Default Premia on European Government Debt

By

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Abstract: This paper addresses the question of the existence and size of a risk premium in the Eurobond market. We measure the yield difference between German government bonds and bonds issued in Deutsche Mark by several European countries. The results are regressed against macroeconomic variables supposed to be determinants of the risk of default on government debt. Our yield differences are smaller than those found between US states. However, some of our macroeconomic variables seem to be good predictors of yield differentials. A natural conclusion is that yield differentials partially are related to risks perceived by market participants.

JEL : E43, E44, F35, F36, H63.

Keywords: Bond Yield, Default, EMU, Government Debt, Risk Premium.

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I would like to thank Steinar Holden, Asbjørn Rødseth, Bent Vale, and Erling Vårdal for valuable comments on this or earlier versions of the paper. In addition, colleagues at Norges Bank (the Norwegian Central Bank) were helpful in discussing this work and The Market Operations Department at Norges Bank provided access to the Bloomberg data system to obtain bonds data. Christian Knivsberg provided useful information about the bond market.

I. Introduction

The planning and introduction of a monetary union in Europe has led to discussions about how national budget deficits can be contained. Given a common currency individual countries in the European Union will no longer have a possibility of monetizing government debt. Also, in a market with decreasing trade restrictions and higher mobility the scope for tax increases to cover budget deficits is limited. Large budget deficits in one country may create pressure on the European Central Bank or the community in general to help solve a debt problem, if they are not willing to let one country default on its debt.

A crucial question is the market's response to a country's wish to increase its liabilities. Several theoretical studies show how the supply curve for loans can be increasing, and even backward bending, when the possibility of default increases with outstanding debt (e.g. Stiglitz and Weiss, 1981). Given a backward-bending supply curve there is an upper limit to the amount that can be borrowed. Before the country meets this quantity constraint, the borrower must promise to pay a higher interest rate to compensate for the increased possibility of default. The higher promised interest rate will increase the cost of borrowing and signal that the market perceives a certain risk of default, thus providing an incentive for the country to slow down on further borrowing. It has also been suggested that within a monetary union a high default premium could be used as a trigger for intervention from central authorities.

Several studies have been made of the US municipal/state bond markets, trying to trace risk premia and the shape of the supply curve. Goldstein and Woglom (1992) show that yield differences on bonds issued by different US states are correlated with the level of state debt and budget deficits. Yields on bonds issued by different states differed by up to 0.84 percentage points, or 84 basis points, in 1989 and 170 basis points in 1982. These results indicate that the public demands a certain compensation for expected risk of default on state bonds, even if default on state debt is a rare event in modern American history.

Some studies have been performed on European data. Giovannini and Piga (1992) discuss the differential between the interest rate on an Italian government bond issued in the Eurodollar market and a comparable World Bank bond issued in the global market. They conclude that, of the total differential of between 20 and 40 basis points, only a small part may be due to fears of the government repudiating debt.

Alesina, De Broeck, Prati and Tabellini (1992) compare the interest rates on public and private financial instruments denominated in the same currencies in 12 OECD countries. They find a strong correlation between the degree of public indebtedness and the interest spread between private and public rates of return, which they interpret as proof of the existence of a small but significant default premium on public debt.

For a bond issued in a national currency the risk involved is related both to the possibility that the government stops payments and to the possibility of monetization of the debt, leading to inflation and devaluation of the national currency. By comparing private and public bonds issued in the same currency, Alesina et al. (1992) avoid premia due to devaluation expectations. On the other hand, it can be hard to tell whether variation in the discrepancies between the interest rate on public and private bonds is due to variation in public or private interest rates between countries. And even if private debt per se was subject to much the same default risk level across countries, any dependency between default risk on public and private financial instruments would bias the results.

Alesina et al. (1992) also present a table of interest differentials between a country's bond issued in an international currency in the Eurobond market and a comparable bond issued by the IBRD[1] or the European Investment Bank. From this table they conclude that the differentials do not show any evidence that more highly indebted countries have to pay a higher risk premium. They point out that the explanation might be that most countries have a very small debt issue in international currencies, and that the market knows that each country has less to win and more to loose by defaulting in the international market, so that risk premia might be lower in the Eurobond market than in national markets.

In this paper we pursue the search for a risk premium on government bonds in the European market, and more specifically we ask whether there exists a default premium also in the Eurobond market. Like Giovannini and Piga (1992) we compare bonds issued in the same currency, but by including a number of European countries, we are able to analyze systematically the extent to which these differentials relate to different risk factors. Thus, we address whether a similar relationship exists between interest rate on government debt and risk factors for a number of European countries, as some studies have found for US states and as Alesina et al. (1992) have found in their study.

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[1] International Bank of Reconstruction and Development

We compare the yield on various countries' bonds issued in Deutsche Mark and regress the yield differences against macroeconomic variables supposed to be important factors influencing risk of default. The yield differences we find are not large, but our regressions show a significant correlation between several of the chosen regressors and yields, which indicates that the yield differences may be due to the perceived risk of default.

The bonds we have chosen to study are quite similar concerning maturity date, coupon size and redemption value, but not entirely equal. We try to make estimates of the possible errors introduced by differences in each of these characteristics. The errors do not seem to be large enough to influence the overall conclusions of the analysis.

The paper is organized as follows: Section 2 gives a brief presentation of the underlying theory for default premia in the market for public bonds. Section 3 discusses issues involved in measuring default premia and the choice of right hand side variables. Regression results are presented in Section 4, and conclusions in Section 5.

II. Theory: The Market for Public Bonds

Our aim is to quantify the supply side, in this case the supply of funds, in the market for public bonds. We assume, as is normal in this literature, that every country is small enough to take the risk-free price of funds as given. Nevertheless, they are not going to face the same price or interest rate, as the risk of default may vary between countries. The following presentation of the theory is based largely on Goldstein and Woglom (1992).

The Supply of Funds

The lender is concerned with the expected return on an investment, which depends on the promised interest rate and the probability of default; that is, the likelihood that the borrower will default on its commitments. For the lender the expected return should be equal on all investments at the margin. In the case of risk neutrality, one dollar invested in a one period public bond should give the same expected repayment at the end of the period as a risk-free investment over the same period:

$$1+E=(1+y)(1-p)=1+r, \qquad (1)$$

where E is the expected return on the bond, y is the promised return, p is the probability of default, and r is the risk-free rate; i.e. the lender receives nothing in case of default.[2]

Rearranging equation (1) gives us an expression for the default premium:

$$y-r=\frac{(1+r)p}{(1-p)}. \qquad (2)$$

Thus, the promised interest rate has to increase with p in order to keep the expected return constant. p is determined by the expected ability and willingness of the country to service its debt in the future. This ability depends again on: (i) the size of future debt, and (ii) future income potential to service the existing debt.

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[2] Yawitz et al. (1985) argues that this all-or-nothing specification is not a severe limitation as it can easily be interpreted as capturing the expected value of a more complex payment stream.

Large current and previous borrowing means that the country has a debt service burden which might increase the possibility of default. Increased borrowing will at the same time lead to a higher interest rate which makes the burden of new debt even harder. These two effects will result in an increasing relationship between borrowing and promised interest rate (e.g. Stiglitz and Weiss, 1981)). The expected return for the lender will be the same along the curve as the higher promised interest rate is just sufficient to cover the potential loss of a larger default probability.

The interest differential (*y*-*r*) is a simple function of *p* on a one period bond, as seen from equation (2). As shown in Yawitz et al. (1985), the same holds for a multi-period bond with *p* constant over time.

