

TOWARDS A COMMON EUROPEAN MONETARY UNION RISK FREE RATE*

Sergio Mayordomo

Juan Ignacio Peña

Eduardo S. Schwartz

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Abstract

A common European bond would yield a common European Monetary Union risk free rate. We present a tentative estimate of this common risk free for the European Monetary Union countries from 2004 to 2009 using variables motivated by a theoretical portfolio selection model. First, we analyze the determinants of EMU sovereign yield spreads and find significant effects of the credit quality, macro, correlation, liquidity and interaction variables. Robustness tests with different data frequencies, benchmarks, liquidity and risk variables, cross section regressions, balanced panels and maturities confirm the initial results. Then, we estimate a common risk free rate and show that this common rate would imply savings in borrowing costs for all the countries involved.

JEL classification: F33, G12, H63

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* Sergio Mayordomo and Juan Ignacio Peña are at the Department of Business Administration, Universidad Carlos III de Madrid, c/ Madrid 126, 28903 Getafe (Madrid, Spain); smayordo@emp.uc3m.es and ypenya@eco.uc3m.es. Eduardo S. Schwartz is at the Anderson Graduate School of Management, UCLA, 110 Westwood Plaza Los Angeles, CA 90095 (USA) eduardo.schwartz@anderson.ucla.edu. This paper was partially drafted during the visit of Eduardo S. Schwartz to the Department of Business Administration at Universidad Carlos III. We acknowledge financial support from the Program “Catedras de Excelencia-Universidad Carlos III” financed by Banco Santander and from MCI grant ECO2009-12551. The usual disclaimers apply.

We present a tentative estimate of a new financial variable: the common risk free rate of interest for the European Monetary Union (EMU) members. We show how to estimate it for a given set of countries and discuss its uses for monetary policy management and its implication for financial markets' integration. The results suggest that this common rate, in all cases, could imply savings in borrowing costs for all the countries involved.

The possibility of a common European bond has attracted the interest of the financial press and is receiving increased attention from policy makers¹. There are potential wider benefits for the Eurozone as well as specific benefits for market agents such as issuers, dealers, and investors. A large common bond issue could have benefits even for countries with low credit risk (Germany, France), as it could rival American's treasuries market for liquidity. Moreover a single issuer would make EMU bonds more attractive to investors in large foreign-exchange reserves (China, Japan) and enhance the euro's standing as a reserve currency, as well as lowering borrowing costs for all countries that took part in it². On the other hand, some arguments against it have been raised focusing on the possible increase in moral hazard as well as the technical and institutional difficulties of managing a common bond issuance. However, as far as we know, there is no published quantification of a common risk free rate, nor a detailed comparison with other possible alternatives is available. This paper addresses both questions.

A common risk free rate could be used as a benchmark for measuring the benefits from financial market integration in the EMU. We conjecture and provide some evidence that

¹ EPDA(2008,2009)

² Additional technical advantages such as minimizing the possibilities of "squeezes" are discussed in Pagano and Von Thadden (2004)

our estimate of this rate would be close to what a common EMU-based single bond would yield for a specified maturity. We can then compare actual rates offered by the different EMU countries with sovereign bonds with this common rate. This allows us to compute the savings in terms of financing costs per year for the different EMU members. Given the common risk free rate measure we conjecture, our results suggest that there would be savings in borrowing costs for all EMU countries involved. . Of course, there are many institutional design features that must be resolved (seniority, amount relative to total debt issues, guarantee fund, etc.) before such a common bond can be launched. But our paper provides a first insight into one central issue, namely, what should be the required compensation a given country X should pay to the actual issuer (let's assume that the issuer is the ECB or other EMU-wide agency) to be allowed to share a given issue of EMU-based single bonds. We argue that this compensation should be the Credit Default Swap (CDS) spread on X's sovereign bonds. The benefits for country X in using the common bond (instead of the sovereign bond) will be the enhanced rating and liquidity the common bond would provide plus additional premiums for country X's macro fundamentals.

Motivated by a simple theoretical portfolio selection model, we first analyze the determinants of EMU sovereign yield spreads and find significant effects of the credit quality, macro, correlation, and liquidity variables. Robustness tests with different data frequencies, benchmarks, liquidity and risk variables, cross section regressions, balanced panels and maturities confirm the initial results.

We define the 'Hedged Yield' of the sovereign debt of a country as the difference of actual yield and the corresponding CDS spread. Based on these hedged

yields we build one estimate of the common risk free rate and show that this common rate would imply savings in borrowing costs for all the countries involved.

The remainder of the paper is organized as follows: Section 1 reviews some current literature on the subject; Section 2 introduces a theoretical model that allows us to determine the main components of the sovereign bond yields. Section 3 describes the data. Section 4 discusses the empirical results and presents some robustness tests. Section 5 introduces the construction of the common risk free rate. Section 6 discusses some policy implications and Section 7 offers some concluding remarks and proposes future lines of research.

1. Related Literature on EMU Sovereign Bond spreads

Since the formation of the European Monetary Union (EMU henceforth) the topic of the determinants of the sovereign bonds' yield spreads within the EMU has been the subject of intense and increasing research. Researchers have tried to find out which are the factors that explain the differences between sovereign yields in the EMU countries, but so far no clear consensus has emerged. Codogno, Favero and Misale (2003) find that for most EMU countries only international risk factors have explanatory power while liquidity factors play a smaller role. Amira (2004) finds that sovereign yields increase with maturity, issue size and gross fees and decrease with credit rating. Geyer, Kossmeier and Pichler (2004) report that EMU government bond spreads are related to common factors whereas they do not find evidence for a significant impact of macroeconomic or liquidity related variables. Bernoth, von Hagen and Schuknecht (2006) report that global risk factors as well as idiosyncratic macroeconomic factors affect yield spreads, whereas liquidity plays a marginal role. Gomez-Puig (2008) finds

that idiosyncratic factors (credit risk and liquidity) mostly drive yield differentials but systemic risk factors play only a marginal role. Favero, Pagano and Von Thadden (2008) find that one aggregate risk factor is consistently priced, that liquidity differentials are priced for a subset of countries, and that the interaction of liquidity differentials with the risk factor is consistently priced. In all these papers the benchmark for comparing the yield spreads is based on the German 10-year bund or German zero coupon curves. Beber, Brandt and Kavajecz (2009), however, use as benchmark the Euro-swap curve and show that the bulk of yield spread is explained by differences in credit quality as measured by the CDS, whereas liquidity plays a nontrivial role especially for low credit risk countries and in times of high market uncertainty. In summary, most papers suggest that credit quality-related factors, common business cycle factors (international or EMU), and, to a lower extent, liquidity-related factors are critical drivers of sovereign yield differentials.

The selection of the appropriate benchmark reference, however, has not received extensive attention in the literature. The most common view associates the benchmark bond with the lowest yield. If that were all that mattered for benchmark status, then the German market would provide, on average, the benchmark at all maturities. Analysts who take this view accept that the appropriate criterion for benchmark status is that this is the security against which others are priced, and they simply assume that the security with lowest yield takes that role. A plausible alternative, however, is to interpret benchmark to mean the most liquid security, which is therefore most capable of providing a reference point for the market. But the Italian market, not the German, is easily the most liquid for short-dated bonds;³ and perhaps the French is most liquid at

³ Most of the trading for 10-year German bonds occurs on the futures market; this market is then more liquid and deeper than the cash market.

medium maturities.⁴ Dunne, Moore and Portes (2002) consider in detail the meaning of the term “benchmark” bond. They investigate two possible criteria, using Granger-causality and cointegration tests. They find rather different results with the two methods, reflecting their different temporal focus. But with neither of them do they find the unambiguous benchmark status for German securities that would come from a simple focus on the securities with the lowest yield at a given maturity. They suggest looking for benchmark portfolios rather than a single benchmark security. This may be particularly appropriate in this partially integrated market and it is the approach we take in this paper. We take the benchmark to be a weighted average of the total gross debt at nominal value issued by the general governments of the different EMU members.

2. Theoretical Model

The model we use to motivate the explanatory variables employed in the empirical part of the paper is an extension of the portfolio model of bond yield differentials developed in Bernoth et al (2006). Consider a domestic (benchmark) investor allocating a fraction θ_t (θ_t^*) of his real wealth w_t (w_t^*) to a domestic D (benchmark F) security and a fraction $1-\theta_t$ ($1-\theta_t^*$) to a benchmark (domestic) security. Assume that both the domestic and benchmark securities are subject to default risk. The default process is assumed to follow a correlated bivariate Bernoulli process (x_t, x_t^*) , with domestic (benchmark) default probability $1-P_t$ ($1-P_t^*$). In the event of default the investor receives a fraction τ_t (τ_t^*) of his gross domestic (benchmark) payment, $\tau_t \in [0,1+r)$ ($\tau_t^* \in [0,1+r^*)$) where r (r^*) is the interest rate on the domestic (benchmark) bond. There are proportional transaction costs l_t (l_t^*) decreasing with domestic (benchmark) market liquidity. To simplify the presentation the coefficient of risk aversion ρ is assumed to be the same for

⁴ Favero, et al. (2008) set the French bond as the benchmark for the five-year maturity. This choice is supported by the evidence in Dunne, Moore and Portes (2002) and by the fact that traders view the French

both investors. Let S_t be the total supply of bond issued by the domestic government and assuming that the market clears, market equilibrium requires that

$$S_t = \hat{\theta}_t w_t + \hat{\theta}_t^* w_t^* \quad (1)$$

where the first term in the right hand side denotes the optimal amount of domestic bonds held by the domestic investor and the second term denotes the optimal amount of domestic bonds held by the benchmark investor. Assuming that the investors maximize a one period mean-variance utility function it is possible to solve for the interest rate differential between the two economies (details of the model can be found in Appendix D):

$$r_t - r_t^* = (l_t - l_t^*) + S_t \frac{\rho}{2} \text{Var}[(1 + r_t - \tau_t)x_t - (1 + r_t^* - \tau_t^*)x_t^*] - \frac{\rho}{2} (w_t + w_t^*) [(1 + r_t^* - \tau_t^*)^2 P_t^* (1 - P_t^*)] \\ + \frac{\rho(w_t + w_t^*)}{2} [(1 + r_t - \tau_t)(1 + r_t^* - \tau_t^*) \text{Cov}(x_t, x_t^*)] + (1 + r_t - \tau_t)(1 - P_t) - (1 + r_t^* - \tau_t^*)(1 - P_t^*) \quad (2)$$

Defining

$$k = (1 + r_t - \tau_t) \\ k^* = (1 + r_t^* - \tau_t^*)$$

The model can then be written:

$$r_t - r_t^* = kE[1 - x_t] - k^*E[1 - x_t^*] + (l_t - l_t^*) + A_1 S_t \text{Var}[kx_t - k^*x_t^*] + A_2 (kk^* \text{Cov}[x_t, x_t^*] - (k^*)^2 \text{Var}[x_t^*]) \quad (3)$$

where

$$A_1 = \frac{\rho}{2} \\ A_2 = A_1 [w_t + w_t^*]$$

Equation (3) decomposes the yield spread into four components. The first two terms are the *default risk premium* which is related with individual (country-specific) default probabilities. The higher is the domestic (benchmark) country-specific default

bond as the most liquid for that maturity.

probability the higher (lower) is the spread. Also, the riskier the domestic bond is in comparison with the benchmark, the greater will be the premium. Overall the effect of increases in the default risk premium will tend to increase yield spreads⁵. The third term on the right hand side is the *liquidity premium*. The less liquid the domestic bond is in comparison with the benchmark's liquidity, the greater will be this premium. The fourth term depends on the total debt S_t (which we later proxy with macro factors like budget and trade balances), the volatility of the differences in the default processes, and their interaction. The last term in the equation is a measure of *covariance risk* (or global risk) in excess of the volatility of the benchmark's default risk.

To test this model empirically we need to specify proxies for the components in equation (3). We use the CDS spreads as a proxy of the default risk premium as suggested in Beber et al. (2009)⁶. As a measure of liquidity we use the bond's daily turnover volume; the difference between the domestic and benchmark economy serves to estimate the liquidity premium⁷. We also include two macro measures directly related with the total supply of bond issued by domestic government and the health of the trade sector: total debt over GDP and net trade balance over GDP, both of them in deviations from the benchmark. Also, we use the interaction between the total debt over GDP and the volatility of the differences between the domestic and benchmark yields⁸ as a measure of both the total supply of debt and its relative risk. Since the overall investor's

⁵ In the domestic (benchmark) cases the default risk premium decreases (increases) with an increase in the recovery rates in case of default τ_t (τ_t^*).

