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Catharina Klepsch* and Timo Wollmershäuser**

Yield Spreads on EMU Government Bonds – How the Financial Crisis Has Helped Investors to Rediscover Risk

This study analyses the determinants of EMU member states' government bond yield spreads from January 2000 until September 2010. Using a dynamic panel regression approach, the authors show that before the outbreak of the financial crisis investors generally ignored fundamental sovereign bond risk factors. However, with the beginning of the financial crisis yield spreads for many member countries escalated. The results indicate not only that investors began to re-evaluate countries' credit risks (measured by projections of debt-to-GDP ratios), but also that risk aversion in the markets, which increased significantly during the crisis, became a major determinant of sovereign bond spreads.

The aftermath of the global financial crisis has been tremendous and still affects the global economy. Unleashed by the housing bubble in the United States in summer 2007, the financial crisis overflowed into the real economy, causing what is now often called the "Great Recession". In response to the financial crisis, many countries, particularly France, Ireland and Germany, launched huge bailout packages to rescue distressed banks, insurance companies and other financial service providers to prevent a collapse of the whole financial system. Furthermore, large economic stimulus packages were passed to reactivate domestic demand and to strengthen the economy. As a consequence, the rescue packages and the capital injections for the financial sector have led to increasing government expenditures, and the stimulus and tax relief packages have caused decreasing government revenues. The measures have therefore resulted in sharply increasing debt and deficit levels in the member states of the European Monetary Union (EMU). Although all member countries are obliged by the Maastricht Treaty to avoid excessive budgetary deficits and to keep the gross government debt to gross domestic product ratio below the threshold level of 60%, several countries such as Greece, Italy and Belgium were unable to stick to this, even before the outbreak of the financial crisis. However, violating countries have not paid a penalty, nor have any measures been taken to stop this trend of increasing budget deficits. The full consequences of the financial crisis became evident when the tremendous debt and deficit levels in Greece and the mismanagement of the Greek government became public. Yields on Greek bonds increased, and with a further scaling up of Greece's deficit, Greek bonds were downgraded to junk status, reflecting the increased possibility of Greece becoming insolvent.[1] In order to prevent a systematic euro crisis, a €110 billion rescue package from the members of the eurozone and the International Monetary Fund was granted on 2 May 2010, although Article 122 of the Lisbon Treaty states that financial assistance to a member state may only be granted if "a Member State is in difficulties [...] caused by natural disasters or exceptional occurrences beyond its control [...]". In order to fight the fears of the Greek debt crisis widening across the eurozone – as bond spreads for several Southern European countries increased – an additional €750 billion rescue package for endangered member countries was agreed to on 9 May 2010.

The 10-year government bond yields of EMU countries in the years before the common currency clearly differed from one another, as Italian, Spanish and Portuguese bonds paid yields of up to 13% and German and French bonds paid only a fraction of this. The main reasons for these high interest payments were exchange rate risks and the fear of systematic currency devaluations.[2] However, with the introduction of the euro,

* Institute for Finance and Banking, Ludwig-Maximilians-University, Munich, Germany.
** Ifo Institute for Economic Research and Ludwig-Maximilians-University, Munich, Germany.

1 P. Belkin, D. Mix, R. Nelson: Greece's Debt Crisis: Overview, Policy Responses, and Implications, in: Congressional Research Service, 2010.
2 H.-W. Sinn: Rescuing Europe, in: CESifo Forum, No. 11, 2010.

yields on government bonds converged, and Italian and Spanish bonds paid almost the same yields as German and French ones. With the beginning of the financial crisis in summer 2007 and the increasing uncertainty regarding the solvency of certain eurozone members in early 2010, yields began to diverge again. The question which arises is what factors determine yield spreads today, as exchange rate risks have vanished and an independent national monetary policy is no longer possible, so that fears of countries inflating their own currencies are redundant.

Determinants of Government Yield Spreads

The academic literature has analysed several determinants of yield spreads. This research is based on the yield spreads of bonds issued by European countries versus the German benchmark figures. Besides the default risk of a country, both liquidity risk and the general risk aversion of investors are mentioned as main factors.[3]

Credit Risk

Investors demand a credit risk premium which depends primarily on the issuer's probability of default. If the risk of a default is high, investors demand a higher yield to compensate. In general, a government's default risk is measured by historical fiscal data such as the debt-to-GDP and the deficit-to-GDP ratios.[4] Both variables represent a country's fiscal performance, with a higher value meaning a higher probability of default. Recent literature also uses forecast debt or deficit levels as investors consider a country's future fiscal position on the basis of current available information[5], using this to anticipate future fiscal performance and adjust their yield demands based on the budgetary outlook.