Equation (3) defines implicitly the promised yield to maturity for a bond with *n* periods left to maturity:

$$K = \sum_{i=1}^{n} \frac{Ci}{(1+y)^i}. \tag{3}$$

K is the price in the secondary market, C_i is the cash flow in period *i* and *y* is the promised yield. Assume that the possibility for default in each period, conditional on default not having occurred in earlier periods, is the same and equal to *p*. The expected cash-flow in each period will then be $C_i\,(1\text{-}p)^i$, and risk neutrality implies that the value of the bond is:

$$K = \sum_{i=1}^{n} \frac{C_i(1-p)^i}{(1+r)^i}. \quad (4)$$

By comparing (3) and (4) we see that *y* must be given by:

$$\frac{1}{(1+y)} = \frac{(1-p)}{(1+r)}, \quad (5)$$

which is the same as (1). As discussed by Yawitz et al.(1985) these results can be generalized to a case with risk aversion.

Risk Premium and Default Premium

In the previous section we assumed risk neutrality. Introducing any other attitude towards risk makes it important to distinguish between default premia and risk premia. The former is meant to cover the expected loss incurred from a possible default, the latter should compensate the lender for the increased risk on the total portfolio resulting from the risk of default. The default premium will always be non-negative. If investors are risk averse the risk premium can be either positive, negative, or zero as the probability of default on one investment might be offset by risk on other assets. Investing in government bonds issued by an oil exporting country can typically offset risk tied to bonds issued by an oil importing country. Given risk neutrality the risk premium will be zero.

The observed yield differential in the market is the total premium. The premium will be due to default risk, but it is hard to distinguish between the direct compensation for expected default and the risk premium. A higher risk of default will increase the compensation needed to keep expected yield at the same level. The risk premium can go either way, but a decrease in the risk on the entire portfolio can not be large enough to offset entirely the direct compensation for the higher default risk. What we can say is that a higher risk of default will give a higher sum of the two, that is, a higher total default premium. In addition, a higher debt outstanding will in itself lead to a higher risk premium, as this debt will be a larger part of investors' portfolios.

Questions of Methodology

If the size of the default premium affects demand for loans there may be a problem of identification and simultaneous equation bias. In order to interpret our observations as lying on the supply curve for government funds we need to assume that the main causes of variations in observations between countries is different levels of demand for credit. The existence of exogenous factors affecting demand and not supply will ensure identification, and as long as the main causes of differences in demand are independent of factors determining supply the simultaneous equation bias should be limited.

In addition, a variety of factors may influence default possibilities and thereby supply. This means that if we estimate the supply curve with lending size as the only independent variable we may have left out some variables of significance to supply, and this will bias the coefficient for lending. In the empirical analysis we try to avoid this bias by running regressions including other variables as determinants of supply.

II. Data

Measuring Risk Premia

Ideally, we would like to compare a set of bonds that are equal in all respects, except that they are issued by different governments; that is, bonds that are issued in the same currency at the same time, mature at the same time, have the same coupon size, and have the same amounts issued. The yields on these bonds should be compared to the yield on a third-country risk-free bond with the same characteristics.

But the number of bonds issued is limited, so we are restricted to comparing bonds that are «almost» equal to a third country's bonds. Furthermore, it is questionable whether we can find a third country whose government bonds are risk free.

We have chosen to compare government bonds denominated in German Mark (DEM). In this way interest differentials will be net of expected changes in exchange rates between currencies. DEM is chosen as the common currency as many of the countries we want to compare issue bonds in DEM. At the same time this leaves German government bonds as a useful bench mark for comparison.

The interest differential we measure is the difference in yield to maturity between the national bond for each country and an equivalent German government bond. We compare the annual average of the daily interest rate differential from 1994 to 1996, which means that we have three observations for each set of bonds compared. Prices, and thereby interest rates or yields, are set by different bond trading firms every day. As daily prices are more subject to short term overreactions in the markets, we choose to use an annual average which will eliminate the daily volatility in prices.

Ideally, we would estimate a reference path for German government bonds and compare all other bonds to this path, but the combination of possible non-linearity of the yield curve and a limited amount of data makes estimation of the path for the entire period difficult. Also, by imposing a certain structural form we will necessarily introduce some errors that may affect the yield differentials as these are relatively small. A look at the yield curve suggests that a linear approximation would come quite close for some years, but not for others. Thus, we have chosen instead to compare each national bond to the German bond closest in time to maturity and coupon size, with a priority to the former given that coupon size difference does not exceed 5/8. To compensate for the differences in maturity and coupon size that still exist, we adjust the observed yield differential as follows:

- Add 1 basis point per 1/4 of a percentage point difference in coupon size between the national and the German bond. The higher coupon size gives the higher yield.
- Add between -1 and +5 basis points per month difference in time to maturity between the two bonds, depending on the period in question.

The effect of the adjustment is limited, however, as the maximum differences between the bonds that we compare are:

- 5/8 of a percentage point in coupon size
- 2 months in time to maturity

In the next section we summarize briefly how the adjustment terms have been calculated by analyzing the German yield curve. A further discussion of this process is available on request from the author.

An alternative way of comparing yields on bonds with different characteristics would be to create a portfolio with the same duration and convexity for each country and then compare to the portfolio of a third country. However, this approach requires that each country has issued at least two bonds large enough to be included for the whole observation period, which is not the case. In addition, calculating a portfolio's duration and convexity requires information about spot rates that is not readily available.

Even when correcting for time to maturity and coupon size, different bonds will be more or less liquid. For instance, some issues may to a larger extent be bought by long-term investors which means that these bonds will be traded less often. This is a factor we will not be able to quantify, but we have chosen 1 billion DEM as a minimum size of an issue in order to increase the possibility that the bonds are traded regularly and thereby securing a certain comparability between bond prices and yields[3]. We found data for government bonds of the size of at least 1 billion DEM for 11 countries. Most of the countries had only one issue large enough to be included, either a 5-year or a 10-year bond. Altogether, we have included observations of 13 national bonds that have been compared to German bonds.

Bond descriptions and yield data are all collected from the Bloomberg data base on financial

[3] That prices are given daily does not necessarily mean that bonds have actually been traded, as many price givers are required to set daily prices.

markets, available through Norges Bank (Central Bank of Norway). Prices set by different price givers vary somewhat. We have chosen to use the Bloomberg Generic price, which is constructed as a combination of prices given by a large number of price givers.Ideally, the study would have included more countries and data also for previous years. However, some countries issue only bonds denominated in a limited variety of currencies. For instance, France issues bonds only in French Francs and ECU, while Switzerland and the Netherlands issue bonds only in their own currency[4]. For previous years the data material is limited. There seem to be more and larger bonds issued in international currencies starting in the early 1990's, possibly reflecting fewer restrictions in financial markets and increasing government debt that needs financing.

The Importance of Differences in Time to Maturity, Coupon Size, and Amount Issued

Because bonds that have been compared are not exactly equal regarding time to maturity, coupon size and amount issued, we try to assess the importance of each of these factors in terms of differences in yield if either factor is slightly changed. We do this by analyzing the yield curve for German government bonds that is three-dimensional in time to maturity, coupon size, and amount issued.

The yield curves for German 5-year and 10-year government bonds for the years 1994 to 1996 are generally upward-sloping, but there are big variations in the shape from year to year. The shape of this time structure depends among other things on the expected development in market interest rates. We will not discuss the determinants further here than to note that even

[4]This is the case at the time this study.

comparing bonds with maturity dates some months apart can make a difference in yield. Also, the bonds along the yield curve have coupon rates varying from 4 3/4 to 9.

The effect of coupon size on yield can theoretically go in both directions, but we would expect the yield to increase with coupon size. A larger coupon means that payments are received earlier in the holding period and will be taxed before they are reinvested, and taxes on received interest rates are generally higher than taxes on capital gains. In addition, the yield on reinvestment is uncertain, which makes the investor want a premium for early payments. On the other hand, when default is possible, larger repayments in earlier periods will be advantageous, making a high coupon value more attractive. However, this effect is likely to be small when the probability of default is low.

