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Sovereign Eurobond Liquidity and Yields

Daniel C. Hardy

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Prepared by Daniel C. Hardy

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ABSTRACT: Market liquidity is of value to both investors and issuers of securities, and is therefore a crucial factor in asset pricing. For the important asset class of Eurobonds, significant feedback from liquidity to pricing is established, and it is shown that bid-ask spreads (a proxy for market liquidity) and yields are closely related to bond characteristics such as issue volume, time to maturity, the inclusion of collective action clauses, and the jurisdiction of issuance. Debt management offices can choose these characteristics in a way that has economically significant and persistent effects on both liquidity and pricing.

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Author's E-Mail Address:	dclhardy@gmail.com

* Vienna University for Economics and Business. Tadeusz Galeza provided important assistance and inputs at an early stage of this project. The paper benefited from constructive comments from Coşkun Cangöz, Sebastian Grund, Joe Kogan, Hui Miao, Robin Tietz, Tomohiro Tsuruga, and participants at seminars at the Vienna University of Economics and Business, the International Monetary Fund, and the Dutch State Treasury Agency, and at the 91st International Atlantic Economic European Conference. Daniel Hardy has recently retired from the IMF and is now based at Vienna University for Economics and Business.

WORKING PAPERS

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I. Introduction

Eurobonds constitute an important asset class. They provide a means of international diversification for investors that offer not only an attractive risk-return trade-off but also relative liquidity and transparency. They allow borrowers in emerging market and developing countries (EMDCs), and especially EMDC sovereigns, to access a wide investor base and to manage their debt portfolios flexibly. Eurobonds are of macro-finance importance as a channel for debt capital flows to and from EMDCs. When an EMDC suffers a debt crisis, the re-profiling or restructuring of its Eurobonds is an essential, if sometimes long drawn out, element of resolution. Eurobond pricing is followed closely as an indicator of the market participants' perception of risk and used as a benchmark for pricing other products, while substantial investment portfolios are tied to Eurobond indices.

Eurobonds are unusual in that they are characterized by being issued in a jurisdiction (typically New York or England) and a currency (predominantly the US dollar) distinct from those of the issuer.[2] They are sold "over the counter" but transactions are normally recorded in one of the major international central securities depositories.[3] Those characteristics make Eurobonds more homogeneous than sovereign bonds issued under myriad national laws and in local currencies; reduces concern that, in case of dispute, either investors or issuers will be unduly favored by courts; and facilitate trading.

By 2020 there were about US$1.5 trillion in rated sovereign EMDC Eurobonds outstanding—up from under US$1 trillion in 2015—with about 70 new issues per year over the past decade (International Debt Statistics, 2021). As of 2017, 82 countries had issued Eurobonds, ranging from major issuers such as Mexico and Turkey to occasional and small-scale issuers such as Gabon, Surinam, or Uzbekistan (van der Wansen et al., op. cit.*).* In addition, about US$500 billion in non-sovereign Eurobonds, issued for example by major EMDC banks and enterprises, were outstanding. These volumes have continued to rise, and ever more issuers have been tempted to raise funds through these instruments.

In this context, a fuller understand of Eurobond pricing and the functioning of the Eurobond market is of value to investors and borrowers alike, and for policy determination. It may be possible to identify certain bond characteristics and debt management practices that do not cost the issuer much but are of substantial benefit to the investors. A borrower, that is, a sovereign issuer, can provide these characteristics and be rewarded by lower financing costs.

Moreover, the Eurobond market, with its homogeneity in some dimensions and heterogeneity in others, can be a source of evidence on the functioning of financial markets generally. The central issue relates to the determinants of pricing, market liquidity, and thus efficiency (O'Hara, 2003). Relevant determinants may include the tenor of the security; issue size; legal provisions relating in particular to restructuring; features of the issuer, including creditworthiness but also the issue's overall market presence and debt management strategy.

This paper is a contribution to that understanding. It is structured to yield results relevant to market participants, especially debt management offices (DMOs) and new issuers in EMDCs, as well as academics. Also, focus rests on the largest and most homogeneous part of market, namely U.S. dollar-denominated sovereign bonds. Specifically, the yields on, and bid-ask spreads of individual US$ EMDC sovereign Eurobonds are related to bond and issuer characteristics that theory and evidence from other empirical studies suggest should be relevant. These relationships are assessed using a large panel of observations and flexible functional forms.

[2] The misleading term "Eurobonds" survives from when they were first issued with the intent of tapping US dollar deposits in Europe.

[3] Choudhry (2008) provides more institutional details. Van der Wansen et al. (2019) provides information on operational matters.

The connection between yields and market liquidity is worth elaborating. The market for a security is said to be liquid if it is possible to buy or sell a reasonable amount of that security, reasonably quickly, with a minimal effect on the price.[4] What counts as a "reasonable amount," "reasonably quickly," and "minimal effect" depends on the nature of the security and the market participants. The concept of market liquidity is multi-faceted and several metrics are relevant; it can be considered an "emergent" phenomenon (Ladyman and Wiesner, 2020). A modest bid-ask spread—that is, the difference between the price at which participants offer to buy the security and that at which they offer to sell it—is necessary but not sufficient for a market to be considered liquid. Again, what counts as "modest" depends on the market: for advanced economy wholesale bonds markets, a "modest" bid-ask spread is a few basis points, but some tens of basis points may be modest in an emerging market bond market. In any case, a market would not be considered liquid if accepting an asking price and then selling at a bid price would result in an immediate loss of, say, 5 percent of value.

Liquidity is of value to both investors and issuers because it promotes "price discovery" (the timely aggregation of information into market prices) and facilitates market transactions. An investor in a liquid asset can readily increase or decrease the stake in reaction to shifting beliefs about risk or expected return, or to meet liquidity needs. On the issuer side, the DMO's job is easier if the market in its securities is liquid, so that it can quickly sell more securities, or sell more than anticipated, without a sharp adverse movement in prices. Moreover, DMOs often engage in "liability management operations" buying in certain bonds in order to maintain a desired duration of its overall portfolio or to reduce roll-over risk as the redemption date of a major issue approaches—which depend on market liquidity. Liquidity, or its sudden disappearance, is especially important for market participants during crisis periods. Brunnermeier and Pendersen (2009) model how market liquidity and funding costs interact, leading to the possibility of amplifying feedback and systemic collapse in case of a negative shock. Moutot et al. (2017) links turnover, bid-ask spreads and sentiment in the sovereign bond market, suggesting the possibility of an abrupt switch to a "market freeze;" Rösch and Kaserer (2013) present a similar model.

The findings presented here on the determinants of bid-ask spreads should therefore be of interest to both sides of the market. Moreover, they will provide one explanation of why certain bond characteristics affect yields: the characteristics that promote greater liquidity in the form of lower bid-ask spreads should be "rewarded" by the market in the form of lower yields.

The next section reviews theoretical and empirical research on securities market liquidity and its connection to pricing. From this a series of testable hypotheses applicable to the Eurobond market are derived, albeit informally. The sources and main characteristics of the data set are explained. The section thereafter presents and discusses the main results for the regressions on bid-ask spreads and yields, and the associated hypothesis tests. The estimated coefficient from the bid-ask spreads and yields regressions are then used to project the magnitude of the effects. This section includes evidence on the robustness of the results and the long-run predictability of yields and spreads based on information available at the time of bond issuance. Efforts to link spreads and yields directly are reported in the penultimate section. The concluding section includes some suggestions for how the approach used here could be applied to other securities markets.

[4] The liquidity of a security is the outcome of the behavior of participants of market in which it is traded, although the securities' features may affect that behavior. In another use of the term, the liquidity of an institution relates to its holdings of liquid assets relative to its liquid liabilities.

II. Background

A. Theory

Investors can be expected to place a higher price, and thus accept a lower yield, on securities for which there is a liquid market. In the first instance, liquidity is valuable because it allows an investor to adjust positions in timely fashion and at little cost; it generates a "convenience yield." An investor may see an opportunity to transact in a way that offers higher returns or the avoidance of losses, but without market liquidity the opportunity may be missed, the pay-off may be offset by transaction costs, or asset prices may react so sensitively to the initiation of the transactions that the chance evaporates. Also, an investor whose aim is consumption smoothing will be discouraged from purchasing an asset that is difficult to realize when funds are needed in a hurry. An investor buying an asset will be concerned that future adjustments to the position will be slow and costly, driving a wedge between the assessed fundamental value and the market price (Garbade and Silber, 1979; Amihud and Mendelson, 1986a). Lo et al. (2004) show how even small fixed costs can discourage trading except in the face of large shocks, and also make it more difficult to hedge positions. These impediments reduce agents' asset demand and can give rise to an illiquidity discount in asset prices.

