

Bid-Ask Spreads and the Liquidity of International Bonds

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While there is no widely accepted definition of liquidity, academicians and practitioners seem to have a common perception of its nature. O'Hara [1995] defines liquidity as the ability to trade a security quickly and with little cost. Practitioners define a liquid issue as one in which two-way markets are made available to investors in reasonable size over an extended period without undue disruptions or difficulties in establishing fair value (Mackintosh [1995]).

In fixed-income markets, a common and systematic source of pricing discrepancy arises because of illiquid bonds. Banks usually price an illiquid issue through interpolation involving the prices of liquid issues with characteristics close to that of the bond in question.

Despite its evident importance in practice, the role of liquidity in bond markets has received inadequate attention in academic research. There is research mostly on the liquidity of U.S. government and corporate bonds (e.g., Amihud and Mendelson [1991a, 1991b], Alexander, Edwards, and Ferri [2000], Hong and Warga [2000], and Kalimpalli and Warga [2002]).

We extend the scope of the research by presenting evidence on the liquidity of international bonds including sovereigns, corporates, banks, and supranational institutions. We find the credit rating and issue size of bonds to be negatively related to the bid-ask spread, while the price volatility is positively related to the spread. We find no significant relationship between bid-ask spreads and bond coupon rates

and maturity. This contrasts with Hong and Warga's [2000] finding that U.S. government and corporate bond spreads are positively and significantly related to time to maturity. In our sample, bonds denominated in pound sterling have wider spreads than U.S. dollar bonds, and corporate bonds have wider spreads than sovereign bonds.

I. LITERATURE

A range of proxies for liquidity are used in previous research, including yield or return spreads (Sarig and Warga [1989], Blume, Keim, and Patel [1991], Warga [1992], and Crabbe and Turner [1995]); the bid-ask spread (Schultz [1998], Chakravarty and Sarkar [1999], and Hong and Warga [2000]); and volume (Kamara [1994], and Alexander, Edwards, and Ferri [2000]). We use the bid-ask spread as a proxy for liquidity.

The last two decades have seen a tremendous growth in the academic literature on market microstructure, which attempts to shed light on the way investors' latent demands are ultimately translated into prices and volumes. Madhavan [2000] provides a review of theoretical, empirical, and experimental studies on market microstructure, and highlights that a growing body of research demonstrates the importance of liquidity as a factor in determining expected returns.

In fact, some research in the market microstructure literature argues that liquidity

has a first-order effect on asset returns (e.g., Datar, Naik, and Radcliffe [1998]). Further, Amihud and Mendelson [1986] show that expected returns are a decreasing function of liquidity because investors must be compensated for the higher transaction costs that they bear in less liquid markets. They find there is a positive relation between returns and the bid-ask spread for NYSE/AMEX common stocks in the period 1961-1980.

Amihud and Mendelson [1991a] note that there is a difference in the bid-ask spread for Treasury bills and Treasury bonds, and that this affects yield to maturity. Amihud, Mendelson, and Lauterbach [1997] document large changes in asset values for stocks moving to more liquid trading systems on the Tel Aviv Stock Exchange. Keim and Madhavan [1997] show that transaction costs are higher in less liquid assets where omission of the compensation for illiquidity in the computation of returns has the strongest effects.

Several empirical studies test the hypothesis that larger issues are more liquid. Studies using yield or return spreads as a measure of liquidity find little or no support for this hypothesis (Warga [1992], Crabbe and Turner [1995], and Fridson and Garman [1998]), although they recognize that this does not necessarily suggest that liquidity itself is not positively priced. On the other hand, studies on bid-ask spreads (e.g., Hong and Warga [2000]) find support for the hypothesis by noting that larger issues are associated with smaller bid-ask spreads. Alexander, Edwards, and Ferri [2000] examine the determinants of trading volume, and their findings support the argument that larger corporate bond issues are more liquid.

