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Bond Yield Spreads and Country Risk

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Abstract:
This paper investigates how bond yield spreads are related to country risk. Bond prices and bond yields are determined in the secondary market. Therefore, bond yields and their spread vis-à-vis US Treasury bonds might provide a continuous and more reliable information base than traditional measures of country risk. We aim at analyzing how changes in the bond yield spread indicate changes in country risk. It turns out that there is a strong relation between the two. Furthermore, we show that higher yield spreads and higher β's result in larger changes in the bond yield spread.

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BOND YIELD SPREADS AND COUNTRY RISK

1 Introduction

The economic literature has come up with various methods to analyze country risk (see e.g. Saini and Bates, 1984). One of them is the analysis of country risk by using interest rate spreads. For example, Angeloni and Short (1980) and Feder and Ross (1982) investigate whether there is a relation between interest rate spreads on international bank loans and country risk. Eichengreen and Mody (1998) model both the determinants of the decisions by countries to enter the bond markets and the factors that influenced the pricing of these bonds when launched. These studies can be called *primary market analysis,* as the interest rate spread investigated in this type of research is determined in the market where the loans are issued and where the loan terms are determined. Dropsy and Solberg (1992) suggest that the prices of bank loans, bond prices and bond yields have substantial informative value in determining country risk as they may render a sensitive reflection of expected debt payments. In analyzing country risk by using bond prices or bond yields, we get *secondary market analysis*, as the bond prices and yield are determined in the secondary market where bonds are traded. Edwards (1986) indicates that country risk does play an important role in the bond market. He finds evidence that bond yield spreads are positively associated with country risk. Stone (1990) also applies secondary market analysis. He finds that debt returns are insensitive to changes in country risk indicators. Chalal et al. (1996) use secondary market prices to examine integration between emerging and U.S. debt and equity markets. Their evidence suggests that the degree of integration varies with security type and the country of origin. However, these differences between security types become less apparent over time.

In this paper, we try to find out about the relationship between Eurobond yield differentials and country risk in the 1990s. We determine the relationship between Eurobond yield spreads and country risk by calculating rank correlations for more than a dozen countries - both developing countries and industrialized ones - in the mid 1990s. Furthermore, we build and interpret regression equations that describe the relationship between yield spreads and country risk. Then, we investigate whether this relationship holds through time. Section 2 gives the methodology and the data. The correlation and regression results are presented in section 3. Section 4 goes into the stability question. Section 5 is the conclusion.

2 Model and data

We first discuss how we estimate yield spreads of international bonds. Then, we discuss the model that relates yield spreads to country risk (see Scholtens, 1999 for a more elaborate discussion).

In using yield spreads in country risk analysis, a basic assumption is that one country is free of country risk. The US suits this purpose best. From this assumption we derive that the US T-bond yield is the country risk free interest rate. This seems reasonable as non-US bond yields often are regarded as the risk-free US bond yield plus an extra risk premium (see Fabozzi 1996). We calculate the yield spread by subtracting the US T-bond yield. As such, we will estimate the US T-bond yield curve. Yields spreads are to be estimated on a yield spread curve function.

We estimate the US T-bond yield curve as a function of remaining maturity, using a semi loglinear OLS regression (see Hull, 1997). For each remaining life, a corresponding US T-bond yield can be estimated by substituting the remaining life into the yield curve function. The yield curves are estimated together with the yield spreads. The next step is to calculate the yield spreads for international bonds. These spreads are found by subtracting the yield of the US T-bond from the yield of the bond of the specific country in question for the same maturity. Thirdly, we determine yield spread curves. Using loglinear regression, we come up with a spread curve. As we usually have much less observations about non-US yields than we have for the US, the yield spread regression will contain only one independent variable. Then, we have to estimate yield spreads, given a remaining life, which is identical for all bonds of all countries in our sample. For example, if we estimate the yield spread for Brazil for a bond with a remaining life of four years, yield spreads for the other countries should also be estimated for four years. For each country in our sample, yield spreads are estimated by using the loglinear estimation function of the spread curve. Then, yield spreads can be estimated by substituting the remaining life for x in the spread function. Estimated - not calculated - yield curves will be used to compare with the country ratings, as the actual, calculated, yield spreads of the countries in the sample carry different remaining maturities which hampers comparison. Note that any relationships between yield spreads and country risk ratings is a stochastic one. Therefore, (changes in) in the country risk ratings implied by (changes in) the yield spread can only be estimated. As a result, we will use a regression equation to describe the relationship between yield spreads and country risk.

