Sovereign yield spreads in the euro area

In the course of the financial and economic crisis, and particularly since the beginning of the sovereign debt crisis, sovereign yield spreads have increased considerably in some parts of the euro area. As these spreads are important measures of governments' relative financing conditions, they have become the focus of public attention. In addition, they have raised questions as to why Greece, Ireland and Portugal have had their access to the capital markets restricted following the crisis, as well as about the economic policy implications.

A detailed analysis of individual countries' sovereign yield spreads over German Federal bonds (Bunds) is simplified by decomposing them into three elements demanded by risk-averse investors as compensation for not investing in secure and liquid benchmark bonds. These components are the expected loss resulting from the credit risk, the risk premium as compensation for possible unexpected losses or elevated volatility throughout the maturity of the bond, and the liquidity premium. Such a decomposition reveals that, from the investor's point of view, it is possible to trace the strong expansion of some peripheral countries' yield spreads back to an increased sovereign credit risk as it reflects unfavourable fundamentals such as the debt ratio, budget deficit, current account balance, price competitiveness and the state of the financial sector. In addition, an overall increase in risk aversion and a rise in liquidity premiums also temporarily contributed to a considerable degree to the expansion of yield spreads.

The central role of weak fundamentals in the context of some euro-area countries' sovereign debt crisis underlines the necessity for the whole euro area to apply strict budgetary discipline. It is essential for the peripheral countries, in particular, to additionally implement structural reforms to strengthen competitiveness and the growth outlook in order to meet the requirements for a sustainable level of sovereign debt and regain access to capital markets. This is of utmost importance as investors will probably continue to discriminate between the government bonds of individual euro-area countries. As a disciplining role of the market – one which has not always been sufficiently played by the market in the past – offers an incentive for sustainable long-term public finances in the euro area, regulatory or other measures which would impair the information content of yield spreads, as well as their capacity to send signals and set incentives, should be avoided.

Measurement and implications of euro-area yield spreads

Yield spreads in the spotlight

While sovereign bond spreads in euro-area countries represent the absolute financing costs of public sector debt in the market, yield spreads between bonds from different countries are not only an important measure of relative financing conditions, but also indicate the degree of integration in the euro-area sovereign bond markets. The strong widening of spreads has attracted growing public attention, especially since the escalation of the sovereign debt crisis in some euro-area peripheral countries.

Measuring yield spreads

In order for yield spreads to be measured, an appropriate benchmark value must be selected. An option would be to use the fixed rate of overnight index swaps (OIS). In the context of such an interest rate swap, fixed interest payments are exchanged for variable ones, with the variable interest rate in the euro area being equivalent to the overnight interest rate (EONIA). As the parties to the contract only exchange the interest payment differences and not the underlying nominal value, the default risk for OIS is only minor.

An alternative would be to use the yield of a fairly safe and liquid government bond. For the duration of this ten-year maturity, which was the basis of his study, German Federal bonds (Bunds) were used here, as they are known to entail virtually no risk.[1] Furthermore, the high liquidity of Bunds, which has been aided by the particularly liquid market for Euro-Bund futures, has contributed significantly to the benchmark status of Bunds.

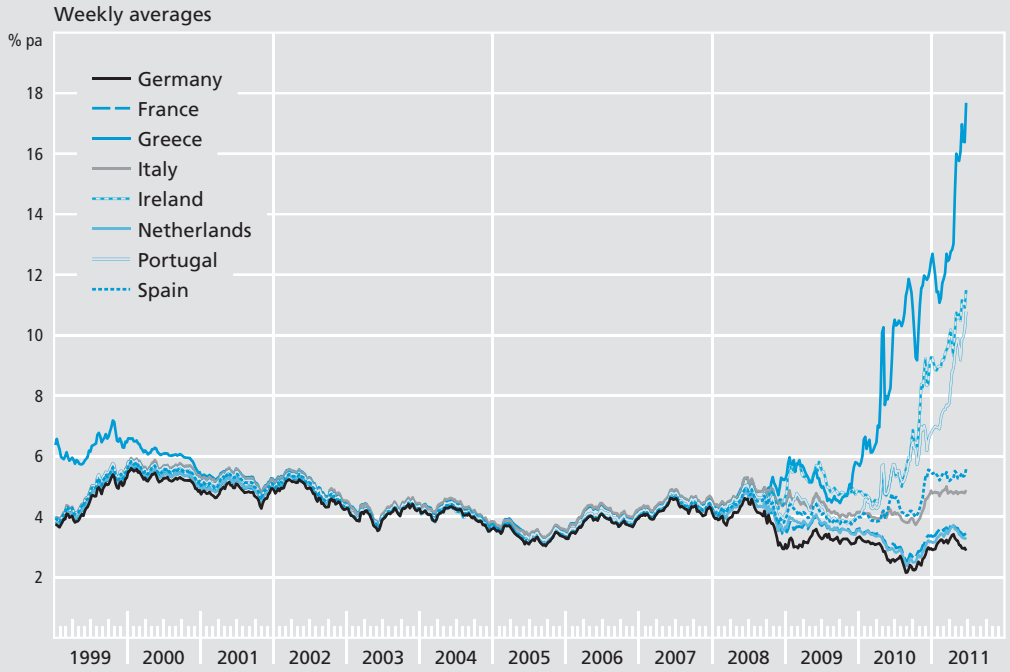
Convergence of yields before the financial crisis

Even before the introduction of the euro at the beginning of 1999, an interest rate convergence process had already begun to unfold in the markets for European government bonds. This reflected the markets' confidence that inflation expectations in the single currency area would remain at a permanently low level – provided that a single monetary policy was applied. In addition, the exchange rate risk between participating countries had been gradually declining prior to the monetary union. While average ten-year government bond yields of those 11 countries which introduced the euro in 1999 were still between 6.9% and 12.6% for all of 1995, this spread only ranged from 4.5% to 4.8% in January 1999.

The bursting of the New Economy bubble temporarily created major uncertainty among market participants and then initially caused yields to spread again slightly. However, as the markets subsequently calmed down, investors no longer discriminated a great deal between different euro-area government bonds. Since 2005, euro-area member states with a low rating recorded a moderate increase in their yield spreads, whereas the spreads of those countries with a better rating remained broadly stable at a low level. The financial crisis, which originated in the US real estate market in mid-2007, initially had virtually no negative impact on the markets for European government bonds. Smaller fluctuations notwithstanding, member states' yield spreads over Bunds remained relatively

1 P Dunne, M Moore and R Portes (2007), Benchmark status in fixed-income asset markets, Journal of Business Finance and Accounting 34, pp 1615-1634.

Ten-year government bond yields for selected euro-area countries*



* Greece joined the euro area at the beginning of 2001.

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narrow, amounting to less than 75 basis points at around end-August 2008.