Liquidity Risk

Liquidity risk increases yield spreads as investors claim a liquidity premium in order to compensate for the potential risks of selling illiquid securities under bad market conditions. This liquidity premium is low if investors can trade their assets at any time. However, this is only possible if the order volume is high, which requires a sufficient number of sell and buy orders. Therefore, if transaction costs are high – due, for example, to mismatches on the financial markets – investors will demand a higher yield. The most conventional approach to capture liquidity risk is the use of bid-ask spreads, which represent transaction costs on capital markets.[6] Alternatively, the volume of government bonds issued is used as a proxy variable for liquidity.[7]

Risk Aversion

The third factor explaining yield spreads is investors' risk aversion. Risk aversion shows the attitude of investors towards bearing risk. Investors are supposed to be more risk averse in times of high uncertainty. A proxy variable often used for risk aversion is the corporate bond spread, which is defined as the difference between the yields of long-term (7-10 years) corporate and government bonds.[8] In the literature, this variable has been specified in different ways; several researchers use BBB rated corporate bond spreads, while others rely on AAA rated corporate bonds. In general, it can be said, the higher the spread, the lower the willingness of investors to bear risk. Alternatively, equity market volatility is used to capture risk aversion, because higher volatility implies greater uncertainty among market participants.[9]

However, the determinants of yield spreads usually depend on the period analysed and the variables used. Studies analysing yield spreads before EMU identify exchange-rate risks, differences in taxation and restrictions on capital movements in addition to credit and liquidity risks as the main drivers for yield spreads on government bonds.[10] Sinn[11] emphasises the devaluation strategies of highly indebted governments, which deliberately inflate and devalue their currencies. This leads to greater uncertainty among investors and thus caused higher yield differentials before EMU. With the introduction of the euro in 1999, exchange-rate risks disappeared, varying tax treatments were harmonised and capital flows liberalised. The threat of systematic

3 See, for example, L. Codogno, C. Favero, A. Missale: Yield spreads on EMU government bonds, in: Economic Policy, Vol. 18, No. 37, 2003, pp. 503-532.
4 See, for example, M. Hallerberg, G. Wolff: Fiscal institutions, fiscal policy and sovereign risk premia in EMU, in: Public Choice, Vol. 136, No. 3, 2008, pp. 379-396.
5 M. Attinasi, C. Checherita, C. Nickel: What Explains The Surge In Euro Area Sovereign Spreads During The Financial Crisis of 2007-09?, in: European Central Bank Working Paper Series, No. 1131, 2009.
6 See, for example, M. Gómez-Puig: Size matters for liquidity: Evidence from EMU sovereign yield spreads, in: Economics Letters, Vol. 90, No. 2, 2006, pp. 156-162.
7 L. Schuknecht, J. von Hagen, G. Wolswijk: Government risk premiums in the bond market: EMU and Canada, in: European Journal of Political Economy, Vol. 25, No. 3, 2009, pp. 371-384.
8 L. Codogno, C. Favero, A. Missale, op. cit.
9 S. Gerlach, A. Schulz, G. Wolff: Banking and sovereign risk in the euro area, in: Deutsche Bundesbank Discussion Paper, No. 09, 2010.
10 See for example, L. Codogno, C. Favero, A. Missale, op. cit. and M. Gómez-Puig, op. cit.
11 H.-W. Sinn, op. cit.

currency devaluations vanished when the European Central Bank took over control from the national central banks in 1999.[12] However, government bond yields have not fully converged under EMU and the remaining yield spreads have to be primarily attributable to differences in liquidity and credit risks among the issuers. The studies covering the time before and after EMU provide important contributions to the analysis of the determinants of yield spreads.[13] First, international risk factors play an important role in explaining yield differentials.[14] Second, the impact of fiscal performance (measured by the debt and deficit ratios) on yield spreads decreased with EMU.[15] The reason for this decrease could be the minor credibility of the no-bailout clause in the European treaties and investors' anticipation that in the case of a sovereign debtor's solvency problems, other member states would step in. Third, with the introduction of the euro, liquidity risk premia decreased as the integration of financial markets increased; however, variables measuring liquidity risk show only a small influence on yield spreads.[16]