Studies on assets' liquidity have generally been directed toward equities, but studies of equity markets cannot completely disentangle liquidity risk from other risk characteristics of different stocks. Kamara [1994] argues that studying identical Treasury notes and bills, however, enables a full separation of liquidity risk from other risks because, apart from liquidity and tax differences, they are identical assets with known cash flows upon maturity. His findings suggest that the time variation in note-bill yield differentials is systematically related to differences in the liquidity of the assets.

Garbade [1984] and Amihud and Mendelson [1991b] find that note yields are higher than bill yields, and suggest that the yield differences result from liquidity differences: Notes are less liquid than bills. Amihud and Mendelson [1991b] also find that the note-bill yield differential narrows with time to maturity.

Sarig and Warga [1989] note that government bond prices are more accurately recorded than corporate bond

prices, both because of higher liquidity in the government bond market and higher uniformity of traded assets. Their conjecture is supported by the evidence of Nunn, Hill, and Schneeweis [1986]. Using a sample of government bonds and proposing the occurrence of price runs (i.e., identical prices for a bond in two consecutive months) as the most pronounced symptom of illiquidity, they show that as a bond becomes less liquid, the quality of the recorded prices deteriorates.

Nunn, Hill, and Schneeweis use three proxies for liquidity: 1) the bond's age; 2) the bid-ask spread quotations; and 3) the amount of bonds outstanding. They find that age fares best of the three proxies, and show that a bond tends to become less liquid with age. Since bond age and bond time to maturity at issuance are correlated, this analysis implies that illiquid bonds are more prevalent among long-maturity bonds than short-maturity bonds.

Fridson and Garman [1998] analyze a sample of non-investment-grade bonds. They find that, of nine issue-specific variables and ten environmental variables, credit ratings have by far the greatest impact on new issue spreads. They note that the connection is more apparent when ratings are analyzed on a senior-equivalent basis than when they are viewed in the more usual (non-senior-equivalent) format.

The rule applied is that if the senior equivalent rating is Baa3 or higher, the subordinated rating is one notch lower, while if the senior equivalent rating is Ba1 or lower, the subordinated rating is two notches lower. Fridson and Garman's results show that a non-investment-grade bond's yield spread will be greater, all other things being equal, the lower its senior-equivalent rating; the lower its seniority in the capital structure; the longer its maturity; if it is callable prior to maturity; if it is a zero-coupon security; if it is the bond of a first-time issuer; or if it is underwritten by a commercial bank.

Given the important role of liquidity, Mackintosh [1995] proposes a methodology for measuring the liquidity of issues by scoring their most widely accepted components, and aggregating them into a liquidity rating. Highly weighted contributors to liquidity in his model include size of issue, name recognition, clearing system, number of market makers, dealers' spread or initial pricing, and initial placement geography.

Recently, Kalimipalli and Warga [2002] have found that volatility and spreads of U.S. corporate bonds are largely positively related while volume is insignificantly related, to spreads. Hong and Warga [2000] hypothesize a positive relationship between bid-ask spreads and the age of the bond, its return, and time to maturity, along with a negative rela-

EXHIBIT 1

Summary Data on Sample Distributions

Credit Rating Distribution

AAA	AA	A	BBB	BB	B or lower
47	21	18	8	4	6

Distribution of Bonds Across Currency and Issuer Type

	U.S. Dollar	Sterling	Euro	Yen	Total
Sovereign	15	5	10	8	38
Corporate	7	19	5	0	30
Financial	6	4	3	5	18
Supranational	4	4	8	1	18
Total	32	32	26	14	104

Sample of 104 international bonds for June 19–September 7, 2000.

tionship between spreads and the amount outstanding, the credit rating, and the volume. They find a bond's return volatility and time to maturity to have the strongest effect and to be of the hypothesized sign.

II. DATA AND METHODOLOGY

The liquidity of a security involves some measure of how easy it is to buy or sell without moving its price unduly, and this will be reflected in the bid-ask spread for a given "standard" size order. In other words, there are aspects of both price and quantity in this concept of liquidity. Here, we control for quantity (through standard order size) in order to focus on the role of the bid-ask spread (price).