Widening of yield spreads after Lehman Brothers insolvency…

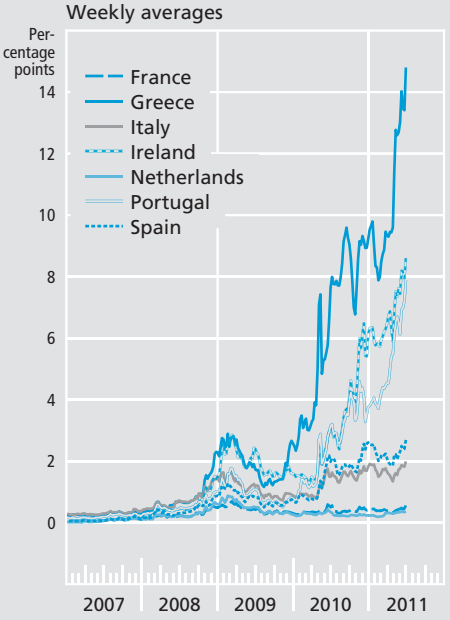
Since the collapse of Lehman Brothers in September 2008, however, euro-area sovereign spreads diverged considerably. While the prices of "safe" government bonds issued by core euro-area countries were fuelled by shifts, in some cases strong, from other forms of investment, the prices of Greek and Irish bonds came under noticeable pressure at the beginning of 2009, which caused the respective spreads to climb to just under 3 percentage points. Amongst other things, this is to be seen against the backdrop of the financial crisis increasingly representing a strain to overall economic activity and, by extension, to general government budgets. Since the beginning of 2010, the debt crisis experienced several waves of intensification. Market participants were less and less inclined to keep or purchase bonds from the peripheral countries (Greece, Ireland and Portugal), pushing the yield spreads to record highs of 15.4, 8.9 and 8.1 percentage points respectively (admittedly given low turnover) despite international rescue measures for these countries. Other euro-area government bonds, eg Spanish and Italian securities, also suffered losses in this environment. However, these were substantially lower compared to the three above-mentioned countries.

… and increase in dispersion

The prices of euro-area government bonds, which have become increasingly divergent since autumn 2008, are also reflected in simple dispersion measures. The unweighted standard deviation of euro-area yields rose

Yield spreads
in the euro area*

Weekly averages



* Spreads of ten-year government bonds over German Federal bonds.

Deutsche Bundesbank

from just under 70 basis points at the beginning of 2010 to around 470 basis points as this report went to press. The fact that most of the countries in question are relatively small economies is reflected in the respective country's GDP-weighted standard deviation. However, this standard deviation has increased, too, from 15 basis points to just over 85 basis points at last report.

Determinants of yield spreads

Grouping the factors

Yield spreads reflect numerous factors which can be systematically grouped according to different criteria. For example, determinants can be grouped according to supply and demand factors in the markets for government bonds or according to country-specific and global factors. In the course of the sovereign debt crisis, another type of distinction has suggested itself: between determinants initiated by private market participants and those which can be linked to public institutions, such as international rescue measures.

A further, analytical systematisation is based on compensation demanded by risk-averse investors for not investing in secure and liquid benchmark bonds. According to this approach, yield spreads can be divided into different components. Firstly, investors demand compensation for the expected loss resulting from the issuer's credit risk. Secondly, in return for the uncertainty of the actual losses incurred at the time of maturity possibly exceeding the expected loss, a risk premium is expected. Investors whose investment horizon falls short of the period until maturity demand an appropriate compensation for the possibility of – compared with the benchmark bond – higher fluctuations occurring during the life of the bond. Another element, the liquidity premium, provides compensation for the possibility that the investor can only acquire and sell the bond at relatively unfavourable terms. As will be discussed below, the financial and sovereign debt crisis has affected all yield spread components listed above.

Credit risk

Expected loss resulting from credit risk

The expected loss component indicates the creditworthiness of the government bond issuer. In statistical terms, this component represents the likelihood of a payment default multiplied by the rate of default, ie the percentage of the credit claim which is irretriev-

able after a default. When assessing this component of the yield, investors must take into account that the reasons for a sovereign default are different to those for a private sector insolvency. An enterprise must file for bankruptcy if it is no longer able to make its payments, at risk of defaulting or over-indebted. By contrast, a sovereign default is more complicated, as it depends a great deal more on political decisions by the government or the parliament of the country in question. Such decisions are strongly influenced by the willingness to pay, which is generally subject to various influences.[2] The same also applies to the extent of the loss actually incurred by the investors in the case of default ("loss given default"). Important fundamental determinants of creditworthiness are fiscal determinants such as the budget balance and the debt ratio, the state of the financial sector and the current account balance or price competitiveness. In practice, assessments by rating agencies also serve as a guideline for credit risk.

Fiscal variables as indicators of debt sustainability

A key determinant of credit risk and, by extension, of expected loss, is the market participants' assessment of the long-term sustainability of a country's public debt. Against the backdrop of the financial crisis-induced economic slump, the in some cases high losses in the financial sector and the costs of economic stabilisation measures, scepticism towards some euro-area countries has increased considerably. This suggests that the expected budget deficit and the debt level are exerting a positive influence on yield spreads. In fact, a relationship of this kind can be empirically proven for the euro area.[3] For instance, in the case of Greece, the considerable upward revision of the 2009 budget deficit in October 2009 and the less favourable fiscal outlook caused yield spreads to rise perceptibly, eventually leading to the request for the international aid package in April 2010.

Feedback effects from rising yields

The increase in yields of government debt securities in some peripheral countries is likely to have repercussions on the sustainability of public debt by worsening the relationship between financing costs and the outlook for growth.[4] This relationship quantifies the primary surpluses – excess of revenue over expenditure, excluding interest payments – needed to stabilise the debt ratio. Countries whose sovereign bonds have come under great pressure and whose new issues therefore became more expensive will need to generate especially high primary surpluses in the coming years in order to guarantee the sustainability of public debt and to (re)gain the trust necessary to access the capital market.

Market players focus on financial sector

In addition, the financial crisis has made it evident that public finances can be put under considerable strain by rescue measures for the financial sector, eg government stake-

2 Duffie et al (2003) point out that governments weigh the advantages against the disadvantages when making a decision about defaulting and that political factors and personal incentives can be of relevance in this context. Among the disadvantages of default are the possible loss of assets held abroad, the loss of reputation and a negative impact on access to capital markets and international trade. The advantage cited is cost savings due to avoiding the servicing of debt. See D Duffie, L H Pedersen and K J Singleton (2003), Modeling sovereign yield spreads: a case study of Russian debt, Journal of Finance 58, pp 119-159.

3 See S Gerlach, A Schulz and G Wolff, Banking and sovereign risk in the euro area, Deutsche Bundesbank Research Centre, Discussion Paper, Series 1, No 09/2010.

4 See Deutsche Bundesbank, Dynamics of debt ratios, Monthly Report, April 2010, pp 18-19.

Components of euro-area sovereign spreads

The sudden widening of euro-area sovereign bond spreads, which had previously moved in a narrow range, has been attributed to a host of causes, most of which are connected with the global financial crisis. For instance, it became clear at an early stage that the financial crisis would place a considerable strain on government budgets; to market participants, this meant that some countries' government bonds had an increased default risk. In addition, liquidity considerations played an increasing role in the financial crisis. Ultimately, the financial crisis may also have adversely affected the risk propensity of market participants, thus in turn causing an increase in risk premiums.

