The Determinants of the Yield Differential in the EU Bond Market

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Abstract

This paper provides a theoretical and empirical study explaining and analysing the existence and the development of bond yield differentials among EU eurobonds issued between 1991 and 2002. A discrete-time two-asset model explains that the yield differential between two countries that issue bonds in the same currency depends on their default probabilities, the liquidity of their bond markets, and the investors' risk aversion towards credit risk.

In the empirical part, we show that the interest differential between EU countries and the benchmark country Germany depends on the fiscal performance of the issuer states. The interest rate spread increases with the debt and deficit level of the issuer country. Also the investors' attitude towards credit risk helps to explain the bond yield spreads between EU countries and Germany. In periods of high risk aversion towards credit risk, which is measured as the yield differential between low grade corporate bonds and government bonds in the USA, the interest rate differentials tend to increase, which reflects the investors' tendency towards more liquid and risk-free bond markets.

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1 Introduction

The influence of the introduction of the European Monetary Union (EMU) on the EU government bond market has been subject of several discussions in the recent literature. It has been found that the introduction of the Euro has significantly affected the relative pricing of securities. The most obvious change with the start of the EMU in bond pricing was the removal of the foreign exchange risk within the euro area with the effect that euro-area government bonds are mainly only subject to liquidity and credit risk[1]. For that reason it was not surprising that one could observe during the first half of 1998 that long-term government bonds interest rates of member states of the EMU strongly converged to German long-term interest rates (compare Goodhard 1999).

But in the recent months the discussion was raised, whether the credit risk contained in government bond prices also changed with the introduction of the monetary union. The credit or default risk denotes the risk that the borrowing country may be unable to serve its debt or interest payment in time. With a credible no-bailout clause of the Maastricht Treaty, one would expect that the credit or default risk of member countries gained in importance, since the national governments lost their monetary sovereignty, and therefore the possibility to monetize and inflate their debt. Opposite to that assumption one could read in an article from Reuters published in June 2002 that the ability or need of financial markets to influence economic policy by reflecting fiscal performance of a country in its interest rate differential has disappeared or at least diminished since the launch of the monetary union in 1999. "'[...], German government bond yields are still below those of bonds issued by Austria and other states which have better budget positions."'[2] But the fact that Germany has still to pay a lower interest than other European countries with a better budget position, does not necessarily mean that the financial market does not value credit risk appropriately. Liquidity aspects may explain the main part of that interest rate advantage of Germany.

[1]The theory supporting the existence of default risk is given e.g. by Uribe (2002), who claims that "'under certain monetary-fiscal regimes, the risk of default, and thus the emergence of sovereign risk premia are inevitable"'. He finds that in monetary regimes, where the central bank pegs the price level, as well where the monetary authority follows a Taylor rule in the sense that that short term nominal interest rates are set as a function of inflation and the output gap, the government has to keep the option to default in order to avoid hyperinflations or hyperdeflations.

[2]compare Reuters fiscal related, 7. June 2002.

But also after controlling for liquidity and credit risk aspects to explain interest differentials between countries, economists recently claim that there seem to be other factors that affect these yield spreads. In periods of financial crises one can observe an increase of existing yield spreads between EU countries. For example a report of the Deutsche Bank Research published in 2001 found that e.g. during the Russian crisis in 1998 the interest differential in the euroarea substantially widened. It seems that in these periods investors flee to highly secure and more liquid bond markets, with the effect that the spread for EMU countries that already had a relative high interest spread compared to the other member countries, increased.

This article analyses, in how far the bond market values the default risk of high indebt EU countries correctly in the way that the bond yield differential between two countries really depends on the debt and deficit levels. It also answers the question in how far that risk valuing changed with the start of the EMU. An important point here is also to analyse, which influence the general investors' attitude towards credit risk has on the default risk premium demanded by investors. In periods of financial crises agents might value credit risk in general more severely which might increase the interest rate spread between a risky and a risk-free country. And finally we address the question, whether countries that belong to the European Union but did not join the European Monetary Union are treated differently on the international bond market than EMU member countries.

The paper proceeds as follows. Section 2 gives a short literature overview about recent empirical papers about bond yield spreads. Section 3 presents a discrete-time two-asset model two explain interest differentials between two countries. In section 4 the estimation equation and the data we use for the estimations are introduced. Section 5 gives detailed description of the estimation results and Section 6 concludes.

2 Literature Overview

The literature dealing with the analysis of default risk premia contained in bond yields can be broadly divided in three groups.

The first group of authors calculates the difference between the return from holding government debt and the return from holding 'safe' private debt of corresponding maturity, denominated in the same currency. An early paper by Alesina, De Broeck, Prati and Tabellini (1992) argues that if the return on private assets is higher than

that of public debt, that indicates that private assets are generally considered more risky than government debt. Their data sample included 12 OECD countries over the period 1974-89 and the results of a panel estimation gave evidence that in this time period the differential between public and private rates of return is positively related to the debt outstanding and to the debt growth. Flandreau Cacheux and Zumer (1998) estimated the link between indebtness and the cost of borrowing by regressing the spreads of government bond yields over the risk free British consul on the Debt to GDP ratio for a panel of 15 European countries between 1880 to 1913. In all regressions, the parameter on the debt level were generally found statistically significant and positive. Lemmen and Goodhart (1999) confirm a positive relation between the debt level of a country and the public/private sector yield differential. They assess the default risk of the EU-13 and EU-12 by the difference between 10-year benchmark and government debt yields relative to interest rate swap yields with the same maturity between January 1987 and September 1998. Additionally, they show that the bond yield differentials are expected to continue within EMU, despite evidence that government bond yield differentials vis-à-vis Germany have narrowed sharply in the observed time period.