We collect a daily sample of bid-ask spreads on bonds, together with some key characteristics of the bonds, with a view to addressing two issues:

1. How stable are the spreads for individual bonds over time and how stable is the ranking of bond spreads over time?

2. Do the characteristics of the bonds that we believe a priori are related to the concept of liquidity empirically influence the bid-ask spread?

We construct a database from a daily feed of bond pricing data supplied by Financial Times Interactive Data (FTID) for 104 international bonds over a 12-week period from June 19 through September 7, 2000. The issuers of these bonds encompass sovereigns, corporates, financial institutions, and supranationals; the issues are denominated variously in U.S. dollars, pound sterling, euros, and yen; and both investment-grade and speculative-grade bonds are included.

Exhibit 1 summarizes the characteristics of the dataset. The majority of issues have high credit ratings, but there is representation from each broad rating category. Around 90% of issues in the sample are investment-grade. With the exception of yen-denominated corporate bonds, the dataset includes combinations of all intended issuer types and currencies.

Data are collected on bid and ask prices, together with bond features as follows: coupon, maturity, issue size (converted to U.S. dollars for non-dollar-denominated issues), and credit rating (assigned by Standard & Poor's if available; otherwise Moody's). We also calculate the volatility of each bond measured by the standard deviation of logarithmic returns based on midpoint prices over the relevant period. Related data such as volume, while interesting to market participants, should be encapsulated in the spread if the spread is calibrated for an appropriate ("standard") order size.

We conduct an empirical investigation into both the stability and the determinants of bid-ask spreads for the 104 bonds over the sample period. We initially focus on some related questions: 1) What is the range of bid-ask spreads on these bonds, and what type of issues have the narrowest and widest bid-ask spreads? and 2) what is the variability in bid-ask spreads over the sample period, and what type of issues have the greatest and least variability?

First, we investigate the ranking of mean daily percentage bid-ask spreads over the whole sample period, and then investigate three four-week subsamples (denoted Month 1, Month 2, and Month 3). Second, a similar analysis is conducted where we rank on the basis of the variability of the percentage bid-ask spread over the same sample periods, as measured by the standard deviation.

We extend the analysis to consider the determinants of the bid-ask spread by estimating the model:

$$BAS_i = \alpha + \beta_1 C_i + \beta_2 M_i + \beta_3 R_i + \beta_4 S_i + \beta_5 \sigma_i + \varepsilon_i \quad (1)$$

where BAS_i is the mean daily bid-ask spread for bond i ($i = 1, 104$) over a given sample period of interest; C_i represents the bond's coupon; M_i is the bond's maturity; R_i is the bond's credit rating (converted to a numeric scale: AAA/Aaa = 16 and B-/B3 = 1); S_i is the size of the bond issue; σ_i is the volatility of the bond price over the relevant period; and ε_i is the error term. The equation is estimated using ordinary least squares for the full sample and for three subsamples to gauge the stability of the relationships.

The selection of explanatory variables is driven by the literature we have mentioned. We expect coupon, maturity, and volatility to be positively related to the spread; we expect credit rating and issue size to have a negative relationship with the spread. Given the continuous nature of our dependent variable, percentage bid-ask spreads, we deem OLS estimation as the most appropriate.

Two extensions are used, where we introduce indicator variables for currency of denomination and type of issuer:

$$BAS_i = \alpha + \beta_1 C_i + \beta_2 M_i + \beta_3 R_i + \beta_4 S_i + \beta_5 \sigma_i + \beta_6 D_{1i} + \beta_7 D_{2i} + \beta_8 D_{3i} + \varepsilon_i \quad (2)$$

$$BAS_i = \alpha + \beta_1 C_i + \beta_2 M_i + \beta_3 R_i + \beta_4 S_i + \beta_5 \sigma_i + \beta_9 D_{4i} + \beta_{10} D_{5i} + \beta_{11} D_{6i} + \varepsilon_i \quad (3)$$

where D_1 , D_2 , and D_3 are indicator variables taking the value of 1 if the issue is denominated in pounds sterling, euro, and yen, respectively, and 0 otherwise; and D_4 , D_5 , and D_6 are indicator variables taking the value of 1 if the issuer is a corporate, financial institution, or supranational, respectively, and 0 otherwise. In the former case, the interpretation is relative to U.S. dollar-denominated issues, and in the latter case the interpretation is relative to sovereign issuers.