A recently published Deutsche Bundesbank discussion paper analyses ways of quantifying the aforementioned elements of sovereign bond spreads in the euro area.[1] By decomposing the spreads into the three specified components, it is possible to determine the probability of default expected in the market while excluding variations in the liquidity and risk premiums.

The study applies an econometric approach which was originally developed in the empirical literature on exchange-rate target zones.[2] This is possible insofar as, in terms of the model, it makes no difference to the investor whether his claims are devalued by means of a default or a depreciation in the exchange rate, depending on whether the bonds in question are denominated in local or foreign currency.[3]

In the study, the spread between a bond issued by country j and a Bund (*DE*) at time t is determined using an estimation equation which models the three specified components,

$$i_{jt} - i_{DE,t} = \alpha\pi_{jt} + \gamma\lambda_{jt} + \delta h_{jt} + \varepsilon_{jt}, \qquad (1)$$

where π denotes the probability of default, λ is a liquidity measure, h a measure of the risk of unexpected losses, ε the residual of the equation and α, γ and δ the parameters to be estimated, of which α can be interpreted as the default rate. The variable h is modelled as a modified GARCH-in-mean process, in other words as a conditional variance of the residuals ε, since an increasing conditional variance heightens the risk of an investment.[4]

Liquidity is approximated using a number of different variables. Among other options, the spread between ten-year Bunds and government-guaranteed bonds with matching maturities issued by KfW Bankengruppe has proved to be a suitable measure and is therefore used for the baseline results presented here. The government guarantee ensures that both bonds are indistinguishable from one another in terms of the credit risk involved while at the same time the liquidity of the Bunds is noticeably higher owing to the larger market volume. This widely-used liquidity measure focuses on the euro-area bond market as a whole and, as such, is not country-specific, $\lambda_{jt} = \lambda_t$, which is why country-specific parameters γ_j are estimated.

The term $\alpha\pi_{jt}$ represents the losses expected by the market due to a possible default expressed as an expected value. While the default rate α is estimated as a fixed parameter, the probability of default π_{jt} is determined conditional on a vector of exogenous variables z_{jt}. By using a probit transformation, ie the normal distribution function Φ, values of π_{jt} that lie in the interval of zero to one permitted for a probability are generated.

$$\pi_{jt} = \Phi(\beta' z_{jt}). \qquad (2)$$

The vector of the variables influencing the probability of default contains several variables. First, use is made of the spread between BBB-rated corporate bonds and euro-area government bonds. This variable, in and of itself, reflects the financing conditions for enterprises; in the estimation, however, it is used as a crisis indicator reflecting tensions in the European financial markets.[5] As with the liquidity measure described above, it is uniform for all euro-area countries, implying that country-specific parameters β_{1j} are estimated. Second, vector z_{jt} includes a variable that reflects the relative earnings outlook of the financial sector. It is constructed as the ratio of the equity index for each country's financial sector and the corresponding index value across all sectors (parameter β_2). Third, use was made of a price competitiveness indicator, the influence of which is represented by β_3. Particularly in the wake of the crisis, unfavourable price competitiveness has been associated with limited prospects for growth.[6] The literature has also expressed the notion that vulnerability to the financial crisis increased in proportion to a country's decreasing competitiveness.[7] Fourth, for the reason stated above, in some of the specifications β_4 was used to calculate the effect of an interaction between the competitiveness indicator and the financial crisis indicator on the probability of default.

1 See N Dötz and C Fischer (2010), What can EMU countries' sovereign bond spreads tell us about market perceptions of default probabilities during the recent financial crisis? Discussion Paper, Deutsche Bundesbank Research Centre, Series 1, No 11/2010. — **2** See C P Hallwood, R MacDonald and I W Marsh (2000), Realignment expectations and the US dollar, 1890-1897: Was there a 'Peso problem'?, Journal of Monetary Economics 46, pp 605–620. — **3** In the real world, however – contrary to the model described – market participants might regard the absence of any option to make an exchange rate adjustment along with the inability of countries in a monetary union to pursue an independent monetary policy in the event of a crisis as an additional negative factor. — **4** See L R Glosten, R Jagannathan and D E Runkle (1993), On the relation between the expected value and the volatility of the nominal excess return on stocks, Journal of Finance, 48, pp 1779-1801. For details on the specification of the approach in the present model, see N Dötz and C Fischer, op cit. — **5** Alternatively, use could have been made of the first factor of a principal component analysis described on p 35. However, such a factor needs to be interpreted more narrowly as an indicator of risk appetite. The spread of corporate bonds in Europe used here differs from the indicator used in the box on pp 36-37 as a global risk factor only inasmuch as the latter uses comparable US bonds. — **6** As low competitiveness impacts negatively on the ability of a country to reduce its debt, the specification of the model presented here refrains

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The equation system was estimated using daily data for the ten-year bond spreads of ten euro-area countries over comparable German Bunds, *inter alia* for the period between the rescue of the US bank Bear Stearns in mid-March 2008 and the end of April 2009.[8] The middle column of the table below shows the relevant estimates, according to which all variables affect the interest rate spread with the expected sign and are statistically significant. According to δ, for example, an increase in the estimated conditional variance h results in a growing yield spread. A similar effect is induced by an increasing liquidity premium (see γ). According to this estimate, the default rate α is relatively low, at 16%. If the above-mentioned interaction term is left out of the equation, however, this delivers a default rate of 43%.

Estimates [9]

Coeffizient	March 2008 – April 2009	July 2009 – May 2011
α	0.16* (0.01)	
β_0	1.89* (0.66)	4.82* (0.14)
β_1 [10]	25.13	2.02
β_2	– 0.81* (0.14)	– 1.44* (0.03)
β_3	14.04* (3.80)	3.95* (0.25)
β_4	– 2.74* (0.83)	
γ [10, 11]	2.04	
γ [12]		0.73* (0.13)
δ	10.04* (1.63)	2.58* (0.19)

Widening spreads over corporate bonds and increasing difficulties in the financial sector of a country, in the markets' view, lead to a growing probability of default (β_1 and β_2). According to β_3, a similar situation arises when price competitiveness declines. Finally, as the estimate for β_4 demonstrates, sensitivity to the escalation of the financial market crisis situation increases in proportion to the decline in competitiveness exhibited by the economy concerned.