Furthermore, illiquidity raises the cost of acting on (small) informational advantages, and therefore reduces informational efficiency. On the one hand, illiquidity makes it less worthwhile to invest in the acquisition of information, and especially granular information that would affect asset valuation modestly (Crabbe and Turner, 1995). Less information is generated. On the other, prices do not react to small differences in valuation, so they reveal less of the information that is available.

Generally, one would expect the market for an asset to be liquid if there is a large and diverse base of investors for that asset who are potentially willing to trade. An asset is unlikely to be liquid if there is little demand for it, or if investors are very homogeneous in terms of their investment horizons and expectations—if they are all "on the same side of the market." Investors must also be willing to trade; buy-and-hold investors may be plentiful and diverse, but they do not contribute to market liquidity. An asset characterized by a substantial issuance volume; limited credit and market risk; moderate duration; and with standard features is likely to attract such a large and diverse investor base.

Liquidity and strong demand for an asset may be mutually reinforcing, and feedback may run from relative yields to market liquidity. Liquidity should make an asset more attractive and reduce its yield. But an asset that offers good relative returns should, for given characteristics, generate strong and widespread demand, and thus generate better market liquidity. There is ample evidence, for example, that low interest rates in advanced economies encourages capital flows into EMDC financial markets and specifically Eurobonds. Aggregate demand strengthens, and perhaps more importantly, the investor base expands and becomes more diverse as more and more agents venture into what had previously been seen as relatively exotic and specialized. Hence, market liquidity should improve, making those assets even more attractive and contributing to the re-convergence of yields—at the margin, the more liquidity instruments should still offer a lower yield. However, disentangling the underlying connections may be difficult because many of the conditions listed above that support high liquidity also imply strong demand.

Liquidity is closely related to the bid-ask spread, which can be viewed as generating a return to making the market. The dealer (whether or not officially designated as such) incurs certain costs and risks in holding an inventory and posting bid and ask prices at which it is willing to buy or sell on demand (at least for small quantities); incurring these costs and risks is compensating through earnings on the bid-ask spread. First, the costs of transacting in the security will include operational costs. Operational costs are not generally observable by investigators, but intuitively they should be fairly stable over the short term and similar across securities. There may be a significant fixed element of operating costs, such that average costs fall with turnover. Hence, covering operating costs requires a narrower bid-ask spread, the higher the turnover.

Second, the bid-ask spread may reflect market power on the part of the dealer(s). Intuitively, a dealer who is permanently in the market can build up a certain reputation, but an individual investor looking for immediacy has will not have much time to “shop around” (Dutta and Madhavan, 1997; Chacko et al, 2008). Third, holding a securities inventory requires financing and capital to absorb short-term price fluctuations. Accordingly, the riskiness of a security should be positively related to the bid-ask spread (Amihud and Mendelson, 1980). Finally, the dealer will charge a bid-ask spread to compensate for the risk of dealing with a better-informed counterpart; the dealer earns the spread on the mass of its transactions and occasionally suffers a large loss (for example, buying a bond of an issuer who is about to default) when faced with an insider (Glosten and Milgrom, 1984; Easly and O’Hara, 1987). With the exception of the market power argument, these arguments imply that the bid-ask spread depends on turn-over and the variety of investors, and thus on market liquidity. Therefore, a dealer who is sure of a steady stream of buy and sell orders from investors who are not exceptionally well informed can charge a low bid-ask spread, and thereby further promote market liquidity.

B. Securities Market Pricing and Liquidity

These considerations have given rise to numerous empirical studies of how market liquidity is related to pricing and of the determinant of market liquidity. The evidence corroborates the hypotheses outlined above: the liquidity premium is generally an important component of asset pricing, and variations in market liquidity across securities and time can largely be explained. The discussion here focuses on the most relevant aspects, namely, results from bond markets and especially Eurobond markets.

Domestic Bond Markets

The empirical evidence shows that yields on bonds tend to increase with illiquidity, both in cross-section and over time. Heck et al. (2015) is representative of studies of the effects of liquidity conditions on US corporate bond pricing. They find that both a common factor and a corporation-specific factor matter for bond yields; the former is more important in stress times, while the latter matters more in normal times. Other studies of liquidity pricing in this market including Schultz (2001), Chacko (2002), Chacko (2005), Longstaff et al. (2005), Ammer and Cai (2007), Chen et al. (2007), Lin et al. (2011), and Bao et al. (2011) come to similar conclusions, while Houweling et al. (2004) relate European corporate bond yields to various proxies for liquidity. De Jong and Driessen (2006) and Friewald et al. (2012) show that liquidity is especially important in the pricing of speculative bonds and in periods of crisis.

Amihud and Mendelson (1991, 2015) provide evidence that yield is negatively related to liquidity in the market for U.S. government securities, and that the excess yield on the less liquid notes is a decreasing function of the time to maturity. Relatedly, Bildersee (1977), Sanig and Warga (1989), and Devani and Zhang (2017) show how “seasoning” increases the bid-ask spread of U.S. government and agency bonds, as does increasing maturity; “seasoned” bonds (i.e., those that have been issued long ago) are likely to have accumulated in buy-and-hold portfolios and thus the “free float” is reduced. Likewise, Warga (1992) finds that recently issued, so-called “on-the-run” Treasury securities have lower returns than "off-the-run" issues, indicating that the greater liquidity of recent issues is positively priced. Afonso et al. (2015) establish that liquidity risk is a substantial factor in the pricing of advanced economy sovereign bonds generally. Hoyos et al. (2020) investigate the pricing of liquidity in the Mexican domestic bond market using an index that combines quote data (notably the bid-ask spread) and transactions data (e.g., order book depth).

Various indices and techniques can be used to measure aspects of market liquidity. However, while employing a number of measures is valuable, studies suggest that most measures tend to move together. Lesmond (2005) and also Chen et al. (op. cit.) document that the bid-ask spread is usually highly correlated with other (price-based) liquidity measures across time, assets, and countries. Volume-based measures, such as turnover and order book size, yield complementary information (Brandt and Kavajecz, 2004). Fleming (2003) compares liquidity measures and concludes that the bid-ask spread is at least as

informative as other (price-based) measures. Results in Langedijk et al. (2018) suggest that the end of day bid-ask spread performs robustly across observation frequencies as a measure of liquidity in the market for EU sovereign bonds.

An early study of the determinants of bid-ask spreads in bond pricing is reported in Tanner and Kochin (1971). They look at the bid-ask spread on Canadian government bonds, which they interpret as compensating dealers for the risk of holding inventories of securities for sale. They find that the bid-ask spread is reliably related to features of the respective security: positively with the term to maturity and yield to maturity, and negatively with the quantity outstanding and the coupon rate (because a higher coupon rate reduces duration and thus price variability). [5] Garbade and Silber (1976), Bildersee (1979), and Hong and Warga (1998) come to similar conclusions looking at bid-asks spreads on US Treasury securities and bonds issued by US federally sponsored agencies (for which credit risk is absent). Results in Bildersee (1980) suggest that duration is the most important determinant of the bid-ask price spreads on US Treasury bonds; other variables such the coupon rate, remaining maturity and yield are mere proxies for duration. Chakravarty and Sarkar (2003), looking at US government, municipal and corporate bonds, find that a bond's bid-ask spread is decreasing in trading volume, and increasing in risk (captured by ratings for corporates), its age, and its remaining time to maturity. Chen et al. (op. cit.) stress that the credit rating interacts importantly with the other determinants of bid-ask spreads on a corporate bond. Kalimipalli and Warga (2001) uncover a significant negative relationship between volatility and observed bid-ask spreads for some US corporate bonds, suggesting that, in thinly traded markets, volatility indicates the arrival of news may therefore promote liquidity. Relatedly, Brandt and Kavajecz (2004) show that variation in the order flow drives much of the fluctuations in US Treasury bond rates on days with little news, conditioned on the seasoned-ness and time to maturity of the bonds.

Eurobond Studies

Most empirical studies of Eurobond pricing focus on the determinants of risk premia and specifically the spread between a country's Eurobond yield and that of a "safe" asset (typically a US government bond). Hilscher and Nosbusch (2010) and Gaillard (2012) are example of such studies. Presumably this premium reflects the investors' beliefs about the probability of the issuing country defaulting; the expected loss given default; compensation for taking on risk; and global macro-financial conditions such as the stance of U.S. monetary policy.[6] One can then relate the premium on a bond to other variables such as the relevant country's macroeconomic indicators and indicators of its fiscal situation; credit ratings; and the price of other financial products such as credit default swaps. The detailed characteristics of the bond other than its duration or remaining maturity are usually neglected.

