Euro) and US$ Bond Yield Spreads between Jan.1993–May 2008.

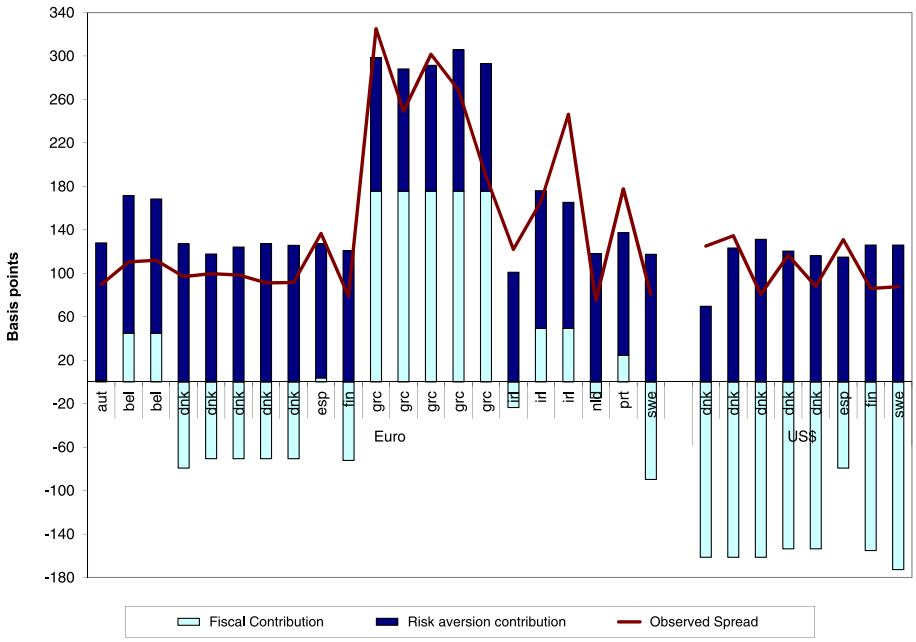

Fig. A.3. Contribution of fiscal variables and general risk aversion to the yield spreads during the crisis period.

Table A.1
Outstanding debt denominated in DM before 1998 and Euro thereafter issued on international capital markets.

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Austria	4057	5401	7398	8962	7947	9224	6286	9845	12,315	19,689	35,200	41,034	44,314	61,869	74,466	78,696	86,410
Belgium	2846	3824	4348	3409	3794	2989	10,046	13,958	22,143	37,072	57,471	76,466	74,981	86,603	115,929	116,114	133,830
Germany	770	1840	2267	2090	2163	4510	4797	10,382	31,763	72,355	130,472	174,905	180,834	240,204	290,389	264,847	275,453
Denmark	1771	1787	2636	3998	4008	3372	553	140	132	1730	4894	8139	9172	10,240	9127	9450	11,605
Spain	3939	4261	6522	6181	6333	6766	2160	3144	3678	13,565	26,074	37,161	43,443	59,172	73,679	81,425	109,557
Finland	4750	7296	7674	7557	5999	6934	0	2792	7050	14,682	32,206	41,544	41,879	44,778	48,579	44,534	54,063
France	0	0	0	0	0	0	3094	2950	6458	11,953	14,501	21,681	26,410	30,403	40,161	42,623	52,280
UK	3186	3551	3837	3537	0	0	0	0	0	0	0	0	0	0	0	0	0
Greece	1245	1905	2197	3390	4475	4316	1849	4691	8937	24,320	44,004	61,963	77,083	110,419	145,695	160,705	218,644
Ireland	3640	3315	3093	2562	1637	1718	199	47	1143	2433	886	89	0	0	9299	41,850	56,863
Italy	2896	4035	4360	4020	5162	2600	6100	13,816	18,973	30,669	65,227	113,314	110,295	149,824	181,391	164,219	168,949
Netherlands	0	0	0	0	0	0	128	305	464	626	817	914	780	7536	8329	17,309	17,415
Portugal	1159	2891	3619	3984	3655	4692	3216	6482	8466	13,928	23,287	27,157	33,415	42,461	48,092	51,454	61,174
Sweden	2677	4302	6723	7073	4643	4455	3239	3075	3102	3908	5115	6605	5302	620	272	875	6380

Source: Bank of International Settlement (BIS) and own calculations.