⁶ To deal with possible endogeneity problems we use the one day-lagged CDS spread

⁷ We realize that there is no generally held definition of liquidity. Many other measures have been suggested in the literature. In fact there is a close relationship between many of the measures and actual transactions costs, and the assumption that liquidity proxies measure liquidity seems to be granted, see Goyenko, Holden and Trzcinka (2008). Moreover, volume and other liquidity measures are usually employed in policy analysis, see European Central Bank (2009). In Section 4.2.4 we perform some robustness tests with respect to different specifications of the liquidity variable.

⁸ The volatility of the differences between the domestic and benchmark yields accounts for the differences in the default processes.

risk attitude is not observable we proxy the global risk aversion with the Chicago Board Options Exchange Volatility Index VIX⁹. Finally, the correlation between the domestic bond yield and the benchmark bond yield is used as a proxy for country-specific covariance risk.

Recent work by Favero et al. (2009) and Berber et al. (2009) suggests that liquidity factors tend to be more important in uncertain times and that liquidity and credit risk potentially interact. We include in the regressions a proxy for that interaction variable between liquidity and credit risk using the product of liquidity¹⁰ times CDS spread to incorporate the effect of time-varying uncertainty. This interaction also allows us to capture the differential effects across countries of flight-to-safety and/or flight-to-liquidity. We also include a crisis dummy variable to take into account possible changes in the intercept before and during crisis.

3. Data

The data consists of daily sovereign yields with maturities of 3, 5, 7, and 10 years for eleven EMU countries from January, 1 2004 to February 27, 2009. From August 9, 2007 to February 27, 2009, the period during the ongoing financial crisis, a crisis dummy is added to some of the estimations. Appendix II provides additional details about the definition, sources, and timing of the data used in the study¹¹. Summarizing the most salient features in Table 1, the three largest EMU bond issuers are Germany

⁹ The VIX is often used as a proxy for investor's attitude toward risk and appears to explain movements of the bond spreads in recent years, see Hartelius et al. (2008) and Pan and Singleton (2007).

¹⁰ The liquidity measure employed to construct the interaction term is the Bid-Ask spread to make sure that both credit and liquidity variables move in the same direction. Thus, the higher the illiquidity or the credit risk, the higher is the interaction term. We also employ this liquidity measure to avoid multicollinearity problems. These problems are derived from the use of the turnover volume variable to control for interaction effects given that the correlation between the CDS spread lagged one period and the interaction term obtained from the turnover volume and the CDS spread lagged one period is 0.9.

¹¹ Detailed descriptive statistics for all the variables and countries are available on request.

(25%), Italy (25%) and France (21%) and the smallest are Austria (2.7%), Portugal (1.6%) and Ireland (1.1%).

In all cases the yields increase and the volatilities decrease with maturity. In general, average trading volume decreased during the crisis¹² suggesting that transaction costs increased across the board in the crisis period as well as CDS spreads and yield volatilities¹³. There is also evidence of an overall worsening of the trade balance across countries after the crisis started¹⁴ as well as a decrease of the ratio of debt to GDP¹⁵.

For the 3, 5, 7, and 10 year sovereign yields the lowest averages are 3.30, 3.51, 3.70 and 3.91 respectively for Germany; the highest averages are 3.56, 3.82, 4.02, and 4.28 for Greece. Both the standard deviations and the minimum and maximum values indicate that there can be significant time-series variation in the sovereign yields. For example, 3-year yield for Italy ranges from 2.29 to 5.02 during the sample period.

Average daily trading volume (in millions of Euros) also presents wide variation ranging from the high volumes for Germany (16,813) and Italy (11,772) to the low volumes for Finland (239) and Ireland (130).

Average CDS rates vary substantially across countries. The lowest average in the whole sample is 8.41 basis points for Germany; the highest average is 40.25 basis points for

¹² There are slight increases in Belgium, Ireland and the Netherlands

¹³ It is interesting to note that some countries viewed by the market as having very little average sovereign risk (CDS spread around 2 basis points) before the crisis, like Germany, Austria, Belgium, France, or The Netherlands, were penalized in different ways once the crisis unfolds, being Germany (16 b.p.) and France (20 b.p.) viewed as the safest, then The Netherlands (25 b.p.) and finally Belgium (33 b.p.) and Austria (37 b.p.). However all countries experienced, in specific days, very high CDS premium, for instance Germany (91.8 b.p.), France (96 b.p.) or Austria (272 b.p.)

¹⁴ The only exception being Italy whose (negative) external balance does not change.

¹⁵ Portugal is the only exception with a ratio of 63% after the crisis in comparison with 61% before it.

Greece¹⁶. The macro factors also vary widely across countries. For instance the country with highest average Debt/GDP ratio is Italy (104%) and the lowest Ireland (27%) and the country with worse average trade balance is Greece (-6.5%) and the best one is Ireland (+5.6%). Regarding the average interaction debt factor, which measures not only the total debt outstanding but also its risk with respect to the benchmark, varies between 10 for Greece and 2 for Ireland, increasing markedly once the crisis starts to 16 and 4 respectively¹⁷. With respect to the liquidity/credit risk interaction factor, it varies between 0.001 basis points for Germany and 0.029 basis points for Greece, increasing substantially during the crisis to 0.004 and 0.079 basis points, respectively. The low magnitude associated to the liquidity/credit risk interaction is due to the low magnitude of the bid-ask spread (i.e.: the average bid-ask spread is 0.067% for Greece). Finally, the average correlation between the domestic 10-year government yield and the benchmark is highest for Germany (0.98) and lowest for Austria (0.87) decreasing in all countries during the crisis period, with France being the highest (0.96) and Greece the lowest (0.76). This decrease in the correlations could reflect a decrease in the degree of integration in the sovereign bond market of the EMU area in time periods of financial distress.¹⁸

4. Empirical Results

Having established the factors to be used as explanatory variables for the sovereign yields spreads (as suggested by the theoretical model), we now turn our attention to examine the economic and statistical significance of the variables in explaining both the

¹⁶ Both the standard deviations and the minimum and maximum values indicate that there can also be significant time-series variation in the sovereign CDS premium. For example, the cost of credit protection for Ireland ranges from 2.80 to 395.80 basis points during the sample period.

¹⁷ Similar increases are also observed in all other countries.

¹⁸ Analyses of financial integration in the Euro Area sovereign bond market can be found in Adam et al. (2002), Adjaouté and Danthine (2003) Baele et al. (2004) and Schulz and Wolff (2008) among others.

cross-section as well as the time series of yields spreads. We group the data by country (11 countries) and maturity (3, 5, 7 and 10 years) totaling 44 groups which form an unbalanced panel.¹⁹

Average correlations among dependent and explanatory variables are presented²⁰ in Table 2. As expected, sovereign yields spreads are positively related to CDSs lagged by one day. This is consistent with our theoretical model's prediction that increases in default risk premiums are associated with increases in yield spreads. The negative correlation between yield spreads and the liquidity variable is in agreement with the theoretical prediction that the less liquid the domestic bond market is in comparison with the benchmark' liquidity, the greater will be the yield spread. The positive correlations for the Debt/GDP, Interaction variable and global risk suggest that as they each increase, sovereign yield spreads increase. The high and positive correlation between the liquidity/credit risk interaction variable and the sovereign yield spread suggests that there is an additional interactive effect in addition to the individual effect of these two variables. The negative correlation for the Trade balance variable suggests that trade deficit increase government yield spreads. Overall, the signs are in agreement with the ones suggested by the theoretical model. Our main objective, however, is to examine the joint effect of these explanatory variables on the yield spreads.

4.1. Unbalanced Panel Regression

We regress the difference between the sovereign yield in EMU country i and the benchmark portfolio yield onto differences in country i 's credit quality, liquidity and

They conclude that despite the great convergence between yields, yield differentials have not disappeared completely under EMU and so, European sovereign bonds are still not perfect substitutes.

¹⁹ The panel is unbalanced because we do not have information on some variables from the beginning of the sample. However, there are no missing values once we include the first realization of the series.

²⁰ All the variables, with the exception of the measure of global risk and the correlation between the domestic Government and benchmark yields, are in deviations from the benchmark

macro measures from their respective cross-sectional weighted averages (or benchmark values) and onto global risk and interaction measures. We employ a Prais-Winsten regression with correlated panels, corrected standard errors (PCSEs) and robust to heteroskedasticity, contemporaneous correlation across panels and serial autocorrelation within panels. The correlation within panels is treated as a first-order autocorrelation AR(1) and the coefficient of this process common²¹ to all the panels.²² Our panel regression model is described by the equation:

(4)

$$r_{it} - r_{it}^* = \alpha + \sum_{k=1}^K \beta_k (X_{k,i,t} - X_{k,BNCH,t}) + \sum_{j=1}^M \gamma_j D_{j,t} + \chi Y_{i,t} + \delta Z_t + \psi C_{i,t} + \phi H_{i,t} + \varepsilon_{i,t}$$

where the dependent variable is the spread between the government bond's yield of country i , r_{it} at four different maturities (3,5,7,and 10 years) and the benchmark yield r_{it}^* , at the same maturities. The benchmark yields are obtained as the weighted average of the Government yields of the EMU countries in the sample for the corresponding maturity (3, 5, 7, and 10 years). The weights are proportional to the portion of debt outstanding by each country with respect to the total amount outstanding by all these countries²³ and change annually. The $X_{k,i,t}$ are credit risk, liquidity and macro explanatory variables (CDS_{t-1}, Volume, Total debt/GDP, Trade Balance/GDP) and $X_{BNCH,t}$ are their respective weighted averages over the eleven countries, obtained using the same procedure employed to build the benchmark yield²⁴. Notice that we specify the credit, liquidity and macro variables as differences from their cross-sectional

²¹ Better fit, as measured by the Schwarz Information Criteria, is obtained using an AR(1) autocorrelation structure common to all panels instead of a panel-specific AR(1) autocorrelation structure.

²² Each element in the covariance matrix of the disturbances is computed with all available observations that are common to the two panels contributing to the covariance.

²³ To gain a better perspective of the dependent variable, it is worth mentioning that its maximum (minimum) average value is equal to 21.5 (-8.9) basis points for Greece (Germany).

²⁴ Notice that the CDS variable is different for different maturities, whereas the other variables are the same for all maturities.

weighted averages (or benchmark value). This approach stresses the fact that credit risk; liquidity and macro variables are relative concepts. The $D_{j,t}$ are dummy variables to take into account the maturity effect in bond yields (3,5, and 7 years) as well as the crisis dummy that is equal to zero before August 9, 2007 and one afterwards. The $Y_{i,t}$ is the interaction term of total debt/GDP of country i times the volatility of the difference between domestic yield and benchmark yield. The Z_t is the global risk factor measured as the log of the VIX index and $C_{i,t}$ is the correlation between the country i yield (for its corresponding maturity) and the benchmark's yield. The $H_{i,t}$ is the interaction between the country i liquidity measured by the bid-ask spread and credit risk measured by the CDS spread lagged one period.

The results of the panel regressions are reported in Table 3. Column 1 gives the results without the crisis dummy, and Column 2 with the crisis dummy. The explanatory power of the regressions, reflected in their adjusted R^2 , are 19.9%, and 19.4%, respectively. Consistent with intuition as well as with our theoretical model and the previous literature, the CDS lagged one period has a strong positive impact on sovereign yield spread which indicates that a lower credit quality increases the yield spread. The liquidity differential is also significant. The negative coefficient suggests that higher than average liquidity is associated with lower yield spreads. The two macro factors (relative to GDP) and the global risk factor have also a positive and significant impact in the sovereign yield spread. The effect of the term measuring the interaction of total debt relative to GDP and the standard deviation of the domestic yield minus the benchmark yield is positive and significant. Recall that this variable measures both the total supply of debt and its relative risk against the benchmark. Therefore the economic meaning of this variable is that, for a given debt level, an increase in the volatility of the

difference of the domestic yield and benchmark yield increases yield spreads. The more the two rates grow apart the higher the effect on yield spreads. This could be the case in a situation where a given country's spreads tends to diverge from the benchmark behavior and then the market penalizes this divergence demanding higher yield spreads. If two countries present the same divergence from the benchmark yield behavior, the penalization is higher for the country with the higher level of debt relative to GDP.

The crisis dummy is positive and significant as well as the liquidity/credit risk interaction variable. This result suggests that there is a constant deviation between the domestic and benchmark yields which increases during the crisis. Moreover, the significant effect of the liquidity/credit risk interaction variable is consistent with the idea that liquidity factors tend to be more important in uncertain times and that liquidity and credit risk interact. Finally the maturity dummy variables coefficients reflect the decreasing premium for longer maturities.²⁵ Overall, these results provide strong support for the theoretical model and for all the proxy explanatory variables chosen. The inclusion of the crisis dummy, though significantly positive, does not affect materially the size and significance of the other explanatory variables.