A few studies have looked at the interaction of liquidity and pricing in international bond markets. Alquist (2008) draws conclusions from data on the late nineteenth century London market data on sovereign bonds; then too, a high bid-ask spread was associated with significantly higher yields, as was small issue size. Duffie et al. (2003) document how liquidity was priced into Russian domestic bond and Eurobond yields, and how the liquidity premium varied over time and depending on the exact terms and conditions of various bond series. Chamon et al. (2018) focus on whether issuance in a foreign rather than the domestic jurisdiction affects yields, but also find a positive relationship between bid-ask spreads and yields (and specifically that the higher bid-ask spreads on foreign jurisdiction bonds makes then less attractive). They emphasize that effects become much more pronounced during stress times, that is, when credit risk is elevated.

The results of Hund and Lesmond (2008) are relatively closely related to those presented here. They look at sovereign and corporate emerging market bonds, and find that liquidity is statistically and economically

[5] The analyses do not allow for the possible endogeneity of yields.
[6] Another strand of research, represented by Csonto and Ivaschenko (2013) and Feyen et al. (2015), looks at issuance volumes rather than prices.

highly significant in explaining differences in yield spreads.[7] Yields are found to be affected also by macroeconomic conditions; political conditions; credit rating; and bond features such as maturity (negative effect); age (negative effect); and coupon rate (positive effect). According to their evidence, the bid-ask spread is well correlated with, and as powerful as, other measures of market liquidity (namely, the percentage of zero returns, and a measure based on a limited dependent variable model known proposed in Lesmond et al., 1999). The bid-ask spread is positively related to other liquidity measures, and affected also by the amount outstanding (positive); credit rating (negative); bond price volatility (positive); bond age (negative but insignificant for sovereign bonds); and maturity (positive but insignificant). The authors undertake joint estimation of yields and the liquidity measures using three-stage least squares; an instrumental variables approach, where macroeconomic variables and indicators of financial market development are the main instruments; and regressions based on year-to-year changes. The relationship between yields and liquidity remains positive and significant.

Bid-ask spreads on international bonds, including sovereign bonds, are examined also in Ap Gwilym et al. (2002). They find that the spread is negatively related to credit rating and issue size, and positively related to price volatility, but the effects of coupon rate and maturity are statistically insignificant.

A sub-literature looks at the effects on pricing of certain features in Eurobond terms and conditions on their pricing, and in particular whether the inclusion of a collective action clause (CAC) is rewarded or penalized (Box 1 provides an explanation of CACs and the related pari-passu clauses). The weight of evidence suggests that the effect is a small but significant reduction in yields, especially for countries with worse credit ratings. Chung and Papaioannou (2020) is a recent example of such a study. They find that the inclusion of an "original" CAC (with only series-by-series voting) has a statistically significant negative effect on bond yields, and that the effect is stronger for countries with lower credit ratings during stress periods. The inclusion of an enhanced CAC had a negative but statistically insignificant effect on yields of bonds issued by lower-rated countries. Broadly similar results were obtained by Becker et al. (2003), Richards and Gugiatti (2003), Bardozzetti and Dottori (2014), and for European issues by Carletti et al. (2018) and Picarelli et al. (2018). Eichengreen and Mody (2004), based on data from an earlier period, conclude that CACs may reduce the cost of borrowing for more creditworthy issuers, but increase them for less creditworthy borrowers. However, they take issuance under English law as a proxy for inclusion of a CAC. Grosse, Steffen et al. (2019) find that the introduction of CACs (as well as their review in European courts) had little impact on pricing of euro area sovereign bonds, but the countries involved were predominantly highly rated.

Ratha et al. (2016) suggest that the choice of jurisdiction is distinct from, and at least as important as inclusion of a CAC. According to their analysis, initial yields on bonds issued under New York law being substantially lower than those issued under English law—a result suggested already in Tsatsaronis (1999).

[7] They focus on annual average yields in excess of a comparable U.S. government bond yield of similar maturity, and annual averages of their liquidity measures.

Box 1. CACs and Pari-Passu Clauses

Eurobond terms and conditions contain clauses that are meant to facilitate restructuring when that is necessary, while preserving appropriate incentives for the issuer and all bond holders (IMF, 2014, provides a summary and history, and links to the literature). These clauses can reduce value-destruction in restructuring situations (caused by the disruption to financing and payments), and therefore should be welfare enhancing. The clauses are designed to ensure an equitable distribution of the benefits, and discourage perverse behavior such as "holding out" for an exceptional good deal by a small group of investors, or premature calling for restructuring by a debtor. These clauses are especially important for sovereign bonds due to the absence of an insolvency procedure that would organize creditor claims.

A CAC enables a qualified majority of bondholders to bind the minority to the terms of a restructuring, making it more difficult to block a restructuring. The original CACs operated on a series-by-series basis, and therefore a group of creditors could relatively easily obtain a "blocking position." This possibility could discourage more cooperation-minded creditors from agreeing to terms that risk being inequitable. In response, CACs have been enhanced to allow for "two limb" aggregation (requiring agreement by series and in aggregate) or "single limb" aggregation (requiring just a supermajority of the aggregate holders of all bonds). However, use of a single limb voting procedure requires the issuer to offer all affected bondholders the same instrument or an identical menu of instruments (conditions that are "uniformly applicable").

A pari-passu clause, as applied to a sovereign bond, protects a creditor from legal subordination of its claims in favor of another creditor. Effectively, the clause impedes the debtor from doing independent deals with different creditor groups, and therefore increases creditor cohesion and strengthens the bargaining powers of creditors. A so-called "modified" pari-passu clause makes explicit that payments are not "ratable." Thus, to the extent that a debt is due and payable to one creditor, the clause allows a debtor to make payments to that creditor even if it does not make pro rata payments to other creditors whose debts are also due and payable. The debtor can therefore service restructured bonds even as it does not make payments on bonds held by "holdouts." The inclusion of enhanced CACs does indeed seem to reduce holdout risk (Fang et al., 2021).

The exact formulation and implications of CACs and pari-passu clauses differ slightly across jurisdiction. Perhaps more importantly, legislation, precedent, and practice differ across jurisdictions in other ways that may affect sovereign debt restructuring. For example, bonds issued under New York law more often use a trust structure than do bonds issued under English law, and therefore typically may incorporate certain protections against holdout creditors.

Use of CACs and pari-passu clauses in sovereign debt contracts has a long history. CACs were promoted by the IMF and others following the wave sovereign debt crises in the late 1980s and 1990s, to counter a tendency for debt restructurings to be excessively costly (Bolton and Olivier, 2007). The inclusion of CACs in their original form became common practice after 2003, also under New York law. Consultation between the official and the private sectors in response to creditor coordination problems in the Argentine and the Greek debt restructurings led to nearly all Eurobonds issued since 2015 including enhanced CACs and modified pari-passu clauses (IMF, 2019). The current contractual clauses and their widespread use thus reflect a consensus on best practice forged between issuers, investors, intermediaries, international financial institutions, and non-government organizations.

III. Testable Hypotheses

Theory and the existing literature suggest that the bid-ask spread on a Eurobond should reflect the costs of transacting and holding the security in the trading book (including the costs of bearing the associated risks), and also the market liquidity of the instrument. These costs and liquidity characteristics are interdependent and also relate to whether a large and diverse investor base is interested in the security, such that it is relatively easy to find a counterpart with which to transact without a significant adjustment in price.

The establishment and maintenance of a large and diverse investor base, eager to trade, is likely to be the product of many factors:

- The security should be issued in sufficient size that it is worthwhile for many investors to undertake initial research into the security's likely performance (for example, related to the macroeconomic and political economy prospects of the issuing country), and then to undertake on-going monitoring. Because many of these informational costs are fixed, the relationship between issue size and the bid-ask spread may be non-strictly monotonic, and there may be threshold effects.[8] Moreover, the distinction needs to be made between initial issue size and the stock outstanding; the latter may be much less than the former when the security is amortized progressively rather than in one 'bullet,' or where the issuer has undertaken liability management operations. Plausibly, the initial issue size matters for creating a large and stable investor base who have gone to the expense of undertaking the necessary research. However, if very little of the issue is still outstanding, the investor base may evaporate. Hence, it is worth looking at both the initial issue size and the amount currently outstanding.