Table A.2
Outstanding debt denominated in US$ issued on international capital markets.

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Austria	4090	4764	4815	4127	3377	3277	5089	4663	6151	7793	11,466	14,354	14,701	15,185	13,100	18,051	18,285
Belgium	7046	7894	8580	6950	6855	5605	4180	3600	2500	2000	1000	1000	500	500	500	9431	2600
Germany	0	0	0	0	0	0	85	0	10	10	520	1181	6395	7164	7055	6747	7030
Denmark	8541	7119	4998	4245	4010	3161	4413	4968	5853	4489	3090	2060	1030	30	0	5372	13,010
Spain	3194	3238	3340	3310	3461	4831	4570	5446	6276	6249	6090	5564	4925	5089	4816	8243	8348
Finland	6356	8981	9041	9341	4741	3041	3041	3001	2981	4400	4350	4400	4400	3500	2000	2000	2500
France	0	0	200	200	200	200	200	200	200	200	250	250	50	50	50	50	50
UK	7007	7007	7007	7000	7000	7000	7000	7000	3000	0	3000	3000	3000	3000	7000	6000	8000
Greece	2676	3363	3162	3822	3509	3746	2737	2487	2237	2237	1900	1900	1900	1900	2900	4041	3517
Ireland	2480	2250	2200	1550	1550	1550	2072	1600	4533	1752	1341	190	500	500	1032	7281	5839
Italy	17,839	17,831	18,418	20,948	21,307	24,413	21,775	25,184	27,579	35,299	44,725	48,580	50,417	41,236	40,359	31,626	32143
Netherlands	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Portugal	1000	1000	1200	1065	1315	1315	2601	2385	3367	2450	1150	150	150	0	0	920	0
Sweden	15,624	21,613	15,679	15,131	16,548	14,143	7397	5640	5109	7221	7048	7641	8232	9921	12,299	7233	13,225

Source: Bank of International Settlement (BIS) and own calculations.

Table A.3
Total foreign-currency bonds relative to total debt (in %).

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Austria	18.90	22.13	23.62	23.39	22.79	27.18	20.55	16.99	15.54	18.51	21.13	22.20	18.79	15.56	14.19	15.22	14.43
Belgium	6.08	6.85	7.26	5.70	5.69	4.78	3.54	3.01	2.26	1.66	1.27	1.05	0.76	0.82	0.90	3.06	0.80
Germany	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.02	0.13	0.31	0.42	0.72	0.75	0.71	0.81	0.79
Denmark	22.64	20.38	19.24	18.43	17.32	14.69	13.51	12.55	11.44	9.99	11.29	13.19	14.34	15.96	15.97	18.72	27.29
Spain	5.61	6.28	6.65	6.65	6.77	7.96	6.65	5.92	5.49	5.33	5.10	4.43	3.57	3.11	2.72	2.82	2.33
Finland	60.01	68.89	66.06	63.04	48.91	49.67	44.17	32.52	26.26	26.87	19.82	16.83	14.31	14.26	9.80	8.46	3.88
France	0.24	0.26	0.31	0.27	0.23	0.27	0.21	0.16	0.13	0.09	0.09	0.07	0.07	0.08	0.12	0.13	0.13
UK	3.44	3.32	3.26	2.57	1.62	2.06	1.73	1.71	0.47	0.00	0.48	0.43	0.39	0.35	0.82	0.76	0.75
Greece	13.03	17.21	16.68	16.95	16.06	18.51	16.97	14.03	8.66	8.41	7.59	7.08	5.51	4.26	3.97	2.85	2.14
Ireland	25.68	25.26	26.13	18.93	15.14	15.78	13.92	12.07	17.35	10.68	5.86	1.74	1.43	1.45	2.53	12.52	9.72
Italy	3.01	3.92	4.52	4.08	4.12	4.58	3.81	4.06	3.94	4.76	5.68	5.91	5.28	4.44	4.05	3.22	2.98
Netherlands	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.12	0.11	0.00	0.00	0.00	0.00
Portugal	8.71	14.02	18.56	18.82	20.40	22.83	15.96	12.60	10.63	8.41	6.03	3.86	1.91	1.79	1.65	1.14	0.19
Sweden	23.16	38.28	38.37	37.35	32.18	32.14	23.06	20.75	17.10	18.39	18.07	18.55	15.62	13.76	16.44	13.51	17.48