Since there is a potential endogeneity between a country's sovereign yields and its CDS rates, in the panel regression results reported in Table 3 we have used a one period (day) lag in the CDS explanatory variable. This is a standard procedure to deal with potential endogeneity. To further address this issue, we have run an identical panel regression but omitting the deviation of the domestic CDS spread from the benchmark and the deviation of the domestic interaction between the CDS and bid-ask spreads from the benchmark corresponding interaction. These results are reported in Table 4 without and

with the crisis dummy (Column 1 and Column 2, respectively). As can be seen from this table the results are qualitatively very similar to those in Table 3, confirming the significance of the other explanatory variables and suggesting that endogeneity is not a serious issue in our case. As expected, the explanatory power of the panel regressions is lower given that we are omitting two powerful explanatory variables: the CDS spread lagged one period and the interaction liquidity/credit risk.

Finally, we analyze the effect of the cross-sectional dispersion between countries in the explanatory variables on the dependent variable. For this aim, we first calculate the standard deviation of each explanatory variable across countries at each date t . Then, we compute the average of these standard deviations for all dates and finally, we multiply this average by the corresponding coefficient (see Table 3). In Table 5 we report the results of this sensitivity analysis of the determinants of the yield spreads. Specifically, we report the magnitude of the change, in basis points, of the dependent variable given a change equal to the average of the standard deviations across countries of a given explanatory variable over all dates.²⁶ We focus on the cross-sectional dimension of the panel and employ the time-series dimension to calculate the average effect across time.

²⁷ This allows us to evaluate how the different macro or risk factors of the countries under study affect the yield spreads.

²⁵ We repeated the regression in Table 3 using weights proportional to the debt outstanding by each EMU member in the Prais-Winsten regression and results do not change significantly. These results are available upon request.

²⁶ The standard deviation of the following variables: CDS spread (lagged one day); interaction of total debt divided by GDP and the standard deviation of the difference between domestic and benchmark yields; correlation between domestic Government yield and benchmark yield; and liquidity/credit risk interaction variable are calculated for the five year's maturity.

²⁷ We repeat the sensitivity analysis focused on the time-series dimension of the panel. By means of this analysis, we estimate the change in the dependent variable after a change of one standard deviation in a given explanatory variable across time and countries. Results are in line with the ones in Table 5 but are

For the whole sample the largest effect on yield spreads is caused by deviations between the countries' CDSs spreads (4.78 b.p.). The variable with the second strongest effect is the total debt issued relative to GDP. In the whole sample the average change in the dependent variable is 3.57 b.p. The next most influential variable is the liquidity albeit with lower order of magnitude (-1.70 b.p.) whereas the other variables have lower effects. Note that the sensitivities are practically unaffected by the inclusion of the crisis dummy.

4.2. Robustness Tests

In this section, we report the results of several checks on the basic results. The robustness tests consider cross-section regressions, changes in the benchmark, using balance panel regressions and alternative liquidity measures, employing alternative data frequencies and analysing maturity by maturity. In all cases the results are robust to the alternative specifications.

4.2.1. Cross Section Regressions

As a first robustness test we run a cross-section regression every day and then we test for the significance of the time series of coefficients, see Fama and Macbeth (1973). Equation (7) details our cross-section regression model:

(7)

$$r_{it} - r_{it}^* = \alpha_t + \sum_{k=1}^K \beta_{k,t} (X_{k,i,t} - X_{k,BNCH,t}) + \sum_{j=1}^M \gamma_{j,t} D_{j,t} + \chi_t Y_{i,t} + \varphi_t H_t + \varepsilon_{i,t} \quad i = 1, \dots, 44$$

$$t = 1, \dots, 1294$$

where the dependent variable is the spread between the government bond's yield of country i ($i=1, \dots, 11$) r_{it} at four different maturities (3,5,7, and 10 years) and the

not reported in this paper given that our aim is to focus on how the differences between countries affect

benchmark yield r_{it}^* , at the same maturities. The benchmark yields are obtained as the weighted average of the Government yields of the EMU countries in the sample for the corresponding maturity (3, 5, 7, and 10 years). The weights are proportional to the portion of debt outstanding by each country with respect to the total amount outstanding by all these countries. The $X_{k,i,t}$ are credit risk, liquidity and macro explanatory variables (CDS_{t-1}, Volume, Total debt/GDP, Trade Balance/GDP) and $X_{k,BNCH,t}$ are their respective weighted averages over the eleven countries. Notice that we specify the credit, liquidity and macro variables as differences from their cross-sectional weighted averages. This approach stresses that credit risk; liquidity and macro stance are relative concepts. The $D_{j,t}$ are dummy variables to take into account the maturity effect in bond yields (3, 5, and 7 years). The $Y_{i,t}$ is the interaction term of total debt relative to GDP times the volatility of the difference between domestic yield and benchmark yield.²⁸ The $H_{i,t}$ is the interaction between the country i liquidity and credit risk.

In order to estimate the cross-sectional effects of the above variables, we run a cross-sectional regression by OLS for every date in the sample (1294 in total) and compute the average coefficient for the whole sample. Petersen (2009) states that the Fama-MacBeth standard errors are biased in exactly the same way as the OLS estimates and the magnitude of the bias is a function of the serial correlation of both the independent variable and the residual within a cluster and the number of time periods per firm (or cluster). Thus, we must adjust the standard errors for the autocorrelation of the

the deviations in the yield spreads and so, we focus in the cross-section dimension.

²⁸ Note that in equation (7) we do not employ the VIX index, the crisis dummy and the correlation between the domestic and the benchmark yields. The reason is because both the VIX index and the crisis dummy are the same for all the countries and maturities. We exclude the correlation variable because it causes multicollinearity problems.

estimated slope coefficients.²⁹ We employ the Fama-MacBeth methodology with Newey-West standard errors.³⁰

The results of the cross section regressions are reported in Table 6. Column 1 gives the results for the whole sample period, Column 2 the corrected *t*-statistics, Column 3 the proportion of coefficients with the right sign, Column 4 the change in the dependent variable given a change of one standard deviation in the explanatory variable and the last Column the % explained variance. The average R^2 of the cross-sectional regression is 73%. The magnitude of the regression coefficient suggests that a one standard deviation increase in the CDS above the weighted average is associated with an average increase in the sovereign yield spread of 6.8 b.p.³¹ This is the most economically significant effect found for the explanatory variables. The two macro factors (relative to GDP) have a significant impact in the sovereign yield spread. One standard deviation increase in the total debt and the net trade balance, both above the weighted average, is associated with an average increase in the sovereign yield spread of 1.8 b.p. and a decrease of 1.6 b.p. respectively.

The effect of the term measuring the interaction of total debt and the standard deviation of the domestic yield minus the benchmark yield is positive and significant. One standard deviation increase in this variable is associated with an average increase in the sovereign yield spread of 1.7 b.p.

²⁹ As Petersen (2009) states, when there is only a time effect, the correlation of the estimated slope coefficients across years is zero and the standard errors estimated by the Fama-MacBeth are unbiased.

³⁰ In order to find an unbiased *t*-statistic, we regress the estimated coefficients on a constant using the Newey-West adjustment to control for serial correlation. This methodology is also employed in Davydenko and Strebulaev (2007).

With respect to the liquidity differential variable the negative coefficient suggests that higher than weighted average liquidity is associated with lower yield spreads. The economic impact of the liquidity differential is the lowest of all the explanatory variables in the analysis. One standard deviation increase in liquidity above the average is associated with an average change in the sovereign yield spread of -1.1 basis points. The liquidity/credit risk interaction factor is significant but its effect is only of 0.5 b.p. Finally the dummy variables coefficients reflect the decreasing premium for longer maturities.

Overall the results of the cross sectional regressions are consistent with the ones given by the unbalanced panel regression reported in Section 4.1 indicating that the main results of the analysis are robust to different specifications of the regressions. The sensitivity analysis' results for the cross-sectional regression are also similar to those reported in Table 5 for the panel regressions.

4.2.2. Changing the Benchmark

We next address the issue of how robust are our results to the choice of benchmark. In particular, as is common in the literature, we use the German bond as a benchmark.

Table 7 presents the results of estimating the panel regression equation (4) using two different benchmarks. Besides the benchmark used in this study, which is obtained from the relative weights calculated from the total debt outstanding by each country over the total amount in the EMU, we present the results obtained using the German bond as the

³¹ To gain a better understanding of the effects of the explanatory variables on the dependent variable, it is worth noting that the maximum (minimum) average value by country for the deviation between the Government yield and the benchmark yield is equal to 21.5 (-8.9) basis points for Greece (Germany).

benchmark. As can be seen from Table 7, our main results are not very sensitive to the choice of benchmark.³²

4.2.3. Balanced Panel

To be able to use as much of the data as possible and deal with missing observations the panel regressions estimated in this paper have been unbalanced. In this section we look at the robustness of our results to the use of a balanced panel.

Table 8 presents the results of fitting equation (4) to a balanced panel data formed by ten of the eleven countries and ranging from March 2006 to February 2009.³³ The estimation is done by means of Generalized Least Squares (GLS). The GLS procedure allows estimation in the presence of AR(1) autocorrelation within panels and cross-sectional correlation and heteroskedasticity across panels. Even though the data used in this regression is somewhat different, the results obtained are similar to those obtained for the unbalanced panel. In fact, the magnitude and significance of the explanatory variables provides stronger support for the specification used.

4.2.4 Liquidity and risk measures

We also analyze the robustness of our results to alternative specifications of the liquidity measure. Table 9 presents the results of fitting model (4) to the full sample using three alternative liquidity measures: total daily turnover volume, bid-ask spreads

³² As a potential benchmark we have also analyzed the Euro Swap rate. In fact, Beber, Brandt and Kavajecz (2009) use the Euro swap curve. When we use the Euro Swap rate as the benchmark and, contrary to our base case, the interaction between the debt and the standard deviation of the difference between the domestic and benchmark yields is not significant. Also the coefficient of the crisis dummy is now negative. Therefore, during the crisis, the Euro Swap rate was on average higher than the sovereign yields and this fact casts doubts on its adequacy as a benchmark

and average daily turnover volume.³⁴ In all cases the liquidity coefficients have the expected signs and are significant and the results for the other variables do not change materially. As the volume and the bid-ask spread are different liquidity measures and they affect yields in the opposite direction, the coefficients' order of magnitude cannot be directly compared. However, looking at a standardized measure such as the t-statistic we observe that all the liquidity measures have a similar effect. Note that in the column (2) the interaction of the liquidity and the CDS spread is not significant given that the individual effect of the liquidity variable (bid-ask spread) seems to be more important than the interaction term. This fact gives support to our approach of using a specific liquidity variable (turnover volume) and an interaction variable (liquidity-risk) defined from the bid-ask spread.

As the liquidity proxies change with maturity and given that what matters to investors is the liquidity of a particular segment of the yield curve and not the overall liquidity of the sovereign bond market, we repeat the analysis using alternative liquidity measures with the corresponding maturity (3, 5, 7 or 10 years). The results obtained under this modification are shown in Table 10 and they do not change with respect to Table 9.

A similar concern can be applied to use of the CDS spread. The price of risk changes with maturity and what matters to investors is the price of the risk for the maturity they are willing to hedge and not only the 5-year maturity. For this reason, we repeat the analysis using both the CDS lagged one period and the interaction of the liquidity (bid-ask spread) and CDS lagged one period variables with the corresponding maturity (3, 5, 7 or 10 years). As one can observe in Table 11 we obtain similar results as in Table 3.

³³ We exclude Finland and the observations before the 27th of March, 2006 in order to have a balanced panel. The reason is that for some countries, the CDSs series present missing values before that date. In the case of Finland there are only 202 observations on CDSs.

³⁴ This average volume is calculated as the ratio between the total daily turnover volume and the number of bonds issued by the corresponding country.

We report and comment the main results of the paper based on Table 3 given that using the CDS spread lagged one period for the 5-year maturity and the liquidity measure for the overall maturities, we have a higher number of observations and we can homogenize the risk and liquidity effects.

Finally, besides the logarithm of the VIX Index we try different proxies for the global risk factor due to the great variety of variables that have been traditionally employed to proxy this factor. For instance, we employ: logarithm of the VDAX Index, square of the MSCI returns, iTraxx Europe (European CDS Index), difference between 10-year AAA US corporate yield and 10-year US Government bonds yield, difference between 10-year BBB US corporate yield and 10-year US Government bonds yield, difference between 10-year BBB US corporate yield and 10-year AAA US corporate yield. We find that their effects are positive in all cases and the standardizations of the coefficients from the t-statistics are very similar among them. Moreover, the coefficients of the remaining variables remain unchanged.³⁵

4.2.5 Data frequency

Some macro series (Gross Debt outstanding) have annual frequency; other series (GDP) have quarterly frequency while others (Net Trade Balance) have monthly frequency. In fact these are the data frequencies employed in Curto et al. (2008) or Codogno et al. (2003) among others. As an additional robustness test we analyze the regression in equation (4) using data with a monthly and quarterly frequency. In both cases the number of observations decreases substantially with respect to the case where we use daily frequency. However, results are in line with the ones obtained using a daily data

³⁵ These results are available upon request.

and are available on request. Overall the above outcomes suggest that our main findings are not sensitive to the data's time frequency³⁶.