While the differentials between 10-year EMU government bond yields and German bond yields converged with the introduction of the euro in 1999, the spreads sharply diverged again at the beginning of the financial crisis in 2007. Recent studies analysing the impact of the financial crisis on EMU government bonds have included additional variables in order to explain increasing yield spreads. Gerlach et al.[17], for example, include a crisis dummy with a value of zero before the crisis and a value of one from the beginning of the crisis. They also use the total assets of the banking sector to find evidence of an emerging linkage between the financial sector and public budgets. However, as in previous studies, the main determinants of yield spreads are shown to be investors' risk aversion and credit risk. With the financial crisis, market uncertainty and investors' risk aversion increased. As a consequence, investors reassessed their risk, concentrating especially on the credit risk of an asset. The fiscal variables, such as debt or deficit ratios, show a positive influence on yield spreads in almost all studies.

12 P. De Grauwe: Economics of Monetary Union, Oxford, 2007.
13 See, for example, L. Codogno, C. Favero, A. Missale, op. cit or C. Favero, M. Pagano, E. von Thadden: How Does Liquidity Affect Government Bond Yields?, in: Journal of Finance and Quantitative Analysis, Vol. 45, No. 1, pp. 107-134.
14 C. Favero, M. Pagano, E. von Thadden, op. cit.
15 L. Schuknecht, J. von Hagen, G. Wolswijk, op. cit.
16 See for example, C. Favero, M. Pagano, E. von Thadden, op. cit.
17 S. Gerlach, A. Schulz, G. Wolff, op. cit.

Data and Empirical Approach

To determine the factors influencing sovereign yield spreads, we analyse a panel data set comprising observations of major EMU countries for the period 7 January 2000 to 3 September 2010. The sample therefore covers the tight yield spreads following the introduction of the euro in 1999 and the divergence with the beginning of the financial crisis in July 2007. The countries which are investigated are Austria, Belgium, Finland, France, Greece, Germany, Ireland, Italy, the Netherlands, Portugal and Spain. For the dependent variable we use the weekly yield spreads of 10-year government bond indices of the ten EMU countries over their German counterparts. The data is taken from the Reuters EcoWin database. Before the financial crisis, yields on EMU government bonds were almost identical; the spread over German bond yields was 15 basis points (bp) on average with a standard deviation of circa 12 bp. Countries such as Ireland, Finland and France paid even lower yields than Germany, and highly indebted countries such as Greece, Italy and Belgium had to pay no more than 60 bp premia compared to Germany. With the beginning of the crisis in late summer 2007, yields on government bonds started to diverge. The first peak in yield spreads was reached in September 2008, when Lehman Brothers filed for bankruptcy and the EMU countries started to unveil huge rescue packages for endangered financial institutions. At this time, Greek and Irish yields were about 300 bp over Germany. Ireland in particular faced high costs resulting from its large, distressed financial sector. Hence, the rescue and stimulus packages strained the countries' budgets and led to sharply increasing debt and deficit levels, which in turn led to rising concerns about several countries' solvency.

To account for credit risk, we follow the approach of Attinasi et al.[18] and use projections of the debt-to-GDP ratio for each country. The forecasts for the upcoming two years are taken from the OECD Economic Outlook, which is published in June and December of each year. We calculate the projected two-year averages by taking the average fiscal position for the upcoming two years until a new forecast becomes available. By using forecast values instead of historical data, we account for investors' ability to anticipate future public budgetary situations. Higher expected debt levels might be a signal to market participants of deteriorating creditworthiness, which in turn influences credit risk. Thus, for the forecast debt ratio a positive influence on yield spreads is expected as highly indebted countries come up with

18 M. Attinasi, C. Checherita, C. Nickel, op. cit, pp.14-15.

higher default risk. The data shows that with a short lag, the debt levels increase with the financial crisis, indicating the rescue and stimulus packages financed by public budgets. Taking into consideration that the GDP of each country also decreased during the financial crisis, the absolute debt levels are probably even higher.