To assess the effect of coupon size, we look at data for the German yield curves. Comparing yield on pairs of bonds maturing the same month but bearing a different coupon value, we find that yield increases by 0 to around 3 basis points per 1/4 of a percentage point increase in coupon size. Linear estimation of a part of the yield curve gives a value of 0 to 2 basis points per 1/4 of a percentage point increase in coupon. We have chosen to adjust yield differences with one basis point per 1/4 difference in coupon size. Differences in coupon size of less than 1/4, i.e. of 1/8, have been ignored. The maximum difference in coupon size between the German and the other country's bond is 5/8 of a percentage point, which means that the necessary corrections will be small.

The effect of time to maturity is approximated by drawing a linear trend between single observations as close as possible in time[5], adjusting for variations in coupon size by 1 basis point per 1/4 difference in coupon value. The two subperiods where all the bonds we use in the comparisons mature are:

- 10/97[6] to 5/98, where all 5-year bonds mature,
- 6/02 to 10/03, where all 10-year bonds mature.

We find that yield differences for different maturity dates vary between -1 and 5 basis points per month. In the comparisons of bonds, we use these numbers as "correction terms" in order to adjust for differences in time to maturity.

The effect of amount issued is hard to assess as most bond issues in a period are about the same size. However, comparisons between the yields on a few bonds of differing amounts do not indicate any effect of the size of the amount issued. This seems reasonable as long as all issues are above a certain level, which means that they are regularly traded, and that market prices are set by brokers every day. As already mentioned, we have set the minimum level to 1 billion DEM.

Distinguishing between 5- and 10-year Bonds

According to the theory presented in (5) yield to maturity is constant over time, independent

[5]We have made one exception by excluding OBL 6 2/98, which seems for some years to have a yield deviating from the trend of the bonds with similar maturities. This only means that we are making a linear trend directly between OBL 6 5/8 1/98 and OBL 6 3/8 5/98 to assess the effect of maturity in early 1998.

[6]month/year.

of time to maturity. However, we will allow for the possibility that the default premium may vary to take into account that the possibility of default and thereby the default premium may tend to increase with time to maturity. All 5-year bonds mature in 1997 - 1998, while all 10-year bonds mature in 2002 - 2003, which means that the within-group differences in time to maturity for 5- or 10-year bonds respectively is limited. The differences in time to maturity between the groups will be captured by a dummy for 5-year bonds used in most of the estimated regression, or by a country dummy.

Interest Rate Differentials

Table 1 reports the difference in yield in percentage points between a bond from the given country and a comparable German government bond. One point in Table 1 equals 1/100 of a percentage point. For 10-year bonds most countries' yields lie between 20 and 30 basis points higher than German bonds. For 5-year bonds the average is lower, while there is larger variation between countries. That yield on German bonds are generally lower should be of no surprise as these are issued in the national currency and can be monetized by the German government.

We note that differences in yield rates between US states, as reported by Goldstein and Woglom (1992) are considerably higher, with a maximum yield difference of 170 basis points[7].

[7] Yield differentials in the two studies are not directly comparable, as the US data compare yield rates on 20-year bonds with unspecified maturity date. Their study also includes more data. However, these differences are not likely to fully explain the larger differences in yield rates between US states.

Table 1 - *Average Yield Differentials between Comparable National and German 10-Year Bonds Measured in Basis Points*

Country	1994			1995			1996		
	Correction terms		Corrected yield differential	Correction terms		Corrected yield differential	Correction terms		Corrected yield differential
	C	M		C	M		C	M	
Austria	0	1	10	0	2	14	0	3	22
Belgium	-1	0	30	-1	1	20	-1	2	17
Finland	-1	1	32	-1	2	28	-1	3	24
Ireland	-2	0	23	-2	2	22	-2	3	18
Portugal	-2	0	29	-2	0	23	-2	0	17
Spain	-2	0	24	-2	2	24	-2	3	18

Note: Yields for all bonds are given by Bloomberg Generic. Source: Bloomberg System.
One basis point is 1/100 of a percentage point. C stands for coupon correction term, M stands for maturity correction term.

Table 2 - *Average Yield Differentials between Comparable National and German 5-Year Bonds Measured in Basis Points*

Country	1994			1995			1996		
	Correction terms		Corrected yield diff.	Correction terms		Corrected yield diff.	Correction terms		Corrected yield diff.
	C	M		C	M		C	M	
Belgium	0	2	3	0	6	12	0	8	15
Denmark	1	1	5	1	3	6	1	4	12
Finland	-1	-2	19	-1	-4	19	-1	-5	12
Italy	-2	-1	26	-2	-3	33	-2	-4	14
Norway	1	0	-1	1	0	0	1	0	13
Sweden	-2	-2	19	-2	-4	17	-2	-5	7
United Kingdom	0	0	3	0	0	1	0	0	2

Note: Yields for all bonds are given by Bloomberg Generic. Source: Bloomberg System.
One basis point is 1/100 of a percentage point. C stands for coupon correction term, M stands for maturity correction term.

To get an idea about the probability of default underlying these numbers we can use equation

(2) in Section 2 to create an example. Assuming a yield differential of 20 basis points, a risk-free interest rate of 6 percent and no risk premium the probability of default given by equation (2) is 0.2 percent. Thus, the default risk must be considered to be quite modest.

The yield differences on 5-year bonds are smaller on average. A reason for this may be the larger uncertainty and thereby the higher degree of risk attached to a bond with a later maturity date. Specifically, looking at the countries that have issued both a 5-year and a 10-year bond, we see that the yield difference between a Finnish 5-year bond and a similar German bond is about 10 basis points lower than that on the Finnish 10-year bond compared to a German 10-year bond. For Belgium, the gap between the yield difference on the 10-year and the 5-year bond falls from 27 to 2 basis points during the observation period.

We also note that for many countries the yield differential has decreased over time. However, for Austria, Belgium's 5-year bond, Denmark and Norway, the differential has increased over time. These differences can be due to developments in macroeconomic variables; however, we note that Norway is the only country in our sample that is not a member of the European Union and that Denmark was hesitant and then decided not to enter the common currency area. We will return to a discussion of the role of the European Monetary Union in a later section.

Are the Differences Related to Macroeconomic Variables?

We want to test whether the differences found in interest rates are related to the risk of default on government debt. The relevant macroeconomic variables are those significant for a country's ability to service its debt in the future. Thus, we are looking for determinants of future government debt and future income potential of the government. We use the following variables:

Determinants of future expenditures and income:

- Net government debt today; this is the basis for the debt the country will have to service in the future.
- Gross government debt serves as a substitute for net debt in several regressions, due to lack of data for net debt for some countries.
- Budget surplus/deficit today; this will be part of future wealth/debt.
- Structural budget surplus, which may be an indicator of future expenditures by indicating the stance of economic policy.

Other variables included:

- The current account, which shows to what extent the country is accumulating foreign debt and may thus indicate the extent of foreign government borrowing.
- Rating, which may capture for instance the effect of macroeconomic variables not included or political instability.

For 9 of the relevant countries we have found data for net government debt. Two more countries, 11 in total, had data on gross government debt. We have run separate regressions on net government debt for the 9 countries and on gross government debt for the 11 country group. We use primary budget surplus and not total surplus, which includes interest payments that directly depend on the interest rate and are closely correlated to debt. Debt data are for the previous year, thus excluding the budget surplus for the current year.

Future income will also depend on future taxes, but we will not speculate on possible extentions of the tax base. Also, as we are studying bonds issued in a foreign currency, debt servicing may depend on availability of currency and the extent of foreign currency debt. As data for the share of government debt held in foreign currencies is not readily available, we have used the current account as a possible indicator.

In order to include rating as a variable in our regressions we assign the following values, used in a paper by Liu and Thakor (1984) where they refer to "Moody's Bond Record:" Aaa = 3.76, Aa = 3.54, A1 = 2.88, A = 2.83, Baa = 0. For the ratings that are not covered we use numbers AA1 = 3.71, AA2 = 3.66, AA3 = 3.60. The non-linearity of the numerations reflects that for instance a fall from A to Baa increases your probability of default by much more than a fall from Aaa to Aa.

