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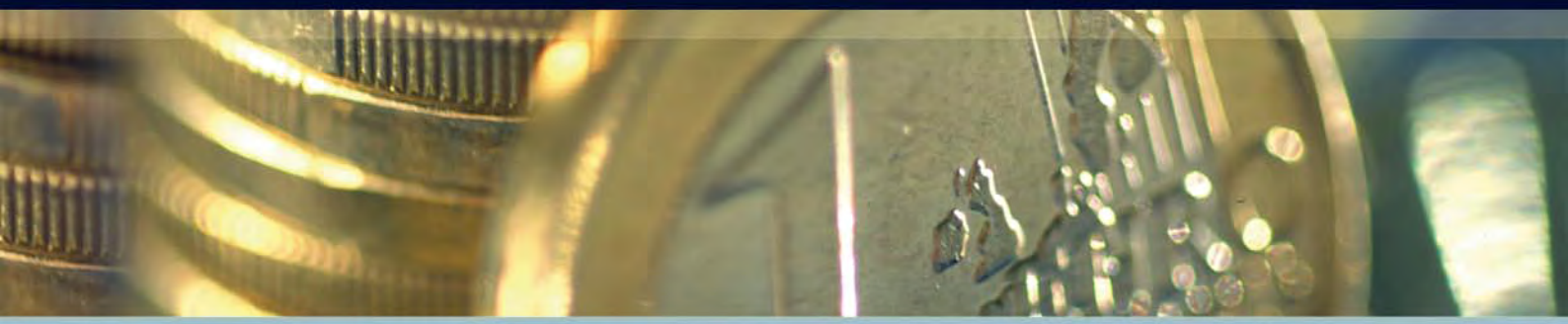

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Salvador Barrios, Per Iversen, Magdalena Lewandowska and Ralph Setzer

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Determinants of intra-euro area government bond spreads during the financial crisis[1]

by

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European Commission
Directorate General for Economic and Financial Affairs

Abstract

This paper provides an empirical analysis of the determinants of government bond yield spreads in the euro area with a focus on developments during the global financial crisis that started in 2007. In line with the previous literature, we find that international factors, in particular general risk perception, play a major role in explaining governments bond yields differentials. While domestic factors such as liquidity and sovereign risk appear to be smaller but non-negligible drivers of yield spreads our results point to significant interaction of general risk aversion and macroeconomic fundamentals. Moreover, the impact of domestic factors on bond yield spreads increase significantly during the crisis, when international investors started to discriminate more between countries. In particular, the combination of high risk aversion and large current account deficits tend to magnify the incidence of deteriorated public finances on government bond yield spreads. Overall, our results suggest that an improvement in global risk perception will lead to a narrowing of intra-euro area bond yield differentials. However, the differing impact of the crisis on Member States' public finances and the expected higher risk awareness of investors after the crisis could keep government bond yield spreads at a higher level then in the pre-crisis period.

[1] This paper has benefited from valuable comments by Servaas Deroose, Massimo Suardi, Lucio Pench, Peter Grasmann, Magnus Astberg, Jakob Ejsing, Wolfgang Lemke, Stefan Kuhnert, Sven Langedijk, Eric Ruscher, Alexander Schulz, Jan In't Veld and Guntram Wolff. The authors are particularly thankful to Carlos San Basilio (MTS group) who provided extensive comments and data on bid ask spreads. The authors also wish to thank to Zbigniew Truchlewski for assistance with the data.

1. Introduction and summary of results

The aim of this paper is to study the determinants of sovereign bond yield differentials in the euro area. Government bond spreads in the euro area have risen sharply since the beginning of the financial crisis. While 10-year yield spreads to the German Bund averaged 18 basis points in the period from 1999 to mid-2007, they averaged 56 basis points since August 2007 and 99 basis points since October 2008 (as of 30 July 2009). At the same time, differences between euro area countries have become more pronounced, as the spreads of some countries (especially Ireland and Greece) widened much more than those of other countries (such as France and the Netherlands). Although financial conditions have been easing since spring 2009, and most of the spread widening since September 2008 has been reversed, spreads remain elevated relative to the pre-crisis period.

In principle, government bond yield differentials within the euro area can be caused by three main factors: First, spreads in government bond markets are indicators of fiscal vulnerabilities and the risk of default. Second, the discrimination among sovereign bonds may reflect their relative liquidity. Third, movements in yield differentials may also be affected by changes in investors' preferences and an associated repricing of risk. In times of heightened financial and economic uncertainty, investors typically have a higher preference for less risky and more liquid assets. This then comes with a higher premium for more risky assets as portfolio composition is adjusted to the desired new equilibrium (Favero et al. 2007, ECB 2009a).

To decompose empirically the driving factors of yield differentials is challenging. For example, it is straightforward to argue that the strong rise in yield spreads in autumn 2008 stemmed from a combination of deteriorating market liquidity, increased pessimism about the sustainability of public finances and "flight-to-safety" flows. The exact disentangling of these factors is however no easy task as only the sum of the three components can be observed. Decomposing empirically credit and liquidity risk is further complicated by the fact that liquidity-related factors influence yields at high frequencies, while credit risk evaluations are based on slow-moving macroeconomic fundamentals such as public debt and current account imbalances (Codogno et al. 2003), which are only observed at lower frequencies. We deal with these difficulties by pursuing two econometric approaches: First, we use the information in credit default swaps spreads to obtain a "high frequency" measure of the size of the credit default component. This allows us to restrict our estimation period and to look for changes in the determinants of yield differentials compared to the pre-crisis period; Second, we use a longer time span and more refined macroeconomic variables observed at quarterly frequency to capture sovereign credit risk. The use of different estimation techniques, specifications and time spans increases the robustness of the results.

Our main empirical findings are as follows:

- First, international factors such as general risk perception play a crucial role in explaining euro area sovereign bond yield differentials. This suggests that an improvement in general risk perception and global growth is likely to result in a narrowing of spreads.
- Second, the role played by domestic factors is smaller, but non-negligible. A deteriorating domestic outlook for fiscal deficits, including the medium term budgetary costs of financial support operations, is associated with higher bond yields. The impact of deteriorated fiscal balance remains limited as our estimates show that, on average, a deterioration by 1 percentage point in deficit (versus Germany) imply a rise by 2.4 basis points in the government bond yield spread (versus Germany). As

regards the importance of liquidity considerations, our results are more mixed depending on the specification and time frequency of the data used.

- Third, our results point to significant interaction of general risk aversion and macroeconomic fundamentals. Domestic factors have become clearly more important in times of financial stress, when international investors started to discriminate more between countries. The combination of high risk aversion and large current account deficits tend to magnify the incidence of deteriorated public finances on government bond yield spreads. Countries with large current account deficits experience a 11 basis points increase in government bond yield spread for each additional percentage point deterioration in public deficit.[2]

Our results are supportive of recent findings in the literature stressing the importance of international factors (see Codogno et al. 2003, Longstaff et al. 2007). Other papers also find country-specific factors to play a non-trivial role. Schuknecht et al. (2008) and ECB (2009a) find an important role for credit risk both before and since the crisis. Haugh et al. (2009) argue that while the degree of general risk aversion is an important factor on its own, it has also magnified the importance of fiscal performance on yield spreads. A recent study by Sgherri and Zoli (2009) find that the sensitivity of sovereign spreads to projected debt changes has significantly increased after September 2008. In another recent study, the ECB (2008) suggests that the broad-based rescue packages in the banking sector have brought about an immediate transfer of risk from the private to the public sector. Furthermore, differences in government bond market liquidity have also been found to be significant for many euro area countries in some studies (Bernoth et al. 2006). Using data until 2004, Beber et al. (2006) find that, while credit risk matters for bond valuation in normal times, liquidity becomes more important in times of financial stress.

Our study provides novel evidence regarding the interaction between international and domestic factors. Following the approach of Codogno et al. (2003), we consider whether changes in fiscal conditions (i.e. projected deficits) have uneven effects across countries depending on the state of general risk aversion and pre-crisis macroeconomic conditions, namely the debt level and current account balance. In contrast with the aforementioned authors, we find that general risk aversion and domestic fiscal conditions interact significantly. In particular, high debt countries and, foremost, countries with large current account deficits are found to experience the highest bond yield increases as consequences of deteriorating public finances and increase in general risk aversion.

The rest of the paper proceeds as follows: First, we highlight the historical evolution of yield differentials in the euro area and discuss the determinants of yield spreads in a monetary union (Section 2). In Section 3, we provide descriptive statistics on intra-euro government bond yields and test for the relative importance of common (versus country-specific) factors of sovereign risk. Section 4 provides empirical evidence at the country-level on the importance of the various determinants of bond yield differentials based on weekly data. In Section 5, the analysis is extended by a panel estimation on quarterly data and adding further macroeconomic indicators. Section 6 concludes.

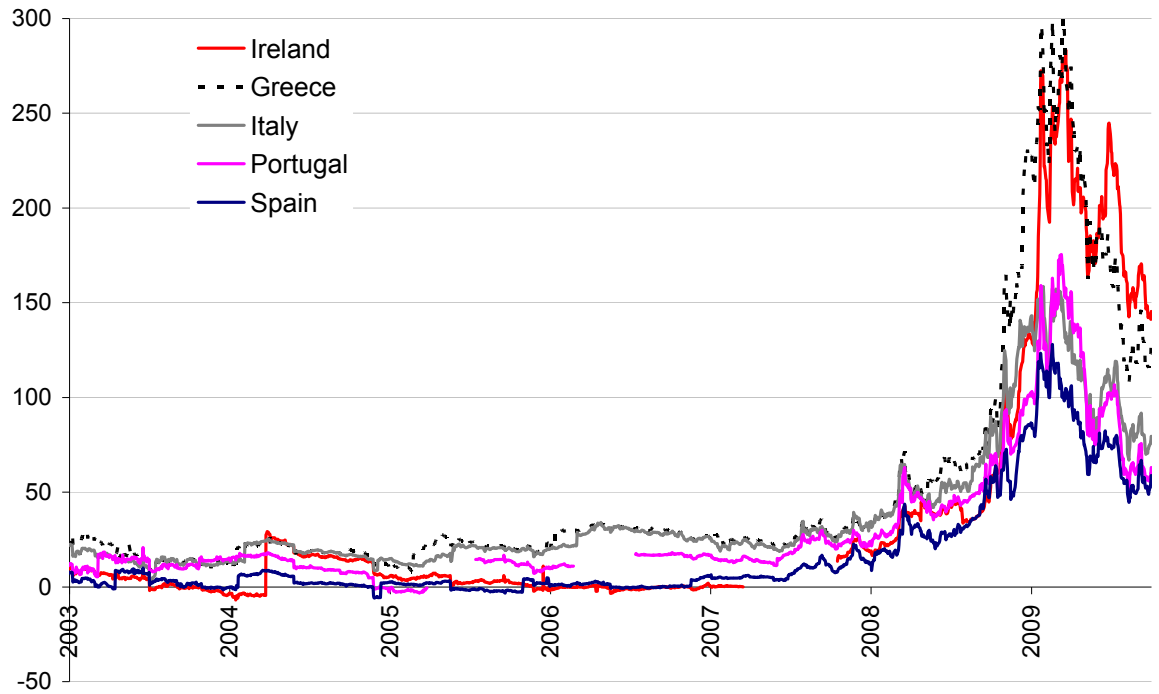
2 Countries with high current account deficit are defined as those with current account deficit higher than the euro area average by one-standard deviation.