In addition to the standard measures of a country's credit risk, we follow the approach of Gerlach et al.[19] and use the aggregate banking assets-to-GDP ratio and the banking equity-to-assets ratio. The reason for the inclusion of these variables is that the financial crisis led to a linkage between the financial and the public sectors. A larger financial sector within a country leads to a higher upper bound for state rescue packages; lower equity ratios imply a higher default probability of banks. The total monthly banking assets of a country are available on the ECB's monetary financial institutions (MFI) database. The GDP data for this variable is sourced from Eurostat on a quarterly basis, however. To calculate the banking assets-to-GDP ratio, we interpolate the quarterly GDP data to get monthly values which represent the denominators of the ratios. Banking equity is also available on the ECB's MFI database on a monthly basis. The component is scaled by the total banking assets. In this context, a large financial sector also explains the worsening of the governments' budgetary situation since the beginning of the financial crisis.

To consider liquidity risk, we use the ratio of the amount of debt issued by a country to the total debt issued by the EU. The debt issued comprises all securities, except shares and financial derivatives, issued by the government of a country.

As a proxy variable for investors' risk aversion, we use the VIX index, which measures the volatility of the US equity market. This index is constructed by using call and put implied volatilities from S&P 500 index options and represents future market volatility over the next 30 calendar days.[20] According to Whaley[21] the VIX reflects the price of portfolio insurance, as put options on the S&P 500 index are mainly bought by investors who are concerned about a potential decline in the stock market. The value of the index increased nearly eightfold from February 2007 to October 2008, demonstrating the high levels of uncertainty released by the financial crisis into the financial markets. The index is considered appropriate for this analysis as it accounts especially for the downside movements. The VIX index is available on Bloomberg; weekly averages are calculated on the basis of daily data.

To account for cyclical variations, which might influence yield spreads, we include GDP growth rates. The idea behind this cyclical indicator is that in a bad economic environment, government revenues are likely to decrease, which leads to higher debt levels and increasing default risk. Data for growth rates is sourced from Eurostat on a quarterly basis.

Finally, data on ECB buy-ins (since May 2010) is considered to show how market interventions by the central bank influence yield spreads. To control for the effect of these interventions, we use weekly data on supporting purchases, which are sourced from the weekly financial statements of the ECB. By 3 September 2010 the ECB had spent close to €61 billion on government bonds, of which €60 billion were spent by 9 July 2010.[22] The data shows that yield spreads between Greek and German government bonds, which were greater than 700 bp on 7 May 2010, declined in the following week to levels of about 475 bp.[23] However, after the reduction of the intervention volume, yield spreads started to pick up again.

Combining the above-mentioned variables in a regression equation by taking into consideration the high persistence of financial time-series, the following regression equation is used to explain 10-year government bond yield spreads:

$$S_{i,t} = \rho S_{i,t-1} + \alpha + \delta_k D_k + \beta_1 R_t + \beta_2 F_{i,t} + \beta_3 L_{i,t} + \beta_4 K_{i,t} + \lambda C_t + \gamma_i C_t D_k + \beta_5 C_t R_t + \beta_6 C_t F_{i,t} + \beta_7 C_t L_{i,t} + \beta_8 C_t K_{i,t} + \varepsilon_{i,t}$$

with $i = 1, ..., 10$ denoting the ten EMU countries and $t = 1, ..., 557$ denoting the weekly time dimension. $S_{i,t}$ is the yield spread of country i over Germany at time t; $S_{i,t-1}$ is the lagged yield spread.[24] α denotes the constant. Moreover, k (with $k = 2,\ldots,10$) country dummies D_k are included to allow for country-specific effects. Investors' risk aversion is captured by R_t, which varies over time but equally affects all countries. Investors' risk aversion is proxied by a variable measuring uncertainty on the capital markets (VIX index). The country-specific

19 S. Gerlach, A. Schulz, G. Wolff, op. cit.

20 A. Beber, M. Brandt, K. Kavajecz: Flight-to-Quality or Flight-to-Liquidity? Evidence from the Euro-Area Bond Market, in: The Review of Financial Studies, Vol. 22, No. 3, 2009, pp. 925-957.

21 R.E. Whaley: Understanding VIX, in: SSRN eLibrary, 2008.

22 P. Belkin, D. Mix, R. Nelson, op. cit.

23 In the first week after the announcement of the European Financial Stabilisation mechanism, the ECB bought bonds amounting to €16.3 billion.