Table 16 in Appendix III presents the data for the right hand side variables. Data are from the years 1994 to 1996. We note that numbers for net and gross debt vary highly between countries but little over time. This means that debt numbers will be strongly correlated with country dummies. The same holds to some extent for rating numbers as each country’s rating rarely changes.

IV. Results

Tables 3 and 4 show results from regressing the corrected yield differential on macroeconomic variables and rating with a dummy variable for 5-year bonds, while Table 5 shows the results from regressions with country dummies.

In all estimations we have used White's method that is robust to heteroscedasticity. «JB» in the table shows the p-value for the Jarque Bera test of normality of the error term. The high p-values observed indicate that the hypothesis of normality can not be rejected. Thus, we can use the reported t-statistics even if our number of observations is limited. «Reset» is the p-value of a RESET test of the functional form. Specifically, a low p-value means that the hypothesis of linearity can be rejected. We see that the Reset value varies between 0.02, which is a clear rejection of linearity to 0.89, which indicates that linearity can not be rejected. In most regressions the Reset value is high enough that linearity can not be rejected. F1 and F2 are F-tests of zero restrictions on various parameters.[8]

The coefficients in our regressions generally have the expected sign. The coefficient for rating is always significant, while coefficients for several of the macroeconomic variables are significant depending on what variables are included. This may be interpreted as evidence both that rating conveys information about default risk beyond the information contained in the macroeconomic variables included, and that the markets and the rating companies differ in their evaluation of default risk.

In Table 3, regressions (1) through (9), all 13 bonds are included with annual observations for 1994-1996, leaving us with 39 observations. In regression (1) most variables have the expected sign. In regression (2) we exclude the structural deficit, which has the opposite sign

[8]The F-test is not based on the White robust covariance matrix.

of expected, and all variables except gross debt and GDP growth are significant on a 5 percent level. However, when we, in regression (3), exclude gross debt and GDP growth the explanatory power of the regression decreases, and the hypothesis of combined zero restrictions on the two variables is rejected on a 10 percent level. This indicates that the low t-values of gross debt and GDP growth when they are both included may be due to multicolinearity. Regressions (4) and (5) illustrate that leaving out either gross debt or GDP growth makes the other variable significant at a 10 percent level. The current account surprisingly comes out with a positive and significant coefficient. As discussed below this may partly be explained by correlation between rating and the current account.

The fact that both rating and several of our macro variables are significant explanatory variables for the yield difference may indicate that the market and the rating companies have different views of what influences default risk and thereby yield.

Regressions (6) to (9) show the results when rating not is included. The explanatory power of the regression is much lower when rating is left out, indicating that rating includes substantial information not contained in our set of macro variables. The value of several of the coefficients changes when rating is taken out. The coefficient for the structural budget deficit turns negative as expected, while the coefficient for the current account is reduced and looses significance. This may indicate that rating companies put more weight on the current account than the market does, while rating captures the negative effect of the structural budget surplus on default risk. The correlation coefficients between rating and the structural budget surplus or the current account are 0.37 for the former, 0.32 for the latter. (The correlation matrixes are presented in Appendix II.) Also, the absolute value of the growth coefficient and the corresponding t-value increases when rating is left out, suggesting the rating also depends on GDP growth. We need, however, to be careful in giving too much weight to the interpretations of the coefficient values when rating is excluded, due to the statistical uncertainty associated with coefficient estimates when a relevant variable is left out.

Table 3 - *OLS Estimates for 11-Country Group*
Dependent Variable: Corrected Yield Differential

Regression no.	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Constant	83.38 (4.47)	79.62 (4.86)	91.06 (5.33)	79.49 (4.98)	87.12 (5.09)	16.26 (3.01)	18.90 (9.42)	11.50 (2.40)	25.04 (15.66)
Gross debt	0.08 (1.43)	0.07 (1.39)		0.08 (1.77)		0.06 (0.96)		0.13 (2.31)	
Struct.bud-get surplus	0.37 (0.68)					-0.65 (0.89)	-1.01 (1.89)		
Budget surplus	-1.51 (3.49)	-1.37 (3.89)	-1.31 (4.98)	-1.53 (5.28)	-1.03 (3.52)	-0.57 (1.07)		-1.00 (2.13)	
GDP growth	-0.47 (0.99)	-0.44 (0.86)			-0.96 (1.78)	-1.05 (1.57)			-2.07 (3.60)
Current account	1.65 (3.08)	1.74 (3.60)	2.09 (4.55)	1.74 (3.53)	1.96 (4.50)	0.91 (1.71)			0.74 (1.71)
Rating	-18.86 (3.75)	-17.91 (4.02)	-20.00 (4.16)	-18.38 (4.31)	-18.36 (3.78)				
Dummy 5	-12.12 (7.02)	-12.55 (7.54)	-12.74 (7.25)	-12.47 (7.72)	-12.82 (7.46)	-12.92 (5.99)	-11.50 (5.14)	-11.04 (4.98)	-12.19 (5.32)
Degrees of freedom	31	32	34	33	33	32	36	35	35
R^2	0.74	0.73	0.69	0.73	0.71	0.54	0.39	0.48	0.48
$\overline{R}^2$	0.68	0.69	0.66	0.69	0.67	0.45	0.36	0.44	0.44
SER	5.26	5.21	5.44	5.16	5.32	6.90	7.43	6.97	6.96
F1			0.17	0.66	0.25		0.07[1]	0.311[1]	0.32[1]
F2			0.10						
JB	0.97	0.96	0.96	0.94	0.96	0.93	0.94	0.92	0.84
Reset	0.09	0.15	0.02	0.21	0.02	0.25	0.68	0.36	0.13

Note: Annual data 1994-96. t-values in parenthesis. Dummy 5 is a dummy variable for 5-year bonds. Fi, i = 1,2 is the p-value of a test of the zero restrictions in the regression relative to regressions (1) and (2), respectively. JB is the p-value of the null hypothesis that the error term is normally distributed, Reset is the p-value of the null hypothesis that the regression is linear.
[1]The F-test is relative to regression (6).

In regression (6) all coefficients, except the one for the current account, comes out with the expected sign. Low t-values may be mainly due to multicolinearity. This is illustrated in regressions (7) to (9), which show that gross debt, the budget surplus or structural budget surplus and growth variably turn out to be significant depending on what variables are excluded in the regression. An F-test shows that the hypothesis of combined zero restrictions is rejected on a 7 percent level. Overall, there seems to be clear support for believing that macro variables affect the yield on government bonds.

Table 4 – *OLS Estimates for 9-Country Group.*
Dependent Variable: Corrected Yield Differential

Regression no.	(10)	(11)	(12)	(13)
Constant	129.05 (4.70)	123.46 (7.57)	120.31 (7.46)	0.96 (0.08)
Gross debt	0.07 (0.37)			0.39 (1.77)
Net debt	-0.03 (0.35)	-0.02 (0.71)		-0.23 (1.93)
Struct.budg.surp.	0.65 (0.93)			-1.18 (1.17)
Budget surplus	-0.85 (1.42)	-0.50 (1.29)	-0.73 (2.73)	0.30 (0.32)
GDP growth	-1.58 (1.80)	-2.16 (4.50)	-1.79 (2.68)	-1.77 (1.50)
Current account	1.05 (1.07)	1.36 (3.15)	1.45 (3.49)	-0.35 (0.29)
Rating	-29.35 (5.06)	-27.16 (6.19)	-26.72 (6.01)	
Dummy 5	-13.05 (7.76)	-13.13 (8.16)	-13.11 (8.26)	-12.15 (6.29)
Degrees of freedom	24	26	27	25
R^2	0.82	0.81	0.81	0.63
$\overline{R}^2$	0.76	0.77	0.77	0.53
SER	4.70	4.63	4.58	6.57
F1		0.57	0.66	
JB	0.79	0.87	0.91	0.81
Reset	0.18	0.38	0.45	0.30

Note: Annual data 1994-96. Portugal and Ireland have been excluded. t-values in parenthesis. Dummy 5 is a dummy variable for 5-year bonds. F1 is the p-value of a test of the zero restrictions in the regression relative to regressions (10). JB is the p-value of the null hypothesis that the error term is normally distributed, Reset is the p-value of the null hypothesis that the regression is linear.