We opt for the country rating as the independent variable and for the yield spread as the dependent variable. As we have chosen the US as the risk free country, it follows that the yield spread cannot be in the negative. This requires a functional form of the regression equation where the y value is always at least 0. It turns out that with the data at hand loglinear estimation results in the highest R^2. Therefore, the general form of the equation is:

(1) $$\ln YS_i = \alpha + \beta \text{ Rating} + \varepsilon,$$

where $\ln YS_i$ is the natural logarithm of the yield spread given a constant remaining life in years i. Rating is the country risk rating that is assumed to be reflected in bond yield spreads. α and β are coefficients to be estimated. And ε is the disturbance term.

The country risk indicator is the Institutional Investor country risk rating, which is published twice a year. The higher the country scores the lower the probability of restructuring or default and, therefore, the lower the country risk. Ul Haque et al. (1996) find that this rating is the best reflection of country risk if compared to other country risks indicators. Second, in contrast to other country risk models, there is no interdependence among independent variables as there is only one independent variable. The third reason is that it is easily available and at low cost.

We estimate the yield spreads twice a year across the entire dataset in the first week of May and November. The country risk scores published in March and September are in fact the markets' view on country risk in the first week of November and May respectively. The ordinary yields to maturity of the bond are yields reported by the International Securities Market Association in their Weekly Eurobond Guide. The reported yields are yields calculated by using bid and ask prices and are transformed to mid yields. We have bonds for a set of 25 countries.[1] Of course, for many periods, we will have not information from all these countries.

For almost all countries, yield spreads can be estimated for remaining lives of 3 and 4 years without relying on extrapolation of the yield curve. The remaining lives for which the yield spreads are estimated is called remaining life range. At each moment in time and for each country, yield spreads are estimated for three different remaining lives (3 and 4, and 2 or 5 year. The choice between 2 and 5 year depends on the extent of extrapolation needed to estimate the yield curve for this maturity.

3 Results

Rank correlation

When there really is a relation between yield spreads and country risk, we expect that higher yield spreads will correspond to higher country risk (see Fabozzi, 1996). Thus, we ask ourselves: do higher Institutional Investor scores (i.e. lower country risk) correspond with lower bond yield spreads?

The rank correlation is calculated as the ordinary correlation between two rankings. The statistic used to calculate a rank correlation is the Spearman rank correlation (R_s; see Benson and McClave, 1991). For each of our eight moments in time (four years, twice a year), three Spearmann rank correlations are calculated. Three, because this is

[1] Argentina, Austria, Brazil, Belgium, Canada, Chile, Colombia, Denmark, Finland, Greece, Hungary, Iceland, Ireland, Italy, South-Korea, Lebanon, Malaysia, Mexico, New Zealand, Philippines, Spain, Sweden, Trinidad & Tobago, Turkey, and Uruguay.

the broadest possible range of integer remaining lives for which the yield spreads can be estimated without having to rely too much on extrapolation of the yield spread curves. Countries are ranked with respect to the yield spread and the Institutional Investor score. The yield spreads are ranked from 1 to n (with n the number of countries) with the country with the lowest yield spread on top. The countries also are ranked for the Institutional Investor score from 1 to n, with countries with the highest score on top. It follows that the higher the rank correlation, the better yield spreads reflect country risk. We calculate as many Spearman rank correlations as possible to achieve the best judgement on the association between yield spreads and country risks. Furthermore, as rank correlations are calculated for different remaining lives of the bonds, it can be verified whether the relationship between yield spreads and country risk scores depends on the remaining life of the bonds. The rank correlations are calculated for May and November during the years 1993-1996. The results are in table 1.