2. Government bond yields in the euro in historical perspective

2.1 Historical perspective

Euro area yield spreads have largely converged in a process that started well ahead of the introduction of the euro in January 1999. Following some initial widening in the early-2000s (related to the bursting of the dotcom bubble and the uncertainty following the terrorist attacks on 11 September 2001), there was a phase of pronounced yield convergence until 2005. After 2005, a moderate reversal in yield differentials between the lower rated euro-area government debt issuers Greece, Italy and Portugal and Germany (the benchmark country), could be observed. At the same time, spreads for the higher-rated government debt issuers remained relatively stable at a low level. Starting in October 2007, and especially after September 2008, spreads between the German Bund and other euro-area government bonds increased substantially. Much of this widening has been reversed in recent months (see Figure 1).[3]

Figure 1: Spreads of 10-year government benchmark bonds to German Bund



3 The main focus of the analysis are 10-year sovereign bond yields of Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, the Netherlands, Portugal, and Spain. For the remaining countries, a comparative analysis is not suitable either due to the unavailability of reliable data or because these countries only joined the euro area in recent years and thus the exchange rate risk is an additional component which would have to be taken into account.

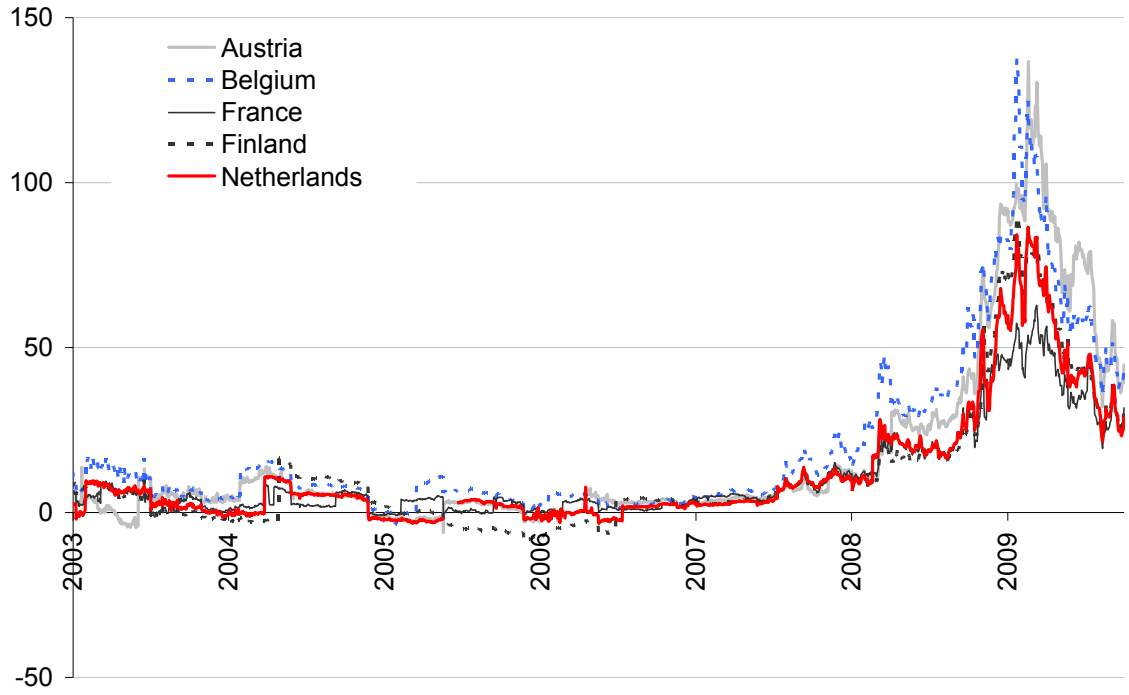
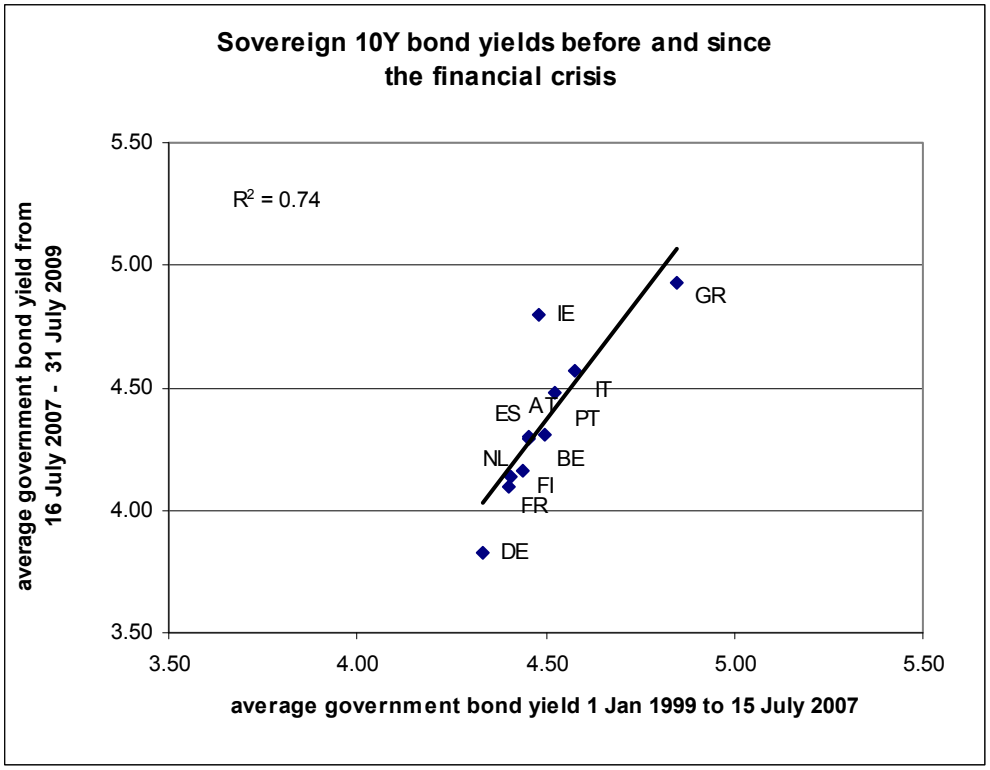


Figure 2 compares government bond yields since the beginning of the financial market turbulences in mid-2007 to historical averages in the pre-crisis period (i.e. the period from 1 January 1999 to 15 July 2007). Three points are worth mentioning: First, countries with higher spreads before the crisis have also exhibited higher relative financing costs since the crisis. Second, differences across countries have been more pronounced since the crisis. This is consistent with earlier research by Copeland and Jones (2001) who find that government bond spreads between EMU member countries widened in periods of financial crises such as the Russian crisis in 1998 or the Turkish currency crisis in 2001; Third, overall financing costs in the crisis period have nevertheless been close to the historical average for most countries as demand for safe assets classes as government bonds increased. The flight to safety, however, clearly depressed German bond yields more than those of other countries. Conversely, Ireland experienced a particularly pronounced increase in bond yields.

Figure 2: Government bond yields in historical comparison



2.2 Determinants of yield spreads

This section describes the three determinants of yield spreads in the euro area: credit risk, liquidity consideration and changes in risk aversion.

a) Credit risk

There are three types of credit risk: (i) default risk, (ii) credit spread risk and (iii) downgrade risk. The default risk is defined as the probability that the issuer fails to meet the obligations either on coupon payments or repayment of principal at maturity. Credit spread risk is the risk based on the price performance of the bond and is defined by the probability that the market value of the bond will decline more than the value of other comparable quality bonds. Downgrade risk reflects the possibility of a downgrade by the credit rating agency (Fabozzi 2007).

The financial crisis has had an impact on all these types of risks. The deterioration of fiscal positions due to the high cost of financial rescue packages, discretionary fiscal stimulus and the operation of automatic stabilisers raised questions about the sustainability of public finances. In addition to the usual indicators of government debt and deficit, high current account deficits in several euro area countries also heightened markets' perception of default as these countries were considered as particularly vulnerable to reversals in international flows of funding. Moreover, credit rating agencies downgraded the debt of several euro-area sovereign issuers. This may have had a direct impact on institutional investor portfolio allocation decisions, as many portfolio managers have limits on investments depending on the credit rating.

b) Liquidity risk

National bond markets in the euro area differ in terms of liquidity. A liquid market allows participants to value and trade positions at any time. This means that there has to be a

sufficient volume of buy and sell orders (market depth) and that large-scale transactions do not affect prices strongly (market breadth). The factors that determine liquidity include the issuing volume and the national issuing policy[4], as well as the existence of sufficiently liquid futures markets that offer investors hedging possibilities. The German bond market is the only one in Europe that has a liquid futures market, and this boosts demand for German Bunds also on the cash side compared to other euro area debt.

Liquidity risk and credit risk are interconnected. On the one hand, an increase in the supply of government bonds, as observed during 2009, should put downward pressure on liquidity premia; on the other hand, high supply is also associated with increased public deficit and debt and thus a higher credit risk premium.

c) Risk aversion

Risk aversion is associated with the willingness of investors to take risk. Investors continuously adjust their risk-return preference function. As a result, even if the "*amount of risk"* embedded in a security remains unchanged, the demanded risk premium may vary depending on the "*price of risk*".

In times of financial uncertainty, investors rebalance their portfolio toward less risky securities as their risk aversion increases. In principle, this should benefit all government bonds as they are typically regarded as less risky than other asset classes such as corporate bonds or equities. However, among euro-area sovereign issuers the German Bund is perceived to be the "safest haven" both in terms of credit quality ("default-free") and liquidity. Therefore, in times of high risk aversion, the "flight-to-safety" and "flight-to-liquidity" flows to the German government bond market are more pronounced than for other sovereign bonds.