A second method is to regard bonds issued by state governments of a federal state, because one can disregard also in this case inflation risk and expectations of exchange rate changes. Goldstein and Woglom (1991), Bayoumi, Goldstein and Woglom (1995) and Poterba and Rueben (1997) applied this method to the US municipal bond market for different time periods. They measured the yield of 20-year general obligation bonds of 39 US states relative to New Jersey. In all three articles the authors conclude that fiscal variables influence the yield differential, and that a higher debt level is associated with a higher yield spread. Lemmen (1999) used the bond yields of different federal states: Australia, Canada, and Germany. He compares the provincial-federal yield differential. Additionally to fiscal variables, he introduces a new variable, which he calls the "'World's appetite for credit risk"'. This variable is measured by the ratio of an index of emerging markets' sovereign debt and an index of G7 countries' sovereign debt. His main findings are that the "'World's appetite for credit risk"' variable is a key determinant of provincial-federal yield differentials and that in all three examples the debt to GDP level has a positive and significant influence on the yield spread.

The third method to get rid of the devaluation risk premium in bond prices is to regard debt issues denominated in a foreign currency. This is done by Lonning

(2000) and also mentioned by Alesina et al. (1992). Lonning (2000) compared the yield on various European countries' bonds issued in Deutsche mark by regressing the annual average of the daily interest rate differentials from 1994 to 1996 against macroeconomic variables which are supposed to be important factors influencing risk of default. They do not find large yield differences, but their regressions show a significant correlation between several of the chosen regressors and also the gross debt level. Alesina et al. (1992) critisized this method since countries have a small debt issue in international currencies. In addition, the market knows that each country has less to win and more to lose by defaulting in the international market, such that risk premia might be lower in the Eurobond market than in national markets. But with the launch of the Euro, the main currency in which EMU member countries issue their debt has been the Euro and the US$, which weakens and eliminates Alesina's et al. concern for these countries and time period.

3 A Portfolio Model of Interest Rate Differentials

3.1 The Basic Model

To construct a theoretical model which shows the effect of default risk on the interest rate differential between two open economies with perfect capital mobility, I will make use of a discrete-time two-asset model with applications of a mean-variance analysis. The main difference to the models described in the previous literature overview is the assumption that investors behave risk-avers in the sense that they dislike dispersion in their possible wealth outcomes. Agents prefer portfolios that generate the greatest amount of wealth with the lowest risk. That means that they try to maximize the expected payoff of an investment and to minimize the variance of it. Goldstein and Woglom (1992), Bayoumi, Goldstein and Woglom (1995), Lemmen and Goodhart (1999) and Lonning (2000) per contra assumed risk neutrality. They assumed that investors make their portfolio investment decision with the aim to maximize their expected wealth outcome only. Therefore, the result of their models was that the bond yield spread between two countries, where one country has a positive and the other one has a zero default probability, does only linearly depend on the default probability of the issuer country and is independent of any parameters that measure the risk attitude of agents or the liquidity of the bond markets.

Assume that a domestic investor maximizes a utility function which depends positively on the expected real wealth in the next period and negatively on the variance of future real wealth:

$$Max\ U\left\{E_t\left[w_{t+1}\right], Var_t\left[w_{t+1}\right]\right\},\ U_1 > 0, U_2 < 0. \tag{1}$$

Furthermore, he allocates a fraction θ of his real wealth w_t to a domestic security DB and a fraction of $1-\theta$ to the foreign security FB. Both securities and the real wealth are priced in the foreign currency, so that:

$$\theta_t w_t = DB_t \tag{2}$$

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

In addition, we assume that the investment in the domestic security is not free of default risk, while the investment in the foreign asset is risk-free. With a positive probability of $1-P(x_t)$ $(0 \leq P(x_t) \leq 1)$ the domestic country will be unable to serve its debt, and lenders will receive nothing in case of default.[3] The expected next period's wealth therefore is described by the following equation:

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

where $1+r_t$ is the gross nominal return during the time to maturity, $P(x_t)$ is the probability of no-default, where x_t indicates the variables that affect this probability. Thus, x_t consists of variables that describe the ability and willingness of the government to pay its debt. A detailed description of these variables is provided in section 3.3. An asterix in the equation indicates the corresponding foreign variables.

The objective function and the budget equations for a representative investor in the foreign country are analogue to the equations (1) and (3) of the domestic investor, and the expected next period real wealth for the representative foreign investor can thus be written as:

$$E(w_{t+1}^*) = (1+r_t)\theta_t^* w_t^* P(x_t) + (1+r_t^*)(1-\theta_t^*)w_t^*. \tag{5}$$

Due to uncertain return of the investment in domestic securities, the variance of the next period's real wealth of the domestic and the foreign investor is non-zero. From

[3] ??? showed in his paper that this simplifying assumption does not lead to different results as when we assume that investors still receive a proportion of their invested wealth in case of default.

$Var_t(w_{t+1}) = E_t\left[w_{t+1} - E_t(w_{t+1})\right]^2$ it follows that the variance of the future wealth of the domestic agent is described by:

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

and of the foreign investor by:

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

Maximizing the utility function given in equation (1) with respect to equation (4) and (6) (resp. equation (5) and (7)), yields the optimal share of initial wealth invested in domestic securities by the domestic investor, $\widehat{\theta_t}$ (resp. by the foreign investor, $\widehat{\theta_t^*}$):

$$\widehat{\theta_t} = \frac{P(x_t)(1+r_t) - (1+r_t^*)}{\Phi(1+r_t)^2 P(x_t)(1-P(x_t))}, \tag{8}$$

$$\widehat{\theta_t^*} = \frac{P(x_t)(1+r_t) - (1+r_t^*)}{\Phi^*(1+r_t)^2 P(x_t)(1-P(x_t))}, \tag{9}$$

where $\Phi = -2w_t U_2/U_1 > 0$ and $\Phi^* = -2w_t^* U_2^*/U_1^* > 0$ denote the coefficients of relative risk aversion for the domestic and the foreign investor, which is assumed to be constant over time. The higher the investor weights the variance of his or her future real wealth in his utility function, the bigger will be the variable Φ.