Source: Bank of International Settlement (BIS) and own calculations.

Table A.4
US$ and DM/Euro currency shares of total foreign-currency bonds (in %).

		1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Austria	DM	21.9	22.2	25.3	31.0	29.8	27.5	–	–	–	–	–	–	–	0.0	0.0	0.0	0.0
	US$	22.1	19.6	16.5	14.3	12.7	9.8	18.6	19.9	27.8	29.0	37.1	42.9	50.2	61.2	57.3	67.1	68.5
Belgium	DM	18.3	20.4	21.2	22.1	24.9	23.2	–	–	–	–	–	–	–	–	–	–	0.0
	US$	45.4	42.2	41.9	45.0	44.9	43.5	43.5	43.9	39.9	43.4	29.1	34.8	23.5	21.6	19.8	99.8	100.0
Germany	US$	0.0	0.0	0.0	0.0	0.0	0.0	94.4	0.0	3.4	0.6	12.0	19.4	58.4	60.7	63.2	50.7	50.3
Denmark	DM	8.1	8.8	13.5	21.8	23.6	23.9	–	–	–	–	–	–	–	–	–	–	–
	US$	39.0	35.0	25.6	23.1	23.7	22.4	34.5	43.5	57.5	49.1	30.8	17.5	9.2	0.3	0.0	36.0	51.5
	Euro	–	–	–	–	–	–	4.3	1.2	1.3	18.9	48.8	69.3	81.8	91.4	92.2	63.4	46.0
Spain	DM	30.1	26.6	33.2	28.7	28.2	24.6	–	–	–	–	–	–	–	–	–	–	–
	US$	24.4	20.2	17.0	15.4	15.4	17.5	19.0	24.6	30.2	30.6	31.3	32.3	35.3	42.0	46.6	67.5	64.0
Finland	DM	18.5	20.4	20.6	20.8	21.3	24.8	–	–	–	–	–	–	–	–	–	–	–
	US$	24.8	25.1	24.2	25.7	16.9	10.9	12.3	15.9	19.2	27.5	33.9	38.7	46.8	37.3	32.3	37.5	85.8
France	DM	0.0	0.0	0.0	0.0	0.0	0.0	–	–	–	–	–	–	–	–	–	–	–
	US$	0.0	0.0	9.6	10.5	11.5	9.3	12.0	14.7	18.5	24.4	28.0	31.3	6.1	5.3	3.6	2.8	2.6
UK	DM	24.0	25.5	26.5	25.3	0.0	0.0	–	–	–	–	–	–	–	–	–	–	–
	US$	52.8	50.3	48.5	50.1	69.7	58.5	62.1	63.9	100.0	0.0	100.0	100.0	100.0	0.0	100.0	100.0	100.0
	Euro	–	–	–	–	–	–	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
Greece	DM	11.3	12.5	13.9	18.6	24.3	20.2	–	–	–	–	–	–	–	–	–	–	–
	US$	24.2	22.0	20.0	20.9	19.0	17.5	13.2	12.6	17.0	16.7	14.9	14.6	17.6	19.9	30.6	54.2	55.2
Ireland	DM	34.6	31.8	28.3	29.7	24.2	25.9	–	–	–	–	–	–	–	–	–	–	–
	US$	23.6	21.6	20.1	18.0	22.9	23.3	33.9	33.4	62.8	39.2	52.8	24.7	78.9	78.1	86.1	72.9	57.4
Italy	DM	9.9	9.9	9.0	8.0	10.2	4.5	–	–	–	–	–	–	–	–	–	–	–
	US$	60.8	43.9	38.0	41.8	41.9	42.5	44.6	47.7	51.5	54.2	56.5	56.9	63.2	58.6	62.3	58.9	61.1
Netherlands	DM	0.0	0.0	0.0	0.0	0.0	0.0	–	–	–	–	–	–	–	–	–	–	–
	US$	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Portugal	DM	32.0	43.3	36.8	38.1	32.9	37.0	–	–	–	–	–	–	–	–	–	–	–
	US$	27.6	15.0	12.2	10.2	11.8	10.4	27.8	30.6	46.3	38.7	24.2	4.6	8.3	0.0	0.0	71.6	0.0
Sweden	DM	8.1	8.5	11.7	12.1	9.2	9.5	–	–	–	–	–	–	–	–	–	–	–
	US$	47.1	42.6	27.2	25.8	32.8	30.0	20.0	19.9	21.9	28.2	26.9	27.7	35.6	49.2	56.5	47.4	59.6
	Euro	–	–	–	–	–	–	8.7	10.9	13.3	15.3	19.6	24.0	22.9	3.1	1.2	5.7	28.8