3. Descriptive analysis

3.1 Yield spreads and credit risk

As a first illustration to the importance of credit risk for yield spreads, we compare euro area government bond yields to public debt, the budget balance and the current account balance as these factors are mainly assumed to drive the markets' beliefs about credit risk. In addition, however, during the crisis governments have taken on large contingent liabilities that, although they do not immediately impact on deficit and debt levels, are likely to affect their perceived creditworthiness.

Figure 3 and 4 suggest that higher government debt and higher fiscal deficits are associated with rising bond yields. The correlation is however in both cases relatively weak. Taken alone, a one percentage point increase in the government debt increases bond yields by around one basis point.[5]

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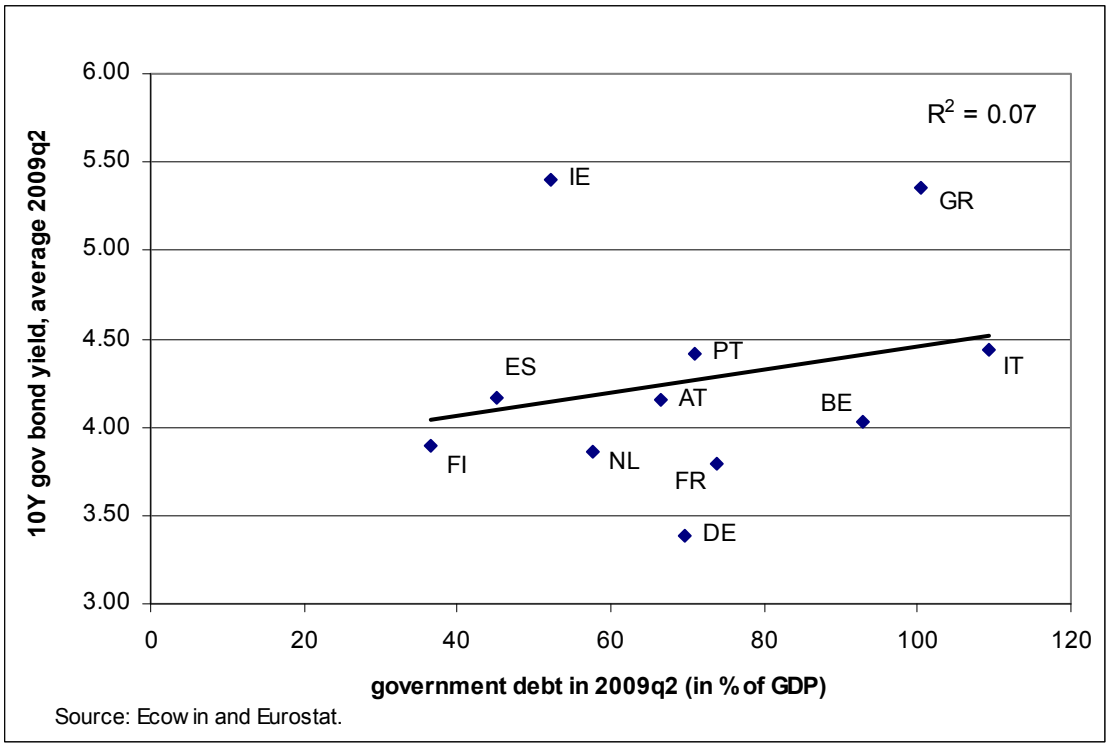
4 The euro-area government bond market remains fragmented from the issuing side with distinctive differences in the size of markets and the credit quality of bonds. Each Member State issues its own government debt, with some harmonisation in key features such as interest-rate calculation, auction calendars, trading days etc. Other features, such as coupons and maturity dates are not standardised and remain specific to national issuers and thus make euro-denominated government bonds not fungible.

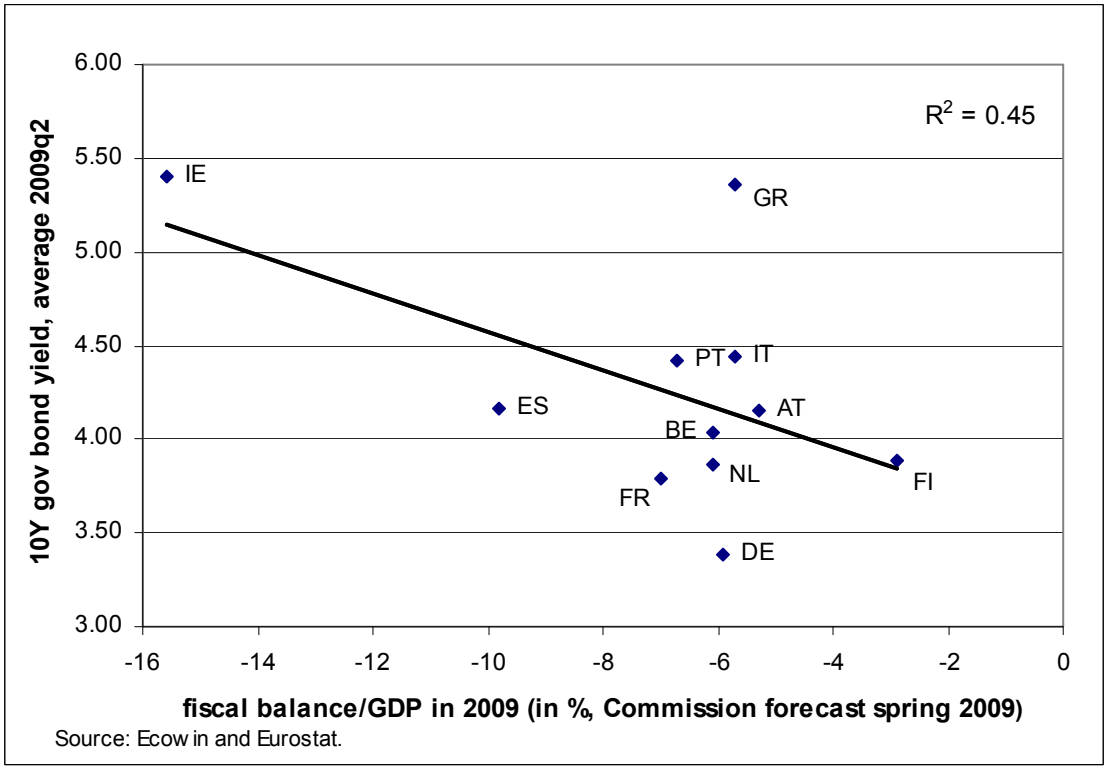
5 The correlation becomes somewhat stronger when government bond yield spreads are compared to the expected fiscal balance for 2009 and 2010.

Figure 3: 10-year sovereign bond yields and government debt



Source: Ecowin and Eurostat.

Figure 4: 10-year sovereign bond yields and expected fiscal deficit

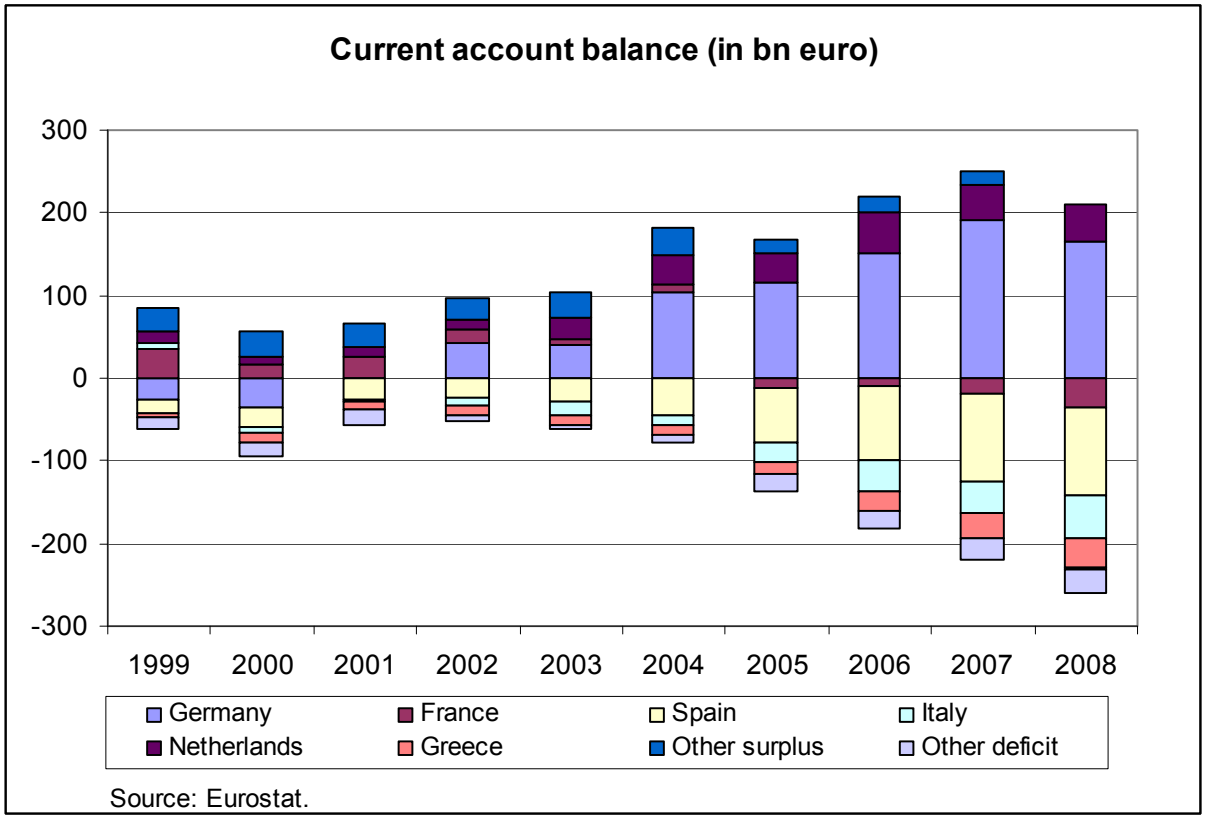


Source: Ecowin and Eurostat.

A one percentage point rise in the expected fiscal deficit for 2009 increases, ceteris paribus, government bond yields by around 10 basis points. The positive link between the two variables is however almost exclusively driven by Ireland.[6]

Credit risk may have been further influenced by the existence of large current account deficits in some euro area countries. The occurrence of the financial crisis heightened the risk for these countries to experience sudden stops in external financing and protracted period of low growth. External imbalances have grown rapidly in the pre-crisis period. Countries such as Spain, Greece, Portugal or Ireland experienced fast current account deterioration since the adoption of the euro while benefiting from exceptionally low interest rates and lenient external debt financing conditions. Other, in particular Germany, built up large current account surpluses (Figure 5).