The total supply of domestic securities,SB, is assumed to be constant. The equilibrium condition for the domestic securities market requires that the total demand is equal to total supply, i.e. $SB = DB + DB^* = \widehat{\theta_t} w_t + \widehat{\theta_t^*} w_t^*$. Accordingly, the equilibrium condition is expressed by:

$$SB = \frac{P(x_t)(1+r_t) - (1+r_t^*)}{(1+r_t)^2 P(x_t)(1-P(x_t))}\left(\frac{w_t}{\Phi} + \frac{w_t^*}{\Phi^*}\right). \tag{10}$$

Solving the equilibrium condition for the interest rate differential yields:

$$\frac{r_t - r_t^*}{1+r_t} = 1 - P(x_t) + \frac{SB(1+r_t)P(x_t)(1-P(x_t))}{w_t/\Phi + w_t^*/\Phi^*}. \tag{11}$$

When we speak in the following about the interest rate spread or interest rate differential, we mean for simplicity the term on the left hand side of the equation, which is actually the interest rate differential between the two countries related to the gross nominal return of the domestic government bond.

As can be seen in equation (11), the bond yield spread between two countries, of which one is default risk free and the other one has a positive default probability, depends on two different terms. The first term on the right hand side, $(1 - P(x_t))$, can be called the *default risk premium*. It confirms that the interest rate differential depends positively on the default probability of the risky issuer country. That means, the higher the default probability of the domestic country, the bigger will be the default risk premium an investor will ask for in relation to the return he gets for a risk-free investment in the foreign asset.

The second term on the right hand side captures the effect of the risk-aversion of investors. In that point our result differs from the results of the models of Goldstein and Woglom (1992), Bayoumi, Goldstein and Woglom (1995), Lemmen and Goodhart (1999) and Lonning (2000). The total supply of bonds, SB, which denotes the liquidity of the bond market, influences the interest rate differential as well as the parameter of relative risk aversion of both investors, Φ and Φ^*. The more investors care about the variance of their future wealth w_{t+1}, that means the higher U_2, the bigger will be the interest rate differential between the risky and the risk-free country. And the bigger the market size SB, the higher will be the interest rate spread between these two countries. At the first view that result seems to be a little bit surprising, as one would expect that the bond yield decreases with the liquidity size due to a lower liquidity risk. As Lemmen (1999) points out, "liquidity risk is the risk that an investor may not be able to liquidate an investment in debt securities within a reasonable time at a reasonable price". In this sense, the bigger the size of the debt issue, the lower the liquidity premium a government has to pay investors for buying its government bonds. But on the other hand the size of the debt market may have an increasing effect on the bond yield spread between two countries, because high debt obligations mean an worsening in the credit standing of the issuer country and the yield demanded by investors will be higher, what is expressed in equation (11).

Thus, the model supports the hypothesis that not only the default risk premium explains the yield differentials of eurobonds issues in the European Monetary Union, but also the market size and investors' general risk-attitude. If a country has in comparison to another country a lower probability of no-default, but has the same bond market size and risk-attitude of investors, the first one has to pay a higher interest on its debt than the latter one. Holding the no-default probabilities constant, in periods of high risk-aversion of investors, the bond yield spread between a risky

and a risk-free country increases.

3.2 The Determinants x_t of the Government Default Risk

In this section we want to describe the factors that determine the no-default probability of a bond issuer country. In general, one can say that the determinants of the government default probability, x_t, reflect the ability and willingness of a country to service its debt.

In the previous literature the factors that determine the default or credit risk of a country have been discussed by various authors, and they can be broadly categorized into two groups. The first one are the *institutional* or *political* determinants. Some authors[4] have argued that e.g. budgeting procedures, that is the rules according to which budgets are drafted by the government, amended and passed by the parliament, and implemented by the government, may have important consequences for the sustainability of fiscal policy and fiscal stability. In other models it has been claimed that left-wing governments aim for a higher share of government spending in total output, and are perhaps even more willing to accept rising government budget deficits than do right-wing governments[5], which decreases the probability of no-default.

The second group, in which the factors x_t can be grouped are the *fiscal* determinants. In our analysis, we will focus on these factors. The fiscal determinants concentrate more on the *ability* of governments to repay their debt and less on their *willingness* to serve their debt. If financial markets value credit risk correctly, the interest rate which a country has to pay on its debt depends positively e.g. on the level of debt to GDP and the deficit level, since these criteria have a decreasing effect on the no-default probability. The latter can be summarized by $\delta P/\delta D < 0$, $\delta P/\delta d < 0$ and $\delta P/\delta I < 0$, where D denotes the debt to GDP level, and d the deficit to GDP ratio and I the debt service. In the literature one finds two different specifications of the relationship of the debt to GDP level and the interest rate differential between two countries.[6] One specification is to assume a linear relationship between these two variables and to claim that increased indebtedness is costly, but that the marginal cost of increased indebtedness is constant. The second specification claims

[4] see for example von Hagen (1991, 1992), and Eichengreen and von Hagen (1996)

[5] compare e.g. Hibbs (1977) and Frey and Schneider (1978)

[6] compare e.g. Bayoumi et al. (1995), Flandreau et al (1998).

that there is a non-linear relationship between the interest rate differential and the debt level of a country. This 'credit punishing' specification assumes that debt accumulation decreases the probability of no-default, such that borrowing costs and the interest spreads grow exponentially with the debt level. We want to investigate whether that theory also holds in the case of the EU countries in the sense that the bond markets push up the yields on bonds of countries with high debt and deficit levels.

Additionally we assume that the probability of no-default depends also on the overall economic situation of a country. In a time period of an economic recession the financial markets will value the risk of increasing and unsustainable debt levels more severely than in an economic boom. The argument behind is that the future ability to serve the debt depends on investments and income today and in the following next years. As investments and government's income decrease in a economic slow-down, this will negatively affect the probability of default.

Also the level of authority that issues the new bond may influence the default risk premium. State/Provincial or local authorities have less fiscal sovereignty and tax collecting capabilities than the central government. The no-default probability should therefore depend on the level of authority on which the bond is issued. One might assume that the default risk is smaller when a bond is issued by the central government than it is issued by the local or state government.