24 In order to account for the dependency of yield spreads on their past values, we include the lagged dependent variable as an additional regressor.

credit risk $F_{i,t}$ is proxied by the forecast debt-to-GDP ratio and by the total assets held by the financial sector relative to GDP. $L_{i,t}$ captures liquidity risk and is proxied by the gross issue of national debt. $K_{i,t}$ refers to several control variables: as mentioned above, the GDP growth rate for each country is included to account for cyclical variations in government revenues, another control variable accounts for the ECB buy-ins beginning in May 2010, for which a negative influence on government yields is expected. To account for the influence of the financial crisis, the crisis dummy variable Ct is used with a value of one from July 2007 onwards and zero otherwise. By including this dummy, we try to capture the effects of the financial crisis which are not absorbed by the other regressors. We interact this crisis dummy with each variable of the equation, except for the lagged yield spread. A significant coefficient of the interaction term would show the additional effect of a variable due to the crisis. It has to be mentioned that all explanatory variables are expressed in differences to the corresponding German values, except for investors' risk aversion and the interventions of the ECB. The independent and identical distributed error term for all models is described by $\varepsilon_{i,t}$. Since heteroscedasticity of the error term is assumed, we use the FGLS estimator, which is more efficient than the OLS estimator if the variance of the error term is not constant.[25]

Results

Table 1 shows the estimation results of four regressions based on different variable specifications. In all estimations the lagged dependent variable shows a positive and highly significant influence. This clearly confirms the strong persistence of yield spreads. In column A, the three main determinants as well as the country dummies and the crisis dummy (including the interaction variables) are included.

Investors' risk aversion shows a positive and significant influence on yield spreads before the crisis and a remarkably higher influence during the crisis. The results of regression A imply an additional yield spread increase of 6.7 bp (0.067 *100) if the VIX index increases by one per cent during the crisis period. The overall immediate effect on spreads of a one per cent increase of investors' risk aversion during the crisis amounts to 8.6 bp, whereas the long-run effect is considerably higher, amounting to 277 bp.[26]

Fiscal performance, proxied by the debt-to-GDP ratio, reveals a significantly positive influence only during the crisis; before the crisis, the effect is insignificant. This reflects the emerging awareness of market participants who started to take differences in public budgets into account. As a result, they demanded a higher risk premium from countries with bad budgetary prospects. The results of regression A imply an immediate increase in yield spreads by 14.1 bp if the debt-to-GDP ratio is expected to rise by one percentage point; the long-run effect is estimated to be 455 bp. The influence of a government's debt ratio remains positive and significant in all specifications.

The liquidity variable, measured by the gross amount of debt issued, is insignificant throughout the sample period. The coefficient only shows the expected negative sign during the crisis period.

The country-specific, time-invariant fixed effects do not show any significant influence in the pre-crisis period. Therefore they are not shown in Table 1. However, in interaction with the crisis dummy, the country dummies of Spain, Greece, Ireland and Portugal in particular show highly significant and positive influences. In detail, the country dummies stand for country-specific effects not covered by the applied fundamental data of the countries. In the case of Greece, for example, the country-specific effects absorb the political instability of the country along with low productivity levels and high levels of corruption which led to a dissatisfied and strike-prone population. The period from December 2009 onwards is particularly responsible for the large influence of the country dummies. Untabulated results show that by estimating regression A without the period from December 2009 onwards the coefficients become significantly smaller. Thus, the country-specific effects gain influence during the crisis, as they capture the rising uncertainty of the countries' future prospects. The negative time-invariant effects in Belgium, Italy and France show that market participants priced these bonds lower during the crisis due to certain country characteristics. The negative influence for France, for example, seems reasonable, as French bonds are often regarded as equivalent to German bonds and are also taken as benchmark bonds, especially for shorter maturities.[27] The negative and significant influence of the Italian/Belgian fixed effect seems confusing at first. It can be explained by the fact that the incentive for investors to buy Italian/Belgian bonds is higher, as the additional risk they have to bear is better compensat-

25 N. Beck, J. Katz: What to do (and not to do) with time-series cross-section data, in: American Political Science Review, Vol. 89, No. 3, 1995, pp. 634-647.

26 The long-run effect is calculated by dividing the coefficient β by $(1 - \rho_i)$ with ρ_i being the coefficient of the lagged dependent variable.