***Figure 5**: Current account balance, euro area countries*

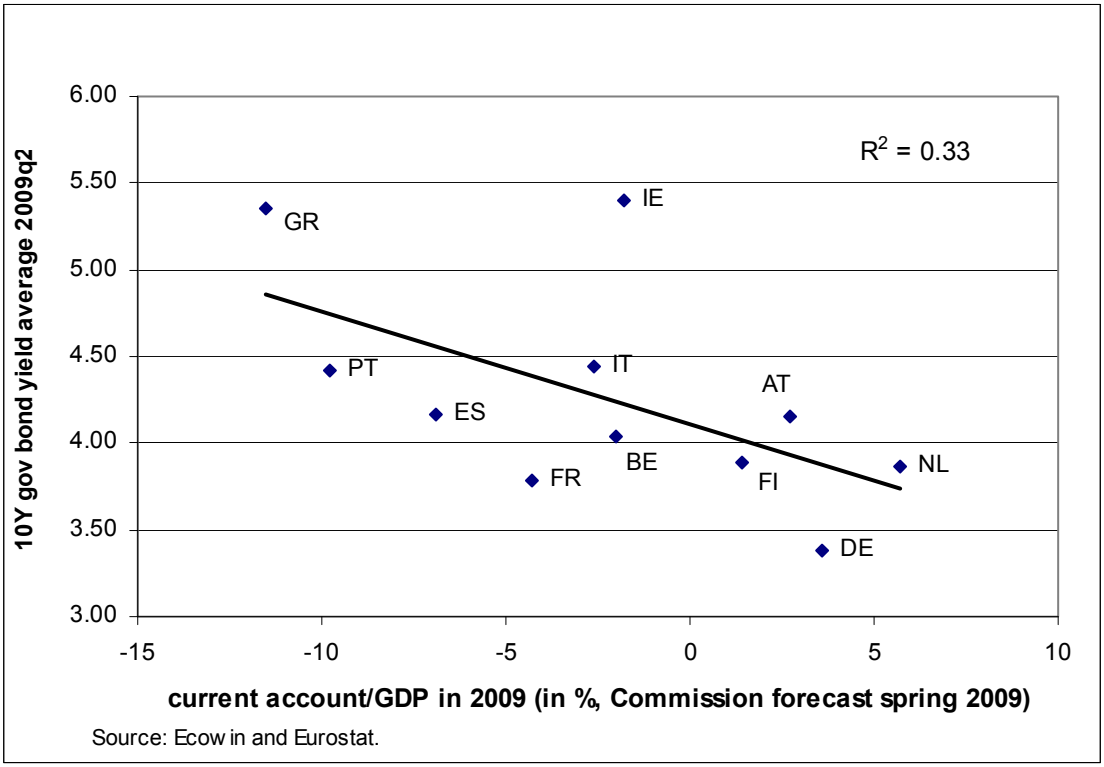


Current account deficits and surpluses mostly reflect private lending and borrowing across borders. Nevertheless, the adjustment of a current account deficit may lead to negative implications for the government budget (Deutsche Bank Research 2009, Goldman Sachs 2009). First, in the EMU countries facing large external deficits can face added difficulties to finance rising debt levels as these can no longer rely on exchange rate adjustments to restore competitiveness and promote export-led recoveries. Current account deficits have to be adjusted through a period of disinflation which, with sluggish price adjustment, implies lower growth and falling tax revenues. Second, the distinction between private and public debt becomes blurred if the government is forced to take over private debt. As the current crisis has shown, once domestic banks encounter severe difficulties, nationalising banks or guaranteeing their debt may be the only option for a government. Moreover, the government might have to

6 The figure does not change substantially when government bond yield spreads are compared to the expected accumulated fiscal balance in 2009 and 2010.

take on part of household mortgages to avoid foreclosures. Investors may take these considerations into account when analysing a country's fiscal conditions. Countries with higher current account deficits have experienced sharper increases in bond yield spreads versus Germany (Figure 6).[7] Again, Ireland is a clear outsider as yields spreads look elevated compared to the current account deficit. This may be due to its high banking sector exposure.

Figure 6: 10-year sovereign bond yields and expected current account deficit



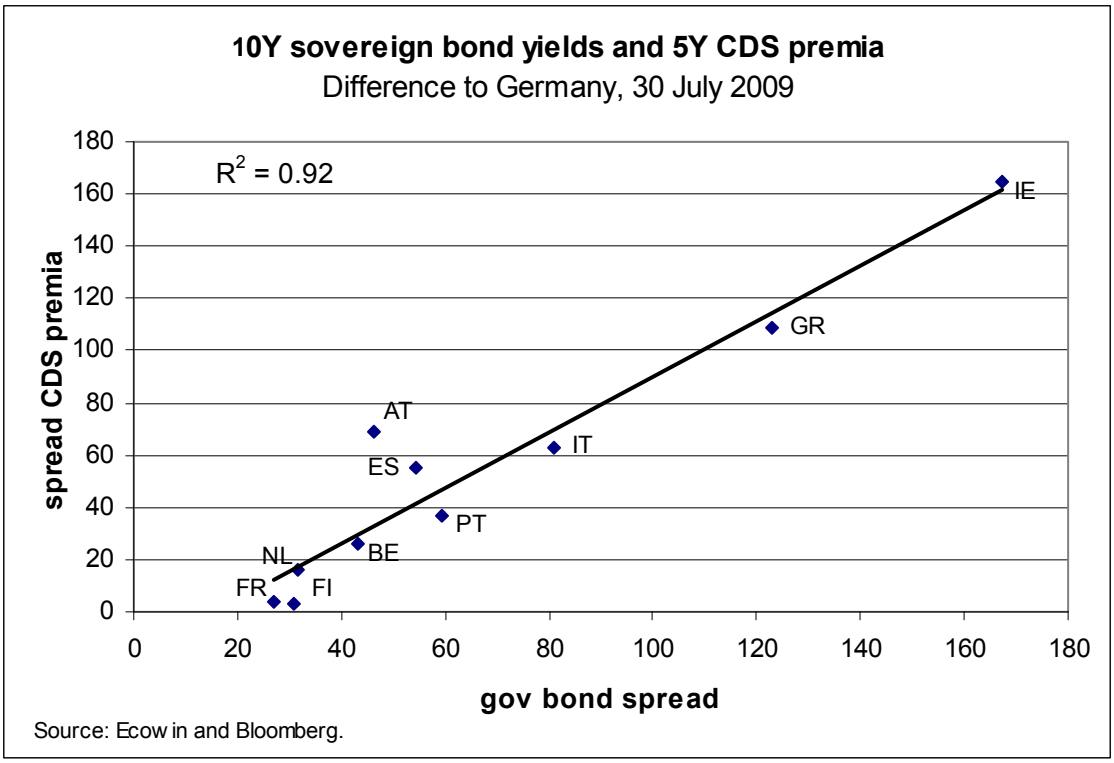
Source: Ecowin and Eurostat.

An alternative way to assess the default risk of a sovereign issuer is to look at credit default swaps (CDS). A sovereign CDS spread entails a transfer of sovereign credit risk between two parties as it provides the buyer of the contract with protection against a negative "credit event" (such as outright default, a rating downgrade, or delayed coupon payments). Figure 7 compares 10-year sovereign bond yields spreads to the German Bund with 5-year CDS premia (in relation to Germany), which is the most standard and most liquid maturity on the CDS market.[8] Not surprisingly, there is a very high correlation between government bond yield spreads and CDS spreads, and there seem to be only small arbitrage opportunities for some countries such as Austria, Finland and Spain.

7 Again, the picture does hardly change if government bond yield spreads are compared to the expected accumulated current account balance in 2009 and 2010.

8 A premium of 100 basis points on the CDS market means it costs about 100,000 euro to buy protection on 10 million euro in government debt.

Figure 7: Government bond yields and CDS premia



3.2 Euro area sovereign bond yields and risk aversion

In this section, intra-euro area sovereign bond spreads are related to a time series of general risk aversion. The analysis is carried out in two steps: First, government bond yield differentials (versus Germany) are decomposed into a common factor and a component which is specific to each country. In the second step, the common sovereign risk factor is related to a time series of general risk aversion. We use weekly data from 1 January 2005 to 30 July 2009.

To separate sovereign bond spreads into common and country-specific components, we apply principal component analysis (Stock and Watson 2002). This involves extracting a linear combination, which captures the common variation in the sovereign bond spreads of individual countries. Government bond spreads in all euro area countries are normalised by subtracting their respective sample mean and dividing by their sample standard deviation. It turns out that the "common sovereign risk factor" (i.e. the first principal component) explains 95 percent of the total variation in the correlation matrix. It can thus be interpreted as a "parallel shift" factor in euro area sovereign bond spreads vis-à-vis Germany. This finding confirms the results of the visual inspection presented above (Figure 1) which suggests a clear tendency of co-movement across sovereign yield spreads of different countries. It also confirms earlier studies which find a high cross-country correlation of spreads movements (Codogno et al. 2003, Favero et al. 2005, Manganelli and Wolswijk 2007, or Longstaff et al. 2007).

The common sovereign risk factor consists of a nearly uniform weighting of the sovereign bond spreads of all countries in our sample. However, the second principal component places significant positive weights on Ireland and Greece, a slight positive weight on Austria and negative weight on all other countries. It could thus be viewed as an additional spread on those countries that have been perceived to be especially vulnerable during the crisis (because

of the expected cost of banking sector rescues (Ireland and Austria) or unfavourable and debt dynamics under current policies).

The sovereign risk factor is then compared to an indicator of general risk aversion. The latter is the first principal component of spreads on AAA- and BBB-corporate bonds (CB_AAA, CB_BBB), a measure of stock market volatility (VSTOXX), and exchange rate volatility in the euro-yen exchange rate (XRVOLA). Corporate bond spreads reflect corporate default probabilities, the VSTOXX index is a measure of economic volatility embedded in stock price movements and the euro-yen volatility is a common indicator of risk perception in foreign exchange markets. The common factor can thus be interpreted as an "overall risk aversion measure".