III. EMPIRICAL RESULTS

We calculate percentage bid-ask spreads (based on $100 [ask - bid] / \text{midpoint}$) for 104 international bonds across 58 daily observations. Exhibit 2 presents summary statistics on the mean percentage spread across the sample by currency, rating category, and type of issuer.

The means and dispersion of spreads on the U.S. dollar- and euro-denominated issuers are quite similar. The sterling-denominated issues tend to have wider spreads with greater dispersion, while the yen-denominated issues have narrower spreads and a tighter dispersion. Issues with higher credit ratings have a clear tendency to have narrower bid-ask spreads, and the dispersion of spreads is tight at the top end of the rating scale. The financial and supranational issuers tend to have narrower and less dispersed spreads than the sovereign and corporate bonds. The sovereign issues tend to have narrower and less dispersed spreads than the corporate bonds.

Next, we use the mean percentage bid-ask spread to investigate the levels of the bid-ask spreads, and then rank the bonds in order to analyze what types of issues have the narrowest and widest bid-ask spreads. Exhibit 3 presents results on the top ten (in Panel A) and bottom ten (in Panel B) for the full sample and for three subsamples.

It is immediately clear that issues with high credit ratings have narrower bid-ask spreads, while the widest bid-ask spreads are for medium- or low-grade credits. Although

EXHIBIT 2

Summary Statistics on Daily Percentage Bid-Ask Spreads

	Mean	Standard Deviation	Minimum	Maximum
By Currency				
U.S. Dollar	0.344	0.396	0.008	2.501
Sterling	0.595	0.595	0.007	2.220
Euro	0.360	0.294	0.030	1.972
Yen	0.164	0.109	0.017	1.410
By Rating Category				
AAA	0.220	0.189	0.007	1.410
AA	0.200	0.165	0.030	0.826
A	0.570	0.599	0.018	2.216
BBB	1.014	0.561	0.149	2.220
Speculative	0.879	0.387	0.248	2.501
By Type of Issuer				
Sovereign	0.369	0.414	0.007	2.501
Corporate	0.592	0.607	0.042	2.220
Financial Institutions	0.296	0.210	0.018	1.277
Supranational	0.255	0.217	0.042	1.339

EXHIBIT 3

Rankings According to Mean Daily Percentage Bid-Ask Spreads

Panel A. Top Ten

Rank	Full Sample	Month 1	Month 2	Month 3
1	0.019 GBP / Sov / AAA	0.018 GBP / Sov / AAA	0.018 GBP / Sov / AAA	0.013 USD / Sov / AAA
2	0.022 JPY / Fin / A-	0.024 JPY / Fin / A-	0.022 JPY / Fin / A-	0.019 GBP / Sov / AAA
3	0.027 USD / Sov / AAA	0.030 USD / Sov / AAA	0.024 USD / Sov / AAA	0.020 JPY / Fin / A-
4	0.028 JPY / Sov / AAA	0.031 EUR / Sov / AA+	0.026 JPY / Sov / AAA	0.024 JPY / Sov / AAA
5	0.030 USD / Sov / AAA	0.032 USD / Sov / AAA	0.026 USD / Sov / AAA	0.030 EUR / Sov / AA+
6	0.031 EUR / Sov / AA+	0.032 JPY / Sov / AAA	0.031 EUR / Sov / AA+	0.033 USD / Sov / AAA
7	0.033 USD / Sov / AAA	0.039 USD / Sov / AAA	0.035 USD / Sov / AAA	0.034 USD / Sov / AAA
8	0.039 GBP / Sov / AAA	0.041 GBP / Sov / AAA	0.036 USD / Sov / AAA	0.037 GBP / Sov / AAA
9	0.039 USD / Sov / AAA	0.043 USD / Sov / AAA	0.039 GBP / Sov / AAA	0.043 USD / Sov / AAA
10	0.046 GBP / Cor / AA-	0.049 GBP / Cor / AA-	0.046 GBP / Cor / AA-	0.044 GBP / Cor / AA-