27 C. Favero, M. Pagano, E. von Thadden, op. cit.

ed than in the case of Greek, Spanish or Portuguese bonds.

In regression B, the control variables are included. The influences of the three main determinants remain almost unchanged with respect to sign and significance. The banking variable shows a positive and significant influence during the crisis. An increase of the total banking assets-to-GDP ratio by one percentage point leads to an immediate increase of government bond yield spreads by 11.5 bp. The long-term effect, which amounts to 250 bp, is similar to the results found by Gerlach et al.[28] This provides evidence for the accrued linkage between the financial sector and government budgets as a consequence of the financial crisis. Regression B also includes the growth variable, which shows a negative influence in the pre-crisis period, then increases and turns significant in the crisis period. An increase in GDP growth rates implies higher government revenues, which reduce government budget balances. Regression B also accounts for the ECB buy-ins. The influence of the ECB interventions is verified by the coefficient, which is negative and significant at the one per cent level. Although the ECB does not provide any information about the composition of the purchases, it is assumed that predominantly Greek, Irish and Portuguese bonds were purchased, followed by Spanish and Italian bonds.[29] The fact that the ECB sequentially reduced the purchasing programmes in the following weeks resulted in increasing yield spreads again. This underscores the negative influence of the variable on yield spreads.

In regression C, the banking equity-to-assets ratio is used as an alternative proxy for sovereign risk. Like the banking assets, the equity ratio is significant for the crisis period. However, when both banking variables are included in regression D only the banking assets variable remains significant. Regression B is therefore the baseline regression.[30]

Table 1
Main Estimation Results

Variable	(A)	(B)	(C)	(D)
spread $_{t-1}$	0.969***	0.954***	0.957***	0.954***
vix	0.019*	0.027**	0.026**	0.028**
crisis*vix	0.067***	0.084***	0.074***	0.078***
debt^{e}	0.013	0.024	0.022	0.024
crisis*debt^{e}	0.141***	0.156***	0.192***	0.183***
issue	0.014	0.015	0.014	0.014
crisis*issue	-0.034	-0.039	-0.033	-0.041
crisis*BE	-2.988***	-3.308***	-6.265***	-5.764***
crisis*ES	4.719***	5.779***	2.704	3.802**
crisis*FI	3.338***	5.492***	5.028***	6.643***
crisis*FR	-0.747	-1.514*	-4.913**	-4.591**
crisis*GR	5.151**	6.769***	3.021	5.886**
crisis*IE	6.776***	-2.532	6.634***	-1.86
crisis*IT	-4.039***	-3.021	-9.772***	-6.937**
crisis*NE	1.355**	1.154	-0.918	-0.909
crisis*PT	1.951*	2.874***	3.798**	4.529***
crisis	-0.811	-1.420*	3.291	1.929***
growth		-0.104	-0.082	-0.089
crisis*growth		-1.119**	-1.452***	-1.251**
banking assets		0.003		-0.001
crisis*banking assets		0.115**		0.112**
ecb		-0.223***	-0.233***	-0.247***
banking equity			-0.71	-0.746
crisis*banking equity			-11.215*	-9.362
constant	0.217	0.289	0.437	0.464
No. of observations	5,498	5,383	5,383	5,383

Notes: The crisis dummy takes the value one as of 27.7.2007. Estimation method: FGLS correcting for heteroscedasticity across panels and panel-specific autocorrelation (AR1). Significance levels: *p<0.05, **p<0.01, *** p<0.001.

Predictive Power

In order to find out the extent to which yields on sovereign bonds were underestimated before the crisis, we use the estimated coefficients of the crisis period (regression B of Table 1) and the country-specific fixed effects of the pre-crisis period to calculate the predicted yield spreads before the crisis. This counterfactual simulation assumes that financial market participants correctly mapped fundamentals into bond yields during the crisis. However, by using the country-specific fixed effects for the pre-crisis period instead of those for the crisis period, we do not carry the negative crisis atmos-

28 S. Gerlach, A. Schulz, G. Wolff, op. cit.

29 A. Belke: Driven by the Markets? ECB Sovereign Bond Purchases and the Securities Markets Programme, in: RUHR Economic Papers, No. 194, 2010.