Again, all four variables are normalised. Together those indicators form the vector of observable variables:

$$(1)\ x_t = \begin{pmatrix} CB\_AAA_t \\ CB\_BBB_t \\ VSTOXX_t \\ XRVOLA_t \end{pmatrix}$$

This results in the extraction of one principal component which explains 89 percent of the variance in the full data set, illustrating that our risk indicators are highly correlated. It is also interesting to note that all four risk indicators contribute to the common factor to a very similar extent as can be seen by the vector of factor loadings:

$$(2)\ F_t = \begin{pmatrix} 0.51 \\ 0.50 \\ 0.49 \\ 0.51 \end{pmatrix}$$

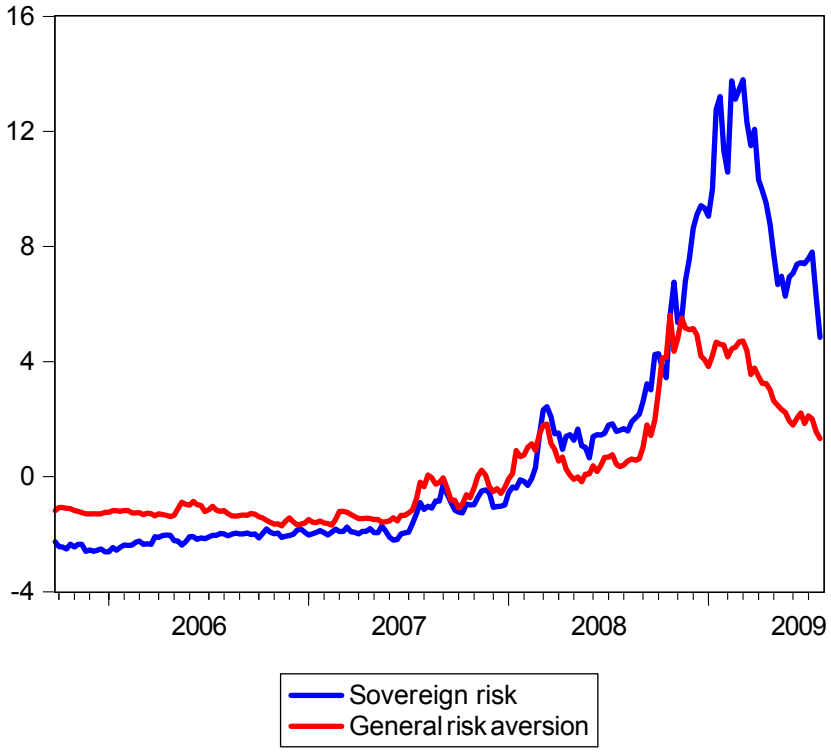
As displayed in Figure 8, general risk aversion and euro area government bond spreads closely moved in tandem for most of the time until the end of 2008q3. Thus, a generalized rise in risk aversion translated into higher sovereign bond risk premia. Since the intensification of the financial turmoil in September 2008, the joint movement between the risk aversion factor and sovereign bond spreads has deviated from the previously observed pattern. This change in behaviour might be related to the transfer of risk from the banking sector to the public sector (see also ECB 2009b for this argument). With the emergence of systemic risk in the banking sector, many governments were called on to support their banking system through direct capital injections (sometimes with state ownership) and indirect balance-sheet support in the form of guarantees.[9] As such, the announcements of the national bank rescue packages in autumn 2008 led to a downward shift in the level of the overall risk aversion factor, while contributing to a significant rise in sovereign risk. The diverging behaviour may also be due to non-linearity in the assessment and pricing of risk, with the impact of domestic fundamentals on spreads assumingly becoming higher in crisis periods (see Sections 4 and 5).

Interestingly, the gap between the sovereign risk and the risk aversion indicator has narrowed over recent months but still remains large. Thus, the risk transfer to the government sector seems to be considered as permanent. This suggests that even with a further improvement in

9 This effect has been particularly strong for Ireland that has a large financial sector compared to the size of its economy and Austria where many banks have relatively large exposure to Central and Eastern European countries.

general risk perception government bond yield spreads could remain higher than in the pre-crisis period.

Figure 8: General risk aversion and sovereign risk indicator (1 January 2005 – 30 July 2009, weekly data)



4. Evidence at the country-level from weekly data

4.1 Data and econometric methodology

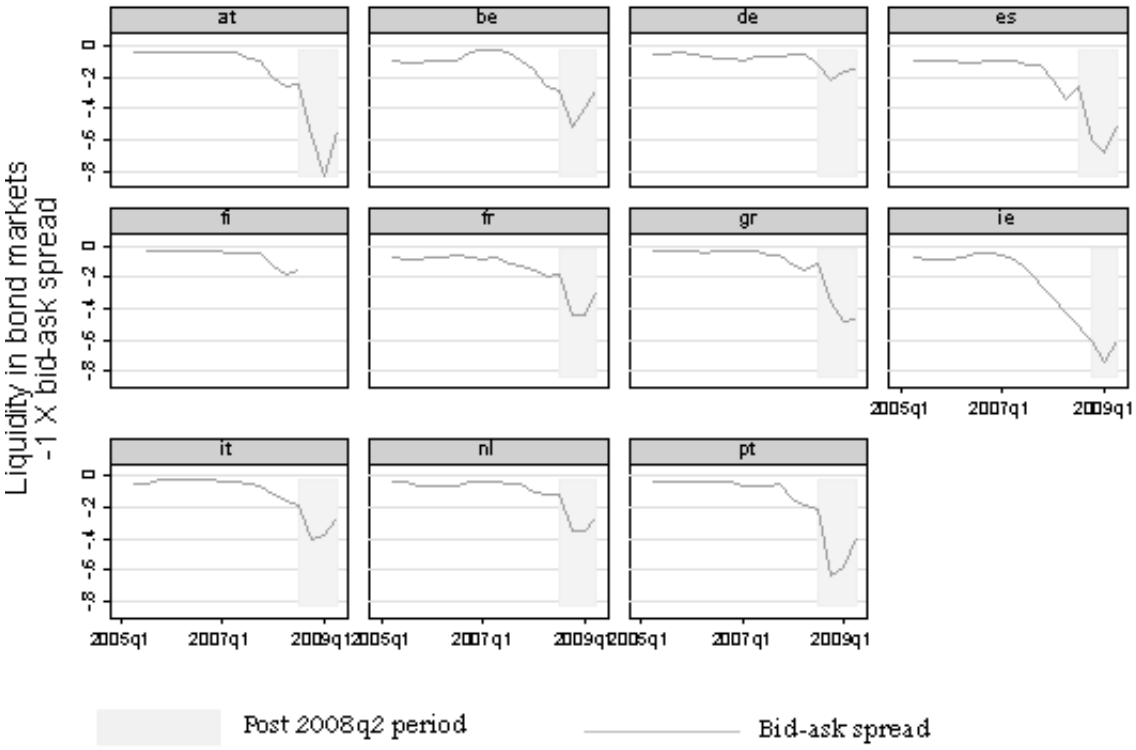
In this section we develop an econometric approach to distinguish between liquidity risk, credit risk and risk aversion in the sovereign bond market. We use weekly data from March 2003 onwards, which allows us to evaluate the effect of the financial crisis on yield differentials at high-frequency.

To measure risk aversion, we rely on our indicator of general risk aversion calculated in the previous section. As regards credit risk, we use 5-year CDS spreads relative to Germany. Although this indicator may be an imperfect proxy for credit risk as CDS spreads are also affected by other factors (such as liquidity), it is seen as the best measure of credit risk available at high frequency (see for example, Longstaff et al. (2005), Blanco, Brennan and Marsh (2005) or ECB (2009)). Alternative measures such as fiscal deficits forecast are only available at monthly or quarterly frequency.

To assess liquidity risk, we follow the literature and use bid-ask spreads (see, e.g. BIS 1999, Brandner et al. 2007, De Nicolo and Ivaschenko 2008). The theoretical justification for this procedure is that the size of the bid-ask spread is influenced by the depth of the market. A deep market is generally considered to have low bid-ask spreads. Bid-ask spreads are better indicators for gauging liquidity conditions in bond markets than traded volumes (as used e.g.

by IMF (2009)) since data on volume can be affected by multiple trading operations between bank's affiliates to meet balance sheet requirements. Thus, big variations in volumes might have little bearing on actual liquidity.[10] We use quoted bid-ask spreads (in relation to Germany) based on electronic-trading data from the MTS Group's European Benchmark Market trading platform (see http://www.euromts-ltd.com), the principal e-trading platform for secondary market trading of European government bonds.[11] Figure 9 illustrates the evolution of liquidity conditions in government bond markets based on our bid-ask measure. It shows a generalised worsening in liquidity from the third quarter of 2007 onwards, with a further pronounced deterioration in the post-Lehman period (i.e. post-September 2008), followed by some improvement during the second quarter of 2009. The worsening was particularly pronounced for Austria, Belgium, Portugal, Spain and Ireland.

Figure 9: Liquidity conditions in 10-year government bond markets



The following seven countries are included in the analysis: Austria, Belgium, Spain, France, Greece, Italy, and Portugal (with Germany as a benchmark). For the remaining countries, sufficiently long enough time series on CDS spreads are not available. All variables are expressed in relation to Germany. To avoid spurious regressions, the basic model is estimated in first differences and set as follows:[12]

$$(3)\ \Delta sov\_spread_t = \alpha + \beta \Delta CDS_t + \gamma \Delta b\_a_t + \eta \Delta risk\_av_t + \lambda crisis_t + u_t,$$

10 We thank Carlos San Basilio (MTS group) for a useful discussion on that point.

11 According to Persaud (2006), MTS maintains a market share of 72% of the electronic European cash government bonds trading. Cheung et al. (2005) report that bid-ask spreads, quoted on EuroMTS and the national platforms do not differ much for most bonds. Quoted spreads on national platforms may, however, include periods where there is little trading and thus may give an inaccurate indication of actually incurred trading costs.

12 In principle, given that all our variables are deviations to Germany, they can be assumed as stationary.

where the dependent variable is the change (Δ) in the 10-year sovereign bond yield spread to the German Bund from week *t-1* to week *t*; ΔCDS is the change in the 5-year sovereign CDS spreads[13], Δb_a is the change in the bid-ask spread, $\Delta risk\_av$ is the change in the general risk aversion indicator, and *crisis* is a variable denoted one in the period from mid-September 2008 until early March 2009 and zero otherwise. It is intended to capture those effects of the financial crisis on sovereign bond spreads which are not captured by our credit risk, liquidity and risk aversion indicators. As noted in the previous section, an extraordinary increase in sovereign spreads in the crisis period could be due to non-linear effects and to the risk transfer from the private sector to the public sector in the aftermath of the announcement of the bank rescue packages and guarantee schemes. Also, differences in size of the financial sector in each country, where a relatively large financial sector is expected to enhance the negative effects from the financial crisis, could have played a role.