- The issuer's overall market presence and its typical debt management strategy may matter. A large and frequent issuer of Eurobonds may have built up an investor base that has already invested in the analysis of potential risk and returns and is relatively eager to hold individual securities issued by that sovereign. Both the total volume and its composition (for example, in terms of currency denomination and range of maturities) may be important: an issuer that has supplied the market with a pallet of securities, each of reasonable size, may be favored. In contrast, an issuer that has just one security outstanding may be treated differently: that uniqueness may discourage some investors, but also implies that demand for exposure to the respective sovereign is concentrated. Even for a regular issuer, significant deviation from its typical bond features (in terms of size or duration) may reduce liquidity and thus increase the bid-ask spread.

- The return on an asset relative to that on alternatives may affect the size of the investor base and thus market liquidity. In particular, low yields on advanced economy securities such as U.S. Treasury bonds may induce investors to "search for yield" in emerging market Eurobonds. This greater demand will not only affect prices but also market activity, as the newcomers search for investments, existing issuers are tempted to offer greater volumes, and new issuers enter the market.

- Duration will matter to investors. Many Eurobond investors may be interested in relatively long-term assets, but they will be concerned that long duration increases exposure to interest rate and credit risk and, for many, does not match the duration of their liabilities.[9] Duration is a function of remaining time to maturity, but initial time to maturity may be important in establishing the initial investor base. Moreover, a high coupon yield reduces duration. Plausibly, the relationship

[8] Calomiris et al. (2019) emphasize the importance of threshold effects in the pricing of emerging market corporate bonds.
[9] Vayanos and Vila (2021) provide a modern version of such a "preferred habitat" theory.

between duration and the bid-ask spread is non-linear and even non-monotonic: the market may be most active for bonds that are neither very close to maturity nor of very long tenor.

- Evidence from other markets suggests that “age” or “seasoning”—that is, the time elapsed since issuance—could be negatively related to market liquidity because the share of a bond in buy-and-hold portfolios tends to increase.

- The degree of sovereign risk will affect the size and diversity of the investor base: fewer investors will be interested in relatively risky sovereign assets. Sovereign risk can be reflected in the respective country’s credit rating, where both the initial and the current rating may matter, but the market’s perception at any point in time may differ from the credit rating, which is relatively slow moving. Achievement of investment grade may expand the investor base to a substantial number of funds that accept only high-quality paper, and correspondingly, a ratings downgrade may shrink the investor base. However, it is possible that very highly rated EMDC sovereign bonds are largely held by buy-and-hold investors, and these countries may generate relatively little “news” that provokes trading. Hence, market liquidity may be relatively weak for highly rated bonds. In addition to the rating, the coupon rate is a signal of riskiness: Eurobonds are normally issued at close to par, so countries that are viewed as relatively risky and have to offer a high yield normally also set a relatively high coupon rate.

- Inclusion of a bond in an index is reportedly important for many investors.[10] It is common for investment intermediaries to offer vehicles such as mutual funds that invest only in instruments included in a recognized index; the JP Morgan “Emerging Market Bond Index Global” (EMBIG) is representative (Gaillard, 2012). Inclusion in an index typically depends, inter alia, on whether the sovereign is a large and regular issuer, and of investment or near investment grade.

- Sovereign risk may depend on contractual features of the respective bond, and in particular whether the terms include a CAC, enhance CAC, or modified pari-passu clause, which are meant to reduce the costs of restructuring a bond should the issuer get into severe payment difficulties. Possibly, the costs of restructuring, and the distribution of those costs among the sovereign and different classes of investors, will depend also on the jurisdiction under whose law the bond is issued (typically New York or English law). The presence of such provisions and features can be captured through dummy variables. However, the effects of these provisions may depend on the riskiness of the sovereigns: for a sovereign that is likely to go into restructuring in any case, a provision that reduces associated costs is unambiguously beneficial. For a moderately risky sovereign, reduced cost of restructuring may make it more tempting to initiate a restructuring, and so the provision may be disadvantageous to investors. The provisions may be unimportant for sovereign issuers that are very remote from a restructuring. Hence, it is worth considering the interaction of risk terms (such as the rating) and the contractual variables.

- The investor base may have evolved over time in terms of size, diversity and familiarity with the Eurobond market, and there may have been structural breaks not captured elsewhere. The market for emerging market debt has expanded in recent years, suggesting that more recent issues may enjoy access to a larger and more diverse investor base. Hence, it is worth including as an explanatory variable that captures when a bond was issued.

- The currency denomination of the bond may matter. Well over three quarters of Eurobonds are denominated in U.S. dollars, with almost all the remainder denominated in euros; a small number of issues are denominated in Japanese yen and other currencies. The currency denomination will affect the risk characteristics (e.g., in relation to interest rate risk) and what counts as the relevant safe interest rate, and different investors will have different ‘natural hedges’ against one of the

[10] See Calomiris et al. (op. cit.) for a discussion.

other currencies. Here, for the sake of parsimony, attention focuses on U.S. dollar-denominated Eurobonds.

These various hypotheses will be tested in the empirical section of the paper, insofar as data on explanatory variables are available.

It should already be apparent that several challenges to the empirical investigation relate to collinearity and identification, because some effects are captured by several variables (e.g., the credit rating and the coupon rate signal credit risk), and some variables reflect several effects (e.g., the coupon rate signals credit risk but also affects duration; the initial maturity and the remaining time to maturity are relevant to investors' investment horizon, but also imply how long the bond has been in the market and the share that has landed in buy-and-hold portfolios).

Many of the factors described above that affect liquidity affect also overall demand for the bond, and thus a bond's yield. Thus:

- A large issue, with a large volume still outstanding, is more likely to overcome the fixed costs of assessing the bond's risks and expected returns, and thus enjoy a large investor base. Repeated large issuers are more likely to have built up a stable investor base, especially if they follow a consistent debt management strategy and exhibit limited credit risk. However, demand may be price elastic: yields may have to be higher in order to mobilize demand to take up a larger-volume issue or an issue by a country with a large total volume of bonds outstanding. That price elasticity may reflect concerns over credit or roll-over risk, so again volume and credit-risk factors may interact.

- Eurobond yields certainly move closely with the yields on corresponding benchmark instruments, which, for US dollar-denominated instruments, are U.S. Treasury bonds of comparable maturity, although the premium will be time-varying.

- Many investors in the bond space have a medium-term horizon, so a certain initial and residual maturity is likely to represent the "preferred habitat;" very long-term bonds or bonds with short residual maturity may carry a premium, in addition to an expectations effect.

- The relationship between "age" and yield depends on the balance of supply and demand: declining liquidity as a bond ages may reduce demand and correspondingly lower prices/raise yields, but the shrinking "free float" of the bond available to buy may push yields down.

- Country risk may be the single most important factor in determining yields relative to that on an otherwise comparable safe asset, possibly with a discontinuity between investment grade and sub-investment grade issuers. Yield and credit risk are likely to be monotonically related, with little of the "tapering" hypothesized for the liquidity of highly rated bonds.

- Inclusion of a bond in an index may make it eligible for investment by a wider range of institutions.

- An (enhanced) CAC and (modified) pari-passu clause in the bond's terms and conditions may affect its yield in a complex way, as may the jurisdiction of issuance, especially if restructuring is not a remote possibility.

Moreover, better market liquidity and lower transaction costs as captured by a narrower bid-ask spread should increase the attractiveness of a Eurobond and reduce its yield, ceteris paribus. However, the overlap in explanatory variables may make it difficult to identify this effect.

IV. Estimation Framework

A. Data Sources

The estimates focus on the explanatory power of financial and institutional variables that are under control of relevant agents, and specifically the country DMO that sets the volume (initial and outstanding), initial maturity, coupon rate, jurisdiction of issuance, and inclusion of CAC and pari-passu clauses. Moreover, these variables are precisely measured and dateable. Hence, they are certainly all predetermined; the values of many are determined years before the observation period.[11]

One could envisage inclusion of other explanatory variables (e.g., macroeconomic indicators). However, not only is the timing of when they were known to market participants problematic, but also, they cannot be influenced by DMOs. In any case, as will be see, considerable explanatory power is achieved with the available explanatory variables.

The data used in the analysis are downloaded from multiple sources and capture issue-specific as well as country-specific information. Bloomberg Generic provides market data on listed bonds, such as prices, yields, and sovereign credit rating. Dealogic provides individual bond characteristic at the time of issue, including issued volume, coupon rates, and past credit rating. The Perfect Information data are used to assess the presence of contractual clauses and the governing laws of securities in the sample. JPMorgan is the source on the EMBIG Index constituents. The FRED Economic Database made available by the St. Louis Federal Reserve provides data on U.S. Treasury bond yields.