30 The results are tested for robustness by excluding Greece and Ireland. The influence of investors' risk aversion, credit risk and liquidity risk remains almost unchanged, in both size and significance. The coefficient of the variable measuring the ECB intervention is considerably smaller. This confirms the assumption that a large amount of the ECB interventions were used to purchase Greek and Irish bonds. In further tests, we use different proxy variables for credit risk, liquidity risk and investors' risk aversion in order to test whether the results solely depend on certain variables. The results remain almost unchanged in sign and significance.

phere over to the pre-crisis period, which is captured by the time-invariant dummies of the crisis period.

The prediction errors, which are defined as the difference between the actual values and the predicted values, are calculated for each country. For almost all EMU countries, the median is negative, which implies that the predicted spreads are higher than the actual spreads. As the country-specific fixed effects are from the pre-crisis period, the predicted spreads result only from changes in the influence of the fundamental factors included in the regression. These results indicate that if investors had priced bonds by considering the fundamental data of a country, spreads would have been higher for almost all EMU countries in the pre-crisis period. Especially highly indebted countries such as Greece, Italy and Belgium would have had higher spreads. Ireland and France are the only countries whose yield spreads were too high, which is shown by a positive prediction error. Countries such as Austria and Finland were priced adequately on average.

Approaching this from a different angle and calculating the predicted values for the crisis period using the estimated coefficients from the pre-crisis period as well as the fixed country effects from the crisis period shows that the prediction errors have nearly identical median values at around zero. However, outliers and extreme values diverge considerably from the median value. These findings clearly indicate the high variability of yield spreads. The fact that the predicted values are larger in the counterfactual simulation than actually observed again underlines the weak influence of fundamentals during the pre-crisis period. Especially for Greece, Ireland and Portugal the prediction errors are very high, with differences of up to 160 bp. This result reflects the low (or even absent) perception of risk on the part of financial market participants during the pre-crisis period, implying that fundamentals were not appropriately priced in during this period.

Political Implications

The empirical evidence shows that with the beginning of the financial crisis, investors began to reassess risk and to punish governments with large debt and deficit levels by demanding higher yields on bonds. Particularly countries such as Greece, Ireland, Portugal and Spain faced such problems. After the political decision to bail out endangered countries, the ECB started to purchase government bonds to prevent a further increase in bond yields. When the ECB gradually reduced its purchase programmes, yield spreads started to increase again, thus showing that the previous decrease was mainly driven by the ECB interventions. Market participants anticipate that risky government bonds will end up on the ECB's balance sheet, leading to a decline in the value of the common currency, which would economically harm the countries of the eurozone.[31]

This consequence clearly shows that interventions by the ECB are not a long-term solution. If large countries such as Italy and Spain face similar problems in the future, more costly interventions will be necessary to prevent the euro's failure. In addition, the governments' rescue packages and the ECB interventions lead to a serious moral hazard problem. The cases of Greece, Ireland and Portugal show that endangered countries will be bailed out by the other EU member states to prevent a bankruptcy. Hence, as long as the irresponsible fiscal policy of a eurozone member country is not punished, other member states will have no incentive to improve their public budgets by reducing expenses. As a consequence, fiscally weak countries gain in terms of yield conditions on the market and fiscally solid countries are punished as credit risk is transferred from the weak to the solid countries.[32]

One solution for the increasing divergence in yield spreads is provided by De Grauwe and Moesen.[33] They argue that the issuance of euro-denominated bonds, guaranteed by all the governments of the eurozone, would help to prevent extensive yield differentials. To deal with obvious moral hazard problems, each country would pay a weighted part of the interest rate depending on its budgetary deficits and debt level. They further argue that a common euro bond would create a huge bond market that would create liquidity premia, from which every country would benefit. However, according to the empirical findings in this study, liquidity factors do not play any role in determining yield spreads. Furthermore, it would seem to be rather difficult to issue a euro bond which is guaranteed by all EMU countries, since many countries fear the above-mentioned moral hazard problem. It remains equivocal whether the creation of a common euro bond would harm the eurozone or whether the members of EMU would gain from a euro bond market.

31 D. Gros, T. Mayer: How to deal with sovereign default in Europe: Create the European Monetary Fund now!, in: CEPS Policy Brief, No. 202, 2010.
32 A. Belke, op, cit.
33 P. De Grauwe, W. Moesen: Gains for all: A proposal for a common Eurobond, in: Financial Markets CEPS Commentary, 2009.