Panel B. Bottom Ten

Rank	Full Sample	Month 1	Month 2	Month 3
95	1.086 USD / Sov / A-	1.110 USD / Sov / BB+	1.099 GBP / Cor / BBB-	1.175 USD / Sov / A-
96	1.193 GBP / Cor / BBB+	1.181 GBP / Cor / A	1.143 USD / Sov / CCC+	1.189 GBP / Cor / BBB+
97	1.214 GBP / Cor / A	1.184 GBP / Cor / BBB+	1.206 GBP / Cor / BBB+	1.195 GBP / Cor / A
98	1.235 USD / Sov / BB+	1.264 USD / Sov / CCC+	1.238 USD / Sov / BB+	1.353 GBP / Cor / BBB+
99	1.283 GBP / Cor / BBB-	1.290 GBP / Cor / BBB+	1.263 GBP / Cor / A	1.371 USD / Sov / BB+
100	1.328 GBP / Cor / BBB+	1.365 USD / Sov / B	1.343 GBP / Cor / BBB+	1.417 USD / Sov / B
101	1.391 USD / Sov / B	1.476 EUR / Sov / CCC+	1.393 USD / Sov / B	1.653 GBP / Cor / A
102	1.725 GBP / Cor / A	1.660 GBP / Cor / BBB+	1.817 GBP / Cor / A	1.723 GBP / Cor / BBB-
103	1.911 GBP / Cor / BBB+	1.696 GBP / Cor / A	2.012 GBP / Cor / BBB+	2.041 GBP / Cor / A-
104	2.042 GBP / Cor / A-	1.952 GBP / Cor / A-	2.132 GBP / Cor / A-	2.079 GBP / Cor / BBB+

USD, GBP, EUR, and JPY denote U.S. dollar-, pound sterling-, euro-, and yen-denominated issues. Sov, Cor, and Fin denote sovereign, corporate, and financial institution issuers.

there are exceptions, the majority of the narrowest spreads are on sovereign bonds, and the majority of the widest spreads are for corporate bonds. The ranking of a sovereign issue, however, appears to have a much stronger relation to its credit rating than to its status as a sovereign bond or its currency of issue. Indeed, no systematic pattern emerges for the currency of denomination. There is a high degree of consistency across subsamples at the top end of the ranking, with more variability across subsamples apparent for the wider bid-ask spreads.

Exhibit 4 consists of a similar analysis, but here the ranking is based on the variability of the daily bid-ask spread, as measured by its standard deviation across each sample. Panel A shows a pattern similar to the pattern in Panel A, Exhibit 3, in that highly rated issuers dominate the top rankings; i.e., many highly rated issuers tend to have stable bid-ask spreads over time. The bonds listed (in both panels), though, are not identical to those in Exhibit 3.

Panel B differs somewhat from that in Exhibit 3 since a number of top-rated issues show a high degree of variability in the bid-ask spread. It seems that no clear inferences can be drawn from this panel, since a wide range of credit ratings, issuer types, and currencies of issue are represented.

We next examine the empirical determinants of the bid-ask spreads. We initially attempt to explain the spreads by considering five features of each bond—namely, coupon, maturity, credit rating, issue size, and price volatility—and subsequently consider the influence of currency and issuer type.

In Exhibit 5, for all models, we find no significant relationship between bid-ask spreads and bond coupon rates and maturity. This contrasts with Hong and Warga's [2000] finding that U.S. government and corporate bond spreads are positively and significantly related to time to maturity. Similar to Kalimipalli and Warga's [2002] results for U.S. corporate bonds, we find a statistically significant positive relationship between bid-ask spreads and price volatility; i.e., spreads are wider for bonds with more uncertain returns after controlling for other factors.