The data are end quarterly and the sample covers securities listed during March 2017 to March 2019. Eurobonds were identified as securities issued in a currency other than that of the issuer and listed in a major jurisdiction. For the sake of comparability, the dataset is limited to fixed-rate straight bonds, issued by EMDCs, denominated in US dollars.

B. Definitions

The various variables are defined as follows:

- The main variables to be explained are the yield to maturity (YLD) of each bond, based on the midpoint of the bid and ask prices, in basis points; and the spread between the ask and bid prices relative to the mid-price (BAS), again in basis points;

- The initial issuance volume (VOL_ISS) and the volume currently outstanding (VOL_NOW) are measured in US$ billions. In addition, to capture possible “threshold” effects, certain volume dummies were defined. For example, the variable D500 takes the value of unity if the initial volume equals or exceeds US$500 million and zero otherwise; other volume dummies are defined analogously;

- Also measured in US$ billions is the total volume of a country’s issues outstanding (CTY_VOL), as captured in this sample. Since the number of issues (CTY_I_NUM) is available, the average issue size (AVG_VOL) can be estimated;

- Initial time to maturity (MAT_ISS) and remaining time to maturity (MAT_NOW) are measured in years;

[11] Consider issue volume: a country may have an opportunistic issuance strategy, issuing more when conditions are favorable. Nonetheless, the initial issue volume is set for the life of the bond and in particular for the observation period.

- The point on the U.S. dollar risk-free yield curve (MAT_NOW_DYC) corresponding to the remaining maturity of a specific bond is measured in basis points. It was approximated with a suitably tuned convex combination of the 1-year and 20-year U.S. Treasury yields.[12] The approximation worked well for most maturities of the Eurobonds in the sample and for the period covered (characterized by little curvature in the yield curve, long rates stable at around 3 percent, and short rates rising slowly until the yield curve was almost flat);

- As the main measure of sovereign risk, Standard & Poor's and Moody's issuer rating were obtained (a Fitch rating was used when an S&P rating was not available). The average score of the available ratings was then translated into a numerical code (from 22 for the highest possible rating of AAA to 1 for the lowest possible rating of D). **Table** provides a translation of the letter ratings into the scores. Both the rating at time of issue (CRR_ISS) and the current rating (CRR_NOW) are considered;

- The coupon rate (CPN_RT) is measured in percentage points;

- Whether a bond is included in the EMBIG is captured by a dummy variable (D_EMBIG) that takes the value of unity in case of inclusion;

- Dummy terms are used to indicate the inclusion of relevant contractual provisions such as an original CAC (D_O_CAC), an enhanced CAC (D_E_CAC), or modified pari-passu clause (D-PARI_P). Similarly, dummies are constructed to indicate whether a bond is issued under New York law (D_NY_LAW) or English law (D_EN_LAW);

- Cross-products with log credit ratings and squared log credit ratings are constructed. D_E_CAC_LCRR_I and D_E_CAC_LCRR_I_SQ, for example designate the product of the enhanced CAC dummy and the log of the relevant country's credit rating at the time off issuance and the square thereof, respectively. These terms allow for the possibility that effects of explanatory variables may differ in complex ways depending on the country's riskiness. For example, on the margin, a highly-rated country may be able to issue more bonds with minimal effect on pricing or liquidity, whereas a country with a low rating may rapidly saturate the market for its debt. Contractual provisions are likely to be much more important for bonds that stand in significant danger of being restructured; and

- A dummy variable is constructed for each quarterly observation date (designated D_MMMYY).[13] Dummy variables are constructed also for each possible issue year in the sample, namely, for 1996 through 2019. On occasion it is useful to include country variables, which are designated by D_(country code), where the country code is the three-digit indicator from used in International Financial Statistics.

Various modifiers are used. The prefix "L" indicates the natural logarithm of the relevant variable. The suffix "_SQ" indicates the square of the variable. A term such as "CHG_A" denotes the difference between the current value of variable A_NOW and the value at time of issue A_ISS. A prefix "R_" indicates the residual from an auxiliary regression. Also included is a variable DAVG_LVOL defined as the difference between

[12] Let 1YR (20YR) denote the one-year (20-year) U.S. Treasury yield. Define a weight $w=(1+\tau)/(\text{MAT\_NOW}+\tau)$, where τ is a tuning parameter. Thus, $w=1$ if MAT_NOW=1, and converges to 0 as MAT_NOW increases. Then MAT_NOW_DYC ≡ w.1YR + (1–w).20YR

For this sample, $\tau=3$ was chosen to achieve a close approximation to the actual dollar yield curve.

[13] To ensure identification when also a constant term is included in the regression specification, one of such dummies must be excluded.

the log average bond size for the respective country and the log issuance volume of the relevant bond; the variable captures whether or not the size of a particular bond is typical for that country's issuance program.

C. Summary Statistics

The dataset includes over 4750 observations of yields and bid-ask spreads on EMDC US$ Eurobonds, implying about 500 observations per observation period. The number of observations per quarter increases slowly over the sample period as new bonds are issued faster than old bonds mature.

The wide ranges of most exogenous and endogenous variables offer the prospect that tests will be powerful and results relevant to many countries and periods (**Table 3** and Figure 1). For example, most initial issue volumes are below US$3 billion, but some are double that. Many issuing countries have less than US$20 billion in bonds outstanding; a cluster of issues have about US$50-US$60 billion outstanding, and another cluster have over US$100 billion outstanding. The modal initial maturity is ten years, but there are substantial numbers of shorter-term bonds and a cluster of bonds with initial maturity around 30 years—besides one 40-year bond and one 100-year bond. The credit ratings in the data sample range from AA (=20) to CCC+ (=6). The modal value is BBB- (=13), with just a few observations with ratings of CCC+ and only about a fifth of the sample had a credit rating above BBB (=14).

The summary statistics and charts show that the distributions of the variables are typically skewed. Most variables (before taking logarithms) are bounded from below. In particular, bid-ask spreads are always positive. In this sample, the US$ yields are all positive. The distributions display long "tails" of relatively high value observations (Figure 1, top row).

The scatter plots for the bid-ask spread against other variables suggest that certain correlations are strong (Figure 1, continued). Most striking is the positive relationship between bid-ask spreads and yields. The bid-ask spread is distinctly negatively correlated with issue size, but the relationship may be non-linear. Any link between yields and issue size is more complex, but (as expected) yields are generally lower for higher-rated issuers.