Estimation is conducted via OLS separately for each country with robust standard errors adjusted for clustering. In our benchmark specification we use the full data set available from March 2003 to April 2009 (though for some countries the estimation starts somewhat later due to data availability). While in principle daily data could be used, we measure all changes over a weekly horizon in order to reduce noise. The 5-year CDS spreads are based on instrumental variables to avoid endogeneity.[14]

4.2 Econometric results

The results for the seven countries in our sample are presented in Table 1. In terms of the R-squared, the model explains between 0.11 and 0.42 of the variance of the dependent variable, which is satisfactory given that the regressions are in differences and at high frequency. Nearly all the variables have the expected sign (among them all significant variables). The Durbin-Watson tests show no serial correlation. However, further residual diagnostic tests revealed signs of serial correlation and heteroskedasticity in the error terms in periods of high volatility from August 2007 onwards. We therefore base our significance tests on autocorrelation and heteroskedasticity consistent standard errors and t-statistics.

Looking at the country-specific results, CDS spreads (our credit risk indicators) are significant for Austria, Spain, Greece, Italy and Portugal, but not for Belgium and France. To get an idea about the economic implications of the results, the coefficient of 0.53 for Greece means, e.g., that an increase of 1 basis point in the CDS spread (i.e. a relative rise in the "insurance costs" of 1,000 euro per 10 million euro of government debt compared to Germany) leads to an increase of 0.53 basis points in the 10-year government bond yield spread. The credit risk effect is strongest in countries such as Portugal, Greece and Spain with large current account deficits in the pre-crisis period and large increases in public debt during the crisis.

Liquidity seems to have played a role in explaining the evolution of yield spreads in France, Greece and Italy. In Italy, the coefficient is 55, meaning that an increase of 1 percentage point in the bid-ask spread leads to an increase of 55 basis points in the yield spread. The large explanatory power of the bid-ask spread in Greece is in line with the fact that the Greek sovereign bond market has been sharply negatively affected by the crisis. In spite of a strong deterioration in liquidity conditions in the Austrian and Portuguese government bond markets in the crisis period, the bid-ask spread is not significant for these two countries.

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13 The use of the 5-year CDS premia results in a maturity mismatch to the government bond market, where we use 10-year maturities; however, the higher liquidity should more than outweigh the differences in risk premia due to different maturities.

14 Based on the method of Generalised Instrumental Variables Estimator, four lags of the CDS spread together with the remaining regressors in equation (3) were used as instruments.

Table 1: Determinants of sovereign bond yield spreads in the euro area: evidence from weekly data (March 2003 – April 2009)

	AUT	BEL	ESP	FRA	GRE	ITA	PRT
Constant	0.049	-0.033	-0.027	-0.005	0.057	0.030	0.000
D(CDS)	0.12*	0.012	0.36**	0.068	0.53**	0.25*	0.52**
D(b_a)	6.03	5.53	5.81	9.04**	32.53**	55.11**	14.27
D(risk_av)	1.51	4.13**	2.39	2.21**	0.69	3.79**	3.96**
crisis	2.07**	2.18*	2.20	1.16*	4.24**	1.87	3.28*
R^2	0.17	0.11	0.23	0.12	0.42	0.29	0.20
DW	2.0	1.9	1.8	2.1	2.1	2.4	1.8
Observations	297	317	259	313	317	317	313

*Note: *, ** means significance at the 0.1, 0.05 percent level.*

The risk aversion component is significant for Belgium, France, Italy and Portugal. Apparently, the general degree of risk aversion has played an important role in driving yield spreads up, thus confirming the results of the previous section. There is also evidence that some high-debt countries such as Belgium, Portugal and Italy are affected more strongly by the risk aversion indicator.

The results also reveal a significant break in the relationship due to the financial crisis. The crisis-effect variable is significant for all countries but Spain and Italy, indicating that factors additional to those included in the model have had an impact on bond spreads during the crisis. Alternatively, investors' risk assessment could have changed after 2008, leading to a change in the coefficient. Credit rating downgrades may have played a role for Greece and Portugal as the coefficient is particularly high and significant for these countries.[15]

The finding of a structural break is also confirmed by further analyses in

Table 2 and Table 3 which split the sample in two periods: before (March 2003-July 2007) and during (August 2007-April 2009) the financial crisis.[16] Interestingly, before the crisis, country-specific factors appear to have hardly played an important role. In some cases, our proxies for credit and liquidity risk even have the wrong sign. Sovereign bond yields spreads were largely driven by the degree of general risk aversion during that period. Since August 2007, however, investors strongly differentiated between countries and took macroeconomic fundamentals and liquidity considerations into greater account. The coefficients have in all cases the expected sign and are often significant. As such, the results confirm the basic picture from the full-sample regression, with changes in credit risk and liquidity risk having played significant roles for yield spreads. At the same time, general risk aversion remained an important determinant of yield spreads.

15 We also tried to relate the extent of the crisis effect to a country's contingent liabilities and external liabilities (both of the total economy and the banking sector). However, no clear conclusions could be drawn from such a comparison.

16 This analysis allows for a more broad-based structural break than the break captured by the crisis-effect variable in the full-sample regression, as the crisis period is now assumed to start in August 2007 (as opposed to September 2008 for the crisis-effect variable) and as the coefficients on all variables are allowed to change. The crisis-effect variable is not included in the sub-sample regressions.

Table 2: Determinants of sovereign bonds yields spreads in the euro area: weekly data (March 2003 – July 2007)

	AUT	BEL	ESP	FRA	GRE	ITA	PRT
Constant	0.04	0.02	0.02	0.02	0.07	0.08	0.1
D(CDS)	0.28	-3.1	0.065	-0.33	-0.009	-0.16	-0.48
D(b_a)	8.33	9.41*	-2.93	1.20	-7.80	5.34	12.68
D(risk_av)	0.38	2.81**	1.39*	2.54**	3.44**	3.90**	3.49**
R^2	0.01	0.10	0.02	0.06	0.09	0.11	0.04
DW	1.9	1.7	1.9	1.9	2.0	1.9	1.8
Observations	213	226	168	222	226	226	222

Table 3: Determinants of sovereign bonds yields spreads in the euro area: weekly data (August 2007 – April 2009)

	AUT	BEL	ESP	FRA	GRE	ITA	PRT
Constant	0.04	-0.26	-0.15	-0.07	-0.01	-0.20	-0.38
D(CDS)	0.12*	0.01	0.36*	0.07	0.53**	0.23	0.53**
D(b_a)	5.74	4.68	6.04	10.94*	37.00**	84.26**	13.42
D(risk_av)	1.71	5.49*	2.65	2.10*	0.10	3.18*	4.41*
crisis	2.06*	2.34	2.28	1.24	4.31*	2.01	3.60*
R^2	0.18	0.11	0.23	0.13	0.43	0.35	0.22
DW	2.0	1.9	1.8	2.2	2.1	2.5	1.8
Observations	84	91	91	91	91	91	91

In addition to the results reported above, several robustness checks have been performed. First, we replaced the CDS spreads with the projected fiscal deficits for the current and next year as a measure of credit risk. In doing so, we avoided the drawbacks of the CDS-spread as a measure of credit risk. Data for the fiscal variable came from the Economist Intelligence Unit and were converted from monthly to weekly frequency by interpolation. Overall, our results were not affected by this substitution. The fiscal variable was however hardly significant which may be due to the low frequency of the raw data or due to the importance of other variables with a longer-term impact on fiscal sustainability such as current account imbalances. Second, country-specific intercept dummies for the period following the announcement of the national bank rescue packages were included but were generally not significant. Finally, interaction terms of the risk aversion indicator with the bid-ask spreads and the CDS spreads were added to the regressions to see if the importance of the domestic fundamentals increased when the overall risk aversion increased. The interaction terms were significant in several cases providing some evidence for the view that the impact of domestic variables on yield spreads depends on the general level of risks aversion. This issue will be analyzed in more detail in the next section.

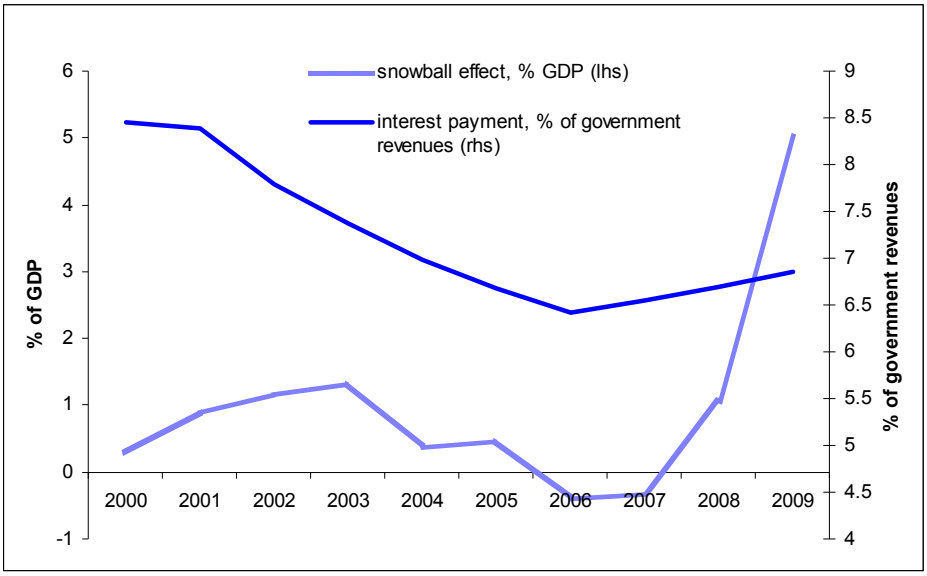
5. The role of public debt and macroeconomic imbalances: evidence from quarterly data

5.1 Econometric evidence from quarterly data

While the use of weekly data in the previous section was best suited to measure how liquidity-related variables have affected bond yields, this approach came at the cost of not fully appropriately capturing the effect of risk-related macroeconomic variables which are only observed at low frequency. In order to have a closer look at the importance of these variables for yield spreads we extend our analysis by estimating the determinants of yield spreads at quarterly frequency. This procedure allows us to have a closer look at fiscal variables such as fiscal deficit, public debt and the weight of interest payments on public debt. Moreover, we analyze the role of current account imbalances in exacerbating risk premia on sovereign bond yields. As argued in section 3, the distinction between private and public debt becomes blurred if the government may be expected to take over private debt.

Financing conditions for euro area governments started to deteriorate already before the global economic downturn (see Figure 10). This is evidenced by the rising ratio of interest payment on government debt to total government revenues—an indicator reflecting borrower quality (see Bernoth et al. 2004). In addition, the snowball effect, which provides an indication of the risk of incurring into ever increasing debt burden due to high interest rates payment and/or low GDP growth rates, also clearly signals the worsening of euro area governments' financing conditions since 2007.

Figure 10: Interest payment on public debt and snowball effect in the euro area, 2000-2009



Source: Commission services

Note: Snowball effect = $\frac{D_{t-1}}{Y_{t-1}} * \frac{i_t - y_t}{1 + y_t}$, where D is the stock of government debt, y is the level of GDP, both measured in year t-1, i represents the average interest payment on debt and y is the nominal GDP growth rate.