3.3 A Measure of the Risk-Aversion parameter Φ

If one assumes that investors behave risk-avers instead of risk-neutral our model suggest that not only the default probability determines the interest differential between two countries, but also the investors' attitude towards credit risk. Some empirical support for that idea came e.g. by a report of the Deutsche Bank Research publish in 2001, which says that in periods of financial crises around the world[7] the interest rate differential between EMU member countries widened. That idea was also mentioned by Lemmen (1999), who used the following example of two recent financial crises to support this hypothesis: State/provincial government bond yields in Australia, Canada, Germany, Switzerland and the US had dramatically dropped to the federal yield level just before the outbreak of the Asian crisis in 1997 and

[7]they mention f.e. the Russian financial crisis in 1998 or the recent currency crisis of Turkey.

the Russian default of August 1998. After the outbreak of these crises differences between provincial and federal yields widened considerably.

Thus, after periods of global financial crises or political/economical uncertainty investors eschew all kinds of risk, and their attitude shifts away from credit risk to more quality and liquid assets. This has the effect that the bond yield spread of countries, that were characterized already by a higher yield spread, increases even more. To control for these risk attitude effects, Lemmen introduced in his estimations a variable that he called the "'World's appetite for credit risk"', which is measured by the ratio of an index of emerging markets' sovereign debt and an index of G7 countries' sovereign debt. In our paper we introduce for the same reasons a variable that measures the yield spread between low grade corporate bonds (BBB) and government bonds in the USA. The intuition behind that variable is that it measures the perceived risk of corporate bonds in relation to relative safe government bonds and it serves therefore as a measure of risk-aversion of investors. Since one can regard the US government bond to be default risk free, that corporate bond spread measures the additional risk premium an investor receives when he buys a low grade corporate bond. The more risk-avers agents are, the higher will be the interest rate he ask for that risky corporate bond. Figure 1 illustrates the development of the corporate-government bond yield spread between 1990 and 2002. After the peak in the first month of 1991, when the yield spread counted more than 2.5 basis point, one observed a continuous downward trend of the corporate-government bond yield spread, which reflects the growing investors' optimism and willingness to take risk. In 1999, with the burst of the asset price bubble, the yield spread increases sharply by more than 1.5 basis points and fluctuates between 1.5 and 2 basis points in the years after, which illustrates the market participants' scepticism and risk aversion in that period.

4 The Data and the Estimation Equation

4.1 Data

The data of the yield spreads are provided by Capital DATA Bondware. We have chosen to compare government bonds issued by the 15 EU countries between 1991 and beginning of 2002 that are denominated on in DM and after 1998 in Euro.

Figure 1: Yield spread between US low grade corporate bonds and US government bonds

In this way, interest differentials will be net of expected changes in exchange rates between currencies.

The interest differential for the DM/Euro denominated bonds is measured as the difference in the yield to maturity between the national bond and an equivalent German government bond. Equivalent or comparable means here, that the bond issues should be similar in the time of issuance, the time to maturity and the coupon size. The whole data set consists of 185 DM/Euro bond spreads issued by all 15 EU countries.

The corporate spreads variable, which measures the difference between 7 to 10 year low grade corporate bonds (BBB) and 7 to 10 year benchmark government bonds in the USA, are provided by Meryll Lynch. All other macro variables are provided by the Ameco Database of the European commission.

4.2 A Descriptive Look at the Data

Figure 2 in the Appendix plots the yield spread of the central government bonds of the EU countries versus Germany over time. This figure shows a downward trend until 1998 and afterwards an upwards trend of the yield differentials of all EU

countries but Greece. Thus, while the bond yields of the EU countries converged in the early 90's to the benchmark values of Germany, they seem to diverge again with the start of the EMU.

Figure 3 in the Appedix plots the yield spreads of government bonds in relation to the debt differential between the European issuer countries and the benchmark country Germany. One observes in this graph a slight positive relation between the debt difference and the interest differential, which seems to be mainly driven by the observations of Greece. Although Belgium has in comparison to all other European countries a high debt level, its interest rate on its debt is not higher then for a lower indebt country like for example Denmark. Thus, also from the graphs one can expect that the inclusion of Belgium into the regression will lower the positive relation between the debt differential and the yield spread.

4.3 Estimating Equation

Since out data set consists of bond yields issued irregularly between 1991 and 2002 by the 15 EU countries, we make use of a cross-sectional time series regression of the following form:

$$S_{it} = \alpha + \lambda_t + \mu_i + \beta_1 Fiscal + \beta_2 Corp.Spread_{it} + \tag{12}$$

$$\beta_3 Corp.Spread_{it} * Fiscal + \beta_4 Instit + \beta_5 Control + \epsilon_{it} \tag{13}$$

where S_{it} denotes the yield spread of an bond issue in EU country i over the benchmark in currency j. $Fiscal$ describes a vector of fiscal variables that contains the gross debt to GPD ratio, the deficit to GDP ratio and the interest payment to revenue and also their squared values in order to capture non-linear effects. All these variables are measured in relation to the benchmark country Germany. We can support our first hypothesis, that the yield spread between EU countries can partly be explained by their default probability, when it turns out that the estimated coefficients on these fiscal variables are positive and significant.

The variable $Corp.Spread$ measures the yield spread between low grade corporate bonds (BBB) and benchmark government bonds in the USA in order to measure the general attitude towards credit risk of investors. Our model suggest that this variable should have a positive coefficient. The higher the spread between the corporate bond and the government bond is, the more investors regard government bonds

as safe heavens and flee away from credit risk. Additionally we estimate the effects of variables that interact the corporate spread with the fiscal variables in order to see, whether the default risk valuing differs with the general "'World's appetite for credit risk"'.