In regressions (10) through (13) net debt is included on the right hand side, while Ireland and Portugal, that have no data on net debt, have been excluded. This leaves us with 33 observations. The coefficient for net debt is negative, while the coefficient for gross debt is still positive. Regressions (11) and (12) test zero restrictions on net debt and other variables. We find that zero restrictions on both gross and net debt can not be rejected, while growth is significant on a 5 percent level. The coefficient for net debt still has the wrong sign when rating is taken out.

In the regressions with country dummies shown in Table 5 we have included only one bond per country, thus reducing the number of observations to 33. Only two countries, Finland and Belgium, have two bonds each in the total data set, and we have run two sets of regressions with country dummies, one where the two countries are represented by their 5-year bond, the other where the two are represented by their 10-year bond.

Using only one bond per country entails that the country dummy also will catch the effect of a 5-year or a 10-year bond. This means that a country coefficient is the combined effect of whether the issue is a 5-year or a 10-year bond and country specific variables other than the macroeconomic variables included. The 5-year dummy coefficients in Tables 3 and 4 are negative. This means that countries represented by a 5-year bond will tend to have a lower country coefficient. A 5-year United Kingdom bond is used as a benchmark. The table shows that values of the country coefficients vary more than the effect of 10 or 5-year bonds would indicate.

Table 5 - *Dependent Variable: Corrected Yield Differential*

Regression	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)
Constant	117.20	116.22	108.46	108.20	30.25	98.46	81.45	95.32
	(2.65)	(3.16)	(4.97)	(8.63)	(1.03)	(2.52)	(3.26)	(9.03)
Gross Debt	-0.37	-0.37	-0.00		-0.48	-0.09	0.07	
	(0.85)	(0.87)	(0.09)		(1.06)	(0.19)	(1.11)	
Structural Budget Surplus	0.15				-2.33			
	(0.05)				(0.77)			
Budget Surplus	-0.50	-0.35	-0.80	-0.82	2.12	-0.70	-0.69	
	(0.16)	(0.39)	(2.19)	(2.30)	(0.64)	(0.79)	(1.55)	
GDP Growth	-2.21	-2.28	-1.78	-1.71	-3.40	-1.89	-1.65	-2.85
	(1.31)	(2.61)	(2.94)	(2.13)	(1.95)	(1.65)	(2.12)	(3.82)
Current Acc.	2.38	2.35	1.93	1.90	1.14	2.12	1.88	1.43
	(1.51)	(1.83)	(3.26)	(3.59)	(0.62)	(1.42)	(2.17)	(2.67)
Rating	-23.85	-23.60	-27.31	-27.35		-23.66	-21.48	-22.87
	(2.84)	(3.61)	(5.05)	(7.18)		(3.77)	(3.58)	(7.33)
DAustria	20.19	20.03	15.46	15.39	16.71	17.92	15.15	13.38
	(2.21)	(2.65)	(3.19)	(3.34)	(1.83)	(2.51)	(3.05)	(3.23)
DBelgium	22.93	22.56			24.72	16.99	5.14	7.30
	(0.74)	(0.79)			(0.75)	(0.58)	(1.01)	(1.59)
DDenmark	9.57	9.80			16.06	5.73		
	(1.03)	(1.14)			(1.81)	(0.66)		
DFinland	1.51	2.03			14.62	13.93	13.98	14.18
	(0.12)	(0.40)			(1.12)	(2.34)	(4.45)	(7.04)
DIreland	32.50	32.97	19.74	19.47	44.75	24.07	17.30	21.31
	(1.90)	(2.14)	(6.83)	(6.53)	(2.76)	(1.51)	(4.97)	(6.22)
DItaly	25.73	-25.06			32.06	9.02		
	(0.82)	(0.97)			(0.90)	(0.34)		
DNorway	-8.17	-8.47			-10.54	-2.24		
	(0.78)	(0.90)			(0.99)	(0.20)		
DPortugal	7.48	7.20	0.15		19.12	5.67	4.75	
	(0.68)	(0.77)	(0.03)		(1.35)	(0.65)	(0.83)	
DSpain	21.02	20.84	15.92	15.91	20.26	18.61	16.12	14.24
	(2.93)	(3.80)	(6.25)	(6.49)	(2.54)	(3.53)	(6.02)	(5.61)
DSweden	9.37	9.54			17.66	3.67		
	(0.90)	(0.97)			(1.70)	(0.38)		
Degr. of freed.	16	17	23	25	17	17	21	24
R^2	0.83	0.82	0.79	0.79	0.77	0.85	0.84	0.83
$\bar{R}^2$	0.66	0.68	0.71	0.74	0.56	0.72	0.76	0.77
SER	5.22	5.06	4.76	4.57	5.88	5.19	4.78	4.65
F1			0.86	0.94			0.93	0.93
F2			0.76	0.89				0.63
F3				0.99				
JB		0.94	0.95	0.96		0.71	0.68	0.73
Reset	0.55	0.55	0.51	0.68	0.67	0.77	0.89	0.40

Note: Annual data 1994-96. t-values in parenthesis. Fi, i = 1,2,3 is the p-value of a test of the zero restrictions. For (16) and (17) F1, F2 and F3 are based on (14), (15) and (16) respectively, for (20) and (21) F1 and F2 are based on (19) and (20), respectively. JB is the p-value of the null hypothesis that the error term is normally distributed, Reset is the p-value of the null hypothesis that the regression is linear.

However, only countries with a 10-year bond have a significant country coefficient. An F-test on the country dummies representing 5-year bonds, show that zero restrictions on these variables can not be rejected.

The coefficient for gross debt is negative or insignificant in all of these equations. This can partly be due to multicolinearity between the country dummies and debt, as the size of gross debt varies highly between countries, but stays fairly constant over time. Rating, GDP growth, and the current account come out with significant coefficients, while budget surplus is significant when 5-year bonds are used for Finland and Belgium.

As before, when rating is taken out, the coefficient for the structural budget surplus turns negative, while the current account looses explanatory power.

V. Conclusions

Governments face different yield rates in the Eurobond market. The differences are fairly small, but are related to for instance the budget surplus and rating. Various other macroeconomic variables show the expected sign, but multicolinearity may be behind varying and low t-values. The effects of the macroeconomic variables are consistent with our view that at least part of the difference in interest rates on government debt between countries is a default premium. However, default premia seem to be modest; a rough numerical example suggests a level around 0.2 percent.

Compared to interest rate differences of up to 170 basis points reported in Goldstein and Woglom (1992) between bonds issued by different US states, a maximum difference of 34 basis points in the interest rate on European government bonds seems quite small. It is tempting to draw a parallel between the US and the European Monetary Union and conclude that the yield spread between European countries will be higher within a monetary union. However, differences between the US and Europe are so important that we can not draw a direct parallel. For instance, labor mobility must be expected to be lower in Europe even with a substantial reduction in formal restrictions on mobility, due to for instance language and cultural differences. This will tend to reduce the yield spread. On the other hand, debt ratios are substantially higher in Europe, and there is hardly any income redistribution among countries, as with the federal budget in the US. This will tend to increase yield differences in Europe compared to the US. The net effect is not evident. See Eichengreen (1990) for a further discussion.

The small yield differences we have found in the Eurobond market are in line with the findings of Alesina et al. (1992). However, contrary to their results we find that yield differentials are correlated with rating and various macroeconomic variables, indicating the existence of default premia in the market for international currency. Debt issued in the Eurobond market is a small part of total government debt for most of these countries. If we believe, like Alesina et al. suggest, that markets realize that countries have much to lose and little to win by defaulting on debt in this market, it is natural to conclude that default premia in the Eurobond market are smaller than in the national markets. That default premia found by Alesina et al. in their comparison of private and public liabilities within each country are small, may imply that the most common “default” expected on national debt is devaluation.