Source: Bank of International Settlement (BIS) and own calculations.

Table A.5
Variable description and summary statistics.

Variable	Description	Mean	Std. Dev.	Min.	Max.
Spread S_{it}	Spread between the yield to maturity of an EU country and a comparable government bond issued by the benchmark country in the same currency. Expressed in basis points. Source: Capital DATA Bondware	45.47	45.65	−5.00	325.10
Debt	Difference of debt-to-GDP outstanding at the end of the fiscal year between the issuer country and the benchmark country (expressed in percent). Source: Ameco database	9.93	27.67	−49.40	88.41
Deficit	Difference of the projected (12-month ahead) deficit to GDP at the end of the fiscal year between the issuer country and the benchmark country (expressed in percent). Source: OECD Economic Outlook.	0.02	3.73	−9.76	9.30
Debt service	Difference of debt service payments to total revenue in the current fiscal year between the issuer country and the benchmark country (expressed in percent). Source: Ameco database	0.70	5.43	−11.70	25.50
Baa–spread	Spread between low grade long-term corporate bonds (Moody's Baa) and 10 government bonds in the US (expressed in percent). Source: Datastream	2.48	1.07	1.29	5.92
Maturity	Time to maturity of the government bond issue measured in years. Source: Capital DATA Bondware.	7.53	5.37	1.80	33.70
Issue size	Size of the bond issue measured by the deal value in Mio. Euros. Source: Capital DATA Bondware.	1796	1865	44	7500
Liquidity	Outstanding amount of securities of the issuer country denominated in DM (Euro) or US$ issued on international markets (in Million US$). Source: BIS and own calculations.	25,487	37,902	500	218,644
US	Dummy variable for all bonds issued in US$.	0.53	0.50	0.00	1.00
EMU	Dummy variable for all member countries of the EMU after 1998.	0.50	0.50	0.00	1.00

Table A.6
Test for poolability of DM(Euro) and US$ denominated bonds.