Table 1
Rank correlations of yield spreads and country risk scores, all countries

	2 year	**3 year**	**4 year**	**5 year**
May 1993	n = 14 R_s = 0.9253	n = 14 R_s = 0.9209	n = 14 R_s = 0.9165	
November 1993		n = 14 R_s = 0.9077	n = 15 R_s = 0.9071	n = 14 R_s = 0.9385
May 1994	n = 14 R_s = 0.8857	n = 14 R_s = 0.8725	n = 14 R_s = 0.8901	
November 1994	n = 16 R_s = 0.8706	n = 16 R_s = 0.9206	n = 16 R_s = 0.9382	
May 1995	n = 18 R_s = 0.8968	n = 18 R_s = 0.9092	n = 18 R_s = 0.8968	
November 1995		n = 19 R_s = 0.8877	n = 19 R_s = 0.8860	n = 19 R_s = 0.8860
May 1996		n = 18 R_s = 0.8803	n = 18 R_s = 0.8927	n = 18 R_s = 0.8968
November 1996		n = 23 R_s = 0.8765	n = 23 R_s = 0.8854	n = 23 R_s = 0.8923

From May 1993 up to May 1994 we have the smallest number of countries included in table 1, namely 14. The critical value for which the H_0 hypothesis of no association between yield spreads and country risk is rejected with n = 14 observations and a significance level of 5%, is 0.457. When R_s is larger than 0.457, the H_0 hypothesis of no relation between yield spreads and country risk can be rejected. The rank correlations range from 0.87 to 0.94 and thus significantly differ from zero at the 5%-significance level. Thus, our results clearly reject the H_0 hypothesis of no relation between yield spreads and country risk scores. They confirm strong and positive associations between yield spreads and country risk. Second, increasing the number of countries does not result in a reduction of the Spearman rank correlation coefficient. To the contrary, it appears that the correlations in table 1 rise with the number of countries. Third, table 1 shows that country risk appears to be independent of the remaining life of the bonds. When we calculate R_s's of different remaining lives and compare these for the same period, they appear not to differ very much. Furthermore, there is not systematic tendency. This result contrasts that of Eichengreen and Mody (1998).

Regression analysis

We estimate equations like (1) for different moments in time; the same moments as analyzed previously. Furthermore, we estimate the equations for all countries. The results are in table 2. Because all rank correlations are strongly significant, it is not surprising that the parameter estimates (table 2) also are strongly significant. The estimates of α and β are significant at the 5%-level. The H_0 hypothesis: $\alpha = 0$ and $\beta = 0$, is strongly rejected by the F-statistic across the entire dataset. The R^2's for all eight moments in time and for all remaining lives are higher than 0.8, except for one (namely for bonds with a maturity of 2 years in November 1994, where the R^2 is .78). Comparing column 3 (N) and column 7 (R^2) suggests that the equations, which include a larger number of countries, do not have lower reported R^2's. This suggests that the relation between yield spreads and country risk remains robust, independent of the number of countries included in the regression estimation.

Table 2
Regression results for all countries

Period	**remaining life**	**N**	**α**	**t-stat. of α**	**β**	**t-stat. of β**	**R^2**	**F**
May 1993	2	14	2.9848	10.46	-.0528	-11.95	.923	142.86
	3	14	2.9489	13.36	-.0492	-14.40	.945	207.54
	4	14	2.9433	14.72	-.0473	-15.29	.951	233.91
November 1993	3	14	2.5033	10.17	-.0437	-11.08	.911	122.79
	4	14	2.5668	13.06	-.0427	-13.23	.931	175.08
	5	14	2.4809	12.36	-.0403	-12.54	.929	157.33
May 1994	2	14	2.2993	6.84	-.0420	-7.80	.835	60.85
	3	14	2.4609	8.82	-.0423	-9.45	.881	89.24
	4	14	2.5526	10.10	-.0424	-10.45	.901	109.29
November 1994	2	16	2.0801	5.70	-.0415	-7.00	.779	49.03
	3	16	2.5247	9.07	-.0450	-9.96	.876	99.28
	4	16	2.7447	10.82	-.0465	-11.27	.900	126.98
May 1995	2	18	3.2449	10.21	-.0571	-10.78	.879	116.16
	3	18	3.4600	11.80	-.0579	-11.87	.898	140.91
	4	18	3.5801	12.35	-.0583	-12.08	.901	145.94
November 1995	3	19	3.2811	12.54	-.0564	-12.68	.904	160.84
	4	19	3.3309	13.01	-.0554	-12.75	.905	162.48
	5	19	3.3664	13.02	-.0548	-12.48	.902	155.81
May 1996	3	18	2.5825	8.52	-.0518	-10.03	.863	100.56
	4	18	2.6333	9.75	-.0502	-10.90	.881	118.91
	5	18	2.6559	10.00	-.0489	-10.81	.879	116.77
November 1996	3	23	2.8452	8.07	-.0564	-9.52	.812	90.59
	4	23	2.9589	10.41	-.0554	-11.55	.865	134.49
	5	23	3.0393	11.59	-.0549	-12.46	.881	155.18

A White-test was applied to test for heteroskedasticity, however, no evidence for heteroskedasticity was found. This suggests that our least squares estimators are efficient, i.e. the standard errors are correct.