4.2.6 Maturity Analysis

The effect of credit or macro risk is likely to have a differential effect on bonds with a different maturity. In equations (4) and (5) we only incorporate a level effect by means of the dummies for the different maturities. As an additional robustness test, we include the effect of the different maturities by regressing the yield spread on the explanatory variables for individual maturities. Results are shown in Table 12.

We observe that the macro variables (total debt divided by GDP and net trade balance divided by GDP) have a stronger effect on the longer maturities. The liquidity, the interaction liquidity/risk, the interaction of the debt and the standard deviation of the difference between the domestic and benchmark yields as well as the correlation between the domestic and benchmark yields have a stronger effect on the shorter maturities. The effect of the crisis dummy is only significant for the 7 and 10 year maturities. Finally, the domestic (CDS lagged one period) and the global risk factors do not follow a clear pattern along the different maturities but they seem to have a more significant effect on the 5 and 7 year maturities. The interaction liquidity/risk is significant for all the maturities but the 7-year maturity. Overall, however, these results are in line with the results presented in Table 3.

³⁶ Gomez-Puig (2007) transforms the macro variables employed in her analysis into variables with a daily frequency. For this transformation, she extrapolates the corresponding variable assuming a daily constant rate of increase. We find that the results obtained after extrapolating the macro variables, assuming a constant rate of increase between two different values of the corresponding variable, are equivalent to the ones obtained in Table 3. These results and the ones commented in Subsection 4.2.5 are available upon request.

5. Computing Common Risk Free Rates

The results in the previous section motivate the following question. What should be the yield of a common eurozone bond, free, at least to some extent, from the effect of the risk factors (credit, liquidity, macro, correlation) that influence the yield of individual sovereign bonds? The existence of a common European bond would imply the existence of a common European interest rate³⁷. In this section, we attempt to provide a measure for this rate and discuss the hypothetical benefits that it would yield. A common risk free rate could produce benefits for every EMU country because of the enhanced rating and liquidity of the common bond and from the reduction of the effects associated with macro fundamentals.

It seems reasonable to suggest that to be allowed to profit from the reduction in borrowing costs this common rate would provide, each EMU country interested in participating in an issue of common bonds should compensate the bond issuer for the specific country's credit risk. As a starting point for this analysis we suggest that the CDSs on its sovereign bonds is the best proxy publicly available to measure the country risk and so, the CDS spreads represent the compensation that a given country should pay in order to be allowed to participate in the issuance of common bonds. In what follows we refer to the 'Hedged Yield' of the sovereign debt of a country as the difference of actual yield and the corresponding CDS spread.

³⁷ As Galati and Tsatsaronis (2001) remark, the most vivid illustration of the shortcomings of the Government bond market is the absence of a single established reference yield curve for the new currency.

Our proposed measure, which we call Common Risk-Free Rate (CRFR), is the Hedged Yield free of liquidity, correlation and macro risk effects³⁸. The reasons why we think CRFR would be free to a considerable extent of those effects are as follows. Regarding liquidity our model implies that CRFR will not be affected by individual bond's liquidity variables. One can argue that a specific liquidity factor related with the common bond may appear in due course but our view is that this variable will have small effects. Liquidity is valuable for market participants, and especially in times of market stress, the most liquid bonds have tended to command a considerable price premium. Previous studies of liquidity and liquidity premia in government bond markets, based mainly on data from the U.S. Treasury market, ECB (2010) have identified pronounced liquidity differences across government securities, being the benchmark bonds (and we assume that the common bond will have a fair chance to be the benchmark) the most favoured. Regarding the net trade balance over GDP, it should be remembered that about 70% of the total trade of EMU countries is within the European Union and therefore the aggregate value of this variable (due to offsetting positions) is bound to be small. Finally, and with respect to total debt over GDP, our model implies that CRFR will not be affected by individual bond's total debt. It can be argued that the aggregate debt ratio of the EMU countries could have some effect on CRFR³⁹. We test this possibility below and the variable is not significant.

³⁸ The impact of these effects is estimated by means of a Prais-Winsten regression with correlated panels corrected standard errors (PCSEs) and robust to heteroskedasticity, contemporaneous correlation across panels and serial autocorrelation.

³⁹ Given the evidence in Krishnamurthy, and Vissing-Jørgensen (2007), we should expect that when the stock of total debt over GDP is low, the marginal convenience valuation of sovereign debt is high. Investors bid up the price of Treasuries relative to other securities, such as corporate bonds, causing the

The CRFR is computed using the following steps:

a) We run the following Prais-Winsten regression:

$$r_{it} - CDS_{it} = \alpha + \sum_{k=1}^K \beta_k X_{k,i,t} + \sum_{j=1}^M \gamma_j D_{j,t} + \chi Y_{i,t} + \delta Z_t + \varepsilon_{i,t} \quad i = 1, \dots, 44 \quad (5)$$

where the dependent variable is the Hedged Yield of country i ($i=1, \dots, 11$) at four different maturities (3, 5, 7 and 10 years). The $X_{k,i,t}$ are liquidity and macro explanatory variables (Volume, Total debt/GDP, Trade Balance/GDP) of country i . The $D_{j,t}$ are dummy variables to take into account the maturity effect in bond yields (3,5, and 7 years) and the crisis dummy. The $Y_{i,t}$ is the interaction term of total debt relative to GDP times the volatility of the difference between domestic yield and benchmark yield. The Z_t is the global risk factor measured as the logarithm of VIX.

This regression is similar to the one in (4) with the exception that the dependent variable is the hedged yield and the liquidity and macro variables are not deviations from the benchmark. Table A1 in Appendix III contains the results for the estimation of equation (5).

b) We define the Common Risk Free Rate (CRFR) at time t for the corresponding maturity according to:

$$CRFR_t = \hat{\alpha} + \hat{\gamma}_j + \bar{\hat{\varepsilon}}_t + \hat{\delta} Z_t \quad j = 1, 2, 3, 4. \quad (6)$$

where $\hat{\alpha}$ is the estimated constant, $\hat{\gamma}_j$ is the estimate of the dummy parameters for the maturities of 3, 5 and 7 years and for the crisis dummy, respectively, $\hat{\delta}$ is the estimate of the logarithm of VIX parameter, and $\bar{\hat{\varepsilon}}_t$ is the average cross-sectional residual among the eleven EMU countries at time t . $\hat{\alpha}$ gives the average common hedged risk

yield on Treasuries to fall further below corporate bond rate. The opposite applies when the stock of debt

free rate without the effect of the other variables, $\hat{\gamma}_j$ gives the term structure and the changes in the intercept before and during crisis, $\hat{\delta}$ gives the global risk effect and $\bar{\hat{\varepsilon}}_t$ gives the time series variation in interest rates. The benefits for a given country in using the common bond will be the enhanced rating and liquidity the common bond would provide plus additional premiums for country's macro fundamentals. On the other hand the common risk free rate is not unfettered of the influence of the crisis and global risk factor's influence. Additionally, we test whether total EMU debt over GDP has any explanatory power for CRFR and the regression coefficient is small and not significant.

As the measure proposed here comes from an estimated model, (equation (5) above) the estimate is vulnerable to sampling and model specification error. To address this point we construct 95% confidence bands around the estimates using 95% upper and lower limits of the estimated parameters (i.e 2.5% in each direction)

In Figure 1 we show the estimated 5-year common risk free rate in the EMU area (CRFR) and the confidence bands around the CRFR. The CRFR average value is 3.13% while the average values for the upper and the lower bands are 3.74% and 2.53%, respectively.

6. Policy Implications: Savings in Borrowing Costs

The measure previously defined can be used to estimate the possible savings in borrowing costs from the issuance of common bonds in the EMU. We obtain these savings for a given country and maturity by subtracting from the corresponding yield the CDS spread and the estimate of the common risk free rate for 3-year, 5-year, 7-year,

is high.

and 10-year maturities. The results are reported in Table 13. The average savings in borrowing costs are positive irrespective of the country and maturity. The country that, on average, gets the biggest decrease in financing costs is Finland while Ireland is the one getting the smallest decrease.^{40 41} Countries above (below) the average are Belgium, Finland, Greece, and Portugal (Austria, Germany, Ireland, Spain, and Netherlands) whereas France and Italy are close to the average. These results are tentative and subject to measurement error (see Figure 1), but they give some idea about the possible savings involved in a common bond. As an additional test, we computed the CRFR increased by the (non-significant) effect of the total EMU debt over GDP. CRFR increases on average by 8 b.p. and the average total saving are 24.7. Again, average savings are positive for all countries.

Adjaouté and Danthine (2003) argue that a unified market is Pareto superior to a fragmented market given that yields will be lower in the former. As Adjaouté and Danthine (2003) point out, the pricing differences between yields reflect a failure of integration and imply costs to the euro-area Treasuries. They estimate that at the debt levels in the euro area in 2000 the annual cost may be as high as €5 billion which could be saved with a common bond.⁴² They consider that the integration could occur simply by the establishment of a centralized agency in charge of issuing debt on behalf of the

⁴⁰ For some maturities, the savings for Finland are higher than for Greece. However, we have only 202 observations for Finland in comparison with the almost 900 observations for Greece.

⁴¹ The low decrease in financing costs for Ireland can be explained from the definition of the cost of financing. This cost is defined from (i) the CDS spread to be paid to participate in the issuance of common bonds and (ii) the common risk free rate. Thus, the difference between the hedge yield (Yield – CDS) and the CRFR represents the savings in terms of borrowing costs. However, the lowest hedge yield is the one corresponding to Ireland due to the high CDS spread and to the fact that the Irish yield is not so high relative to other countries' yields.

⁴² Adjaouté and Danthine (2003) estimate this amount by multiplying the outstanding debt of the Euro area minus Germany in 2000 (2,470 billion) by the average difference of the yields with respect to German yield which is employed as the benchmark (20 basis points).

euro area's governments.⁴³ However, they do not give additional details about how to achieve this integration and how to estimate the common rates derived from the centralized debt issuance. According to our estimations of the common risk free rate, the average savings could be higher than in Adjaouté and Danthine (2003). Our estimations suggest that the average annual savings for the EMU in the period that spans from September 2005 to February 2009 might be around €19.52 billions with the Common Risk Free Rate.⁴⁴ As Favero and Von Thadden (2004) state, the possibility of joint bond issuance by euro-area countries has been repeatedly considered because of its ability to exploit fully the liquidity benefits, among others, of a unified market. They also suggest that this scheme has been discarded because it would generate an implicit debt guarantee by some countries in favour of others. Our tentative evidence, based on hedged yields, suggests that a common bond market with a common yield would reap liquidity benefits for all countries involved.

7. Summary and Conclusions

In this paper we study the determinants of EMU sovereign bonds yields and then present an estimation of the hypothetical risk free rate that a common bond would yield. To model the determinants of yield spreads we first propose a theoretical portfolio selection model to motivate the variable selection. Then for the period 2004 to 2009 we fit an unbalanced panel model, using as a benchmark a weighted average of the total gross debt issued by the governments of the different EMU members. We find that

⁴³ Such a proposal was made in 1999 with a view of harmonizing the maturity structures, delivering a true and single benchmark curve and helping reduce the cost that some member states have to pay to primary dealers in order to promote their debt outside the country (Favero et al., 2000). Adjaouté and Danthine (2003) proposal was met with considerable skepticism, because such a set-up implies some collective responsibility for national debts, which runs contrary to the Maastricht Treaty but they also argue that the debate on the establishment of a multilateral agency should be reopened.

⁴⁴ The annual average savings are obtained by multiplying the annual average debt outstanding in the EMU during the period 2003-2008 by the average annual profits in terms of yields for the period 2004-

credit quality, macro, correlation, and liquidity variables have a significant effects on EMU sovereign yield spreads. Robustness tests with different data frequency, benchmarks, liquidity and risk variables, cross section regressions, balanced panel and maturities analyses confirm the initial results.

Motivated by these results we try to answer the following question: What should be the yield of a common eurozone bond, free, at least to some extent, from the effect of the risk factors (credit, liquidity, macro, correlation) that influence the yield of individual sovereign bonds? We present an estimation of this hypothetical common risk free rate and show that average savings in borrowing costs for all EMU countries are positive irrespective of the maturity of the common risk free rate measure employed.