Within a monetary union the possibility of “defaulting” through currency devaluations disappears, and governments may have to default in other ways. In this situation we might expect default premia in the European market to rise.

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Appendix I: Bonds Used in Comparisons

All yield differences are the difference between yield to maturity for each country's government bond and a comparable German government bond. Under the heading «BGN» prices and thereby yields are generated by Bloomberg Generic, which uses a combination of prices from a large number of price givers. Under the heading "DBG" prices are given by the Deutsche Bank Group. DBR bonds are German 10-year government bonds. OBL bonds are German 5-year bonds. Each bond is described by coupon size and maturity date.

Table 6 - *Yield Differential on 10-Year Bonds*

Issuer country	Bonds compared: Issuer, coupon and maturity	Size of issue in bio. DEM: National/German	1994		1995		1996	
			DB	BG	DB	BG	DB	BG
Austria	AUST 8 6/2 DBR 8 7/2	1 15	8	9	12	12	18	19
Belgium	BELG 6 1/4 10/3 DBR 6 9/3	1 12	32	31	21	20	18	16
Finland	FINL 8 1/4 6/2 DBR 8 7/2	2 15	33	32	24	27	22	22
Ireland	IRELND 71/4 3/3 DBR 6 3/4 4/3	1,5 10	25	25	21	22	17	17
Portugal	PORTUG 7 1/8 7/3 DBR 6 1/2 7/3	1,5 16	31	31	31	25	18	19
Spain	SPAIN 7 1/4 3/3 DBR 6 3/4 4/3	4 10	25	26	23	24	15	17

Note: Bonds are characterized by name (issuer), coupon value and maturity date. For instance, Aust 8 6/2 is an Austrian 10-year bond with coupon rate 8, maturing June, year 2002. DBR is the label for a German 10-year bond. Under the headings DB and BGN we present rates quoted by the Deutche Bank and by Bloomberg Generic respectively.

As an example "Finland 8 1/4 6/2" is a Finnish government bond with a coupon of 8 1/4 percent of par value and maturity in June year 2002. It has been compared to the German bond DBR 8 7/2. The yield difference is 32 basis points in 1994 as given by the Bloomberg generic which means that the yield is 32/100 of a percentage point higher for the Finnish bond than for the German bond. Yields are the average of daily registrations over the year.

Table 7 - *Yield Differential on 5-Year Bonds*

Issuer country	Bonds compared: Issuer, coupon and maturity	Size of issue in bio. DEM: National/German	1994		1995		1996	
			DB	BG	DB	BG	DB	BG
Belgium	BELG 6 3/8 3/98 OBL 6 3/8 5/98	1 6	2	1	3	6	5	7
Denmark	DENK 6 1/8 4/98 OBL 6 3/8 5/98	2 6	4	3	0	2	5	7
Finland	FINL 7 3/4 11/97 OBL 7 1/2 10/97	1 7	18	22	21	24	19	18
Italy	7 1/4 2/98 OBL 6 5/8 1/98	5 10	30	29	36	38	19	20
Norway	6 1/8 5/98 OBL 6 3/8 5/98	1,5 6	-1	-2	-3	-1	8	12
Sweden	8 11/97 OBL 7 1/2 10/97	2,5 7	17	23	19	23	15	14
United Kingdom	7 1/8 10/97 OBL 7 1/4 10/97	5,5 7	3	3	-1	1	4	2

Note: Bonds are characterized by name (issuer), coupon value and maturity date. For instance, Belg 6 3/8 3/98 is a Belgian 5-year bond with coupon rate 6 3/8, maturing March, 1998. OBL is the label for a German 5-year bond. Under the headings DB and BGN we present rates quoted by the Deutche Bank and by Bloomberg Generic respectively.

Appendix II: Correlation Matrixes

Table 8a - *Correlation Matrix for All Observations*

	Yield	Budget surplus	Struct. budget surplus	Gross debt	GDP growth	Current account	Rating	Dummy5	DEMU
Yield	1	-0.1	-0.13	0.23	-0.29	-0.04	-0.45	-0.58	0.67
Budget surplus	-0.1	1	0.44	0.54	0.45	0.49	-0.1	-0.04	0.17
Struct.budg.surpl.	-0.13	0.44	1	-0.06	0.47	0.35	0.37	-0.19	0.03
Gross debt	0.23	0.54	-0.06	1	-0.15	0.47	-0.11	0.02	0.39
GDP growth	-0.29	0.45	0.47	-0.15	1	0.16	0.16	-0.07	-0.18
Current account	-0.04	0.49	0.35	0.47	0.16	1	0.32	0.28	0.03
Rating	-0.45	-0.1	0.37	-0.11	0.16	0.32	1	0.11	-0.28
Dummy5	-0.58	-0.04	-0.19	0.02	-0.07	0.28	0.11	1	-0.62
DEMU	0.67	0.17	0.03	0.39	-0.18	0.03	-0.28	-0.62	1

Table 8b - *Correlation Matrix Excluding Data for Ireland and Portugal*

	Yield	Budget surplus	Struct. budget surplus	Gross debt	Net debt	GDP growth	Current account	Rating	Dummy 5	DEMU
Yield	1.00	-0.16	-0.19	0.26	0.15	-0.53	0.05	-0.46	-0.54	0.65
Budget surplus	-0.16	1.00	0.41	0.55	0.54	0.45	0.59	-0.07	0.06	0.12
Struct. budget surplus	-0.19	0.41	1.00	-0.14	-0.21	0.31	0.39	0.51	-0.09	-0.05
Gross debt	0.26	0.55	-0.14	1.00	0.93	-0.30	0.45	-0.34	0.00	0.42
Net debt	0.15	0.54	-0.21	0.93	1.00	-0.21	0.19	-0.27	-0.08	0.39
GDP growth	-0.53	0.45	0.31	-0.30	-0.21	1.00	0.17	0.18	0.18	-0.43
Current account	0.05	0.59	0.39	0.45	0.19	0.17	1.00	-0.01	0.19	0.13
Rating	-0.46	-0.07	0.51	-0.34	-0.27	0.18	-0.01	1.00	-0.20	-0.21
D5	-0.54	0.06	-0.09	0.00	-0.08	0.18	0.19	-0.20	1.00	-0.57
DEMU	0.65	0.12	-0.05	0.42	0.39	-0.43	0.13	-0.21	-0.57	1.00