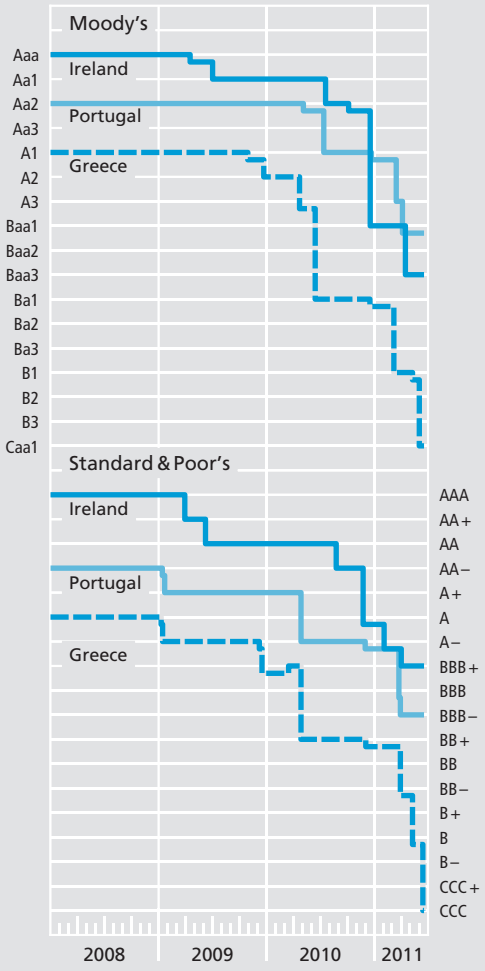
Decomposing the spreads of individual countries into the three components shows that, during the first year of the crisis, the observation period of the discussion paper, the increase in spreads over Bunds was largely attributable to an increase in the probability of default expected by the market, especially in those countries with wide interest rate spreads. That said, particularly in the Netherlands and Austria, whose yield spreads over Bunds also rose somewhat in this period, an increase in the risk premium was also of great importance. The estimates could therefore be a sign of speculative pressure in these countries. Lastly, the results suggest that liquidity factors played a comparatively important role for the price losses experienced by bonds from Finland, France and Portugal.

There are several particular aspects which make it difficult to apply the approach to current developments in the European government bond markets. One is that euro-area spreads have risen further, reaching exceptionally high levels, and in some euro-area member states the financial and economic crisis has been compounded by a debt crisis. However, in particular, it must be borne in mind that ever since the Eurosystem's Securities Markets Programme (SMP) began, spreads in the euro area have no longer reflected solely the perceptions of existing market participants and are therefore likely to have a downward bias.

If the aforementioned reservations are ignored and the approach estimated for the period between the end of July 2009 and the beginning of May 2011, this produces the coefficients listed in the right-hand column of the table. Since a liquidity measure covering the euro area as a whole, such as the initially applied KfW spread, appears unsuitable for countries suffering a debt crisis, a country-specific liquidity measure, namely bid-ask spreads, is used instead.[13] Once again, the coefficients prove significant and plausible in terms of their sign. Corporate bond spreads, however, have lately lost some of their explanatory power with regard to sovereign spreads. This is because they have narrowed in line with the favourable economic developments seen in several major euro-area countries while sovereign bond spreads have continued to widen, particularly in the case of smaller euro-area member states with debt problems. According to the estimates, the importance of risk premiums for countries such as Greece and Portugal has grown considerably since the second quarter of 2010.

from including any additional debt variables. — **7** See A Mody (2009), From Bear Stearns to Anglo Irish: how eurozone sovereign spreads related to financial sector vulnerability, IMF Working Paper WP/09/108. — **8** The countries included were: Austria, Belgium, Finland, France, Greece, Ireland, Italy, the Netherlands, Portugal and Spain. For the purpose of estimation, the data of all these countries were grouped together in a pool. To avoid potential endogeneity problems, all exogenous variables were lagged by one period in the estimation. The estimation method used was the full information maximum likelihood approach. — **9** Newey-West robust standard errors are shown in parentheses; an asterisk (*) denotes significance at the 5% level. — **10** The coefficients are estimated on a country-specific basis. Here, an average value across countries is specified, the significance of which is not stated. — **11** Variable: KfW measure for a global liquidity premium. — **12** Variable: bid-ask spread for a country-specific liquidity premium. The coefficient and standard error are multiplied by 100. — **13** As the corresponding data have only been available for all countries since the end of July 2009, this date was therefore chosen as the beginning of the estimation period. In order to guarantee a robust estimate, in this case the default rate was not estimated but instead exogenously set at 0.6% on the basis of historical experience. The interaction term is left out of the equation.

Ratings of Greece, Ireland and Portugal*



* Foreign currency long-term debt rating. A negative or positive outlook is equivalent to one-third of a notch.

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holding, guarantees or the setting up of bad banks. For this reason, the soundness and outlook of the financial sector have increasingly become the focus of investors' attention. For example, the announcement by the Governing Council of the ECB of unconventional monetary policy measures in May 2009 and the publication by the USA of the results of a bank stress test appeared to quell market participants' concerns about the banking sector, which was initially reflected in decreasing yield spreads on euro-area sovereign bonds. However, the example of Ireland shows that problems in the banking system can have direct and more extreme repercussions on public budgets. When it became apparent in the third quarter of 2010 that the fragile Irish banking sector was in need of further government support – which would have considerably strained public finances – Irish yield spreads widened drastically. This development continued in the fourth quarter of 2010 and resulted in the Irish government taking recourse to the EU/IMF rescue package in November 2010. Empirical studies also suggest a link between the situation in the banking sector and euro-area yield spreads. According to these studies, yield spreads tend to increase particularly strongly in countries with large banking sectors and relatively low capital ratios (see box on pages 36-37).

Current account balance and competitiveness

Furthermore, the financial crisis has caused the attention of market participants to fall on external imbalances in the euro area and the danger of inflows of external capital abruptly drying up. The euro-area peripheral countries in some cases used to, and still do, rely heavily on capital imports in order to finance their current account deficits. Before the outbreak of the financial crisis, given a low-interest rate environment and thus favourable financing conditions, these capital imports had increased, in some cases considerably. At the same time, price competitiveness, too, decreased in some euro-area member states, which is likely to have intensified the sensitiv-

ity of these countries to the financial crisis.[5] The influence current account deficits and low competitiveness exert on yield spreads in the euro area can also be demonstrated empirically (see, for instance, the box on pages 32-33).

Role of rating agencies

When quantifying the creditworthiness of government debt securities, many market participants take the assessment of rating agencies into account. Some institutional investors, such as pension funds or insurers, are obliged by law or their own statutes to only purchase and hold bonds with a certain minimum rating. One widely known minimum rating is "investment grade" (S&P: at least BBB-, Moody's: at least Baa3). For a country which has been downgraded, or is expecting a downgrade, to sub-investment grade, significant portfolio shifts can be assumed. Since 2007, several euro-area member states have been downgraded; Greek bonds have lost their investment-grade status.

A downgrade – or even an increased likelihood of this, as it is expressed by the term "negative outlook" in the ratings supplement – also represents an important indicator for investors which are not bound by ratings as they indicate possible tensions on the market for government bonds. For instance, when Ireland, Portugal, Greece and Spain were downgraded to varying degrees in the first quarter of 2011, it is likely that this alone increased the pressure on prices. However, ratings do not ideally reflect short-term influences, which means that they are not appropriate near-term measures of credit risk in many cases.[6]

Risk premium

Risk premium as compensation for risk-averse investors

From a risk-averse investor's point of view, the risk premium is a compensation for the uncertainty about whether, when the bond matures, unexpected losses could emerge alongside the already expected losses; or – in the case of a shorter investment horizon – a compensation for higher fluctuations compared to a benchmark bond throughout the lifetime. The size of the risk premium is therefore determined by the extent of uncertainty and risk aversion.