We realize that there are many complex institutional design features that must be resolved before an actual common bond issue for the eurozone could be a reality, but our paper provides a first insight into one central issue. Namely, what should be the required compensation a given country should pay to the formal issuer to be allowed to share a given issue of EMU-based single bonds. We argue that this compensation should be the CDS spread on a given country sovereign bonds. The benefits for a given country in using the common bond (instead of the sovereign) will be the enhanced rating and liquidity the common bond would provide plus additional premiums for country macro fundamentals, and exposure to global risk.

Our results may be interpreted as tentative evidence in favour of the hypothesis that a common bond and a common risk free rate in the EMU could produce substantial

2009 (see Panel A of Table 6). The average yield value is obtained as the average of the four different maturities.

savings in borrowing costs for all the countries involved. Looking forward, we expect more conclusive evidence on other common risk free rate measures as well as in other market segments. The procedures of this paper can also be applied to other sovereign bonds and common currency areas.

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Appendix I

We consider a domestic (benchmark) investor allocating a fraction θ_t (θ_t^*) of his real wealth w_t (w_t^*) to a domestic (D (benchmark, F) security and a fraction $1-\theta_t$ ($1-\theta_t^*$) to a benchmark (domestic) security. We assume that both the domestic and benchmark securities are subject to default risk. The default process is assumed to follow a correlated bivariate Bernoulli process (x_t, x_t^*) , with domestic (benchmark) default probability $1-P_t$ ($1-P_t^*$). In the event of default the investor receives a fraction τ_t (τ_t^*) of his gross domestic (benchmark) payment, $\tau_t \in [0, 1+r)$ ($\tau_t^* \in [0, 1+r^*)$) where r (r^*) is the interest rate on the domestic (benchmark) bond. There are proportional transaction costs l_t (l_t^*) decreasing with domestic (benchmark) market liquidity. The coefficient of risk aversion ρ is the same for both investors. The utility function of both the domestic and foreign investors depends positively on the expected real wealth, $E_t[w_{t+1}]$ and negatively on its variance $Var_t[w_{t+1}]$. The domestic investor maximizes the following mean-variance utility function:

$$E_t[w_{t+1}] - \frac{\rho}{2} Var_t[w_{t+1}] \quad (A.1)$$

where according to the previous notation, the expected wealth and variance of wealth are, respectively:

$$E_t[w_{t+1}] = (1+r_t)\theta_t w_t P_t + \tau_t \theta_t w_t (1-P_t) - \theta_t w_t l_t + \\ + (1+r_t^*)(1-\theta_t)w_t P_t^* + \tau_t^* (1-\theta_t)w_t (1-P_t^*) - (1-\theta_t)w_t l_t^* \quad (A.2)$$

$$Var_t[w_{t+1}] = (1+r_t - \tau_t)^2 \theta_t^2 w_t^2 P_t (1-P_t) + (1+r_t^* - \tau_t^*)^2 (1-\theta_t)^2 w_t^2 P_t^* (1-P_t^*) + \\ + 2w_t^2 \theta_t (1-\theta_t) (1+r_t - \tau_t) (1+r_t^* - \tau_t^*) Cov(x_t, x_t^*)$$

The domestic investor maximizes his corresponding utility function to obtain the optimal fraction of his wealth to allocate to the domestic bond, $\hat{\theta}_t$:

$$\hat{\theta}_t = \frac{(1+r_t)P_t + \tau_t(1-P_t) - l_t - (1+r_t^*)P_t^* - \tau_t^*(1-P_t^*) + l_t^* +}{\rho w_t \left[(1+r_t - \tau_t)^2 P_t (1-P_t) + (1+r_t^* - \tau_t^*)^2 P_t^* (1-P_t^*) \right.} \quad (A.3) \\ \left. + \frac{\rho w_t (1+r_t^* - \tau_t^*)^2 P_t^* (1-P_t^*) - \rho w_t (1+r_t - \tau_t) (1+r_t^* - \tau_t^*) Cov(x_t, x_t^*)}{-2(1+r_t - \tau_t)(1+r_t^* - \tau_t^*) Cov(x_t, x_t^*)} \right]}$$

The foreign investor maximizes his corresponding mean-variance utility function:

$$E_t[w_{t+1}^*] - \frac{\rho}{2} Var_t[w_{t+1}^*] \quad (A.4)$$

The foreign investor's expected wealth and variance of wealth are the following:

$$\begin{aligned}
E_t[w_{t+1}^*] &= (1+r_t)\theta_t^* w_t^* P_t + \tau_t \theta_t^* w_t^* (1-P_t) - \theta_t^* w_t^* l_t + \\
&\quad + (1+r_t^*)(1-\theta_t^*) w_t^* P_t^* + \tau_t^* (1-\theta_t^*) w_t^* (1-P_t^*) - (1-\theta_t^*) w_t^* l_t^*
\end{aligned} \tag{A.5}$$

$$\begin{aligned}
Var_t[w_{t+1}^*] &= (1+r_t - \tau_t)^2 \theta_t^{*2} w_t^{*2} P_t (1-P_t) + (1+r_t^* - \tau_t^*)^2 (1-\theta_t^*)^2 w_t^{*2} P_t^* (1-P_t^*) + \\
&\quad + 2w_t^{*2} \theta_t^* (1-\theta_t^*) (1+r_t - \tau_t)(1+r_t^* - \tau_t^*) Cov(x_t, x_t^*)
\end{aligned}$$

The foreign investor maximizes his utility function to obtain the optimal fraction of his wealth to allocate to the domestic bond, $\hat{\theta}_t^*$:

$$\begin{aligned}
\hat{\theta}_t^* &= \frac{(1+r_t)P_t + \tau_t(1-P_t) - l_t - (1+r_t^*)P_t^* - \tau_t^*(1-P_t^*) + l_t^* +}{\rho w_t^* [(1+r_t - \tau_t)^2 P_t (1-P_t) + (1+r_t^* - \tau_t^*)^2 P_t^* (1-P_t^*)]} \\
&\quad + \frac{\rho w_t^* (1+r_t^* - \tau_t^*)^2 P_t^* (1-P_t^*) - \rho w_t^* (1+r_t - \tau_t)(1+r_t^* - \tau_t^*) Cov(x_t, x_t^*)}{-2(1+r_t - \tau_t)(1+r_t^* - \tau_t^*) Cov(x_t, x_t^*)}
\end{aligned} \tag{A.6}$$

After imposing market clearing equation (1) and rearranging terms we get the final expression:

$$\begin{aligned}
r_t - r_t^* &= (l_t - l_t^*) + S_t \frac{\rho}{2} Var_t[(1+r_t - \tau_t)x_t - (1+r_t^* - \tau_t^*)x_t^*] - \frac{\rho}{2} (w_t + w_t^*) [(1+r_t^* - \tau_t^*)^2 P_t^* (1-P_t^*)] + \\
&\quad + \frac{\rho(w_t + w_t^*)}{2} [(1+r_t - \tau_t)(1+r_t^* - \tau_t^*) Cov(x_t, x_t^*)] + (1+r_t - \tau_t)(1-P_t) - (1+r_t^* - \tau_t^*)(1-P_t^*)
\end{aligned} \tag{A.7}$$

Appendix II

This appendix provides additional details about the definition, sources, and timing of the data used in the study.⁴⁵

1. Sovereign Yields Spreads. 3, 5, 7 and 10 years daily sovereign yields are obtained from Datastream. These yields are computed using “on the run” (benchmark) 3, 5, 7 and 10-year bonds at every moment of time. The dependent variable in equation (4) is defined as the difference between the domestic sovereign yield and the benchmark yield. The benchmark yield is defined as the weighted average of the EMU Government yields. The weights are proportional to the portion of debt outstanding by each of the EMU countries with respect to the total amount outstanding in the EMU. The general governments gross debt data employed to form the weights are reported in Table 1 and are obtained from the AMECO database.

2. Liquidity (total bond daily turnover volume). Liquidity is proxied by the total daily turnover volume reported in Datastream. The total turnover volume is obtained as the sum of the turnover volumes of all the sovereign bonds issued by a given country. This volume is reported in terms of monthly information on the average daily turnover volume per bond during a given month by Datastream. The turnover volume for the total number of bonds issued by a given Government derives from trades entered into TRAX. In equation (4), we employ the deviation of the logarithm of the domestic total bond daily turnover volume, in million of Euros, from the log of the benchmark total bond daily turnover volume, in million of Euros.

3. CDS. The daily CDS spreads in the study are obtained from the Datastream system. These CDS spreads are midmarket indicative prices for three, five, seven and ten year CDS contracts. In all cases, the CDS contract references the sovereign (as opposed to a central bank or some other entity). For all countries CDSs are Euro-denominated. CDSs quotes are given in basis points. In equation (4) the explanatory variable referent to CDSs is obtained as the difference between the domestic and benchmark (weighted average) CDS spreads lagged one day, in percentages.

4. Debt/GDP. This variable is the ratio between the general Government gross debt at nominal value and the GDP, obtained from Ecwin. As the frequency of the gross debt is annual, the frequency of this ratio is also annual. In equation (4), we employ the difference between the domestic and benchmark Debt/GDP ratios as explanatory variable.

5. Interact.(Debt). This variable is an interaction term representing the product of Debt/GDP and the monthly standard deviation of the domestic yield minus the benchmark yield. This variable has monthly frequency.

6. Trade Balance/GDP. This variable is the ratio between the net trade balances at the end of every month divided by the GDP. The net trade balance data as well as GDP data are obtained from Ecwin. The frequency of this ratio is monthly. The explanatory

⁴⁵ For yearly, quarterly and monthly data we use end of previous year (quarter or month) data. For instance, in the case of the Debt/GDP variable which has yearly frequency, we use the value at the end of 2004 for the whole year 2005. Thus, we are assuming that investors at any time in 2005 know the value of Debt/GDP variable at the end of 2004 but do not know its 2005 end-of-year value.

variable of equation (4) is obtained as the deviation of the domestic Trade Balance/GDP ratio from the benchmark equivalent ratio.

7. VIX (Global risk). This variable represents the overall global risk and it is proxied by the Chicago Board Options Exchange Volatility Index (VIX) (it is a measure of the implied volatility of S&P 500 index options). VIX is obtained from the Reuters system. We take the logarithm of VIX when we employ it as an explanatory variable. VIX has daily frequency.

8. Corr (domestic, benchmark). This variable is the monthly correlation between the domestic Government bond yield and the EMU benchmark bond yield. This correlation is reported for the 3, 5, 7 and 10 years maturities. The frequency of this variable is monthly.

9. Yield – CDS. This variable is the difference between the Government yield minus the CDS spread for the same maturity (3, 5, 7 and 10 years). The deviation of this variable from the benchmark equivalent measure is employed as dependent variable in equation (5). This variable has daily frequency.

10. Crisis dummy. This variable is a dummy variable which is equal to zero before August 9, 2007 and one afterwards.

11. Interaction of liquidity (bid-ask spread) and CDS lagged one period. This variable represents the difference (in basis points) between two interaction terms referred to the domestic country and the benchmark, respectively. The first interaction term is referred to the domestic country and represents the product of a liquidity premium or trading costs, which are measured by means of the bid-ask spread (in basis points) for the overall maturities, and the CDS spread (in basis points) for the 5-year maturity lagged one day while the second interaction term represents the benchmark equivalent measure.

Appendix III

Table A1: Determinants of the Government Hedge Yield

The table reports the results of the unbalanced panel regressions where the dependent variable is the country hedged yield. All the variables (dependent and explanatory) except the measure of global risk, the crisis dummy and the measure of correlation between the domestic Government and benchmark yields are presented in deviations from the value of the variable for the benchmark. We group the panels by country and maturity (3, 5, 7 and 10 years) such that we have, at most, 44 groups which form a global unbalanced panel. We estimate the coefficients of the determinants of deviations between yields by means of a Prais-Winsten regression with correlated panels corrected standard errors (PCSEs) and robust to heteroskedasticity, contemporaneous correlation across panels and serial autocorrelation within panels. The correlation within panels is treated as a first-order autocorrelation AR(1) and the coefficient of this process common to all the panels. Each element in the covariance matrix of the disturbances is computed with all available observations that are common to the two panels contributing to the covariance. Column (1) reports the results which are obtained without using the interaction of liquidity and CDS(-1) and the crisis dummy as explanatory variables and Column (2) reports the results without using the interaction of liquidity and CDS(-1) as explanatory variable but using the crisis dummy. The results presented correspond to the estimated coefficient and the *t*-statistic (between brackets).