	(A)	(B)	(C)
Debt*US	0.29		
Debt*EMU*US	0.53		
Debt^2*US	0.09		
Debt^2*EMU*US	0.16		
Deficit*US		0.06	
Deficit*EMU*US		0.30	
Deficit^2*US		0.50	
Deficit^2*EMU*US		0.63	
Debt Service*US			0.26
Debt Service*EMU*US			0.29
Debt Service^2*US			0.55
Debt Service^2*EMU*US			0.24
Liquidity*US	0.98	0.67	0.27
Baa–Spread*US	0.02	0.02	0.00
Baa–Spread*EMU*US	0.94	0.48	0.69
Maturity*US	0.03	0.12	0.50
F-test	0.00	0.00	0.01
F-test (excl.Baa–spread*US)	0.06	0.17	0.13

Note: Entries in this table record the *p* -ratios of the poolability tests for individual variables and the corresponding overall *F* -test. Variables denoted "**US*" are interacted with a dummy for the US$ market.

Table A.7
Determinants of interest rate spreads – Jan. 1993–July 2007 – without country dummies

	(A)	(B)	(C)
Debt	0.96 (0.00)		
Debt^2	−0.01 (0.00)		
Deficit		3.79 (0.00)	
Deficit^2		0.61 (0.04)	
Debt Service			0.69 (0.24)
Debt Service^2			0.17 (0.00)
Liquidity	−0.001 (0.04)	−0.002 (0.00)	−0.001 (0.05)
Baa–Spread	−8.92 (0.19)	−8.40 (0.20)	−5.60 (0.35)
Baa–Spread*US	19.45 (0.00)	22.58 (0.00)	21.67 (0.00)
Maturity	0.69 (0.00)	0.85 (0.00)	0.67 (0.01)
US Dummy	−16.82 (0.16)	−25.46 (0.01)	−17.67 (0.11)
Constant	43.65 (0.01)	24.41 (0.12)	13.61 (0.39)
EMU effect			
Debt	−0.68 (0.02)		
Debt^2	0.01 (0.06)		
Deficit		−1.00 (0.48)	
Deficit^2		−0.47 (0.20)	
Debt Service			−0.04 (0.97)
Debt Service^2			−0.15 (0.23)
Liquidity	0.001 (0.05)	0.002 (0.01)	0.001 (0.04)
Baa–Spread	7.85 (0.22)	9.40 (0.13)	4.50 (0.46)
EMU Dummy	−34.96 (0.03)	−38.15 (0.01)	−15.17 (0.27)
N	266	266	266
R^2	0.51	0.57	0.62
Time-fixed effects	Yes	Yes	Yes
Country fixed effects	No	No	No

Note: Entries in brackets record *p* -values. The coefficients and their interacted terms are constructed in an additive way. The coefficients in the upper panel show the effects for the pre-EMU period. By adding to these the coefficients shown the lower panel, one gets the post-EMU effects.

Table A.8
Determinants of interest rate spreads – Jan. 1993–July 2007 – with country dummies

	(A)	(B)	(C)
Debt	0.16 (0.51)		
Debt^2	−0.01 (0.01)		
Deficit		3.34 (0.00)	
Deficit^2		0.42 (0.09)	
Debt Service			2.19 (0.03)
Debt Service^2			0.09 (0.03)
Liquidity	−0.002 (0.00)	−0.002 (0.00)	−0.001 (0.02)
Baa–Spread	−11.01 (0.09)	−9.27 (0.13)	−5.73 (0.34)
Baa–Spread*US	29.26 (0.00)	27.76 (0.00)	23.06 (0.00)
Maturity	0.58 (0.01)	0.81 (0.00)	0.70 (0.00)
US Dummy	−37.81 (0.00)	−35.87 (0.00)	−11.91 (0.35)
Constant	38.51 (0.05)	10.19 (0.55)	−8.77 (0.66)
EMU effect			
Debt	−0.24 (0.30)		
Debt^2	0.00 (0.31)		
Deficit		−0.52 (0.70)	
Deficit^2		−0.42 (0.21)	
Debt Service			1.19 (0.27)
Debt Service^2			−0.50 (0.00)
Liquidity	0.001 (0.01)	0.001 (0.01)	0.001 (0.04)
Baa–Spread	3.63 (0.55)	2.94 (0.61)	2.40 (0.67)
EMU Dummy	−10.00 (0.53)	−16.66 (0.24)	3.08 (0.83)