In comparing our regression results with the findings elsewhere in the literature (see section 1), it should be noted that we use a different estimation method. Furthermore, except for Angeloni and Short (1980) and Feder and Ross (1982), the other studies include country risk indicators as the independent variable instead of the Institutional Investor country credit score. As a result, we must be careful in comparing our results with others in terms of R^2's and other statistical inferences.

Given these remarks, we find that, based on a comparison of correlation coefficients, it appears that the relationship between yield spread and country risk is stronger than that between loan spread and country risk. If we compare our regression results for the relation between yield spread and country risk with other regression results for loan spreads and country risk, the same conclusion can be drawn. As such, it appears that yield spreads are a better reflection of country risk than loan spreads. Edwards' (1986) result tends to be in the same direction as ours, however, his findings are somewhat inconclusive. Our homogeneous dataset, the coming of age of the international bond market for developing country debt, and the use of Institutional Investor country risk scores instead of macroeconomic country risk variables are the most likely reasons for the fact that the relation between yield spreads and country risk in this paper is much stronger than the one found in Edwards (1986). Note that the results in table 2 tend to confirm the observation of Eichengreen and Mody (1998) that yield spreads increase with maturity (1993 is an exception).

4 Stability

The parameters estimated in the previous section might suffer from instability. Country risk analysts must be aware of the fact that analyzing country risk after November 1996 by using the estimation results of November 1996 is out-of-sample forecasting. To avoid the unreliability stemming from out-of-sample forecasting, country risk analysts would have to wait until March 1997 to perform their country analysis along the lines shown in this paper. Furthermore, as the yield spreads of November 1996 are used, they can only analyze country risk of November 1996: four months back in time compared to March 1997. Therefore, it seems interesting to analyze the stability of the parameters of the α's and the β 's during a couple of years. If the α's and the β 's would turn out to be stable during a certain period of time, a pooled regression estimation can be used. As such, more observations can be included, which increases the reliability of the regression results and results in a narrower confidence interval. We choose testing stability for a group of eleven countries (Argentina, Austria, Belgium, Brazil, Canada, Finland, Italy, Ireland, Mexico, Sweden, Venezuela; only in 1996 Ireland and Venezuela are excluded because the bonds of those countries didn't meet the required specifications; the net effect of leaving those two countries out in 1996 will be ignored.) and bonds with a remaining life of 3 and 4 years. As such, we have a homogeneous group of countries and we do not need to rely on extrapolation of the spread curve. We investigated whether the estimate of both the α's and the β 's differ between yield spread regressions with remaining life of 3 and 4 years. If so, the outcome of the stability tests also might differ for 3 and 4-year yield spreads.

We created subsamples of observations for the 3 and 4-year yield spreads in each period of observation. It is verified whether the estimated coefficients of equation (1) significantly differ for 3 and 4-year yield spread estimations. Since the dataset reveals that most spread curves are upward sloping as a function of remaining life, it is expected that the α's increase with remaining life. Furthermore, it is verified whether the β's differ for the two groups of remaining life. If both the α's and the β 's do not significantly differ between 3 and 4 year yield spread regressions, it doesn't matter which of the two is chosen to carry out the stability tests. A dummy was used for both the intercept and the slope coefficient. The following regression is estimated:

$$\text{(2)} \qquad \ln YS = \alpha_1 + (\alpha_2 - \alpha_1)\, D1c + \beta_1\, Rating + (\beta_2 - \beta_1)\, D2s + \varepsilon$$

with D1c = 0 for all 3 year yield spreads

D1c = 1 for all 4 year yield spreads

D2s = 0 for all 3 year yield spreads

D2s = $Rating_2$ for the respective values of country ratings for all 4 year yield spreads.

Subscript 1 refers to the first subset, i.e. the 3 year yield spread in each observation period; subscript 2 refers to the second subset: 4 year yield spreads. The 'c' refers to the intercept dummy, the 's' to the slope dummy. Furthermore, in (2) we have YS = YS_2, if D2s = $Rating_2$ and D1c = 1. In this case, $Rating_2$ has to be substituted for Rating in the third term on the right hand side of the equation. If both dummies are zero, YS

= YS_1 and Rating = $Rating_1$. Then, we have the estimated coefficients of the 3-year yield spreads. The group for which the regression is estimated, setting both dummies equal to zero, is called the reference group. The results of the estimates of regression (2) are in table 3.