To capture the role of domestic macroeconomic fundamentals, we estimate the following equation:

$$(4)\ sov\_spread_{it} = c + \lambda_1 fiscal\_conditions_{it} + \lambda_2\ current\_account_{it} + \lambda_3 x_{it} + u_{it},$$

where the dependent variable is the 10-year government bond spread versus Germany, and the set of explanatory variables includes fiscal conditions (i.e. fiscal balance and the debt level) and the current account balance (all as a percentage of GDP). Data on budget balances are provided by the Economist Intelligence Unit. We use the fiscal balance forecast for the current year *t* as indicator of countries' fiscal position. In addition, we include the bid-ask spread and the general risk aversion indicator represented by the vector *x*. Risk aversion is represented by the summary variable obtained using principal components (see Section 3).[17] The country-specific variables are expressed relative to Germany. In view of the low number of observations available, panel regressions rather than country-level regressions are pursued.[18] The error term u_{it} thus comprises a random term ε_t and a component ω_i which captures (unobservable) time-invariant country *i*-specific effects.

Table 4 reports the results of estimating equation (4). The findings indicate that the deterioration in the fiscal position significantly increases the bond yield spread. The quantitative effect of deteriorated fiscal balance remains relatively modest, however, as the coefficient estimate shows that a one percentage point increase in the deficit implies, on average, an increase of 2.4 basis points in the spread versus Germany. Such estimate is somewhat similar in magnitude to those of Bernoth et al. (2004) and Schuknecht et al. (2008) for EMU countries, who report coefficient estimates of 3.4 and 3.8 basis points respectively.[19] As regards the remaining variables, the results show that the bid-ask spread and the risk aversion variable exert a positive and significant influence on government bond interest spreads. The result concerning the influence of liquidity conditions (i.e. the bid ask spread) thus seem more robust in contrast to results reported in Section 4. Column (2) extends the empirical specification by considering the role played by the current account balance and shows that a deterioration by one percentage point in the current account balance leads to a rise by 1.3 basis points in the yield of a given country with respect to Germany. This result suggests that current account evolutions might also influence significantly government bonds yields in the medium term.

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17 Using the deficit forecast for year t+2 provided very similar results.

18 Although the time series by country are too short to run simple OLS by country, panel regressions also suffer from the fact that the set of countries considered (i.e. 11 euro area countries) is short compared to the length of the time series (t=26) which entails estimation issues preventing the use of simple least square dummy variable estimators in order to control for country-fixed-effect. There are two alternative ways to correct for serial correlation in the dependent variable: the first one is to use lagged dependent variable; the second one is to transform the variables to get rid of the serial correlation. The first solution would call for using a dynamic panel data model (DPD) as the one described by Arellano and Bond (1991). One important reason not to use a GMM estimator is that we avail of a short panel of countries observed over a relatively long time period as noted above. If the time span considered is relatively large compared to the number of countries available, dynamic panel bias becomes insignificant. Furthermore, the number of instruments in system-GMM tends to explode with *T* and the Arellano-Bond autocorrelation test may become unreliable. The second solution proposed by Beck and Katz (1995) is to use a panel corrected standard errors (PCSE) or Prais-Winsten model with panel-corrected standard errors, which is proposed as an alternative time series/cross section model where the disturbances are assumed to be correlated across both panels and time. With this model at hand, one can specifically correct for (and measure the degree of) serial correlation. The advantage of the PCSE model is that one can assume the disturbances to be autocorrelated both within and across individuals (i.e. countries) assuming an AR(1) process. In the following, therefore we will make use of the PCSE model to estimate equations (4).

19 Bernoth et al. (2004) results concern the period 1991-2002 while Schuknecht et al. (2008) consider the period 1992-2003.

Columns (3) and (4) further extend the model to consider the role played by fiscal conditions in more details while controlling for the current account balance. Column (3) shows that an increase in interest payment (as a ratio of government revenues) acts to increase government bond yields spreads versus Germany. This suggests that financial markets tend to penalise countries with shrinking capacity to finance the interest burden of public debt, although the magnitude of this effect appears relatively limited given that the coefficient estimate indicates that an increase in interest payment on public debt as percentage of government total revenue by 1 percentage point increases interest rate spread versus Germany by only 0.7 basis points.

Column (4) replaces the fiscal balance with the public debt. The influence of public debt on government bond yield spreads must be gauged with caution, however, given that a high debt level might also coincide with relatively liquid bond markets. The relationship between the debt level and government bond yields could in fact be non-linear, i.e., countries with historically high debt levels might benefit from liquid bond markets but might be penalised by financial markets if debt rises above a given threshold. In order to investigate this possibility, Column (4) includes, together with the initial debt position (i.e. the public debt level at *t-1*), the square value of this variable. The deficit variable was omitted in order to avoid collinearity. Results show that the non-linear relationship does hold as both the initial debt level and its square term display positive and significant coefficients. In addition, the square term of the debt level variable displays a much larger coefficient than the debt level suggesting that acceleration in the public indebtedness exerts a further significant upward pressure on government bond yields. This should provide an additional incentive for countries with a high pre-crisis debt level to keep rising deficits at bay.

Table 4: Determinants of sovereign bonds yields spreads in the euro area: evidence from quarterly data (2003q1-2009q2)

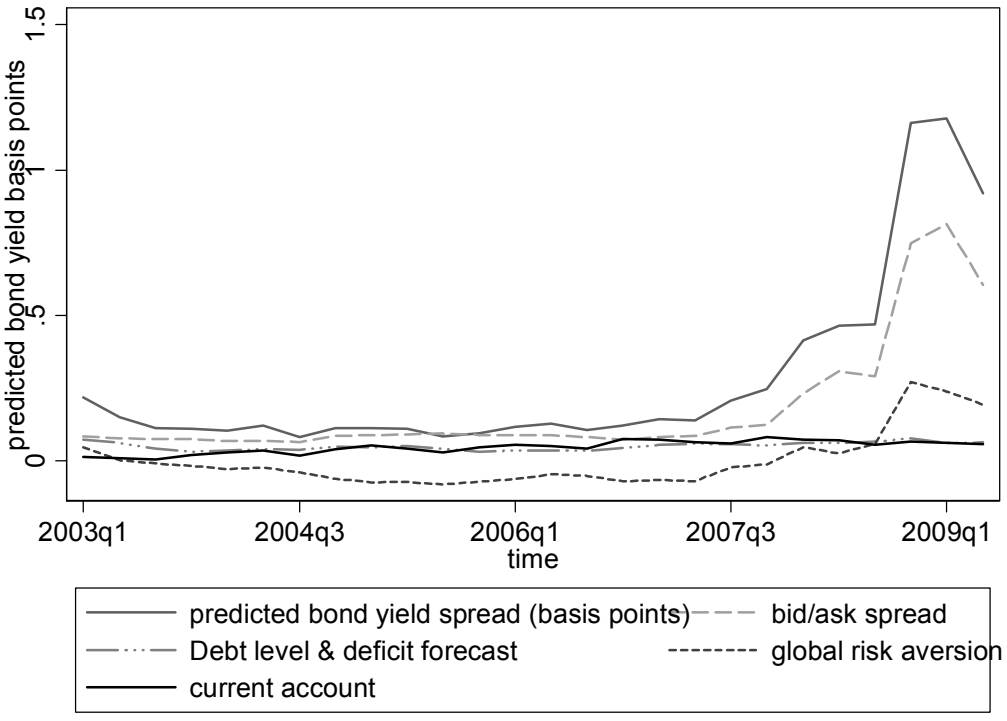
	(1)	*(2)*	*(3)*	*(4)*	(5)
Risk aversion	0.062***	0.071***	0.071***	0.050***	0.151***
	(0.018)	(0.019)	(0.011)	(0.017)	(0.013)
Bid-ask	0.012***	0.011***	0.003*	0.016***	
	(0.002)	(0.003)	(0.002)	(0.002)	
Fiscal balance	-0.024***	-0.013**	-0.015***		
	(0.006)	(0.005)	(0.003)		
Current account		-0.008***	-0.005***	-0.008***	-0.012***
		(0.003)	(0.001)	(0.002)	(0.003)
Debt				0.003***	0.002***
				(0.000)	(0.000)
$Debt^2$				0.007**	0.005*
				(0.003)	(0.003)
Interest payment			0.007***		
			(0.002)		
Constant	0.001***	0.000	0.001***	-0.001	0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Observations	242	242	224	242	260
R^2	0.66	0.68	0.68	0.72	0.65

Notes: Standard errors in parentheses
** significant at 10%; ** significant at 5%; *** significant at 1%*
Coefficients estimated using panel-corrected standard errors assuming first-order autocorrelation in disturbance terms based on the Durbin Watson approach

Column (5) excludes the bid-ask spread variable from the specification in Column (4) to investigate whether the positive influence of the debt level on spreads exceed the negative impact of higher indebtedness on spreads which results from a reduction in liquidity premium. Interestingly, the influence of the debt level on yield spreads remains positive and significant (although in case of the square term only at the 10 percent level). As such, the credit risk effect associated with higher debt clearly outweighs the opposing liquidity effect.

Overall these results show that domestic factors such as fiscal conditions and macroeconomic imbalances together with market liquidity and general risk aversion have played a significant role in determining government bond spreads in the euro area during the recent period. As regards the economic significance, however, considerable differences between these determinants of spreads can be observed. Based on the results of Column (2) in Table 4, Figure 11 displays the predicted value of the government bond yield for each determinant. It becomes evident that even after controlling for fiscal conditions and current account imbalances, general risk aversion and bond market liquidity conditions explain most of the surge in government bond spreads since the third quarter of 2008. This finding is in line with the prominent role played by the surge in global risk aversion that took place in the aftermath of the collapse of Lehman Brothers and the severe tightening of financial markets liquidity conditions that followed during the fall of 2008. In our quarterly-data model, the tightening of liquidity conditions since the third quarter of 2008 seems to have played an even more important role compared to the country-level results reported earlier.[20]

Figure 11: Predicted value of government bond yield spreads and the economic significance of explanatory variables



Notes: Based on estimations reported in Column (2) of Table 4. Constant term deducted from fitted values.

20 It must be noted that the robustness of the bid/ask spread variable (compared to the results reported in Section 4 where this variable displayed mixed result) could be due to the fact that the CDS variable is not used here. Given that the CDS spread might also capture part of the influence of liquidity conditions as suggested in Section 4, not including the CDS spread variable in the quarterly data could thus indirectly increase the explanatory power of the bid/ask spread variable..