The word $Instit$ in equation (13) captures a vector of institutional dummies. One of them is the EMU dummy, that relates the value one to all the EMU member countries after 1999 and for Greece after 2001 and zero otherwise, and which we additionally interacted with the fiscal variables. If the second hypothesis is true, which sayes that with the start of the EMU the bond market values the default risk of the member countries differently than the one of the non-EMU countries, we will expect that dummy to be significant. Additionally, the $Instit$ vector contains the two dummies "'State/Provincial Authority"' (SA) and "'Local Authority"' (LA), that capture the authority level, which issued the new bond in order to distinguish between yields spread of bond issued on the central government level.

The vector $Control$ in equation (13) includes several control variables that also have an explainable effect on the bond yield spread S_{it}, and without them one would risk the problem of omitted variable bias. One of these variables is the variable $Maturity$, which is included in the regression linearly and in quadratic form. With the inclusion of that variable we allow for the possibility that the default premium may vary with time to maturity. With an increased time to maturity also the investors' uncertainty towards the credibility of the more risky country increases, which might cause them to ask for a higher risk premium.

Another factor we want to control for and which was already addressed by Alesina et al. (1992) is the influence of the business cycle on the bond yield spread S_{it}. For that purpose I created a variable which collates the value 1 when the detrended and standardized nominal GDP of the issuer country is bigger than 0.5 (boom), the value -1, when it is smaller then -0.5 (Recession) and 0 otherwise. In the regression I used again the difference between the related value of that variable of the issuer country and the benchmark country. If both countries are in a recession or in a boom, that would that the resulting difference is 0, if the issuer country is in a recession and the benchmark county is in a boom, the variable will carry the value -2 and a 2 if the situation is the other way around.

As proposed by our model and the theory of bond pricing, does also the size of the supply of government bonds may have an effect on the pricing of government

Variable	Desciption	Average	Std. Dev.	Min.	Max.
Spread S_{it}	The spread between the yield of a government bond issue of an EU country and a comparable goverment bond issued in the same currency related to the gross nominal return of the government bond issue. Expressed in basis points. Compare equation (11) . Source: Capital DATA Bondware.	27.77	19.33	-28.08	145.31
Debt	Difference of debt to GDP outstanding at the end of the fiscal year between the issuer country and the benchmark country. *Source:* European Commission (Ameco database)	9.80	20.76	-17.66	90.86
Deficit	Difference of deficit to GDP (including debt service payments) at the end of the fiscal year between the issuer country and the benchmark country. *Source:* European Commission (Ameco database)	0.05	2.06	-8.32	10.13
Debt Service	Difference of debt service payments to total revenue in the current fiscal year between the issuer country and the benchmark country. *Source* : European Commission (Ameco database)	0.02	0.04	-0.02	0.29
Corp. Spread	Spread between 7 to 10 years low grade corporate bonds (BBB) and 7 to 10 government bonds in the US to the time of issuance. *Source:* Meryll Lynch	1.47	0.44	0.76	2.20
Maturity	Time to maturity of the government bond issue measured in years. *Source:* Capital DATA Bondware.	9.13	5.61	1.60	30.10
Liquidity 1	The ratio of the issue size in Euro over the total gross debt of the issuer country in Euro. Source: Capital DATA B ondware, European Commission (Ameco database) and own calculations.	6.14	12.91	0.06	100.20
Liquidity 2	The ratio of the total debt of the issuer country over the total debt of the euro area. *Source:* European Commission (Ameco database) and own calculations.	13.11	9.70	0.96	25.71
Business Cycle	The difference of the business cycle variable between the issuer country and the benchmark county, which collates the value 1 when the detrended and standardized nominal GDP is bigger than 0.5, the value -1, when it is smaller then -0.5 and 0 otherwise.	-0.32	0.80	-1.00	1.00
SA	Dummy variable when the sovereign borrower is the State/provincial authority.	0.45	0.50	0.00	1.00
LA	Dummy variable when the sovereign borrower is the local authority.	0.10	0.30	0.00	1.00
EMU	Dummy variable for all member countries of the EMU after 1998.	0.45	0.50	0.00	1.00

Table 1: Variable Description and Summary Statistics

debt. On the one hand does the liquidity risk premium decrease with the size of the national bond market, on the other hand does the default probability of the issuer country increase with the liquidity size. Thus, from the theoretical standpoint, the impact of the liquidity size of bond markets on the yield level is ambiguous. To account for the influence of the bond market size we constructed two different liquidity variables. The first one, $liquidity1$ is the ratio of the issue size in Euro over the total gross debt of the issuer country in Euro. The second variable, $liquidity2$ is calculated as the ratio of the issuer's debt over the total debt of the Euro area in Euro.

All regressions are estimated either with country dummies (μ_i) to capture country specific effects, or year dummies (λ_t) to control for time specific effects. With the inclusion of country dummies, we focus on the time series component of the data. By controlling for year dummies, the estimation results reflect the cross-sectional component of the data.

A detailed summary statistic of all used variables is listed in table (1).

5 Estimation Results

Table 2 and 3 describe the estimation results for the DM/Euro denominated bonds. The estimations in these two tables differ in so far that the regressions in table 2 include year dummies and these in table 3 country dummies, that are jointly significant in all regressions. Thus, the results in the first table focus more on the cross-sectional dimension of the data, while these in the second table reflect more the time series dimension.

As one can see in both tables, 2 and 3, all three fiscal variables, the debt/GDP, deficit/GDP and debt service/revenue differential, have a positive and significant effect on the yield spread of the issuer country versus Germany, which supports our assumptions. The deficit and the debt service differential show increasing and the debt differential small decreasing marginal effects. The coefficients on the fiscal variables in the regressions that control for time fixed effects, are slightly bigger than those in the regressions, where country fixed effects are estimated. That means that within the EU countries the fiscal performance has less influence on the yield level than between the EU countries.