Figure 1. Variable Distributions and Scatter Plots

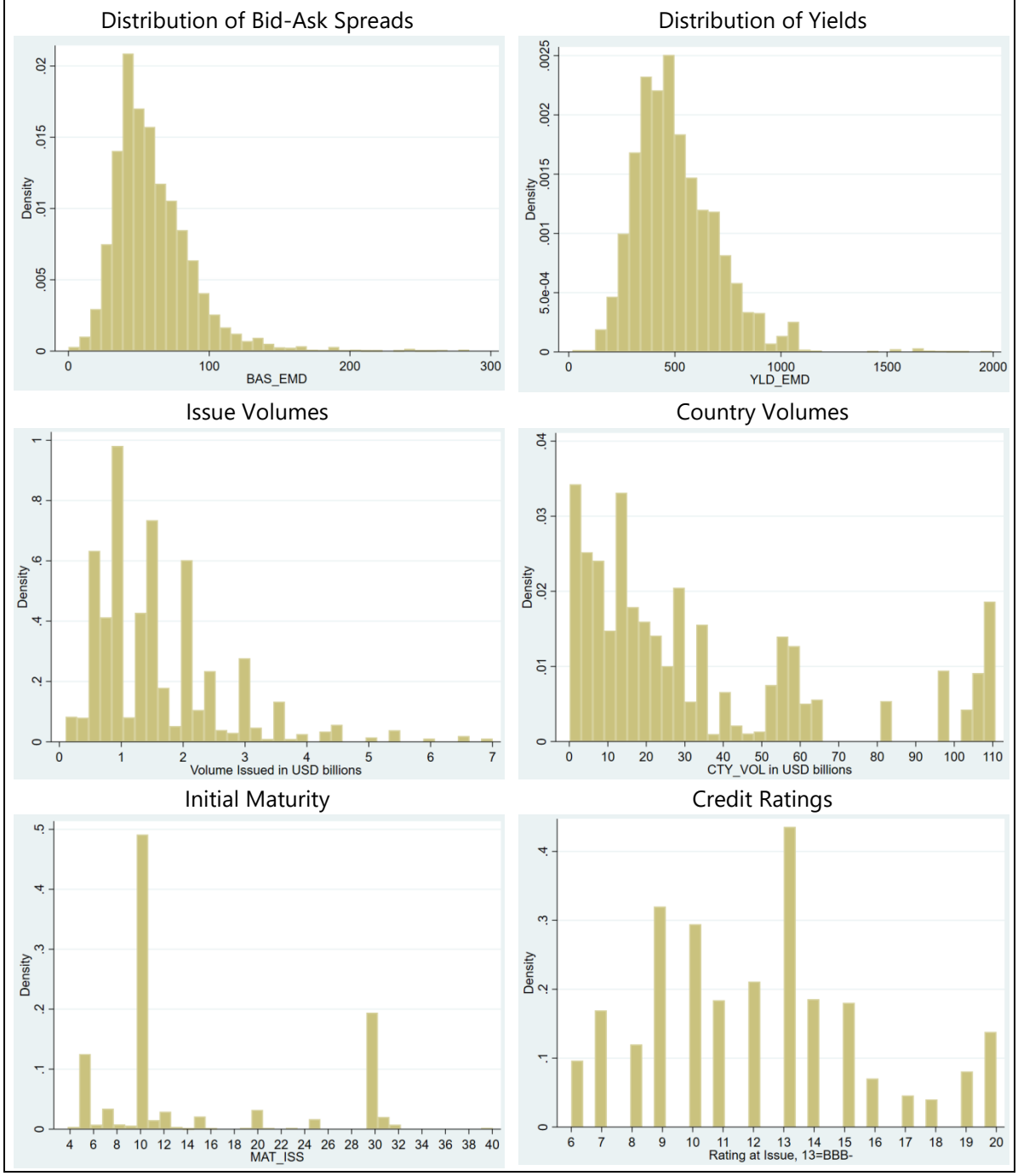
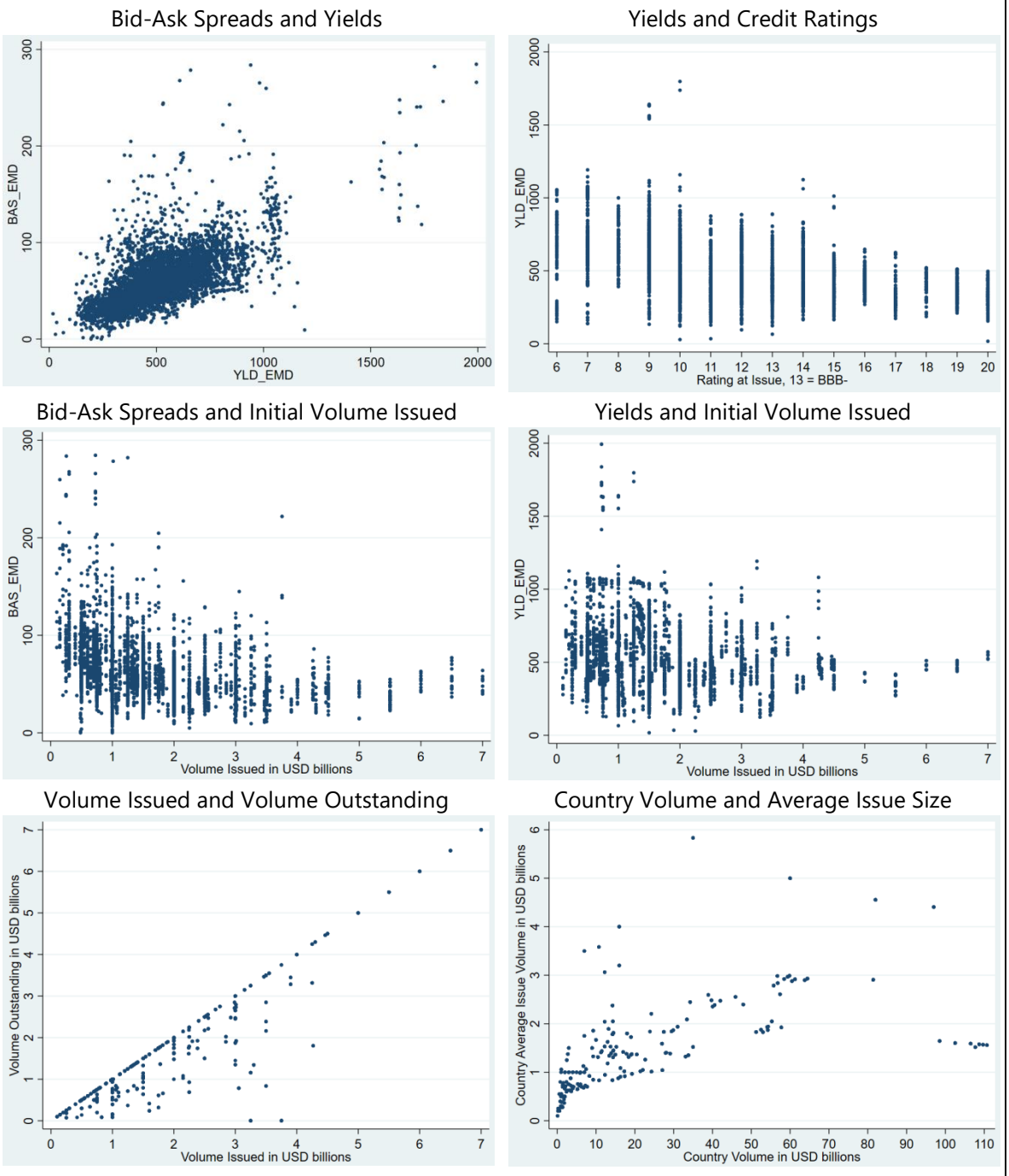


Figure 1 (Continued). Variable Distributions and Scatter Plots



Source: See text.

A preliminary examination of the data reinforces concerns about collinearity. For example, for a substantial portion of bonds, the respective DMO had carried out no liability management operations by the time of the observation date, so the initial and current volumes outstanding are identical. Countries that issue a large total volume of Eurobonds tend to offer individually large-sized bonds. Almost all bonds that include a CAC also include a modified pari-passu clause.

Moreover, the review suggests the presence of extreme outliers (mostly with very large bid-ask spreads or yields). These outliers are almost all for bonds from countries that had undertaken restructurings or were in or close to default. Most of the outlier bonds are Venezuelan or Argentine, but some are from Barbados, and a few are legacies from Uruguay's restructuring in 2001. Presumably these bonds are very illiquid. Some outliers—especially very small bid-ask spreads—may represent data entry errors. Others may represent "stale data," where a bid or an ask price is not current. However, stale data may be of limited concern with quarterly observations. Indeed, there is just one instance where a bid price is unchanged from one observation period to the next, and a separate instance where the ask price is unchanging.

Given the large dataset, outliers are treated conservatively: for estimation purposes, all Venezuelan bonds are excluded, as are bonds with a residual maturity less than one month; a volume outstanding less than US$100 million; a bid-ask spread outside the range of 25 basis points (bps.) to 175 bps.; or a yield above 15 percent. That trimming (plus a handful of missing values for explanatory variables) brings the sample size of US$ Eurobonds down to 4,363. As will be shown, results are not sensitive to the severity of outlier exclusion, although the proportion of observations with very low credit ratings is much reduced if more high yield or high spread observations are excluded. Issues from 61 countries are included in the sample, and all regions are represented.

The summary statistics for the main estimation sample are presented in Table 3b. Logarithms have been taken of relevant variables, as needed for use in estimation. Allowing for the taking logarithms, the coefficients of variation and the ranges are contained compared to those seen in the full sample. Summary statistics for two distinct sub-samples are worth reporting. Tables 3c shows comparable statistics for a sub-sample of bonds issued with unusually high credit ratings. The average yield on these bonds is lower than that on bonds in the fall sample, as is to be expected, but also yields are less variable across bonds; bid-ask spreads tend to be noticeably narrower; and the individual issue volumes and country total volumes tend to be larger. Tables 3d shows summary statistics for a sub-sample of bonds issued by countries with less than US$10 billion in Eurobonds outstanding. The bonds from this sub-sample have higher average yields and bid-ask spreads, and they are typically issued in smaller amounts and for shorter maturities. These differences are sufficient to motivate the re-estimation of behavioral relationships for these sub-samples.

V. Specification of Reduced Form Regressions

The dependent variables are the logarithms of the bid-ask spread and the yield on individual EMDC U.S. dollar-denominated Eurobonds (*LBAS* and *LYLD*, respectively). Taking logarithms is essential to achieve error terms that are symmetrically and, it is hoped, normally distributed.[14] Otherwise, standard tests of significance are inapplicable and possibly very misleading.