Log (Total bond daily turnover volume)	0.005 (0.54)	0.004 (0.44)
Total debt issued divided by GDP	0.009 (2.48)	0.004 (2.40)
Interaction of total debt divided by GDP and the standard deviation of the domestic yield minus the benchmark yield	0.0002 (0.11)	0.0001 (0.05)
Net Trade Balance divided by GDP	0.114 (0.39)	0.130 (0.45)
Global risk measure: log(VIX index)	-0.087 (-4.99)	-0.089 (-5.00)
Correlation between domestic Government yield and EMU benchmark Government Yield	-0.004 (-0.17)	-0.11x10 ⁻³ (-0.00)
Dummy for the 3-year yield	-0.731 (-4.76)	-0.603 (-7.70)
Dummy for the 5-year yield	-0.457 (-3.26)	-0.408 (-6.35)
Dummy for the 7-year yield	-0.242 (-2.66)	-0.210 (-4.86)
Crisis dummy		-0.044 (-1.14)
Constant	3.266 (9.99)	3.676 (20.19)
Autorregressive (AR(1)) coefficient	0.993	0.991
R-squared	0.038	0.066
Observations	44062	44062
Number of groups	44	44
Observations per group	Minimum Average Maximum	202 1001 1294
Wald chi2 (10 df)	53.300	90.060
Prob. > chi2	0	0
Condition Index	22.220	24.580

Table 1: General Government Gross Debt

This table reports the total gross government debt outstanding at the end of the year for eleven EMU members for the period 2003-2008 in billions (milliards) of Euros. It also reports the proportion of the total debt outstanding by each of the EMU members.

		2003	2004	2005	2006	2007	2008
Austria:	Amount outs.	150.7	155.8	159.5	161	176.4	193.2
	% of the total	2.78%	2.75%	2.75%	2.73%	2.76%	2.77%
Belgium:	Amount outs.	273.2	278.6	279.7	281.2	308.7	325.7
	% of the total	5.04%	4.91%	4.82%	4.77%	4.83%	4.68%
Finland:	Amount outs.	67.24	65.05	65.54	63.03	62.14	71.61
	% of the total	1.24%	1.15%	1.13%	1.07%	0.97%	1.03%
France:	Amount outs.	1076.9	1145.4	1149.9	1208.8	1327.1	1531.6
	% of the total	19.87%	20.20%	19.83%	20.50%	20.78%	21.99%
Germany:	Amount outs.	1451.1	1521.9	1569	1576.6	1641.8	1752.7
	% of the total	26.77%	26.83%	27.05%	26.74%	25.71%	25.17%
Greece:	Amount outs.	183.2	195.3	204.4	216.4	237.2	254.1
	% of the total	3.38%	3.44%	3.52%	3.67%	3.71%	3.65%
Ireland:	Amount outs.	43.9	44.6	44.2	47.6	80.3	102.1
	% of the total	0.81%	0.79%	0.76%	0.81%	1.26%	1.47%
Italy:	Amount outs.	1444.6	1512.8	1582	1599	1663.6	1732.1
	% of the total	26.65%	26.67%	27.28%	27.12%	26.05%	24.87%
Netherlands:	Amount outs.	257.6	266.1	255.9	258.8	346.2	332.2
	% of the total	4.75%	4.69%	4.41%	4.39%	5.42%	4.77%
Portugal:	Amount outs.	84	94.8	100.5	103.7	110.4	123.4
	% of the total	1.55%	1.67%	1.73%	1.76%	1.73%	1.77%
Spain:	Amount outs.	388.4	391	389.4	380.7	432.5	545.4
	% of the total	7.16%	6.89%	6.71%	6.46%	6.77%	7.83%
Total:	Amount outs.	5420.84	5671.35	5800.04	5896.83	6386.34	6964.11
	% of the total	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

Source: Ameco Database. Economic and Financial Affairs, European Commission.

Table 2: Correlation between explanatory variables

This table reports the correlation between the dependent and explanatory variables employed in equations (4), (5) and (7). Gov. Yield refers to the difference between the domestic Government yield and the benchmark yield. CDS(-1) refers to the difference between the domestic and benchmark CDS spreads (in percentage) lagged one day. Liquidity represents the deviation of the logarithm of the domestic total bond daily turnover volume, in millions of Euros, from the log of the benchmark total bond daily turnover volume. Debt/GDP refers to the difference between the domestic and benchmark total gross debt outstanding at the end of the year divided by the corresponding GDP at that moment. Inter. (Debt) is an interaction term that represents the product of Debt/GDP and the standard deviation of the domestic yield minus the benchmark yield. Trade Balance/GDP refers to the deviation of the domestic net trade balance at the end of every month divided by the GDP from the benchmark equivalent measure. Global Risk is a measure of the overall risk which is obtained from the Chicago Board Options Exchange Volatility Index (VIX) and it is a measure of the implied volatility of S&P 500 index options. Corr(dom. & bnchmk y.) is the monthly correlation between the domestic Government bond yield and the EMU benchmark bond yield. Yield - CDS refers to the deviation of the domestic Government yield minus the CDS spread for the same maturity from the benchmark equivalent measure. Inter. Liq. (Bid-Ask) - CDS(-1) represents the difference (in basis points) between two interaction terms referred to the domestic country and the benchmark, respectively. The first interaction term is referred to the domestic country and represents the product of a liquidity premium or trading costs, which are measured by means of the bid-ask spread, and the CDS spread lagged one day while the second interaction term represents the benchmark equivalent measure. Crisis Dummy represents a variable which is equal to one during the crisis and zero otherwise. Gov. Yield is employed as dependent variable in equations (4) and (7) while Yield - CDS is the dependent variable in equation (5).

Observations = 44062	Gov. Yield	CDS(-1)	Liquidity	Debt/GDP	Inter. (Debt)	Trade Bal./GDP	Global Risk	Corr(dom&bnchmk)	Yield - CDS	Inter. Liq-Risk	Crisis
Gov. Yield											
CDS(-1)	0.849										
Liquidity	-0.014	-0.073									
Debt/GDP	0.290	0.142	0.600								
Inter. (Debt)	0.608	0.535	-0.016	0.180							
Trade Bal./GDP	-0.275	-0.144	-0.210	-0.476	-0.170						
Global Risk: log(VIX)	0.224	0.192	0.024	-0.045	0.540	0.011					
Corr(dom. & bnchmk y.)	-0.398	-0.481	0.241	0.137	-0.725	-0.045	-0.333				
Yield - CDS	0.311	-0.219	0.073	0.245	0.169	-0.208	0.053	0.115			
Inter. Liq. (Bid-Ask) - CDS(-1)	0.697	0.764	-0.062	0.146	0.584	-0.151	0.319	-0.453	-0.082		
Crisis Dummy	0.153	0.135	0.032	-0.059	0.404	-0.008	0.801	-0.216	0.011	0.213	

Table 3: Determinants of the deviations between the Government Yield and the Benchmark Yield

This table reports the results of the unbalanced panel regressions. The dependent variable is the deviations between the Government yields and the Benchmark yields which are obtained as the weighted average of the Governments yields of the different European Monetary Union countries in the sample. The weights are proportional to the portion of debt outstanding by each of the EMU countries with respect to the total amount outstanding by all these countries. Our database is formed by eleven EMU countries and spans from January 2004 to February 2009. All the variables (dependent and explanatory) except the measure of global risk, the measure of correlation between the domestic Government and benchmark yields and the crisis dummy are presented in deviations from the value of the same variable for the benchmark. We group the panels by country and maturity (3, 5, 7 and 10 years) such that we have, at most, 44 groups which form an overall unbalanced panel. We estimate the coefficients of the determinants of deviations between yields by means of a Prais-Winsten regression with correlated panels corrected standard errors (PCSEs) and robust to heteroskedasticity, contemporaneous correlation across panels and serial autocorrelation within panels. The correlation within panels is treated as a first-order autocorrelation AR(1) and the coefficient of this process common to all the panels. Each element in the covariance matrix of the disturbances is computed with all available observations that are common to the two panels contributing to the covariance. Column (1) reports the results which are obtained without using the crisis dummy as an explanatory variable and Column (2) reports the results using the crisis dummy as explanatory variable. The results presented correspond to the estimated coefficient and the *t*-statistic (between brackets).

	(1)	(2)
CDS(-1)	0.522 (34.68)	0.519 (34.19)
Log (Total bond daily turnover volume)	-0.011 (-5.85)	-0.011 (-5.92)
Total debt issued divided by GDP	0.144 (12.11)	0.148 (12.29)
Interaction of total debt divided by GDP and the standard deviation of the domestic yield minus the benchmark yield	1.234 (12.60)	1.187 (11.88)
Net Trade Balance divided by GDP	-49.049 (-6.39)	-48.639 (-6.27)
Global risk measure: log(VIX index)	0.013 (4.80)	0.011 (3.63)
Correlation between domestic Government yield and EMU benchmark Government Yield	0.076 (4.51)	0.073 (4.28)
Interaction of liquidity (bid-ask spread) and CDS(-1)	0.165 (2.57)	0.161 (2.50)
Dummy for the 3-year yield	0.013 (3.98)	0.013 (3.93)
Dummy for the 5-year yield	0.012 (4.27)	0.012 (4.22)
Dummy for the 7-year yield	0.005 (2.21)	0.005 (2.16)
Crisis dummy		0.011 (2.58)
Constant	-0.135 (-7.29)	-0.127 (-6.75)
Autoregressive (AR(1)) coefficient	0.900	0.901
R-squared	0.199	0.194
Observations	47904	47904
Number of groups	44	44
Observations per group	Minimum Average Maximum	202 1089 1294
Wald chi2 (10 df)	2835.130	2791.910
Prob. > chi2	0	0
Condition Index	20.190	27.160

Table 4: Determinants of the deviations between the Government Yield and the Benchmark Yield without including CDSs

This table reports the results of the unbalanced panel regression excluding the CDS variable, that is, the variables employed in this table are the same as in Table 3 with the exception of the deviation of the domestic CDS spread from the benchmark and the deviation of the domestic interaction between the CDS and bid-ask spreads from the benchmark corresponding interaction which are now excluded. All the variables (dependent and explanatory) except the measure of global risk, the measure of correlation between the domestic Government and benchmark yields and the crisis dummy are presented in deviations from the value of the same variable for the benchmark. We group the panels by country and maturity (3, 5, 7 and 10 years) such that we have, at most, 44 groups which form an overall unbalanced panel. We estimate the coefficients of the determinants of deviations between yields by means of a Prais-Winsten regression with correlated panels corrected standard errors (PCSEs) and robust to heteroskedasticity, contemporaneous correlation across panels and serial autocorrelation within panels. The correlation within panels is treated as a first-order autocorrelation AR(1) and the coefficient of this process common to all the panels. Each element in the covariance matrix of the disturbances is computed with all available observations that are common to the two panels contributing to the covariance. Column (1) reports the results obtained excluding the CDS(-1) variable, the interaction of liquidity and CDS(-1) variable and the crisis dummy. Column (2) reports the results obtained excluding both the CDS(-1) and the interaction of liquidity and CDS(-1) variables. The results presented correspond to the estimated coefficient and the *t*-statistic (between brackets).

	(1)	(2)
Log (Total bond daily turnover volume)	-0.014 (-4.53)	-0.015 (-4.64)
Total debt issued divided by GDP	0.221 (8.89)	0.228 (9.16)
Interaction of total debt divided by GDP and the standard deviation of the domestic yield minus the benchmark yield	0.882 (8.10)	0.839 (7.69)
Net Trade Balance divided by GDP	-42.481 (-3.36)	-41.766 (-3.31)
Global risk measure: log(VIX index)	0.014 (4.79)	0.012 (3.89)
Correlation between domestic Government yield and EMU benchmark Government Yield	0.032 (1.78)	0.030 (1.65)
Dummy for the 3-year yield	0.014 (2.07)	0.014 (2.07)
Dummy for the 5-year yield	0.013 (2.41)	0.013 (2.40)
Dummy for the 7-year yield	0.006 (1.31)	0.006 (1.30)
Crisis dummy		0.028 (5.08)
Constant	-0.074 (-3.55)	-0.073 (-3.53)
Autorregressive (AR(1)) coefficient	0.952	0.952
R-squared	0.014	0.015
Observations	47904	47904
Number of groups	44	44
Observations per group	Minimum Average Maximum	202 1089 1294
Wald chi2 (10 df)	245.420	281.150
Prob. > chi2	0	0
Condition Index	20.840	28.160

Table 5: Sensitivity Analysis of the Determinants of the deviations between the Government Yield and the Benchmark Yield

This table provides the sensitivity analysis of the determinants of the deviations between the Government yields and the Benchmark yields. All the variables (dependent and explanatory) excepting the correlation between the domestic and benchmark yields are presented in deviations from the value of the variable for the benchmark. Column (1) reports the results which are obtained without using the crisis dummy as an explanatory variable and Column (2) reports the results using the crisis dummy as explanatory variable. Each column reports the response, in basis points, of the dependent variable (deviation of the domestic Government yield from the benchmark yield) to a change equal to the average of the standard deviations of a given explanatory variable across countries over all dates. For this aim, we first calculate the standard deviation of each explanatory variable across countries at each date t . Then, we compute the average of these standard deviations for all the dates t and finally, we multiply this average by the corresponding coefficient (see Table 3). The standard deviation of variables: CDS spread (lagged one period); interaction of total debt divided by GDP and yield S.D.; correlation between Gov. yield and benchmark yield; and interaction of liquidity and CDS spread (lagged one period) are presented for a maturity of five years.