In order to avoid the moral hazard problem, Sinn et al.[34] believe that an effective economic governance system, capable of disciplining the European countries, should not try to circumvent the market but, rather, use its disciplinary force in a way that allows for the fine-tuning of the necessary checks to excessive public borrowing. Such a system must strike a balance between providing a limited degree of protection to investors buying government bonds as well as useful support for troubled countries on the one hand, and taking care not to turn into a full-coverage system for lenders or borrowers free of any deductibles on the other. They claim that, in order to be successful, any crisis mechanism aimed at providing effective help to endangered countries and avoiding panics without becoming full-coverage insurance against insolvency must stipulate credible rescue measures that force investors to bear part of the costs. The crisis mechanism takes effect when a sovereign debtor faces a liquidity crisis or threatens to become insolvent. A system of support would provide liquidity assistance from the community of states for only a limited period of time and in limited amounts and would then be followed by an insolvency procedure that requires a clearly defined shouldering of responsibility on the part of the creditors as a condition for further financial assistance. This, of course, entails a potential capital loss, but it is precisely this fact which leads to the proper pricing of the various risks, thereby inducing investors to choose more cautious strategies and debtors to be more reticent in taking on debt. The potential capital loss leads investors to demand higher interest premia to cover the idiosyncratic country risks. Borrowers will also be more circumspect in taking on debt, further reducing the danger of a solvency crisis. Thus, a bankruptcy is less likely to occur in the first place and, in case of a crisis, a panic-driven intensification is prevented because of the assistance from the community of states.

Gros and Mayer[35] state that the creation of a European Monetary Fund (EMF) could also solve the moral hazard problem. As market discipline can only be restored when failure is possible, an independent EMF would be able to manage a controlled default as a measure of last resort. Countries with excessive budgetary deficits and debt levels would fund the EMF, and the money could be used to support countries that need financial assistance. The ECB's balance sheet would therefore not be put at risk, and the ECB could maintain its political independence. An EMF would also allow bankruptcy procedures for EMU members, which would on the one hand decisively reduce the moral hazard problem and on the other hand ensure an incentive for fiscal discipline. The Maastricht criteria and the Stability and Growth Pact already represent the first steps toward a successful monetary union. However, regulations and laws are irrelevant if violations go unpunished. Hence, the creation of an independent institution is only reasonable when regulations and laws are enforced and violations are sanctioned.

Moreover, our results show that sovereign risk is influenced by banks' equity ratios. Thus, it seems reasonable that the equity levels of banks should be increased, as higher equity capitalisation makes a bank less vulnerable to economic downturns. A first step in this direction was already taken with the implementation of the Basel III standards, which include common equity definitions and several measures to limit credit risk. Forcing banks to capitalise more equity leads to heightened risk awareness as shareholders' liability increases. This in turn could improve a bank's risk management, leading to better risk adjustments and evaluations. The task for future policies is to ensure and control equity regulations and to sanction violations; this should make financial crises less likely in the future. The results further indicate that high forecast debt levels have a greater influence on yield spreads than expected GDP growth rates. A policy of excessive deficit spending in times of economic downturn therefore leads to increasing yield spreads. A possible increase in GDP growth rates, however, has only a negligible influence on yield spreads.

Thus, politicians and economists have to be cautious when passing stimulus packages at the expense of future generations. The positive effects of these might be small and only of short duration. Taken as a whole, the results provided by empirical analysis show that it is essential – for all EMU member countries – to reduce debt and deficit levels in the long term in order to prevent further solvency problems. The current developments in the bond markets and the empirical findings of this study demonstrate that investors became more aware of the importance of fundamental data during the financial crisis, which led to diverging yield spreads. If endangered countries do not start to improve their debt and deficit levels, the monetary union could end up as an abortive and expensive dream. Therefore, the main aim should be to stabilise the European common currency by reducing debt levels.

34 H.-W. Sinn, T. Buchen, T. Wollmershäuser: Trade Imbalances – Causes, Consequences and Policy Measures: Ifo's Statement for the Camdessus Commission, in: CESifo Forum, Vol. 12, No. 1, 2011, pp. 47-58, and H.-W. Sinn and K. Carstensen: Ein Krisenmechanismus für die Eurozone, in: ifo Schnelldienst, Special Issue, November 2010.

35 D. Gros, T. Mayer, op.cit.