5.2 The interaction between global risk aversion, fiscal conditions and macroeconomic imbalances

The impact of domestic factors on government bond yields cannot be considered as independent of that of global risk aversion. In particular the surge in government bond yield spreads in the euro area was also driven by risk perception concerning the ability of some countries to cater for the fiscal impact of the financial crisis. The role played by fiscal conditions, including increases in public deficit as well as initial debt levels, might thus be closely related to the global risk aversion as shown in particular by Codogno et al. (2003) and Haugh et al. (2009).

In order to highlight the interaction between fiscal conditions, public debt and global risk aversion we follow the simple approach described in Aiken and West (1991).[21] Two types of interactions are considered here. The first one concerns the interplay between the fiscal deficit and global risk aversion. It is represented in Figure 12 by the shift from the bottom line to the line labelled "risk aversion effect". It shows that the additional premium on the interest rate to finance new government bond issuance increases with the level of risk aversion. Specifically, an increase of the general risk aversion by one standard deviation, which corresponds approximately to the rise in risk aversion observed in 2008q3, significantly shifts upward the impact on bond yield spreads of a deteriorated fiscal balance. Thus, an increase in the public deficit by one percentage point leads to an additional premium of 1.9 basis points (i.e. to the 2.4 basis points increase reported in column (1) of Table 4) in times of high risk aversion.

The second interaction concerns the link between global risk aversion, fiscal deficits and the debt level and is represented by the shift to the third line located at the upper right of Figure 12 ("risk aversion and high debt effect"). Interestingly, the shift in the relationship between deteriorated fiscal deficit and bond yields spreads implied by the interaction between the deficit forecast and the debt level appears to be nearly parallel to the situation where this interaction is not considered. This result indicates that high debt countries tend to *always* experience higher bond yield spreads in times of high risk aversion while the sensitivity of their bond yield spread to the deficit forecast during periods of high risk aversion remains similar to other countries. This result is especially relevant for countries such as Italy, Greece and Belgium and also, to some extent, France and Portugal.

21 A simple interaction term between fiscal deficits and public debts would be of little help to consider the differential impact of fiscal deficits on government bonds yields for high vs low-debt countries because these two variables are continuous and have changing sign (in particular given that the change in the debt variable can differ from the change in deficit due to stock flow adjustment, below the line operations and snow-ball effect). Therefore there is no straightforward way to interpret their interaction. In order to remedy this issue the simple approach described by Aiken and West (1991) is used in order to obtain correct coefficient and standard errors. Accordingly, the coefficients estimated on interacted variables between (centered) continuous variables can be decomposed into groups of estimated coefficient depending on the values taken by the conditioning variable, i.e., in our case, the global risk aversion variable and the level of deb. This simple method therefore allows us to estimate two different slope coefficients for the forecast deficit variable according to whether the global risk aversion and debt variables are at the mean value (i.e. relatively close to the German benchmark) or at one standard deviation above that level.

Figure 12: The impact of the budget balance on 10-year government bond spread at high level of risk aversion and high debt level

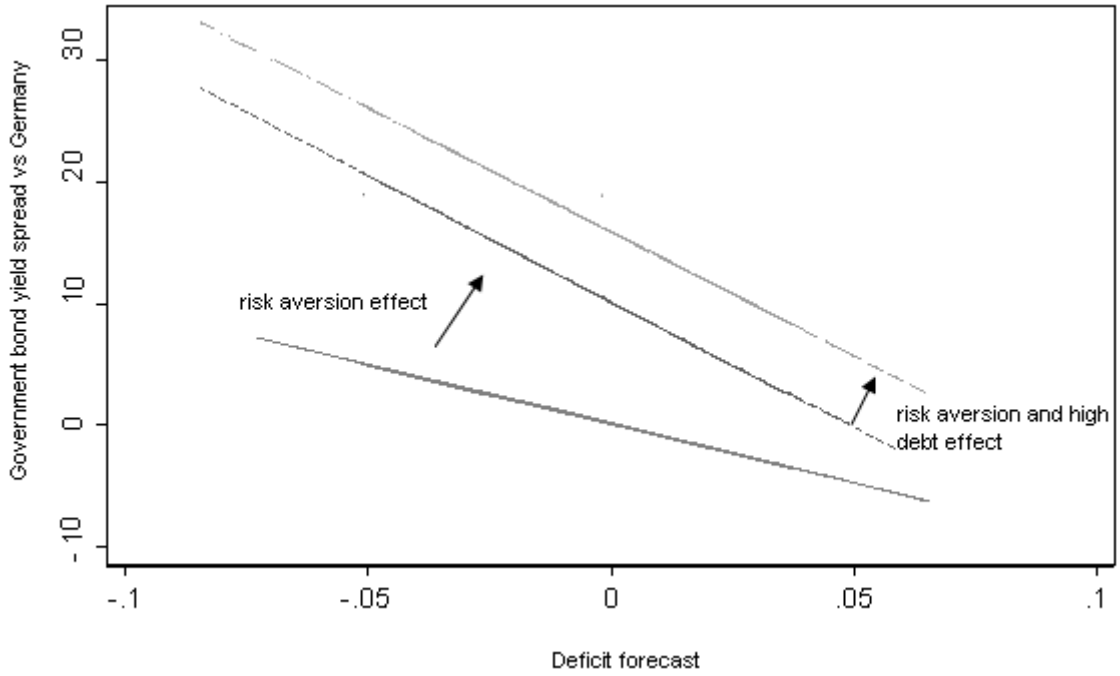
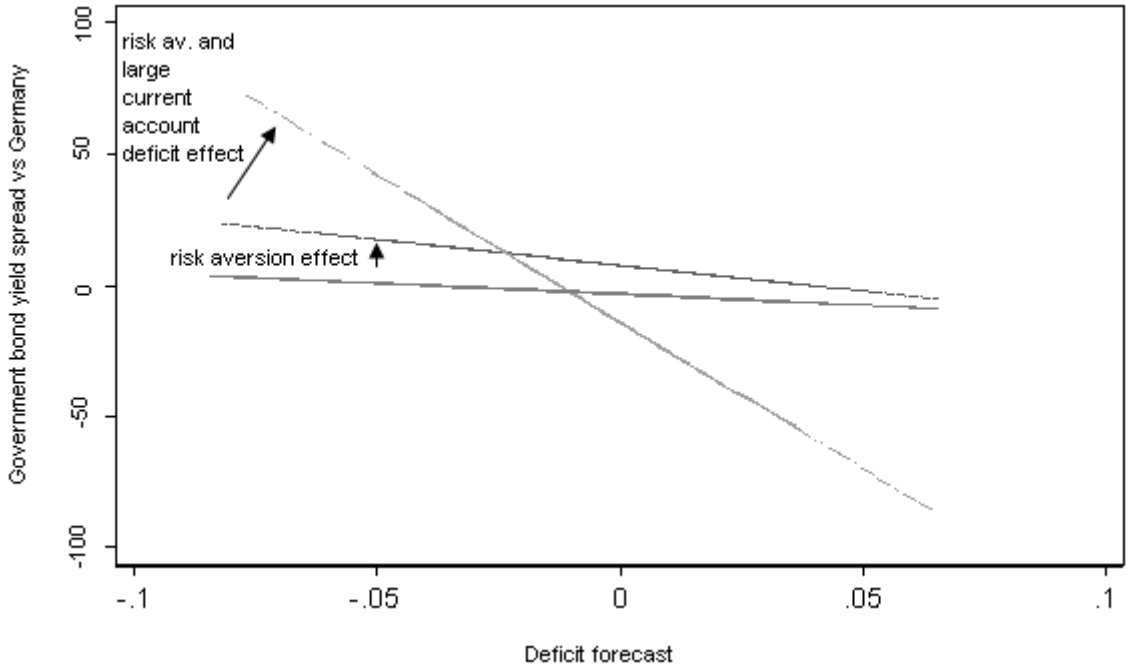


Figure 13: The impact of budgetary balance on 10-year government bond spread at high level of risk aversion and large current account deficit



In Figure 13 we conduct a similar exercise considering now the interaction between risk aversion, current account balances and public deficits. The impact of these interactions on government bond yield spreads becomes considerably larger as evidenced by the much wider range of values in the y-axis. As a consequence, the interaction effect between the global risk aversion and the public deficit variables now looks much more limited compared to the full interaction between public deficit, risk aversion and current account imbalances. The estimates obtained suggest that under a situation of relatively high general risk aversion (i.e. with the risk aversion variable reaching values one standard deviation above its mean), the

additional risk premium for high current account deficit countries jumps from 2.4 basis points to 11.2 basis points for each percentage point deterioration in the budget deficit.

6. Concluding remarks

The analysis presented in this paper has shown that euro area sovereign bond interest rates are strongly influenced by conditions in global financial markets. Domestic factors like liquidity and credit risk have become more important in the recent financial crisis to explain yield differentials. More specifically, with respect to credit risk the role played by macroeconomic fundamentals like fiscal and current account deficits is shown to increase with the level of general risk aversion. In particular, high debt countries and countries with large current account deficits are found to experience the highest bond yield increases as consequences of deteriorated public finances. This may reflect market perceptions according to which countries with high current account deficit might experiment added difficulties to restore fiscal sustainability without compromising economic growth further. Thus our results are in line with the 2009 Public Finance report (European Commission (2009)), which concluded that post-crisis current account adjustment was instrumental to determine countries' room for expansionary fiscal policy.

Compared to other asset classes like equities and corporate bonds, the adjustment in yield differentials during the period of intense financial market turbulences appears to have been proportionally stronger. This may be explained by a risk transfer effect from the private to the public sector amid the announcement of the national financial rescue packages. These comprehensive measures, though successful to the extent that they averted a financial meltdown, came at the cost of increasing the level of government bond risk premia and their sensitivity to further aggravations of the financial crisis.

Although conditions on government bond markets have been easing considerably since spring 2009, it seems unlikely that spreads will revert to pre-crisis levels in the near future. A number of elements suggest this. First, the strong rise in financing costs by sovereign issuers since September 2008 may, to a certain extent, be explained by the correction of abnormally narrow spreads in the pre-crisis period, when domestic risk factors resulted in small yield differentials. Second, it can be expected that government bond yield spreads will remain elevated compared to the pre-crisis period as debt levels have increased significantly in a number of countries (relative to the German benchmark) and the contingent liabilities assumed by the public sector in rescuing the financial sector will continue to weigh on the outlook for public finances.

Looking further ahead, greater market discrimination across countries may provide higher incentives for governments to attain and maintain sustainable public finances. Since even small changes in bond yields have a noticeable impact on government outlays, market discipline may act as an important deterrent against deteriorating public finances.

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