	(1)	(2)
CDS (lagged one period) spread	4.78	4.75
Total bond daily turnover volume	-1.70	-1.74
Total debt issued divided by GDP	3.57	3.67
Interaction of total debt divided by GDP and the yield S.D.	1.27	1.22
Net Trade Balance divided by GDP	-1.74	-1.72
Correlation between Gov. yield and benchmark yield	0.45	0.43
Interaction of liquidity (bid-ask spread) and CDS(-1)	0.01	0.01

Table 6: Determinants of the deviations between the Government Yield and the Benchmark Yield (Cross Section Analysis)

This table reports the results of the cross-sectional regressions. All the variables (dependent and explanatory) are presented in deviations from the benchmark. We run a cross-sectional regression by OLS for every date (1294) in the sample and calculate the average coefficient for the 1294 regressions which is reported in the first column. We find that the estimated slope coefficients present autocorrelation and for this reason, in the second column we report the t-statistic obtained from the Newey-West adjusted standard errors. These errors are obtained after regressing with Newey-West standard errors adjustment the loadings on each factor, which are shown in the first column, on a constant. The intercept that was included at the first stage is not reported. The third column reports the portion of cross-sectional regressions where the sign of the coefficient is the same as the expected sign. The fourth column shows the change in the dependent variable after a change in the explanatory variable equal to one standard deviation. Last column reports the portion of variance in the dependent variable explained by the corresponding explanatory variable. This proportion is calculated after multiplying the coefficient by the ratio of the standard deviations of the independent variable and the dependent variable. We report the results obtained using all the explanatory variables in Table 3 excluding the global risk, the crisis dummy and the correlation between domestic and EMU benchmark Government yields.

	Coefficient	Corrected t-stat	Right Sign (%)	1 S.D. change	Explained var. (%)
CDS spread lagged one period	0.861	15.21	0.808	0.068	0.256
Log (Total bond daily bond turnover volume)	-0.009	-5.98	0.566	-0.011	0.002
Total debt issued divided by GDP	0.075	10.49	0.658	0.018	0.009
Interaction of total debt divided by GDP and the standard deviation of the domestic yield minus the benchmark yield	1.884	29.730	0.727	0.017	0.024
Net Trade Balance divided by GDP	-46.220	-9.09	0.320	-0.016	0.015
Dummy for the 3-year yield	0.019	15.02	0.737	0.008	0.014
Dummy for the 5-year yield	0.016	13.29	0.688	0.007	0.007
Dummy for the 7-year yield	0.008	10.84	0.667	0.004	0.002
Interaction of liquidity (bid-ask spread) and CDS(-1)	1.916	4.800	0.505	0.005	0.009
Constant	-0.030	-21.25	0.264		
Average R-squared	0.736				
Cross-Sections with Condition Matrix Above 30	66				

Table 7: Determinants of the deviations between the Government Yield and the Benchmark Yield for different benchmarks

This table reports the results of the unbalanced panel regressions using an alternative benchmark: the German bond yield. All the variables (dependent and explanatory) except the measure of global risk, the measure of correlation between the domestic Government and benchmark yields and the crisis dummy are presented in deviations from the value of the variable for the benchmark. We group the panels by country and maturity (3, 5, 7 and 10 years) such that we have, at most, 44 groups which form an overall unbalanced panel. We estimate the coefficients of the determinants of deviations between yields by means of a Prais-Winsten regression with correlated panels corrected standard errors (PCSEs) and robust to heteroskedasticity, contemporaneous correlation across panels and serial autocorrelation within panels. The correlation within panels is treated as a first-order autocorrelation AR(1) and the coefficient of this process common to all the panels. Each element in the covariance matrix of the disturbances is computed with all available observations that are common to the two panels contributing to the covariance. Column (1) reports the results for the benchmark employed in Table 3 and it is equivalent to the second column of that table. The results in Column (2) are obtained by using the values of Germany as the benchmark. The results presented correspond to the estimated coefficient and the *t-statistic* (between brackets).

	(1)	(2)
CDS(-1)	0.519 (34.19)	0.439 (22.31)
Log (Total bond daily turnover volume)	-0.011 (-5.92)	-0.004 (-1.36)
Total debt issued divided by GDP	0.148 (12.29)	0.099 (4.37)
Interaction of total debt divided by GDP and the standard deviation of the domestic yield minus the benchmark yield	1.187 (11.88)	0.011 (8.61)
Net Trade Balance divided by GDP	-48.639 (-6.27)	-40.154 (-3.26)
Global risk measure: log(VIX index)	0.011 (3.63)	0.034 (3.78)
Correlation between domestic Government yield and EMU benchmark Government Yield	0.073 (4.28)	0.025 (1.07)
Interaction of liquidity (bid-ask spread) and CDS(-1)	0.161 (2.50)	0.358 (4.68)
Crisis dummy	0.013 (3.93)	0.120 (7.70)
Dummy for the 3-year yield	0.012 (4.22)	-0.026 (-2.33)
Dummy for the 5-year yield	0.005 (2.16)	-0.009 (-1.24)
Dummy for the 7-year yield	0.011 (2.58)	-0.006 (-1.08)
Constant	-0.127 (-6.75)	-0.052 (-1.46)
Autoregressive (AR(1)) coefficient	0.901	0.943
R-squared	0.194	0.107
Observations	47904	47904
Number of groups	44	44
Observations per group	Minimum Average Maximum	202 1089 1294
Wald chi2 (10 df)	2791.910	1344.340
Prob. > chi2	0	0
Condition Index	27.160	24.030

Table 8: Determinants of the deviations between the Government Yield and the Benchmark Yield using a balanced panel

This table reports the results of the balanced panel regressions. The data includes only ten of the eleven EMU countries and spans the period from March 2006 to February 2009. In order to have a balanced panel, Finland and the observations before the 27th of March are excluded. All the variables (dependent and explanatory) except the measure of global risk, the measure of correlation between the domestic Government and benchmark yields and the crisis dummy are presented in deviations from the value of the variable for the benchmark. We group the panels by country and maturity (3, 5, 7, and 10 years) such that we have, at most 40 groups which form a balanced panel. The estimation is done using Generalized Least Squares. The GLS procedure that we employ allows estimation in the presence of AR(1) autocorrelation within panels and cross-sectional correlation and heteroskedasticity across panels. Column (1) reports the results for the whole sample without using the crisis dummy as an explanatory variable and Column (2) reports the results using the crisis dummy as explanatory variable. The results presented correspond to the estimated coefficient and the t-statistic (between brackets).

	(1)	(2)
CDS(-1)	0.416 (40.12)	0.416 (40.03)
Log (Total bond daily turnover volume)	-0.013 (-8.00)	-0.013 (-8.07)
Total debt issued divided by GDP	0.207 (20.46)	0.208 (20.50)
Interaction of total debt divided by GDP and the standard deviation of the domestic yield minus the benchmark yield	0.245 (13.40)	0.235 (12.94)
Net Trade Balance divided by GDP	-38.713 (-6.44)	-38.536 (-6.39)
Global risk measure: log(VIX index)	0.006 (7.06)	0.005 (5.22)
Correlation between domestic Government yield and EMU benchmark Government Yield	0.011 (3.83)	0.010 (3.70)
Interaction of liquidity (bid-ask spread) and CDS(-1)	0.258 (5.78)	0.246 (5.48)
Dummy for the 3-year yield	0.003 (6.90)	0.003 (6.98)
Dummy for the 5-year yield	0.004 (11.99)	0.004 (12.05)
Dummy for the 7-year yield	0.001 (2.66)	0.000 (2.58)
Crisis dummy		0.006 (3.96)
Constant	-0.033 (-8.33)	-0.032 (-7.90)
Autorregressive (AR(1)) coefficient	0.896	0.897
Log likelihood	105576	105600
Observations	35040	35040
Number of groups	40.00	40
Time periods	876.00	876
Wald chi2 (10 df)	4343.320	4359.290
Prob. > chi2	0	0
Condition Index	19.260	26.380

Table 9: Determinants of the deviations between the Government Yield and the Benchmark Yield using different liquidity measures

This table reports the results of the unbalanced panel regression using alternative liquidity measures. Column (1) reports the results obtained using as liquidity proxy the total daily turnover volume, Column (2) reports the results obtained using the bid-ask spread (b.p.) as the liquidity measure and Column (3) shows the results obtained using as a proxy for liquidity the average daily turnover volume. This average volume is calculated as the ratio between the total daily turnover volume and the number of bonds issued by the corresponding country. The results presented correspond to the estimated coefficient and the t-statistic (between brackets). We estimate the coefficients of the determinants of deviations between yields by means of a Prais-Winsten regression with correlated panels corrected standard errors (PCSEs) and robust to heteroskedasticity, contemporaneous correlation across panels and serial autocorrelation within panels. The correlation within panels is treated as a first-order autocorrelation AR(1) and the coefficient of this process common to all the panels. Each element in the covariance matrix of the disturbances is computed with all available observations that are common to the two panels contributing to the covariance.

	(1)	(2)	(3)
CDS(-1)	0.519 (34.19)	0.537 (35.21)	0.519 (34.09)
Liquidity	-0.011 (-5.92)	0.256 (3.60)	-0.012 (-4.77)
Total debt issued divided by GDP	0.148 (12.29)	0.099 (8.85)	0.135 (11.38)
Interaction of total debt divided by GDP and the standard deviation of the domestic yield minus the benchmark yield	1.187 (11.88)	1.236 (12.36)	1.176 (11.77)
Net Trade Balance divided by GDP	-48.639 (-6.27)	-51.846 (-6.79)	-49.791 (-6.37)
Global risk measure: log(VIX index)	0.011 (3.63)	0.010 (3.39)	0.011 (3.63)
Correlation between domestic Government yield and EMU benchmark Government Yield	0.073 (4.28)	0.073 (4.31)	0.070 (4.14)
Interaction of liquidity (bid-ask spread) and CDS(-1)	0.161 (2.50)	0.047 (0.64)	0.162 (2.52)
Dummy for the 3-year yield	0.013 (3.93)	0.014 (4.00)	0.013 (3.90)
Dummy for the 5-year yield	0.012 (4.22)	0.012 (4.30)	0.012 (4.19)
Dummy for the 7-year yield	0.005 (2.16)	0.005 (2.25)	0.005 (2.16)
Crisis dummy	0.011 (2.58)	0.007 (1.74)	0.011 (2.60)
Constant	-0.127 (-6.75)	-0.116 (-6.22)	-0.121 (-6.44)
Autoregressive (AR(1)) coefficient	0.901	0.899	0.902
R-squared	0.194	0.199	0.191
Observations	47904	47904	47904
Number of groups	44	44	44
Observations per group	Minimum Average Maximum	202 1089 1294	202 1089 1294
Wald chi2 (10 df)	2791.910	2834.750	2729.960
Prob. > chi2	0	0	0
Condition Index	27.16	26.32	27.07

Table 10: Determinants of the deviations between the Government Yield and the Benchmark Yield using different liquidity measures with the corresponding maturity

This table reports the results of the unbalanced panel regression using alternative liquidity measures with the corresponding maturity (3, 5, 7 or 10 years). This table is similar to Table 10 but the liquidity variables are defined for different maturities. Column (1) reports the results which are obtained using as liquidity proxy the total daily turnover volume, Column (2) reports the results which are obtained using the bid-ask spread as the liquidity measure and Column (3) shows the results obtained using as a proxy for liquidity the average daily turnover volume. This average volume is calculated as the ratio between the total daily turnover volume and the number of bonds issued by the corresponding country. The results presented correspond to the estimated coefficient and the *t*-statistic (between brackets). We estimate the coefficients of the determinants of deviations between yields by means of a Prais-Winsten regression with correlated panels corrected standard errors (PCSEs) and robust to heteroskedasticity, contemporaneous correlation across panels and serial autocorrelation within panels. The correlation within panels is treated as a first-order autocorrelation AR(1) and the coefficient of this process common to all the panels. Each element in the covariance matrix of the disturbances is computed with all available observations that are common to the two panels contributing to the covariance.