Table 3
Differences in α and β; 3 year versus 4 year yield spreads

Period	***estimate of D1 (=α_2 - α_1)***	***estimate of D2 (=β_2 - β_1)***	***t-stat. of D1***	***t-stat. of D2***	***p-value D1c***	***p-value D2s***
May 1993	-.0026	.0018	-.01	.49	.9912	.6299
November 1993	-.0718	.0028	-.30	.76	.7694	.4549
May 1994	.0279	-.0008	.08	.13	.9400	.8942
November 1994	.1938	-.0011	.56	-.21	.5843	.8367
May 1995	.1237	-.0003	.32	-.06	.7540	.9548
November 1995	-.0006	.0018	-.001	.25	.9990	.8050
May 1996	-.0455	.0029	.53	-.12	.9053	.6070
November 1996	.0317	.0022	.06	.28	.9533	.7833

Table 3 shows that the p-values of the dummies are much larger than 0.05. The null hypothesis of all dummies, each separately, being equal to zero cannot be rejected. All dummies are insignificant. Applying a White-test for heteroskedasticity shows that no heteroskedasticity was found. (The smallest p-value corresponding to heteroskedasticity tests – i.e. the probability of incorrectly rejecting the null hypothesis of homoskedasticity – found was for May 1996: 0.23). As α and β are not statistically different for 3 and 4-year yield spread regressions, it doesn't make a difference whether the stability tests are carried out for 3 or for 4-year yield spreads. We test for 3-year yield spreads. Whether the estimated α and β are stable in time is tested by Chow breakpoint estimation and by the dummy variable technique.

The Chow breakpoint estimation tests for stability of both intercept and slope parameters between two or more populations. A disadvantage is that it might reject the hypothesis of stability but not reveal which particular coefficients are unstable; that is the reason we also will employ the dummy variable technique. Stability was investigated for the estimated coefficients α and β for:
1993 versus 1994; 2. 1993/94 versus 1995/96; 3. 1995 versus 1996.

As such, stability could not be found for the complete dataset. In fact, there appears to be a breakpoint with the Mexico crisis of December 1994. After this crisis, it seems that country risk was perceived quite different than before, and investors began to attach more weight to country risk than before, when trading in bonds.

5 Conclusion

Secondary bond market analysis seems useful to analyze country risk. Compared with primary market analysis, we find higher rank correlation coefficients for bond yield spreads and country risk than for loan spreads and country risk. Secondary market analysis might be superior too from a theoretical perspective as it continuously reflects the changes in perceptions and expectations of bond traders and investors. The primary market is bound to one single moment in time in this respect, namely the moment of the issue of the bond. Compared with other secondary market analyses, our results suggest a much stronger relation between bond yield spreads and country risk. The high rank correlations between the bond yield spreads vis-à-vis US T-bonds and the country ratings indicate that bond yield spreads may be a better reflection of country risk than loan spreads in the secondary market.

When we compare our regression results for the relation between yield spread and country risk with other regression results for loan spread and country risk, it appears that the relationship between yield spread and country risk is stronger than that between loan spread and country risk. In tandem with the rank correlations, it seems that yield spreads are a better reflection of country risk than loan spreads. Our homogeneous dataset, the coming of age of the international bond market for developing country debt, and the use of Institutional Investor country risk scores instead of macroeconomic country risk variables are the most likely reasons for the fact that the relation between yield spreads and country risk in this paper is much stronger than found elsewhere in the literature.

Stability could not be found for the complete dataset. There appears to be a breakpoint with the Mexico crisis of December 1994. After this crisis, it seems that country risk was perceived quite different than before, and investors began to attach more weight to country risk than before, when trading in bonds. In this respect, our results confirm the findings of Eichengreen and Mody (1998) that are based on primary market analysis.

In all, the methodology developed in this paper can be very valuable in analyzing the behavior on international financial markets. Furthermore, our findings indicate that country risk analysts must be very careful in applying this methodology. However, further analysis of the secondary international bond market and country risk rating is warranted to come to more robust conclusions about the relationship between yield spreads and country risk.

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