DM Bonds with Year Dummies							
	Regression						
	1	2	3	4	5	6	7
Constant	**-3.09**	**-3.38**	**0.81**	**-11.87**	**21.92**	**12.42**	**0.32**
	17.98	18.73	17.99	17.90	14.66	15.43	16.74
Δ Debt	**0.96 ***	**1.50 ****		**1.57 ****		**1.22 ****	
	0.52	0.48		0.29		0.54	
Δ Debt^2	**-0.01 ****	**-0.01 ****		**-0.01 ****		**-0.01 ****	
	0.00	0.00		0.00		0.00	
Δ Debt*EMU	**-1.41 ****	**-0.41**		**0.22**		**-1.09 ****	
	0.50	0.36		0.19		0.49	
Δ Deficit	**-0.62**		**5.24**	**0.56**			**0.01**
	2.39		3.51	2.65			2.42
Δ Deficit^2	**0.56 ****		**0.82 ****	**1.05 ****			**0.56 ****
	0.27		0.19	0.12			0.25
Δ Deficit*EMU	**1.00**		**1.61**	**4.92 ****			**0.88**
	2.52		2.42	2.22			2.04
Δ Debt Serv.	**212.88**				**60.54**	**-91.19**	**319.94 ****
	257.01				127.38	215.72	157.00
Δ Debt Serv.^{2}	**1329.05 ****				**1840.72 ****	**1950.29 ****	**865.35**
	665.98				415.37	582.95	591.43
Δ Debt Se.*EMU	**1272.92 ****				**299.49 ****	**985.22 ****	**457.05 ****
	331.90				124.74	331.81	123.24
Liquidity 1	**-0.74**	**0.29**	**-0.96**	**-0.54**	**0.06**	**-0.19**	**-0.59**
	0.53	0.66	0.65	0.55	0.61	0.64	0.52
Liquidity 2	**-1.12 ****	**-0.90**	**-0.76**	**-0.89**	**-1.65 ****	**-1.32 ****	**-1.41 ****
	0.55	0.62	0.63	0.58	0.55	0.54	0.56
Corp.-Spread	**12.13 ***	**14.92 ****	**5.74**	**12.67 ****	**3.56**	**7.81**	**9.48**
	6.73	7.47	7.25	5.99	6.04	5.76	6.53
Co-Spr.* Δ Debt	**-0.03**	**-0.09**		**-0.47 ****		**-0.32**	
	0.44	0.36		0.18		0.45	
Co-Spr.* Δ Deficit	**1.24**		**-1.67**	**0.48**			**1.80**
	1.94		2.43	2.00			1.77
Co-Spr.* Δ DebtServ.	**-270.07**				**-121.98**	**-7.96**	**-284.46 ****
	239.31				100.18	223.58	109.21
Co.Spr.*Liqu1	**0.46 ***	**0.00**	**0.42**	**0.40**	**0.03**	**0.22**	**0.38**
	0.25	0.33	0.33	0.27	0.31	0.33	0.25
Co.Spr.*Liqu2	**0.46**	**0.35**	**0.33**	**0.26**	**0.70 ****	**0.66 ****	**0.49**
	0.32	0.38	0.37	0.33	0.32	0.31	0.33
Maturity	**2.44 ****	**1.73 ****	**2.64 ****	**2.55 ****	**1.97 ****	**2.06 ****	**2.32 ****
	0.78	0.82	0.81	0.76	0.73	0.72	0.78
Maturity^2	**-0.03**	**-0.01**	**-0.03**	**-0.03**	**-0.02**	**-0.02**	**-0.03**
	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Bus. Cycle	**0.08**	**-2.57**	**0.74**	**0.65**	**-1.32**	**-0.88**	**0.15**
	1.54	2.00	1.68	1.53	1.51	1.54	1.65
SA	**18.53 ****	**17.31 ****	**6.87**	**22.81 ****	**18.01 ****	**15.51 ****	**21.80 ****
	5.22	6.38	4.61	5.29	5.50	5.10	5.63
LA	**16.53 ****	**18.22 ****	**12.55 ****	**20.65 ****	**17.89 ****	**15.69 ****	**19.15 ****
	5.00	5.41	5.38	4.99	5.55	5.20	5.22
EMU	**-13.78 ***	**8.57**	**-7.17**	**-4.74**	**-12.81 ***	**-9.13**	**-21.65 ****
	7.65	10.10	7.47	8.10	7.64	6.04	8.22
Country Dummies	**No**	**No**	**No**	**No**	**No**	**No**	**No**
Year Dummies	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
R^2	**0.73**	**0.49**	**0.59**	**0.68**	**0.65**	**0.71**	**0.68**
N	**185**	**185**	**185**	**185**	**185**	**185**	**185**