	(1)	(2)	(3)
CDS(-1)	0.530 (35.38)	0.533 (31.76)	0.530 (35.32)
Liquidity	-0.007 (-5.65)	0.089 (4.59)	-0.007 (-4.87)
Total debt issued divided by GDP	0.137 (11.84)	0.108 (9.51)	0.128 (11.23)
Interaction of total debt divided by GDP and the standard deviation of the domestic yield minus the benchmark yield	1.220 (11.62)	1.235 (11.75)	1.217 (11.59)
Net Trade Balance divided by GDP	-53.750 (-6.63)	-56.165 (-6.92)	-55.223 (-6.79)
Global risk measure: log(VIX index)	0.011 (3.61)	0.010 (3.36)	0.011 (3.59)
Correlation between domestic Government yield and EMU benchmark Government Yield	0.083 (4.52)	0.083 (4.52)	0.082 (4.45)
Interaction of liquidity (bid-ask spread) and CDS(-1)	0.093 (5.21)	0.117 (1.64)	0.092 (5.19)
Dummy for the 3-year yield	0.013 (3.42)	0.013 (3.67)	0.012 (3.23)
Dummy for the 5-year yield	0.010 (3.77)	0.013 (4.85)	0.009 (3.26)
Dummy for the 7-year yield	0.003 (1.40)	0.006 (2.75)	0.002 (0.77)
Crisis dummy	0.009 (2.18)	0.007 (1.69)	0.009 (2.13)
Constant	-0.130 (-6.56)	-0.124 (-6.25)	-0.126 (-6.31)
Autorregressive (AR(1)) coefficient	0.901	0.901	0.901
R-squared	0.193	0.193	0.191
Observations	45256	45055	45248
Number of groups	44	43	44
Observations per group	Minimum Average Maximum	202 1029 1294	202 1028 1294
Wald chi2 (10 df)	2546.960	2499.170	2516.500
Prob. > chi2	0	0	0
Condition Index	19.83	26.50	26.93

Table 11: Determinants of the deviations between the Government Yield and the Benchmark Yield using the CDSs with the corresponding maturity

This table reports the results of the unbalanced panel regression using the CDS(-1) and the Interaction of liquidity (bid-ask spread) and CDS(-1) variables with the corresponding maturity (3, 5, 7 or 10 years). This table is similar to Table 3 but the CDS(-1) and the Interaction of liquidity and CDS(-1) variables are defined for the different CDS maturities. Column (1) reports the results which are obtained using the crisis dummy as explanatory variable. Column (2) reports the results without using the crisis dummy as an explanatory variable. The results presented correspond to the estimated coefficient and the *t-statistic* (between brackets). We estimate the coefficients of the determinants of deviations between yields by means of a Prais-Winsten regression with correlated panels corrected standard errors (PCSEs) and robust to heteroskedasticity, contemporaneous correlation across panels and serial autocorrelation within panels. The correlation within panels is treated as a first-order autocorrelation AR(1) and the coefficient of this process common to all the panels. Each element in the covariance matrix of the disturbances is computed with all available observations that are common to the two panels contributing to the covariance.

	(1)	(2)
CDS(-1)	0.209 (26.16)	0.210 (26.20)
Liquidity	-0.019 (-9.34)	-0.019 (-9.25)
Total debt issued divided by GDP	0.192 (16.51)	0.189 (16.30)
Interaction of total debt divided by GDP and the standard deviation of the domestic yield minus the benchmark yield	1.754 (17.25)	1.786 (17.91)
Net Trade Balance divided by GDP	-50.754 (-6.85)	-51.035 (-6.89)
Global risk measure: log(VIX index)	0.011 (3.37)	0.014 (4.59)
Correlation between domestic Government yield and EMU benchmark Government Yield	0.066 (3.63)	0.068 (3.77)
Interaction of liquidity (bid-ask spread) and CDS(-1)	0.954 (16.10)	0.958 (16.19)
Dummy for the 3-year yield	0.010 (3.04)	0.010 (3.04)
Dummy for the 5-year yield	0.009 (3.41)	0.009 (3.33)
Dummy for the 7-year yield	0.005 (2.23)	0.005 (2.25)
Crisis dummy	0.009 (2.13)	
Constant	-0.133 (-6.69)	-0.140 (-7.19)
Autorregressive (AR(1)) coefficient	0.884	0.884
R-squared	0	0
Observations	44055	44055
Number of groups	44	44
Observations per group	Minimum Average Maximum	202 1001 1293
Wald chi2 (10 df)	2801.440	2763.790
Prob. > chi2	0	0
Condition Index	26.68	19.87

Table 12: Determinants of the deviations between the Government Yield and the Benchmark Yield by maturity

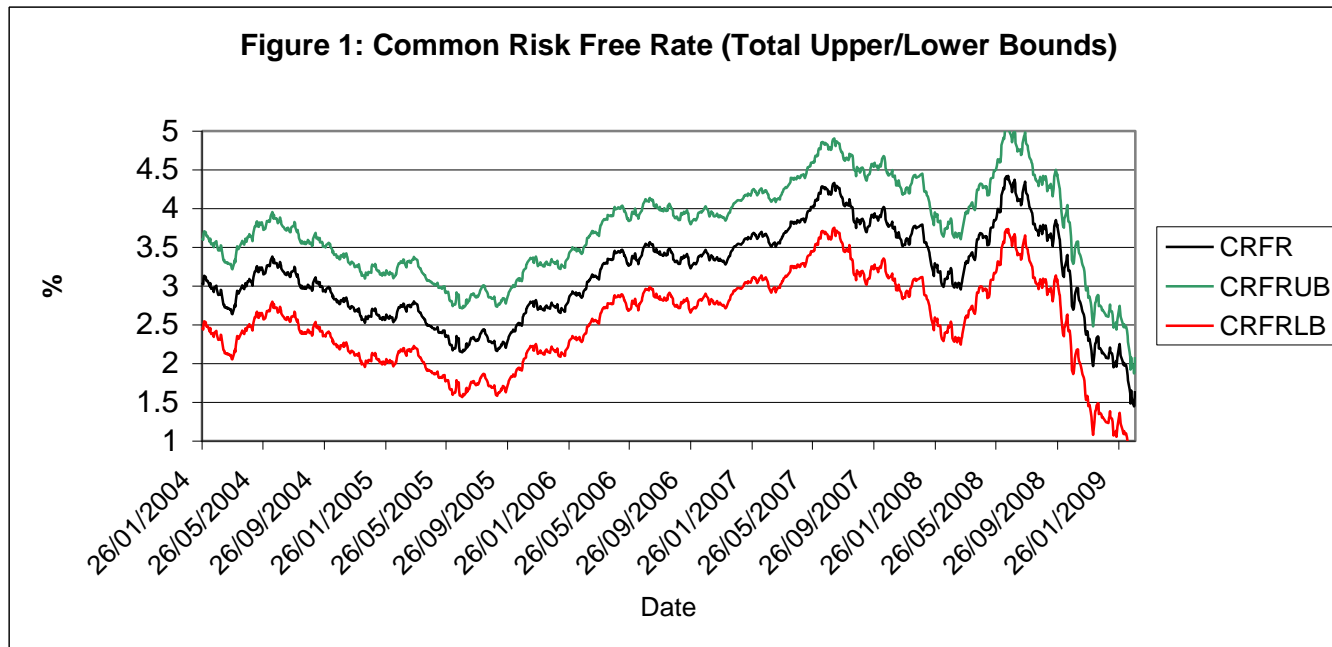
This table reports the results of the unbalanced panel regressions. The dependent variable is the deviations between the Government yields and the Benchmark yields which are obtained as the weighted average of the Governments yields of the different European Monetary Union countries in the sample. The weights are proportional to the portion of debt outstanding by each of the EMU countries with respect to the total amount outstanding by all these countries. Our database is formed by eleven EMU countries and spans from January 2004 to February 2009. All the variables (dependent and explanatory) except the measure of global risk, the measure of correlation between the domestic Government and benchmark yields and the crisis dummy are presented in deviations from the value of the same variable for the benchmark. We group the panels by country such that we have, at most, 11 groups for each maturity which form an overall unbalanced panel. We estimate the coefficients of the determinants of deviations between yields by means of a Prais-Winsten regression with correlated panels corrected standard errors (PCSEs) and robust to heteroskedasticity, contemporaneous correlation across panels and serial autocorrelation within panels. The correlation within panels is treated as a first-order autocorrelation AR(1) and the coefficient of this process common to all the panels. Each element in the covariance matrix of the disturbances is computed with all available observations that are common to the two panels contributing to the covariance. Columns (1), (2), (3) and (4) report the results for the 3, 5, 7 and 10 years maturities, respectively. The results presented correspond to the estimated coefficient and the *t*-statistic (between brackets).

	(1)	(2)	(3)	(4)
CDS(-1)	0.479 (19.13)	0.541 (28.87)	0.585 (38.08)	0.497 (30.51)
Log (Total bond daily turnover volume)	-0.013 (-4.79)	-0.012 (-5.06)	-0.010 (-4.91)	-0.010 (-4.46)
Total debt issued divided by GDP	0.082 (5.30)	0.117 (7.90)	0.166 (13.05)	0.223 (13.38)
Interaction of total debt divided by GDP and the standard deviation of the domestic yield minus the benchmark yield	1.717 (10.99)	1.310 (10.24)	1.097 (9.20)	0.688 (5.41)
Net Trade Balance divided by GDP	-31.024 (-2.83)	-34.535 (-3.59)	-40.182 (-5.10)	-86.617 (-9.34)
Global risk measure: log(VIX index)	0.008 (1.79)	0.012 (3.19)	0.014 (3.90)	0.009 (2.55)
Correlation between domestic Government yield and EMU benchmark Government Yield	0.119 (3.90)	0.121 (4.88)	0.082 (3.86)	-0.017 (-0.79)
Interaction of liquidity (bid-ask spread) and CDS(-1)	0.268 (2.51)	0.198 (2.51)	-0.026 (-0.38)	0.189 (2.69)
Crisis dummy	-0.009 (-1.46)	0.009 (1.64)	0.015 (3.12)	0.024 (4.84)
Constant	-0.157 (-4.95)	-0.168 (-6.30)	-0.135 (-5.83)	-0.027 (-1.18)
Autorregressive (AR(1)) coefficient	0.893	0.904	0.894	0.901
R-squared	0.163	0.208	0.272	0.205
Observations	11976	11976	11976	11976
Number of groups	11	11	11	11
Observations per group	Minimum Average Maximum	202 1089 1294	202 1089 1294	202 1089 1294
Wald chi2 (10 df)	1754.280	2039.130	2910.910	2487.630
Prob. > chi2	0	0	0	0
Condition Index	24.510	25.790	25.940	25.370

Table 13: Savings in borrowing costs derived from a single EMU bond

This table reports the estimated average savings by country and the overall EMU average savings, in basis points, for the maturities of 3, 5, 7 and 10 years derived from the existence of a single EMU bond market. We report the average savings for the period that spans from September 7th, 2005 to February 27th, 2009. The beginning of the sample is set in September 2005 in order to facilitate comparisons between countries due to the lack of CDSs data for some maturities before that date. CDSs are necessary to obtain the hedged yield which enables us to estimate the savings in borrowing costs. The Common risk-free rate that we propose is estimated by subtracting the effect of country specific risk factors, the liquidity factor and macro factors from the hedged yield. The effect of the previous factors is estimated by means of a Prais-Winsten regression with correlated panels corrected standard errors (PCSEs) and robust to heteroskedasticity, contemporaneous correlation across panels and serial autocorrelation (AR(1)) within panels. The dependent variable in the previous regression is the hedged yield, and the explanatory variables are the same as those in Table 4 but in absolute terms instead of deviations from the benchmark. In the last column we show the average profits (in basis points) in terms of yields for the overall EMU derived from the existence of a single EMU bond for the different maturities.

	Austria	Belgium	Finland	France	Germany	Greece	Ireland	Italy	Netherlands	Portugal	Spain	Average
3y Common Risk-Free Rate	29.6	35.3	43.1	33.1	29.1	40.4	22.8	32.9	31.4	36.6	29.3	33.0
5y Common Risk-Free Rate	30.2	36.1	45.3	33.6	29.7	38.8	25.2	33.1	31.7	34.1	28.3	33.3
7y Common Risk-Free Rate	31.6	36.8	44.8	34.0	30.4	36.8	24.1	34.7	32.7	31.6	27.1	33.2
10y Common Risk-Free Rate	30.8	37.1	41.6	33.2	30.1	37.2	19.2	34.4	34.4	37.3	26.9	32.9



The figure shows the estimated 5-year common risk free rate in the EMU area (CRFR) and the confidence bands around the CRFR. The common rate measure (CRFR) is obtained as the sum of an intercept on the hedge yields, a maturity adjustment, a crisis constant adjustment, the effect of the VIX Index on the hedge yields, and a residual after controlling for liquidity and macroeconomic variables using a Prais-Winsten regression with correlated panels corrected standard errors (PCSEs) and robust to heteroskedasticity, contemporaneous correlation across panels and serial autocorrelation. To estimate the lower (CRFRLB) and upper (CRFRUB) confidence bands, we employ the estimated lower and upper confidence limits of the 95% confidence interval for each parameter involved in the estimation of the CRFR.