Principal component analysis for the measurement of risk aversion

It is often difficult to interpret individual indicators of risk appetite as they are also affected by a number of other factors that are unrelated to risk appetite. Therefore, aggregated indicators, which are made up of several individual indicators, are often used for this purpose. This can be exemplified by an analysis which includes the following individual indicators: the volatility index VDAX, the time-varying correlation between the returns on German government bonds and shares, interest rate spreads of AAA-rated corporate bonds, interest rate spreads of BBB-rated corporate bonds over Bunds, credit default risk

5 Mody (2009), for instance, underlines that the relationship between financial sector soundness and sovereign spreads was particularly pronounced in countries with a large decline in price competitiveness. See A Mody (2009), From Bear Stearns to Anglo Irish: How Eurozone Sovereign Spreads Related to Financial Sector Vulnerability, IMF Working Paper WP/09/108.

6 On the long-term strategy of credit rating agencies, see E Altman and H Rijken (2004), How rating agencies achieve rating stability, Journal of Banking and Finance 28, S. 2679-2714; on the role of ratings for the assessment of euro-area government bonds, see S Manganelli and G Wolswijk (2007), Market discipline, financial integration and fiscal rules – what drives spreads in the euro area government bond market?, ECB Working Paper No 745.

The impact of the banking sector on euro-area yield spreads

The fact that the banking sector has played a major role in the financial crisis over the past few years has raised the question as to what extent the state of a country's banking system has an impact on its sovereign bond yields. The very fact that using government funds to support the financial sector could, at least potentially, present a considerable fiscal burden for the future, which, in turn, should be reflected in a government's financing conditions suggests that such a relationship does exist.

A study which examines this relationship for euro-area countries uses the following estimation equation:[1]

$$(i_j - i_{DE})_t = \rho_j (i_j - i_{DE})_{t-1} + \gamma \tau_{jt} + \beta_{1j} z_t + \beta_{2j} \lambda_{jt} + \beta_{3j} d_{jt} + \beta_{4j} z_t d_{jt} + u_{jt}$$

where $(i_j - i_{DE})_t$ denotes the yield spread between the bonds of country j and Bunds at time t. Bonds with a maturity of around ten years are used. The yield spread $(i_j - i_{DE})_{t-1}$, which is lagged by one period, is included as an explanatory variable in order to take account of the persistence of yield spreads; the parameter ρ_j reflects autocorrelation. The variable z_t represents a global risk factor, which plays a very significant role in explaining the variance of the yield spreads. The yield spread between US corporate bonds with a BBB rating and US government bonds is used in the estimation as a proxy variable for this global risk factor.[2] In the estimation, the liquidity of bonds of country j relative to Bunds is incorporated as λ_{jt}. The bid-ask spread of a given country j's bonds serves as a measure of that country's liquidity.[3]

The variable d_{jt}, which has been left out in the initial specification A, represents alternative banking sector-specific determinants. In specification B, for example, this is the aggregate balance sheet of the banking sector from country j in relation to its GDP, and for specification C, the average equity ratio of banks. In the case of both variables, the corresponding value for Germany is subtracted in the same way as for the endogenous variable. Whereas β_3 depicts the direct impact of the banking sector on the yield spread, β_4 measures the effect of the interaction between the banking sector and the global risk factor. The disturbance term u_{jt} completes the equation.

In order to avoid potential statistical inconsistencies in the results, Swamy's panel estimation procedure was used; this procedure determines country-specific parameters which share a common probability distribution.[4] The following table provides an overview of weighted averages of the parameters calculated using the Swamy procedure.

Weighted averages [5]

Specification	A	B	C
ρ	0.94*	0.96*	0.96*
	(105.73)	(58.72)	(51.70)
γ	0.22	0.18	0.11
	(1.51)	(1.17)	(0.93)
β_1	0.01*	0.03	0.02*
	(5.60)	(1.65)	(2.37)
β_2	0.43*	0.23	0.32*
	(2.81)	(1.68)	(2.22)
β_{3B}		– 3.51*	
		(– 2.60)	
β_{4B}		0.02*	
		(2.37)	
β_{3C}			1.10*
			(2.51)
β_{4C}			– 0.75*
			(– 2.87)

Positive autocorrelation plays an important role in determining interest rate spreads (coefficient ρ). Ac-

1 See S Gerlach, A Schulz and G B Wolff (2010), Banking and sovereign risk in the euro area, Discussion Paper, Deutsche Bundesbank Research Centre, Series 1, No 09/2010. — **2** In the estimation presented on pp 32-33, a very similar variable is used. The variable used there refers to European bonds, however, as the idea is to model a specific European crisis indicator rather than a global indicator. — **3** The interest rate spreads used in the estimation refer to individual bonds for which corresponding buying and selling rates are also available. The difference between the effective maturities τ_{jt} must be included as a correction factor in the equation; the corresponding coefficient

cording to β_2, a higher bid-ask spread also significantly contributes towards increasing the yield spread over Bunds. This suggests that interest rate spreads of Bunds are also influenced by liquidity effects in the euro area. According to the estimation, however, the influence of the global risk factor is much more significant from an economic perspective: an increase in global uncertainty – measured in terms of interest rate spreads between corporate and government bonds in the USA – results in growing yield spreads between euro-area sovereign bonds.

In specification B, the size of the banking sector in relation to GDP is also taken into consideration. Its influence is significant both in economic and statistical terms. The direct effect of the size of the banking system on sovereign spreads is negative (coefficient β_{3B}). Economies with a comparatively large banking sector therefore have relatively small yields. This is plausible insofar as a large banking sector is a source of government revenue and can bolster economic growth. Furthermore, banks also generally act as investors on the sovereign bond market, which could have a negative impact on their yields.

However, the significantly positive coefficient β_{4B} shows that this only applies in times when global risks are deemed to be low. If global risks increase, the advantages of an economy with a large banking system decrease. Thus, beyond a certain threshold – in this case an interest rate spread between corporate and sovereign bonds of around 200 basis points – a larger banking sector becomes a burden as it begins to drive up sovereign yields rather than reducing them. The countries concerned are therefore more susceptible to fluctuations in the global risk factor than other countries. In the case of Ireland, the country with the largest banking sector among the various states considered (measured in terms of GDP), this factor, according to the estimation, contributed up to 80 basis points to the yield spreads observed during the period under review, which expanded to 270 at their peak.

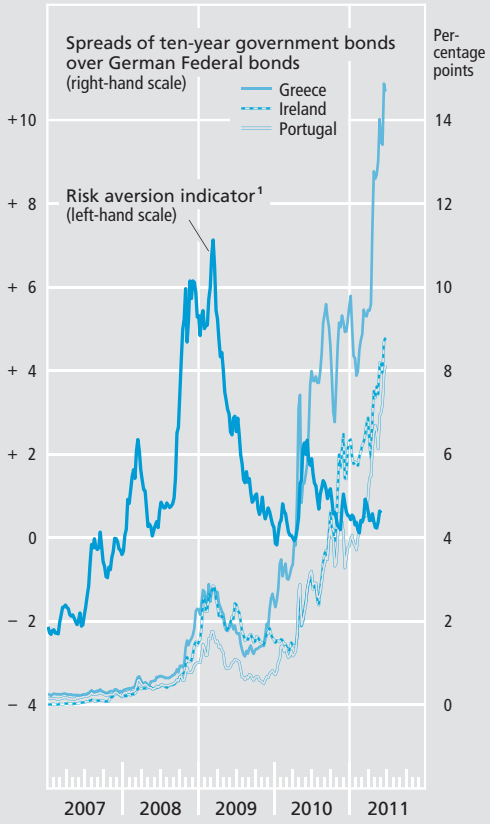
In addition to the size of its banking sector, the banking sector's resilience also has an impact on the yields of government bonds. Whereas the former of the two variables provides, above all, information about the potential costs of a possible government bail-out, the latter relates, in particular, to the likelihood of such a rescue operation taking place. Specification C shows that such considerations actually have a significant impact on euro-area yield spreads: the higher the capital ratio of the banking sector, the lower the yield spreads of the country concerned in times of economic uncertainty.