Table 2: Estimation Results for DM/Euro denominated Bonds

DM Bonds with Country Dummies							
	Regression						
	1	2	3	4	5	6	7
Constant	**68.47**	**105.96 ***	**75.31**	**63.25**	**60.10**	**82.94**	**64.47**
	61.54	62.14	51.59	58.02	55.78	60.30	58.47
Δ Debt	**1.08 ***	**1.06 ****		**1.02 ****		**1.52 ****	
	0.57	0.43		0.46		0.59	
Δ Debt^2	**-0.01 ****	**-0.01 ****		**-0.01 ****		**-0.02 ****	
	0.00	0.00		0.00		0.00	
Δ Debt*EMU	**-0.31**	**-0.52**		**-0.07**		**-0.45**	
	0.62	0.34		0.19		0.60	
Δ Deficit	**1.83**		**2.68**	**-0.92**			**2.39**
	3.19		2.83	3.32			3.09
Δ Deficit^2	**-0.19**		**0.39 ****	**0.56 ****			**-0.37**
	0.35		0.18	0.24			0.28
Δ Deficit*EMU	**-4.15**		**-1.65**	**-0.92**			**-6.12 ****
	3.41		2.25	3.25			2.55
Δ Debt Serv.	**-376.99**				**72.06**	**-362.38**	**-125.36**
	301.69				165.53	247.64	202.18
Δ Debt Serv.^{2}	**2173.81 ****				**1130.05 ****	**2768.29 ****	**1932.03 ****
	682.31				475.72	664.58	645.02
Δ Debt Se.*EMU	**140.66**				**191.95**	**130.05**	**144.16**
	447.61				124.28	447.67	142.80
Liquidity 1	**0.41**	**-0.13**	**-0.24**	**-0.74**	**0.92**	**0.43**	**0.81**
	0.69	0.72	0.63	0.71	0.65	0.52	0.65
Liquidity 2	**-5.09 ***	**-6.22 ****	**-5.27 ****	**-4.84 ***	**-4.44 ***	**-5.54 ****	**-4.94 ***
	3.02	2.93	2.56	2.86	2.69	2.94	2.85
Corp.-Spread	**10.65**	**-1.09**	**6.01**	**8.78**	**4.04**	**3.65**	**14.29 ****
	6.98	7.15	5.35	7.08	7.42	6.73	6.68
Co-Spr.* Δ Debt	**-0.23**	**0.12**		**-0.33 ***		**0.12**	
	0.46	0.28		0.17		0.41	
Co-Spr.* Δ Deficit	**1.26**		**1.12**	**3.03**			**1.78**
	1.89		1.99	2.13			2.03
Co-Spr.* Δ DebtServ.	**20.32**				**10.04**	**-95.65**	**-92.63**
	222.65				80.41	206.24	103.34
Co.Spr.*Liqu1	**-0.22**	**0.05**	**0.08**	**0.35**	**-0.44**	**-0.19**	**-0.43**
	0.36	0.34	0.30	0.34	0.32	0.25	0.33
Co.Spr.*Liqu2	**0.51**	**0.63 ***	**0.55 ***	**0.53 ***	**0.66 ****	**0.68 ****	**0.38**
	0.33	0.35	0.32	0.33	0.32	0.32	0.30
Maturity	**2.37 ****	**1.80 ****	**2.50 ****	**2.50 ****	**2.02 ****	**2.21 ****	**2.32 ****
	0.75	0.77	0.75	0.72	0.70	0.71	0.74
Maturity^2	**-0.03**	**-0.02**	**-0.03**	**-0.03**	**-0.02**	**-0.03**	**-0.03**
	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Bus. Cycle	**-1.77**	**-3.53 ***	**-1.22**	**-1.26**	**-3.34 ****	**-2.63**	**-1.63**
	2.00	1.88	1.81	1.89	1.72	1.86	1.85
SA	**15.75 ****	**15.69 ****	**16.86 ****	**16.54 ****	**15.46 ****	**15.08 ****	**16.60 ****
	7.43	7.48	7.01	7.09	7.75	7.59	7.23
LA	**17.78 ****	**17.31 ****	**17.97 ****	**18.19 ****	**17.48 ****	**17.45 ****	**18.21 ****
	5.50	5.69	4.91	4.98	5.79	5.75	4.98
EMU	**2.08**	**9.90 ***	**4.74**	**3.22**	**2.78**	**5.22**	**0.43**
	4.83	5.57	4.12	4.57	5.03	4.71	4.88
Country Dummies	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Year Dummies	**No**	**No**	**No**	**No**	**No**	**No**	**No**
R^2	**0.73**	**0.60**	**0.69**	**0.71**	**0.68**	**0.72**	**0.72**
N	**185**	**185**	**185**	**185**	**185**	**185**	**185**

Table 3: Estimation Results for DM/Euro denominated Bonds with Country Dummies

The estimation results give no clear evidence, if the influence of the fiscal variables on the interest differential changed for the member countries with the start of the EMU. In table 3, where we controlled for country fixed effects, the results support that the EMU membership has no significant effect on the relationship between fiscal performance and interest rate differentials. In table 2, where we controlled for time fixed effects, the results is not that clear. In regression (1) and (6) the coefficient on $Debt * EMU$ is significant and negative, which is probably due to multicollinearity effects between the debt and the debt service variable, since that variable turns insignificant, when it is estimated without the debt service variable. The coefficients of the interacted debt service variable and the coefficient of the interacted deficit variable in regression (4) in table 2 turn out to be significantly positive. Accordingly, these results explain that with the start of the monetary union, member countries are punished more severe for an increase in their deficit and debt service level than non-member countries.

Additionally to these findings, the estimation results in regression (1), (5) and (7) of table 2 support that the yield spread of EMU member countries decreased by around 15 basis points in comparison to non-member countries after 1998, since the EMU dummy there is negative and significant. In table 3 the coefficients on that institutional dummy are insignificant in all regressions but in regression (2), where the figure on EMU dummy is positive and weakly significant.

The relative issue size of the bond emission, which is expressed by the $liquidity1$ variable, shows to have no power to explain the variation of the bond yield spread of EU countries versus Germany. The coefficients of that variable turn out to be insignificant in both tables. The second included liquidity variable, that measures the relative size of the issuer's outstanding debt, is significant in four out of seven regressions when one controls for time fixed effects, and in all regression, when country dummies are included. The estimation results in table 2, which focus more on the cross sectional dimension of the data, give evidence that an increase of the relative debt size by one percent decreases the interest rate of the issuer country by around 1.5 basis points. The results in table 3, that stresses the time series dimension of the data, describe that the yield spread decreases by even around 5 basis points. That result supports the theory that bond yield spreads of EU countries versus Germany can partly be described by positive liquidity premia.

The variable $CorporateSpread$ turns out to be significant only in regression (1), (2), (4) in table 2 and in regression (7) of table 3. Supporting our model

results and assumptions does the yield spread between EU countries versus Germany increases with increasing investors' risk aversion, which is measured as the spread between corporate and government bonds. The risk valuation concerning the fiscal performance seems to stay unaffected by the level of the corporate spread. The coefficients of interacted fiscal variables turn out to be insignificant in nearly all regressions. The only exceptions are observed in regression (4) in both tables, where the variable $Corp.Spread * Debt$ is weakly significant and regression (7) in table 3, where coefficient of the variable $Corp.Spread * DebtService$, turns out to be significant and negative. One variable that gains influence, when the investor's risk aversion increases, is the relative debt market size of the issuer country, $liquidity2$. In two out of seven regression in table (2) and six out seven regressions in table (3) the estimation results give evidence that the positive affect of the corporate spread increases further when the relative debt market of the issuer country increases and vice versa. This shows that in periods of high risk aversion, the yield differential of countries with a relative big share of EU debt increases versus Germany, which supports our assumptions, that investors tend to flee in those periods to more secure bond markets.