Appendix III: Data for Right Hand Side Variables

Table 9 - *Data for Right-Hand Side Variables*

Country		GDP[1] Growth	Primary Balance	Structural Balance	Gross[2] Debt	Net Debt	Current Account	Rating
Austria	1994	1.925	-1.4	-4.4	62.7	45.4	1.1	3.76
	95	1.600	-1.3	-4.6	65.4	49.8	-2.1	3.76
	96	1.675	-0.2	-3.4	69.3	49.4	-1.9	3.76
Belgium	1994	1.000	4.4	-3.6	135.1	124.6	5.3	3.71
	95	1.125	4.5	-2.8	133.5	124.4	5.4	3.71
	96	1.125	4.8	-1.9	131.2	121.2	5.4	3.71
Denmark	1994	1.875	0.5	-1.3	79.7	44.4	2.1	3.71
	95	2.300	1.2	-0.9	77.5	44.6	0.9	3.71
	96	2.825	1.3	-0.5	73.6	43.4	1.6	3.71
Finland	1994	-1.850	-4.9	-2.3	58.0	-15.7	1.3	3.66
	95	1.200	-3.9	-3.4	59.6	-10.3	4.1	3.66
	96	2.925	-1.4	-2.0	58.1	-6.6	3.8	3.66
Ireland	1994	3.675	2.7	0.8	99.0	.	2.8	3.66
	95	5.800	2.0	-1.1	92.2	.	2.8	3.66
	96	6.850	2.9	0	85.6	.	2	3.66
Italy	1994	0.675	0.1	-9.0	118.9	111.7	1.3	2.88
	95	1.125	3.2	-6.7	125.1	109.7	2.3	2.88
	96	1.150	2.8	-6.1	124.3	110.4	3.4	3.60
Norway	1994	3.650	0.8	-5.0	45.5	-21.5	3.1	3.71
	95	3.775	3.9	-2.0	43.9	-23.4	3.2	3.71
	96	4.275	6.4	-0.3	43.1	-27.2	7.1	3.71
Portugal	1994	1.275	0.5	-5.3	64.3	.	-2.2	2.88
	95	1.175	0.9	-4.8	66.3	.	-0.7	2.88
	96	1.475	1.8	-2.3	69.2	.	-2.5	2.88
Spain	1994	1.000	-1.5	-5.0	65.8	45.8	-1.4	3.66
	95	1.100	-1.4	-5.2	68.1	49.3	0.2	3.66
	96	1.500	0.6	-2.8	71.0	52.0	0.3	3.66
Sweden	1994	-0.350	-8.3	-8.5	76.3	21.9	0.4	3.66
	95	0.900	-4.4	-6.6	81.2	23.9	2.1	3.60
	96	1.575	0.3	-2.3	80.1	23.8	2.3	3.60
UK	1994	0.975	-4.2	-6.0	56.6	35.6	-0.3	3.76
	95	2.150	-2.6	-5.1	54.2	41.7	-0.5	3.76
	96	2.850	-1.7	-4.3	59.7	44.3	-0.1	3.7

Note: All variables except rating in percentage of GDP

[1]Data on GDP Growth have been used with three desimals due to being a four-year average of one-desimal numbers.

[2]Debt data are from the end of the previous year.

Appendix IV: Yield to Maturity on German Government Bonds

Table 10 - *Yield to Maturity, 5-Year German Government Bonds*

Coupon and maturity	Bond no.	Size, bio. DEM	Yield, 1994		Yield, 1995		Yield, 1996	
			DB	BGN	DB	BGN	DB	BGN
OBL 8 3/97	OB 99	8	5.989	5.992	5.008	5.007	3.229	3.205
OBL 8 1/4 7/97	OB 100	10	6.085	6.088	5.163	5.162	3.385	3.379
OBL 8 9/97	OB 101	8	6.130	6.131	5.242	5.234	3.462	3.453
OBL 7 1/2 10/97	OB 102	7	6.153	6.154	5.276	5.27	3.504	3.499
OBL 7 1/4 10/97	OB 103	7	6.152	6.153	5.277	5.272	3.505	3.497
OBL 7 12/97	OB 104	10	6.183	6.182	5.332	5.326	3.58	3.573
OBL 6 5/8 1/98	OB 105	10	6.202	6.201	5.374	5.369	3.63	3.622
OBL 6 2/98	OB 106	6	6.172	6.171	5.383	5.379	3.666	3.659
OBL 6 3/8 5/98	OB 107	6	6.210	6.212	5.482	5.478	3.777	3.771
OBL 5 3/4 8/98	OB 108	5	6.200	6.201	5.525	5.523	3.869	3.86
OBL 5 1/4 10/98	OB 109	5	n.a.	n.a.	5.527	5.522	3.896	3.888
OBL 5 3/8 2/99	OB 110	4	n.a.	n.a.	5.656	5.653	4.079	4.076

Note: Bonds are characterized by name (issuer), coupon value and maturity date. For instance, OBL 8 1/4 7/97 is a German 5-year bond with coupon rate 8 1/4, maturing in July, 1997. Under the headings DB and BGN we present rates quoted by the Deutche Bank and by Bloomberg Generic respectively.

Table 11 - *Yield to Maturity, 10-Year German Government Bonds*

Coupon and maturity	Size	1994		1995		1996	
		DB	BGN	DB	BGN	DB	BGN
DBR 6 3/97	4	5.917	5.919	5.013	5.013	3.235	3.256
DBR 5 1/2 5/97	4	5.909	5.918	5.047	5.048	3.303	3.325
DBR 6 1/8 7/97	4	5.942	5.945	5.153	5.155	3.395	3.388
DBR 6 3/8 8/97	4	6.033	6.041	5.206	5.207	3.44	3.438
DBR 6 3/4 9/97	4	6.068	6.072	5.244	5.241	3.473	3.475
DBR 6 3/8 10/97	2	6.046	6.049	5.258	5.253	3.517	3.512
DBR 6 3/8 1/98	5	6.204	6.195	5.409	5.397	3.657	3.648
DBR 6 1/4 2/98	4	6.202	6.194	5.441	5.431	3.705	3.694
DBR 6 1/8 3/98	4	6.195	6.187	5.469	5.461	3.73	3.721
DBR 6 4/98	3	6.209	6.204	5.5	5.49	3.786	3.777
DBR 6 1/2 5/98	4	6.246	6.237	5.521	5.51	3.825	3.817
DBR 6 3/4 7/98	4	6.267	6.261	5.579	5.57	3.9	3.889
DBR 6 3/4 8/98	4	6.252	6.244	5.593	5.583	3.93	3.92
DBR 6 10/98	4	6.26	6.255	5.633	5.624	4.042	4.034
DBR 6 3/8 11/98	4	6.293	6.286	5.693	5.683	4.09	4.084
DBR 6 3/8 12/98	4	6.297	6.293	5.708	5.7	4.114	4.109
DBR 6 1/2 1/99	5	6.314	6.309	5.753	5.746	4.159	4.147
DBR 6 3/4 1/99	4	6.344	6.342	5.756	5.747	4.174	4.164
DBR 7 2/99	4	6.357	6.357	5.765	5.756	4.214	4.205
DBR 7 4/99	4	6.352	6.349	5.795	5.787	4.281	4.274
DBR 6 3/4 6/99	4	6.372	6.368	5.852	5.846	4.383	4.376
DBR 7 9/99	4	6.396	6.394	5.92	5.913	4.506	4.4
DBR 7 10/99	4	6.404	6.401	5.928	6.692	4.546	4.539
DBR 7 1/8 12/99	4	6.432	6.431	5.955	5.948	4.622	4.618
DBR 7 1/4 1/0	5	6.46	6.464	5.983	5.977	4.648	4.643
DBR 7 3/4 2/0	4	6.499	6.499	6.043	6.038	4.709	4.705
DBR 8 3/4 5/0	6	6.586	6.587	6.131	6.126	4.811	4.807
DBR 8 1/2 8/0	8	6.671	6.67	6.206	6.2	4.925	4.92
DBR 9 10/0	17	6.722	6.725	6.268	6.265	5.002	5.0
DBR 8 7/8 12/0	8	6.746	6.748	6.301	6.3	5.054	5.051
DBR 9 1/1	10	6.766	6.77	6.332	6.331	5.09	5.087

DBR 8 3/8 5/1	10	6.817	6.815	6.404	6.403	5.173	5.171
DBR 8 1/4 9/1	1.8	6.875	6.876	6.483	6.481	5.292	5.291
DBR 8 7/2	15	6.951	6.952	6.638	6.637	5.575	5.57
DBR 7 1/4 10/2	10	6.937	6.939	6.639	6.638	5.638	5.635
DBR 7 1/8 12/2	16	6.955	6.956	6.689	6.686	5.702	5.698
DBR 6 3/4 4/3	10	6.936	6.936	6.738	6.738	5.803	5.801
DBR 6 1/2 7/3	16	6.911	6.91	6.769	6.768	5.871	5.864
DBR 6 9/3	12	6.819	6.819	6.767	6.768	5.821	5.819
DBR 6 3/4 7/4	10	n.a.	n.a.	6.84	6.84	6.046	6.046
DBR 7 1/2 11/4	10	n.a.	n.a.	6.849	6.846	6.106	6.104

Note: Bonds are characterized by name (issuer), coupon value and maturity date. For instance, DBR 5 1/2 5/97 is a German 10-year bond with coupon rate 5 1/2, maturing in May, 1997. Under the headings DB and BGN we present rates quoted by the Deutche Bank and by Bloomberg Generic respectively.