We also find statistically significant negative relationships between bid-ask spreads and both credit rating and issue size, although the relationship with credit rating is much stronger as also suggested by Hong and Warga [2000]. Issues with a low credit rating and small issue size tend to have wider spreads, i.e., are less liquid. These relationships are consistent across subsamples of the data, as

shown in the second through fourth columns of Exhibit 5, except for Month 1, for which the issue size is insignificant at the 5% level although of the correct sign.

The last two columns of Exhibit 5 present results for extended models that account for currency of issue and issuer type. In the former case, we find that sterling-denominated issues in our sample tend to have significantly wider bid-ask spreads than U.S. dollar-denominated issues, while there are no significant differences between the spreads on dollar- versus euro- or yen-denominated issues. In the case of issuer type, we find that corporate bonds in the sample have significantly wider bid-ask spreads than sovereign bonds, while there are no significant differences between the spreads on sovereign versus financial or supranational issuers.

In addition to the consistency in the relationships for each regression, the models for the full sample typically explain more than half of the variations in bid-ask spreads (i.e., the R^2 values are above 50%). This compares favorably with other work that reports much lower R^2 values (see, for instance, Hong and Warga [2000]).

IV. CONCLUSIONS

Using a diverse sample of international bonds, we observe that issues with high credit ratings have narrower bid-ask spreads. Also, the majority of the narrowest spreads are on sovereign bonds, while the majority of the widest spreads are for corporate bonds. Overall, while issues with higher credit ratings tend to have more stable bid-ask spreads over time, a number of top-rated issues show a high degree of variability in the bid-ask spread. In general, sterling-denominated and corporate bonds have wider spreads.

A detailed econometric examination of the determinants of the bid-ask spread confirms that credit rating, issue size, and price volatility affect liquidity in a plausible way, and account for over 50% of the total variation in the spread.

EXHIBIT 4

Rankings According to Standard Deviation of Daily Percentage Bid-Ask Spreads

Panel A. Top Ten

Rank	Full Sample	Month 1	Month 2	Month 3
1	0.496 EUR / Sov / AA+	0.189 EUR / Sov / AA+	0.108 USD / Sov / AA+	0.143 EUR / Sov / AA+
2	0.536 USD / Sov / AA+	0.200 USD / Sov / AA+	0.111 USD / Sup / AAA	0.160 USD / Sov / AA+
3	0.566 USD / Sup / AAA	0.215 USD / Sup / AAA	0.151 USD / Sov / AA+	0.177 GBP / Sov / AAA
4	0.611 USD / Sov / AA+	0.260 USD / Sov / AA+	0.160 EUR / Sov / AA+	0.185 USD / Sup / AAA
5	1.268 GBP / Sov / AAA	0.396 GBP / Sov / AAA	0.307 USD / Sup / AAA	0.215 USD / Sov / AA+
6	1.292 GBP / Sov / AAA	0.416 GBP / Sov / AAA	0.323 USD / Fin / AAA	0.386 GBP / Sov / AAA
7	1.449 USD / Fin / AAA	0.429 JPY / Sov / AAA	0.366 USD / Fin / AAA	0.424 USD / Fin / AAA
8	1.480 GBP / Sov / AAA	0.532 USD / Fin / AAA	0.417 USD / Sup / AAA	0.444 GBP / Sov / AAA
9	1.550 USD / Sup / AAA	0.548 USD / Fin / AAA	0.447 GBP / Sov / AAA	0.469 USD / Fin / AAA
10	1.577 USD / Fin / AAA	0.574 USD / Sup / AAA	0.531 USD / Fin / AAA	0.469 USD / Sup / AAA

Values are times 10^{-4} in Panel A only.