In summary, it may therefore be stated that, according to the estimations, the banking sector has a significant impact on sovereign yield spreads in the euro area. The interaction with a global risk factor plays a crucial role in this: in countries with large banking sectors and lower bank equity ratios, an increase in aggregate risk causes interest rate spreads to widen more sharply. This is because a rise in global risk makes it more likely that a country will need to draw on relatively large amounts of state aid, which, in turn, could have a negative impact on public finances.

is shown in the table as γ. — **4** See P Swamy (1971), Statistical inference in random coefficient regression models, Springer, Berlin. The countries included in the estimation are Austria, Belgium, Finland, France, Greece, Ireland, Italy, the Netherlands, Portugal and Spain. The estimation period runs from the beginning of 1999 to the end of February 2009 with a weekly data recording frequency. The results remain the same even if Greece, Ireland, or both countries are left out of the estimation. — **5** The estimated values shown for the coefficients β_{3B}, β_{4B} and β_{4C} are multiplied by 100; t-values in brackets; an asterisk (*) denotes significance at the 5% level.

Yield spreads and risk aversion

Weekly averages



1 First principal component of a principal component analysis, calculated from the following individual indicators: volatility index VDAX, time-varying correlation between returns on German sovereign bonds and shares, interest rate spreads of AAA-rated corporate bonds, interest rate spreads of BBB-rated corporate bonds, credit default swap premiums of investment grade European corporates (Itraxx Europe), credit default swap premiums of non-investment grade European corporates (Itraxx Crossover).

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premiums of investment-grade European corporates (Itraxx Europe) and non-investment grade credit default risk premiums (Itraxx Crossover). The principal components analysis method can better segregate risk aversion, which is reflected in all variables, from other specific influences than if only a single indicator were considered individually.[7]

Abrupt increase in risk aversion after Lehman Brothers insolvency, ...

The results show that the turmoil on the financial markets after Lehman Brothers went bankrupt in September 2008 was accompanied by a sudden increase in general risk aversion. The change in risk appetite caused yield spreads over Bunds to increase in some euro-area peripheral countries. However, compared with the much higher risk aversion in the financial markets overall, the increase initially remained moderate.

... but subdued after government aid to the financial sector

Amidst concerns over the stability of the financial system in autumn 2008, many euro-area member states adopted support measures for banks, which comprised both government capital assistance and guarantees. These support packages implied a transfer of risk from the financial sector to the sovereign.[8] These packages are likely to have fed the general risk aversion, which had reached a record level in April 2009 before gradually receding to a level similar to that before the Lehman Brothers collapse at the turn of the year 2009-10. By contrast, market participants shifted their focus towards the creditworthiness of some euro-area peripheral countries in particular and at the beginning of 2010 Greek, Irish and Portuguese spreads rose sharply despite a decrease in general risk aversion.

7 The estimation period starts on 2 July 2004 and runs to 3 June 2011. At just over 80%, the first principal component explains a relatively high percentage of the total variance. All the variables included are incorporated in the first principal component with the expected sign (+/-). To see how indicators of investors' risk aversion are constructed, see Deutsche Bundesbank, Monthly Report, August 2008, pp 38-39.

8 See also J Ejsing and W Lemke (2011), The Janus-headed salvation: sovereign and bank credit risk premia during 2008-2009, Economics Letters 110, pp 28-31.

This disengagement of yield spreads in the above-mentioned countries from the overall risk appetite suggests the relevance of other determinants, such as the country-specific default risk, which could have an extremely strong influence on yield spreads in times of crisis. After the support package for Greece, overall risk aversion increased again at the beginning of May 2010. In this environment the group of countries which had been classified as being more prone to "contagion" from the decrease in value of Greek bonds grew noticeably. Investors' concerns about such contagion effects, which also led to increasing liquidity premiums, reflected the close interconnectedness of the markets for euro-area government bonds. Yet the EU-IMF rescue package then considerably helped contain the risk of contagion. Similarly, there was a gradual decline in risk aversion at the same time. Risk aversion is likely to have had at least a temporary effect on the risk premiums of euro-area peripheral countries' bonds, however.

Safe haven effects

Contribution of safe haven shifts

The yield of ten-year Bunds, which had still been at 4.7% in mid-2007, decreased markedly in the wake of the financial and sovereign debt crisis; by the end of August 2010 yields had reached a historical low of just over 2%. This development can partially be explained by safe haven flows, ie investors shifting their capital away from risky investments to Bunds, which are considered safe and liquid. Especially in times of strongly increasing overall risk aversion, as was the case in autumn 2008 and in May 2010, investors' demand for Bunds was high, which caused their yields to drop.[9]

Yields of Bunds, which have climbed by around 80 basis points since September to just under 3% as this report went to press, indicate that safe haven flows have become less important although they rose again slightly in connection with the increased uncertainty about Greece's creditworthiness. Also, the strong recovery of the German economy has led to higher returns. Furthermore, it cannot be ruled out that the increase in yields is a reflection of Germany's elevated financial burden.

Liquidity premiums

Liquidity premiums…

The markets for government bonds have always had varying levels of liquidity. An entirely liquid market is characterised by market participants being able to buy and sell securities at the equilibrium price in large quantities and at all times. High liquidity manifests itself in low bid-ask spreads, little movement in prices even after large-scale transactions and possibly a swift return of prices to the equilibrium price after potential deviations from this.[10] A security's expected present and future liquidity as well as the investors' time-varying liquidity preferences are the essential factors which affect the liquidity premium demanded by investors.

9 See also Deutsche Bundesbank, Monthly Report, October 2010, pp 30-31.
10 Kyle (1985) calls these three characteristics of a liquid market tightness, depth and resiliency; see A Kyle (1985), Continuous auctions and insider trading, Econometrica, pp 1315-1335.

... higher since the financial crisis, in some cases considerably

Several indicators suggest that the liquidity premiums of some euro-area government bonds have increased, in some cases considerably, in the wake of the financial and sovereign debt crisis. While the bid-ask spreads of Bunds have had low values of around five basis points and have remained constant for the most part, the already higher spreads of, for instance, Portuguese and Irish sovereign yields have widened noticeably since 2008 (to around 85 basis points and 90 basis points respectively on average over 2010). In addition, trading of some government bonds issued by euro-area peripheral countries has weakened noticeably, especially since May 2010. On balance, existing liquidity differences have further intensified. Furthermore, the value attributed to liquid assets by investors increased considerably during the financial crisis, which has likewise had an effect on liquidity premiums.[11] An indicator for this is the yield spread of bonds issued by the Reconstruction Loan Corporation (Kreditanstalt für Wiederaufbau or KfW) over Bunds, which have identical default risk but differ in terms of liquidity.[12] During the financial crisis, this spread climbed from around ten basis points to peak at 110 basis points; even as this report went to press, this spread, at around 45 basis points, still stood above pre-crisis levels. Empirical studies show that the contribution of the liquidity premium to explaining the yields of euro-area sovereign bonds varies considerably. Even though its exact size cannot be determined, it is likely to play an important role for some countries' bonds (see box on page 33).