Appendix V: Construction of "Correction Terms"

We want to compare each national bond to a similar German bond. However, the two bonds will not be completely equal, so to correct for the differences between the bonds we try to assess the importance of coupon, maturity and size of an issue by looking at the German yield curve. We use a variety of approaches, combining the comparison of single bonds with a tentative estimation of yield curves for each year.

The Value of Coupon Size:

In Tables 10 and 11 in Section I, we find two observations of pairs of bonds that are quite similar, except for coupon size, one pair maturing in October 1997 and the other in January 1999. The table below shows the difference in yield between each pair of bonds:

Table 12 - *Yield Differential Between Bonds with the Same Coupon Value*

Bonds compared	Yield difference		
	1994	1995	1996
OBL 7 ½ 10/97 - OBL 7 1/4 10/97	0.001	-0.002	0.002
DBR 6 3/4 1/99 - DBR 6 ½ 1/99	0.033	0.001	0.017

Note: OBL 7 ½ 10/97 is a 5-year German government bond with coupon rate of 7 ½ percent, maturing in October, 1997. DBR 6 3/4 1/99 is a 10-year German government bond with a 6 3/4 percent coupon rate, maturing in January, 1999.

For the first pair the difference in yield is less than 1 basis point every year and close to 0 for most years, for the latter the difference is between 0.1 and 3.3 basis points. The bond with the higher coupon value has the higher yield.

In addition, we run linear regressions in coupon and maturity, separate for each year and for 5-year and 10-year bonds. We include 10-year bonds maturing between 7/2 and 9/3 and 5-year bonds maturing between 10/97 and 8/98, which covers the two periods in our sample. The results are shown in Table 13.

The value of coupon varies from 0.9 to 6.7 basis points per one percentage point coupon value with standard deviations ranging from 0.5 to 2.5 basis points. Most estimates lie around 4 basis points per one percentage point coupon; i.e., one basis point per 1/4 percentage point variation in coupon, where the higher coupon value gives the higher yield. Given these data and the above comparison of yield on single bonds we decide to set 1/4 of a percentage point higher coupon value equal to an average of one basis point higher yield. In any case, the maximum difference in coupon value is 5/8 of a percentage point, so that the error committed by this approximation is likely to be small.

Table 13 - *Estimated Linear Yield Curves for German Government Bonds*

	DBR (10-year)		OBL (5-year)	
	month	Coupon	month	coupon
1994	.010 (.003) (3.50)	.067 (.025) (2.71)	.010 (.005) (1.98)	.043 (.023) (1.90)
1995	.018 (.001) (13.81)	.042 (.011) (3.86)	.026 (.006) (4.76)	.042 (.025) (1.71)
1996	.027 (.003) (10.39)	.025 (.022) (1.12)	.036 (.005) (7.10)	.009 (.023) (0.39)

Note: Standard deviation is reported in the first parenthesis, t-values in the second.

The Value of Time to Maturity:

Trying to assess the value of time to maturity we see that the estimated coefficients in Table 13 range from 1 to 3.6 basis points per month. A linear approximation does not seem to fit for all years, and also, from the data for the yield curves in Tables 10 and 11 in Section I we see that for the longest maturities yield increases seem to come down with time, and even become negative in some years. Thus, we choose to use a linear approximation between bond observations close in time. The results from this process is shown in Tables 14 and 15 below.

The tables show the average yield increase per month to maturity between the two maturity dates in the left column. c = 0 is the yield difference when there is no correction for coupon size. 1/4c = 1 is the yield difference per month given a correction of 1 basis point yield difference per 1/4 of a percentage point in coupon.

Table 14 - *Average Yield Increase per Month to Maturity, 10-Year German Government Bonds*

10-year bonds compared	1994		1995		1996	
	c=0	1/4c=1	c=0	1/4c=1	c=0	1/4c=1
8 1/4 9/1 - 8 7/2	1	1	2	2	3	3
8 7/2 - 7 1/4 10/2	0	1	0	1	2	3
7 1/4 10/2 - 7 1/8 12/2	1	1	2	2	3	3
7 1/8 12/2 - 6 3/4 4/3	-1	0	1	2	3	3
6 3/4 4/3 - 6 ½ 7/3	-1	-1	1	1	2	2
6 ½ 7/3 - 6 9/3	-4	-3	0	1	-2	-1
6 9/3 - 6 3/4 7/4	n.a	n.a.	2	1	2	2

Note: Bonds are characterized by their coupon value and maturity date, i.e. 8 1/4 9/1 is a 10-year bond with coupon rate 8 1/4, maturing in September, year 2001. c = 0 indicates that there is no adjustment in yield for differences in coupon rate. c=1/4 indicates an adjustment of 1 basis point per 1/4 difference in coupon rate between the two bonds.

Table 15 - *Average Yield Increase per Month to Maturity, 5-Year German Government Bonds*

5-year bonds compared	1994		1995		1996	
	C=0	1/4c=1	c=0	1/4c=1	c=0	1/4c=1
7 ½ 10/97 - 7 12/97	1	2	3	4	4	5
6 5/8 1/98 - 6 3/8 5/98	0	1	3	3	4	4

Note: Bonds are characterized by their coupon value and maturity date, i.e. 7 ½ 10/97 is a 5-year bond with coupon rate 7 1/2, maturing in October, 1997. c = 0 indicates that there is no adjustment in yield for differences in coupon rate. c=1/4 indicates an adjustment of 1 basis point per 1/4 difference in coupon rate between the two bonds.

The effect of increased time to maturity ranges from -4 to 3 for 10-year bonds, and from 0 to 5 for 5-year bonds, with the higher values for both categories in 1996, indicating that the yield curve has gotten steeper from 1994 to 1996. In general the yield curve seems to get less steep and may even slope downwards at the longest maturity ranges.

DBR 6 9/3 and OB 6 2/98 both seem to have a slightly lower value than expected. In Table 14 yield decreases from 7/3 to 9/3 and then increases again to 7/4 in 1996. Table 16 shows that if we draw the line directly between 7/3 and 7/4 yield increases with time to maturity for this period also in 1996. DBR 6 9/3 has only been used in comparison with the Belgian 10-year bond. Table 16 also shows that yield per month would develop less smoothly if OB 6 2/98 had been included.

Table 16 - *Average Yield Increase per Month to Maturity*. *Additional Bonds*

Bonds compared	1994		1995		1996	
	c=0	1/4c=1	c=0	1/4c=1	c=0	1/4c=1
DBR 6 ½ 7/3 - DBR 6 3/4 7/4	n.a.	n.a.	1	1	2	1
OBL 7 12/97- OB 6 5/8 1/98	2	2	4	6	5	6
OBL 6 5/8 1/98 - OB 6 2/98	-3	-1	1	4	4	6
OBL 6 2/98 - OB 6 3/8 5/98	0	0	2	2	3	4

Note: Bonds are characterized by their coupon value, name and maturity date. DBR 6 ½ 7/3 is a 10-year bond with coupon rate 6 1/2, maturing in July, 2003. OB bonds are 5-year bonds. c = 0 indicates that there is no adjustment in yield for differences in coupon rate. c=1/4 indicates an adjustment of 1 basis point per 1/4 difference in coupon rate between the two bonds.

The Value of Size:

Most bonds issued during a certain period have the same size, which means that it is hard to test whether size has any effect on yield. Comparing for instance DBR 7 1/4 10/2 with a size of 10 billion DEM and DBR 7 1/8 12/2 with a size of 16 billion DEM, the yield difference between the two is close to the estimated yield difference due to different maturity dates. This indicates that there is no effect of size given that an issue is larger than a certain amount.