Attention focuses mainly on the reduced form specification, relating *LBAS* and *LYLD* to the explanatory variables, which are clearly predetermined.[15] The reduced form is sufficient for the purposes of market participants, be they investors or DMO, and is econometrically more straightforward. In particularly, the reduced forms can be estimated by OLS, each as a panel regression.[16]

Each panel regression includes explicit quarterly dummy variables. These dummies capture common quarterly shocks and variations in explanatory variables that are not available in the sample, and thus

[14] The support of the distribution of the bid-ask spread, and that of the yield, are narrow and certainly non-negative. Hence, a regression of levels on levels cannot yield normally distributed residuals.

[15] Many explanatory variables indeed are determined years in advance at the time of issuance.

[16] Stata Version 16 was used for all estimation.

global macro-financial conditions. Most importantly, the quarterly dummies capture fluctuations in the short-term "safe" interest rate and parallel shifts in the yield curve. If the excess yield over a safe rate were used as the dependent variable, all coefficient estimates except those on the observation period dummies and the intercept would be unchanged. The period dummy cannot capture steepening or flattening of the yield curve.

In one variant, country dummies are added in order to provide a robustness check. However, they necessarily obscure the effects of country-specific variables such as credit ratings, and they are not useful to market participants in making predictions for when country situations have changed substantially. Hence, they are normally excluded.

A flexible translog functional form is adopted. This form, which includes both logs and squares of logs of the explanatory variables, allows for non-linear and possibly non-monotonic relationships. For example, it may be that liquidity peaks (and bid-ask spreads are minimized) for securities with mid-level credit ratings because fewer investors favor high-risk securities while very low-risk securities are absorbed by buy-and-hold investors or generate little "news" that provokes trading. However, for certain ranges of parameter values, the translog form can approximate a linear form. The relatively large number of observations in the sample implies that the translog specifically does not use up so many degrees of freedom that the power of tests is substantially reduced.

As demonstrated above, many of the right-hand-side variables are correlated with each other. Moreover, the inclusion of both levels and squared values in translog specification creates further correlation. Therefore, attention focuses on joint (Wald) tests of related groups of variables (e.g., all terms related to the issue volume). Also, since collinearity implies that coefficient estimates may be sensitive to slight changes in sample or specification, little effort is devoted to finding a "best" specification. Some further adaptations are worth noting:

- When meaningful, one variable may be included along with the difference between that variable and some closely related variable. Since it is of interest to highlight the effects of choices made by the respective DMO at time of issuance, usually the initial value variable is included along with the difference between the initial and current value (e.g., the volume issued and the difference between the current and initial volume; the initial credit rating and the current rating);

- The "contractual" variables (inclusion of an enhanced CAC, etc.) are of special interest, given the existing literature and policy debate, but here the correlations are very high. For example, there are almost no bonds that include an enhance pari-passu clause but no CAC. Therefore, it was decided to concentrate on dummies capturing whether a bond's terms include an original or enhanced CAC.

- For the sake of parsimony and clarity of the results, not every possible cross-product of the right-hand-side variables is included. A full translog specification would normally include all such cross-products (used, for example, in estimating an efficiency frontier), but here the inclusion of the product of, say, the coupon rate and the country volume would likely be merely distracting;

- Cross-products with credit rating terms are included, motivated by the theoretical arguments for expecting that the effect of an explanatory variable depends on the respective country's credit rating. For example, bond yields and liquidity may be largely independent of issuance volume for a highly rated country, but sensitivity may be greater for a lower-rated country. The cross-products of the dummies for "contractual terms" with the credit rating variable may be especially relevant given the theoretical argument and empirical evidence cited above to suggest that the contractual

variables are disproportionately important for bonds issued by low rated countries. Anticipating the results given below, the empirical results justify the inclusion of the extra terms.[17]

The principal specification for the dependent variable Y (the bid-ask spread or the yield) is thus[18]

$$LY = \sum_{h}^{H}(\alpha_{1h}LX_h + \alpha_{2h}LX\_SQ_h + \alpha_{3h}LX\_LCRR\_I_h + \alpha_{4h}LX\_LCRR\_I\_SQ_h) + \sum_{i}^{I}(\beta_{1i}DV_i + \beta_{2i}DV\_LCRR\_I_i + \beta_{3i}DV\_LCRR\_I\_SQ_i) + + \sum_{j}^{J-1}(\gamma_j D\_period\_j) + \sum_{k}^{K-1}(\gamma_k D\_ISSUE\_YR\_k) + CONSTANT$$

where *LW* denotes the log of variable *W*; LX_SQ_h denotes the square of the log of explanatory variable X_h (such as issue volume); $LX\_LCRR\_I_h$ denotes the normalized cross product of LX_h and the log initial credit rating *LCRR_ISS* for that observation (see below); $LX\_LCRR\_I\_SQ_h$ denotes the normalized cross product of LX_h and the squared log initial credit rating *LCRR_ISS_SQ* for that observation;[19] DV_i denotes a dummy variable indicating a contractual or institutional feature of the bond (such as jurisdiction of issue or presence of an enhanced CAC); $DV\_LCRR\_I_i$ denotes the normalized cross product of DV_i and the log initial credit rating *LCRR_ISS*; $DV\_LCRR\_I\_SQ_i$ denotes the normalized cross product of DV_i and the squared log initial credit rating *LCRR_ISS_SQ*; *D_period_j* denotes a dummy variable taking a value of 1 for observations from quarter *j* and zero otherwise; and *D_ISSUE_YR_k* denotes a dummy taking a value of 1 in for bonds issued in year *k* and zero otherwise.[20]

As mentioned, Wald tests for the joint significance of groups of variables are especially informative because collinearity may make individual parameter estimates relatively imprecise. Therefore, F tests were performed for hypotheses such as

- LX_h =0; and LX_SQ_h =0;
- $LX\_LCRR\_I_h$ =0; and $LX\_LCRR\_I\_SQ_h$ = 0;
- LX_h =0; LX_SQ_h =0; $LX\_LCRR\_I_h$ =0; and $LX\_LCRR\_I\_SQ_h$ = 0;
- DV_i =0; $DV\_LCRR\_I_i$ =0; and $DV\_LCRR\_I\_SQ_i$ = 0;
- All *D_period_j* =0; and
- All *D_ISSUE_YR_k* =0

Also, when a "*CHG_LX*" variable (denoting the difference between variables *LX_NOW* and *LX_ISS*), an F test is undertaken to help assess whether component *LX_NOW* or *LX_ISS* has influence. Suppose the relevant part of the specification is

$$\alpha_{11}LX\_ISS + \alpha_{12}CHG\_LX$$

[17] Both the flexible functional form and the inclusion of cross-products among explanatory variables distinguish this approach from that taken in past literature.
[18] The observation index is suppressed for the sake of concision.
[19] Cross-products of the credit rating terms with themselves are not included.
[20] With the inclusion of a constant, one observation period dummy and one issue year dummy must be dropped for the specification to be identified.

If only the estimate of α_{12} is statistically insignificant, one can conclude that alone *LX_ISS* has influence. If only the estimate of α_{11} is statistically insignificant, one can conclude that alone the difference *CHG_LX* has influence. If both are significant but the hypothesis ($\alpha_{11} - \alpha_{12} = 0$) is not rejected, then one can conclude that alone *LX_NOW* has influence.

The specifications can be "pared down" to include only variables known to the DMO and initial investors at the time of issuance or which can be perfectly predicted. The results of these "when issued" estimates could be used by a DMO to optimize the design of the instruments to be offered to investors. What the DMO cannot know in advance is the volume currently outstanding, the current credit rating, and the period and issue year dummies.

Robustness will be assessed by repeating the regressions (1) using the robust regression procedure available in Stata;[21] (2) on a trimmed sample, where more observations are dropped from the "tails" of the distributions of bid-ask spreads or yields; (3) on an extended sample, where fewer observations are dropped from the "tails" of the distributions of bid-ask spreads or yields; (4) on a sample of just those bonds that were issued after 2009, that is, once the Eurobond market was very well established and after the onset of the global financial crisis; (5) after dividing sample by observation period groups; (6) using country dummies and dropping variables that therefore become unidentified (i.e., total country volume and credit rating level); (7) after dividing the sample by country issue size, to investigate whether small, infrequent issuers face distinct conditions; and (8) after dividing the sample by rating groups. Some experimentation suggested that a dividing point comes between credit ratings of BBB (= 14) and BBB+ (=15), such that the determinants of yields and bid-ask spreads of bonds issued by countries with a lower rating are distinct from those issued by countries with at least that rating. Dividing the sample into lower and higher rated bonds seems worthwhile even though, since the credit rating is an important explanatory variable, doing so in effect creates sample selection bias. Generally, the usual heteroskedasticity-consistent variance-covariance matrix estimator will be used in calculating test statistics, but results on the "conventional" variance-covariance matrix estimator will be reported.