Assessing the determinants and further outlook

Fundamentals crucial

Econometric estimations show that – on the basis of the decomposition of yield spreads into their individual components presented here – the strong widening of spreads in some euro-area peripheral countries can be attributed to an elevated credit risk which is linked to a higher expected loss of an investment in government bonds (see box on page 33). Reasons behind this development are country-specific macroeconomic fundamentals such as the debt ratio and the budget deficit, the current account balance, price competitiveness and the soundness of the financial sector. The financial sector occupies a particularly important place in Ireland, where comprehensive public aid for financial institutions implies a massive transfer of risk to the sovereign, placing a considerable burden on its creditworthiness.

Disproportionate effect of weak fundamentals

In the wake of the financial and sovereign debt crisis, financial market participants have been increasingly sceptical of some countries' public debt sustainability. The at times abrupt and massive revaluations can also be explained by the nonlinear relationship between the credit risk and the aforementioned fundamentals. Firstly, there could be a type of threshold value with regard to fundamentals such as the debt ratio where – once surpassed – the markets are especially critical of

11 See also S Sgherri and E Zoli (2009), Euro area sovereign risk during the crisis, IMF Working Paper WP/09/222.
12 See also Deutsche Bundesbank, An indicator to measure the liquidity premium in the bond market, Monthly Report, February 2005, p 29.

any further increase.[13] Secondly, there are signs suggesting that a certain combination of weak fundamentals – eg low price competitiveness alongside an ailing financial sector, or a large banking sector in times of economic uncertainty – have their own positive impact on yield spreads.

Role of risk and liquidity preferences

In comparison with the financial crisis, during which shares and corporate bonds had come under enormous pressure due to a strong increase in risk aversion, risk appetite played a less significant role during the sovereign debt crisis. However, increased overall risk aversion also contributed to the widening of the spreads. This was particularly true in May 2010, when risk aversion temporarily attained a relatively elevated level. Depending on the country, the power of liquidity premiums to explain yield spreads varies. Overall, however, the results indicate that euro-area yield spreads are mainly based on fundamentals and cannot be attributed to exaggerated risk aversion or liquidity premiums.

Budgetary discipline and structural reforms needed

The central role of weak fundamentals for high yield spreads in the euro area since the onset of the sovereign debt crisis demonstrates the need for strict budgetary discipline throughout the euro area. Additionally, important structural reforms need to be implemented particularly in the peripheral countries in order to create long-term prerequisites for higher growth, an improved current account and consequently reduced dependency on capital imports, stronger competitiveness as well as a sound financial sector. However, it is to be expected that, even after the necessary reform measures have been taken, some euro-area sovereign spreads will remain at a higher level than in the first few years of the monetary union. The wide dispersion between individual countries is also likely to persist.

Reasons for persistently higher spreads and heterogeneity

This seems appropriate as risks connected to financial investments were often understated, causing market participants to raise their risk awareness. In addition, market participants' experience of liquidity risks occurring in a more comprehensive and abrupt manner than previously assumed, is likely to be reflected in persistently higher liquidity premiums and in greater liquidity spreads between euro-area sovereigns.

Another important factor for future yield spreads is also the development of economic fundamentals, which can only gradually be adapted in some cases. Improving competitiveness within the monetary union, for example, requires a long period of low inflation, which in turn calls for wage restraint, greater labour market flexibility and increasing labour productivity. In the short term, this could represent a burden on the economy and on tax revenue; it is, however, necessary if the forces of growth are to be strengthened in the long-term. Added to this is the fact that it is generally difficult to assess the future burdens emerging from government support measures for financial institutions.

13 See also S Barrios, P Iversen, M Lewandowska and R Setzer (2009), Determinants of intra-euro area government bond spreads during the financial crisis, Economic Paper 38, European Commission.

Relationship between yield spreads and CDS premiums

There is generally a very close arbitrage relationship between sovereign bond yields and the premium for credit default swap (CDS) contracts.[1] This is because they both express *inter alia* the risk of default of the bond issuer and the risk aversion of the market participants. Here, it is generally assumed that, all other things being equal, the higher the yield of a security, the greater the risk perceived by market participants that a debtor will be unable to meet his payment obligations. The pricing relationship between sovereign bonds and CDS markets became more relaxed during the financial crisis and even more so during the sovereign debt crisis. The following text explains how arbitrage occurs under normal market conditions and then moves on to discuss the reasons for this relationship becoming more relaxed. The relationship between CDS and bond markets turns out to be no longer quite so closely coupled, especially in the case of bonds issued by those countries at the centre of the sovereign debt crisis. This was the result not only of liquidity premiums but also the financing costs of arbitrage positions, which increase in times of crisis. The intervention of the Eurosystem in the bond market under the Securities Markets Programme (SMP) might have temporarily led to anomalies in some markets.

Both bonds and CDS contracts on these bonds generally carry the same credit risk.[2] Simple arbitrage logic therefore suggests that there is a close relationship between yield spreads and CDS premiums, as the haircut on a bond with a default risk compared with a safe security should just suffice to cover the CDS insurance premium. This is because the portfolio combination of higher-interest-bearing bonds and CDS contracts is risk-free and should therefore generate the same return as a security which is risk-free from the outset. If price movements create a substantial gap between the interest rate premium and the CDS premium, this provides traders on a perfect market with the opportunity to skim the market for risk-free profits. Such transactions tend to result in the prices of sovereign bonds and CDS constantly moving towards a state of arbitrage equilibrium in which it is not possible to make a profit without taking risks. As a rule, the CDS markets hold the price leadership position during the adjustment process.[3]

In practice, traders tend to calculate the so-called basis in order to be able to quickly identify any arbitrage opportunities that occur in the short term "at the edge of equilibrium". This is the difference between CDS and bond spreads with matching maturities, which is expressed in basis points. As a rule of thumb, the profitability of the trading position increases with the difference (positive or negative) between the two variables. In a perfect market, the basis should be completely eliminated in the long term through trading activity. In reality, however, a number of factors drive a wedge between these closely linked variables; the resulting gap therefore cannot always be plugged by trading.

The fact that traders have different methods of calculating the basis – depending on the intended purpose – plays an important role in this. For example, depending on the model used, the calculation of the interest rate spread of the bonds, in particular, can be a rather complex process.[4] However, a good first insight can be obtained if the bond spread is roughly calculated as the interest rate spread over the benchmark bond. In the context of the euro area, the basis therefore often contains the yield spread of ten-year bonds of a country over the latest issues of ten-year Bunds, as explained in the main body of this article.