The estimation results in both tables explain that the interest differential between an EU country versus Germany increased with the time to maturity. With every additional year of maturity the spread increases by about 2.2 basis points. The dummies SA and LA, which capture the effects when the bond is issued by state/provincial and local authorities instead of national governments, are positive and significant in all regression with included time as well country dummies. Thus, the default risk premium in bonds prices increases as expected by around 16 basis points, when the bonds are issued by a lower authority level.

6 Conclusion

This paper analyzes the determinants and also the development of the EU government bond yield spreads over the last ten years. One of the questions we addressed in this paper was, whether the financial market values the default risk of high indebt EU countries correctly in the way that their bond yield differential depends really on their debt and deficit level. Another focus of this work is to examine, whether with the start of the EMU member countries' fiscal performance is treated differently than that of non-member countries.

We first constructed a discrete-time two-asset model to explain the interest differential between a default risk-free and a country that has a positive default probability. While it was assumed in the previous literature that investors behave risk-neutral, we make the more realistic assumption that investors are risk-avers in the sense that they try to maximize the expected payoff of an investment and to minimize the variance of it. The result is that the bond yield spread is not only determined by the default probability of the issuer country, but also by the liquidity of the bond market and the relative risk-aversion of investors.

Afterwards we estimated the determinants of the EU yield spread of the government bonds issued in DM/Euro. The result is that the interest differential between EU countries can be explained by their fiscal performance. The yield spread between an EU countries versus Germany increases with their debt to GDP, deficit to GDP and debt service to revenue level. With a one percentage increase in national debt, the interest rate level of that country increases by around 1.20 basis points.

We could also confirm the assumption and the theory that the interest differential between EU countries can be explained by the issuer's debt market size. Countries that have a higher ratio of national debt over total EU debt have to pay lower interest rates than EU countries with a smaller bond market. Accordingly, the decreasing effect of the liquidity premium on the interest rate differential overbalances the positive effect of the corresponding default risk premium increase.

As proposed by our model, we included in the regressions a variable that captures the investors' risk aversion towards credit risk, which is measured as the yield spread between low grade US corporate bonds and US government bonds. The estimation results supported only in four out of 14 regressions the theory that investors ask for a higher risk premium for bonds of high indebt countries, when the overall risk aversion towards credit risk increases.

The estimation results do not support that the financial market treat the EMU member countries systematically different than non-member countries. Neither the included EMU dummy nor the interacted fiscal variables show a clear trend, whether one group of these countries is punished more severe for an increase in their fiscal variables than the other.

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A Figures

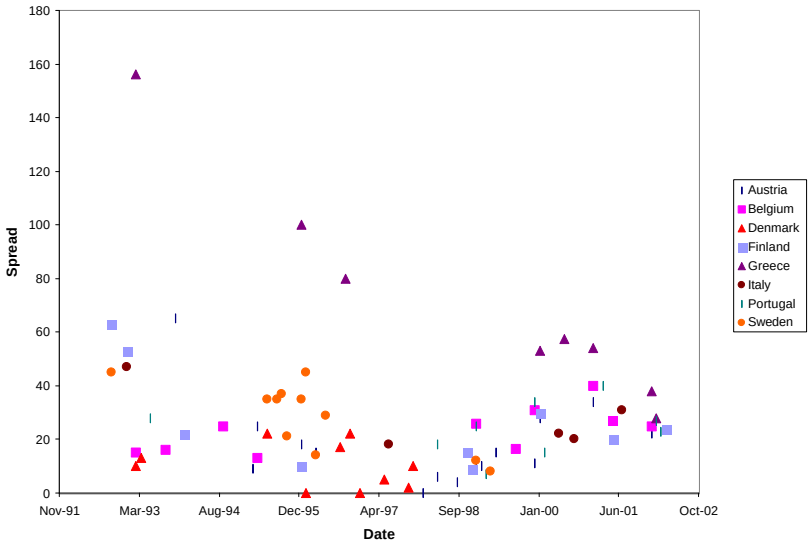

Figure 2: DM/Euro Bond Yield Spreads between 1992-2002

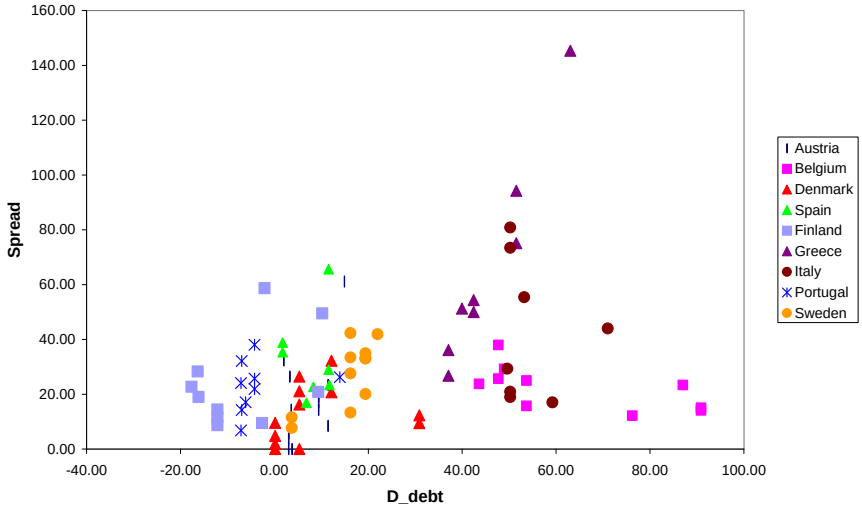

Figure 3: Bond Yield Spread in Relation to the debt to GDP level, DM 1991-2002