Panel B. Bottom Ten

Rank	Full Sample	Month 1	Month 2	Month 3
95	0.223 GBP / Fin / AAA	0.218 EUR / Fin / A	0.223 GBP / Fin / A	0.203 GBP / Cor / AA
96	0.254 USD / Sov / BB+	0.238 USD / Sov / BB+	0.239 JPY / Sov / AAA	0.216 GBP / Cor / A-
97	0.261 JPY / Sov / AAA	0.264 USD / Sov / B+	0.256 EUR / Sov / CCC+	0.220 USD / Sov / A-
98	0.314 USD / Sov / B+	0.278 EUR / Sup / AAA	0.269 USD / Sov / B+	0.246 GBP / Cor / BBB+
99	0.337 USD / Sov / CCC+	0.287 EUR / Sov / CCC+	0.273 GBP / Fin / AAA	0.262 EUR / Sov / CCC+
100	0.369 USD / Sov / BB+	0.293 USD / Sov / CCC+	0.323 USD / Sov / BB+	0.272 GBP / Fin / AAA
101	0.430 GBP / Cor / BBB-	0.349 GBP / Cor / A-	0.339 USD / Sov / CCC+	0.299 USD / Sov / B+
102	0.433 EUR / Sov / CCC+	0.387 USD / Sov / BB+	0.351 GBP / Cor / BBB+	0.383 JPY / Sov / AAA
103	0.520 GBP / Cor / BBB+	0.695 GBP / Cor / A	0.451 GBP / Cor / A	0.565 GBP / Cor / BBB-
104	0.597 GBP / Cor / A	0.765 GBP / Cor / BBB+	0.470 USD / Sov / BB+	0.642 GBP / Cor / A

USD, GBP, EUR, and JPY denote U.S. dollar-, pound sterling-, euro-, and yen-denominated issues. Sov, Cor, and Fin denote sovereign, corporate, and financial institution issuers.

EXHIBIT 5

Regression Results

Period	Full Sample Eq. (1)	Month 1 Eq. (1)	Month 2 Eq. (1)	Month 3 Eq. (1)	Full Sample Eq. (2)	Full Sample Eq. (3)
Intercept (α)	0.774 ^a (4.02)	0.874 ^a (5.03)	0.917 ^a (4.33)	0.657 ^a (2.98)	0.885 ^a (4.18)	0.620 ^a (3.26)
Coupon (β_1)	0.009 (0.64)	0.007 (0.56)	0.007 (0.47)	0.011 (0.76)	-0.011 (0.72)	0.002 (0.16)
Maturity (β_2)	-0.001 (1.13)	-0.0004 (1.05)	0.001 (0.95)	-0.0002 (0.42)	-0.001 (1.14)	-0.0004 (0.80)
Credit Rating (β_3)	-0.043 ^a (4.94)	-0.050 ^a (6.39)	-0.048 ^a (4.93)	-0.035 ^a (3.48)	-0.049 ^a (5.94)	-0.043 ^a (4.71)
Size (β_4) Coefficients $\times 10^3$	-0.015 ^b (2.41)	-0.009 (1.57)	-0.018 ^b (2.48)	-0.017 ^b (2.54)	-0.014 ^b (2.36)	-0.005 (0.64)
Volatility (β_5)	1.005 ^a (4.69)	0.811 ^a (5.51)	0.452 ^b (2.01)	0.942 ^a (3.94)	0.985 ^a (4.80)	1.098 ^a (5.33)
Sterling-Denominated (β_6)					0.302 ^a (4.37)	
Euro-Denominated (β_7)					0.036 (0.49)	
Yen-Denominated (β_8)					0.024 (0.22)	
Corporate Issuer (β_9)						0.315 ^a (3.69)
Financial Institution Issuer (β_{10})						0.093 (0.93)
Supranational Issuer (β_{11})						0.084 (0.80)
Adjusted R ²	0.52	0.58	0.42	0.44	0.60	0.58

Absolute t-statistics in parentheses.

^a Denotes significance at the 1% level.

^b Denotes significance at the 5% level.

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