The respective liquidity premiums of the bonds are an additional decisive determinant of the level of the basis. Particularly the often tense situation on the markets over the past few years has meant that the relative liquidity of the instruments has become increasingly important. Given that Bunds are the most liquid interest-bearing market instrument in the euro area, the market tensions over the crisis years have meant that the basis is tending to become increasingly negative. The high level of liquidity of Bunds, together with the declining liquidity of sovereign bonds in other euro-area countries, have consequently driven up the yield spreads. The CDS premiums did not completely follow suit.

The financing costs of trading transactions are a further factor which have a similar effect. Financial institutions generally use bank-specific financing rates as the base for their calculations. In times of crisis with high institution-specific risk premiums, banks exposed to higher credit risk have an incentive to assume the role of the protection seller by engaging in a CDS contract rather than the equivalent position (viewed from a credit risk perspective), which involves obtaining funds (at higher rates owing to the risk premiums) and purchasing risky bonds. This effect can be magnified by the fact that the quality of risky bonds used as collateral decreases in times of crisis and higher haircuts are therefore applied on the repo markets. In relative terms, the cost of a bond with a higher risk of default therefore declines owing to the lack of demand on the bond market, with the result that the bond spread increases, while the

1 A CDS contract is essentially an insurance contract in which the insurer covers the losses which occur in the event of a pre-defined "credit event" – which is defined in a standard contract – such as a default, arising. In return, the buyer of the protection pays the insurer a premium, which increases with the likelihood of a credit event occurring. See Deutsche Bundesbank, Development, information content and regulation of the market for credit default swaps, Monthly Report, December 2010, pp 43-59. — **2** The counterparty risk resulting from the CDS contract is dealt with in greater detail below. — **3** See Deutsche Bundesbank, Empirical evidence on the relative price leadership in CDS and bond markets, Monthly Report, December 2010, pp 54 – 55. — **4** Examples of well-known measures are the Z-spread, the par-asset swap spread

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CDS premium tends to decline at the same time. Both of these factors contribute towards the basis moving into negative territory.

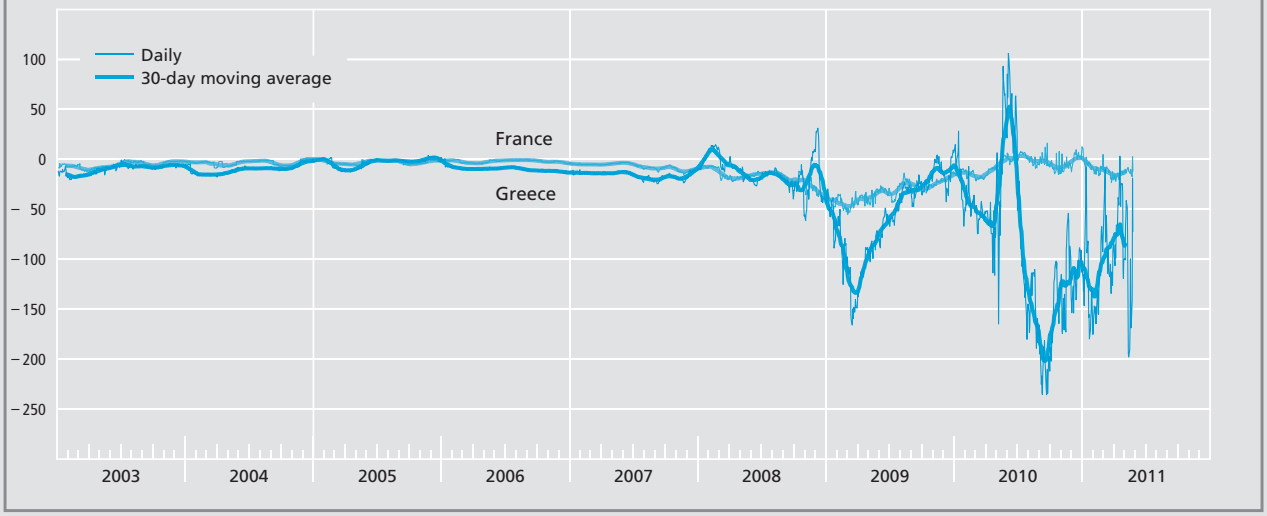
In addition to these market price factors, the level of the basis is also influenced by contract-specific variables. The basis can consequently fall below zero, for example, as the CDS protection buyer is not usually covered against the loss of coupon payments in the event of a default. The wedge increases as the coupon payment date approaches and the coupon amount to be paid increases.

However, there are also factors which tip the scales in the other direction and contribute towards the basis moving into positive territory. For example, the protection seller usually issues CDS contracts with a "cheapest to deliver" (CTD) option, which, in the case of a credit event, gives the protection buyer the right to deliver the bond which is the most favourable for him. The protection seller demands a premium for this option, which widens the CDS spread in relation to the yield spread, which is based on specific bonds. Furthermore, there are a number of other factors which have to be taken into consideration when trading using the basis.[5]

Regulatory responses to the sovereign debt crisis and Eurosystem interventions in the financial markets might also have had an impact on the basis. It was, however, evident during the crisis that in the case of Greece, for example, the difference between CDS premiums and bond yields, which is generally negative, experienced a temporary shift in signs during the course of the measures that were taken and reached an exceptionally positive level. The Eurosystem interventions under the SMP may also have played a significant role in the development of the basis, when public market participants restricted their activity to the purchasing of bonds. By doing so, the support purchases could have pushed up the price for bonds from individual ailing countries to an excessively high level (measured in terms of the market-clearing price). In this case, private agents would not have been prepared to purchase bonds at the price paid by the Eurosystem or to enter into a short sale position. Potential private sector suppliers would consequently have been faced with quantitative restrictions, thus preventing the realisation of the risk-free profits contained in the positive values of the basis.

It can therefore be concluded that, during the crisis months, the arbitrage relationship between the two markets, which is otherwise very close, tended to become more relaxed. As a result, the basis became predominantly negative and fluctuated considerably in the case of the crisis countries. This would argue against the hypothesis that CDS markets have an independent, destabilising effect on the bond markets.

Basis calculated on the base of benchmark bonds [6]



(ASW) and the par-equivalent CDS spread (PECS). The PECS is a very significant indicator as the information contained in the CDS market prices relating to maturity-specific implicit probabilities of default is used in the calculation in order to calculate CDS-implied "fair" market rates for bonds. — **5** For further details about the concept of the basis, see also A Fontana and M Scheicher (2010), An analysis of euro area sovereign CDS and their relation with government bonds, ECB Working Paper Series, No 1271. — **6** CDS spreads minus bond spreads with a residual maturity of ten years; in addition to Greece, which has been hit particularly badly by the sovereign debt crisis, France is also shown for comparison purposes; like Germany, it also has a top-notch rating.

Market discipline could make decisive contribution

Even if future yield spreads in the euro area were above (the extremely low) pre-crisis levels, it can be expected that, if adjustment is successful, those countries presently in the spotlight will experience a substantial decrease in yields compared with current levels. Regulatory or monetary and economic policy measures which constrain yield differentials and their disciplining effect on fiscal policy should be avoided; market discipline – if actually exercised by market actors – offers a decisive incentive to guarantee sustainable long-term finances in the euro area.