Table A.8 (*continued*)

	(A)	(B)	(C)
N	266	266	266
R^2	0.64	0.67	0.70
Time-fixed effects	Yes	Yes	Yes
Country fixed effects	Yes	Yes	Yes

Note: Entries in brackets record *p* -values. The coefficients and their interacted terms are constructed in an additive way. The coefficients in the upper panel show the effects for the pre-EMU period. By adding to these the coefficients shown the lower panel, one gets the post-EMU effects.

Table A.9
Determinants of interest rate spreads – Jan. 1993–May 2009

Variable	(A)	(B)	(C)
Debt	0.84 (0.00)		
$Debt^2$	−0.01 (0.01)		
Deficit		2.56 (0.01)	
$Deficit^2$		0.60 (0.01)	
Debt Service			0.66 (0.15)
$Debt\ Service^2$			0.16 (0.00)
Liquidity	−0.001 (0.03)	−0.002 (0.00)	−0.001 (0.03)
Baa–Spread	−11.21 (0.09)	−8.56 (0.22)	−10.36 (0.10)
Baa–Spread *US	19.23 (0.00)	22.40 (0.00)	22.41 (0.00)
Maturity	0.48 (0.07)	0.47 (0.10)	0.57 (0.02)
US Dummy	−15.43 (0.18)	−20.63 (0.05)	−19.14 (0.06)
Constant	49.35 (0.00)	29.51 (0.07)	25.19 (0.12)
EMU effect			
Debt	−0.62 (0.02)		
$Debt^2$	0.01 (0.10)		
Deficit			
$Deficit^2$			
Debt Service			
$Debt\ Service^2$			
Liquidity	0.001 (0.03)	0.002 (0.00)	0.001 (0.04)
Baa–Spread			
EMU Dummy	−16.61 (0.02)	−23.48 (0.00)	−4.21 (0.40)
Crisis effect			
Debt	1.36 (0.00)		
$Debt^2$	0.04 (0.03)		
Deficit		8.20 (0.05)	
$Deficit^2$		0.45 (0.49)	
Debt Service			11.28 (0.00)
$Debt\ Service^2$			0.94 (0.19)
Baa–Spread	23.50 (0.00)	14.78 (0.01)	23.37 (0.00)
Baa–Spread *US	−16.72 (0.00)	−10.60 (0.11)	−17.15 (0.00)
N	311	311	311
R^2	0.74	0.77	0.80
Time-fixed effect	Yes	Yes	Yes
Country fixed effects	No	No	No

Note: Entries in brackets record *p* -values. The coefficients and their interacted terms are constructed in an additive way. The coefficients in the upper panel show the effects for the pre-EMU period. By adding to these the coefficients shown the middle panel, one gets the post-EMU effects. By adding the coefficients listed in the lower panel to this sum, one ends up with the total effects after the outbreak of the financial crisis.

Table A.10
Hypothesis Tests

	(A)	(B)	(C)
Data sample: January 1993–August 2007			
No reaction to public debt in EMU	0.00		
No reaction to public deficit in EMU		Reject	
No reaction to debt service in EMU			Reject
No reaction to liquidity in EMU	0.86	0.92	0.53
Data sample: January 1993–May 2009			
No reaction to public debt in EMU	0.03		
No reaction to liquidity in EMU	0.91	0.00	0.58
No difference in safe-haven status after crisis	0.55	0.09	0.26

Note: Entries in this table show the significance levels at which the relevant hypothesis is rejected. In case of "reject" this hypothesis is directly rejected by coefficient estimates shown in the results tables.

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