A battery of diagnostic test was performed. Especially useful were standardized normal probability plots of the residuals and plots of residuals against quantiles of the normal distribution (also called probit plotting).[22] The former is helpful in spotting deviations from normality near the center of the distribution, and the latter for spotting deviations in the tails.

VI. Results of Reduced Form Regressions

The regressions were able to explain a large proportion of the variation in the dependent variables, with estimated parameters being statistically significant (individually or as groups) and economically plausible. Results also were mostly robust, and the distributions of residuals close to normal.

Due to the large number of estimates and the complex translog specification, the effects of the various explanatory variables are presented here graphically, and the detailed results are reported in the Appendix. The graphs are constructed to show how the level of a dependent variable varies as the level of the respective explanatory variable varies, as appropriate taking into effect the interaction with the credit rating

[21] This procedure works iteratively to down-weight outliers.
[22] The studies of market liquidity summarized above do no report indicators of residual normality, even when they include regressions of levels on levels.

variable. The graphs are normalized such that the curve goes through the mean value of the dependent variable when the respective explanatory variable is (close to) its mean.[23]

A. Bid-Ask Spreads

Using All Explanatory Variables

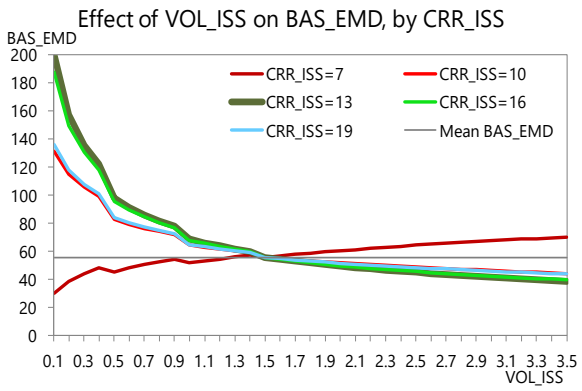
The regressions for the log bid-ask spreads explain over two thirds of its variation (Table 4). There are many individually highly significant parameter estimates, and most groups of parameter estimates (e.g., for all issued volume variables) are significant at beyond the 1 percent level (Table 5). The typical effects of the various explanatory variables are illustrated in Figure 2.

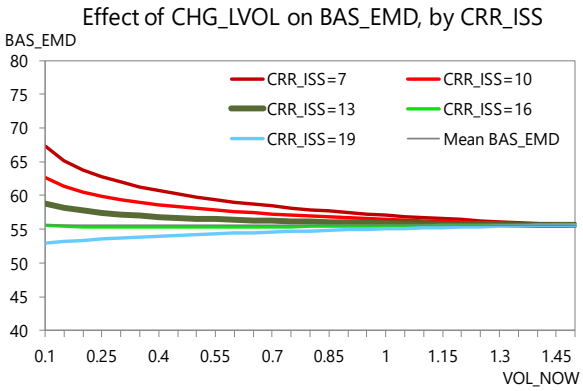
Looking at the effects of the various explanatory variables, it can be seen from the top left chart in Figure 2 that issue volume has a strong and negative effect on the bid-ask spread. Reducing the volume from US$1.5 billion (just above the sample average) to US$750 million raises the bid-ask spread from about 55 bps. to over 80 bps. for a typical bond with rating of BBB-. The relationship tapers off after issue size exceeds US$1.5 billion but is seen even at higher volumes.[24] There are distinct threshold effects at US$500 million, US$1 billion, and US$1.5 billion, but they tend to reinforce the overall relationship. Credit ratings matters: the volume effect is somewhat less important for bonds with the low credit ratings; perhaps they have a narrower investor base, so, on the margin, a smaller volume is enough to generate as much market liquidity as they ever enjoy. The relationship between issue volume and the bid-ask spread is positive for very low rated bonds. The explanation could be that the issuance volume itself signals higher creditworthiness more strongly than what is indicated by the rating. Qualitatively similar results are found, for example, in Ap Gwilym et al. (op. cit.), Bildersee (1980), and Hong and Warga (op. cit.).

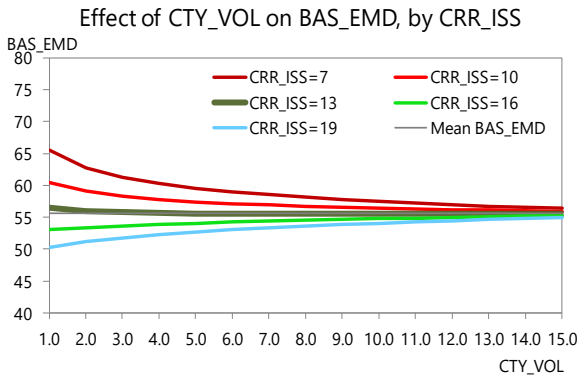
[23] The regressions yield results that can be represented in stylized form as ln(*y*)=a0+a1ln(*x*), where y and x are respectively the dependent variable and the (group of) explanatory variable(s); a1 is the parameter estimate for the variable ln(*x*); and a0 captures the other remainder of the specification. The predicted value of the level of *y* is therefore given by $\hat{y} = e^{a0}.x^{a1}$. To construct the graphs, the term a0 is chosen such that $\bar{y} = e^{a0}.\bar{x}^{a1}$, where the top bar indicates the mean of the respective variable. For ease of presentation, the normalization used a "rounded" value of the respective explanatory variable at a benchmark value close to its mean (e.g., an issue volume of US$1.5 billion, when the sample mean is about US$1.3 billion). For a dummy variable (such as the indicator of whether a bond includes an enhanced CAC), the projection is scaled by the inverse of the sample average value of the dummy variable, so that the projection for the whole sample goes through the mean of *y*, but the curve shows the effect when the dummy takes the value of unity.

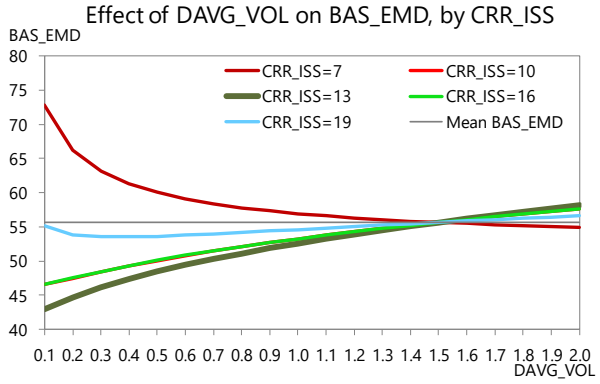
[24] It is worth noting that yield and liquidity are not the only considerations facing a debt manager. Concentrating issuance in a few large issues increases roll-over risk.

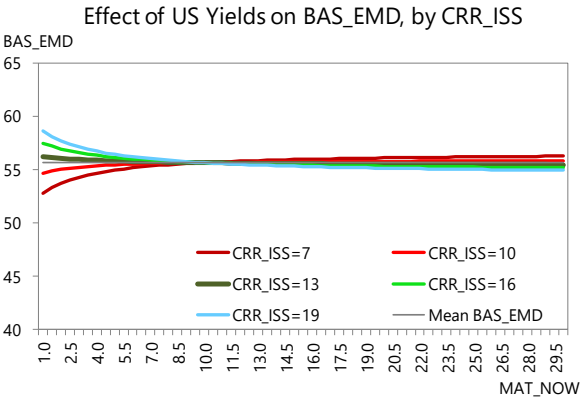
Figure 2. Bid-Ask Spread Determinants; Reduced Form Regressions

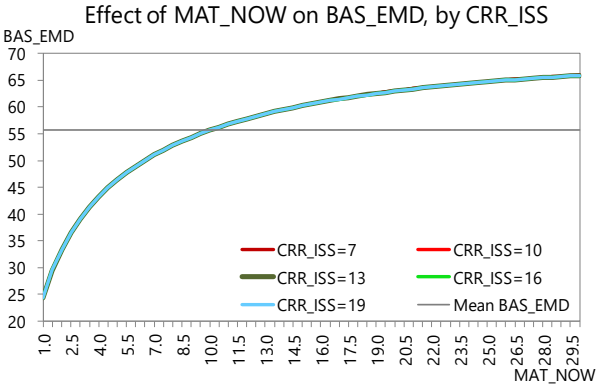


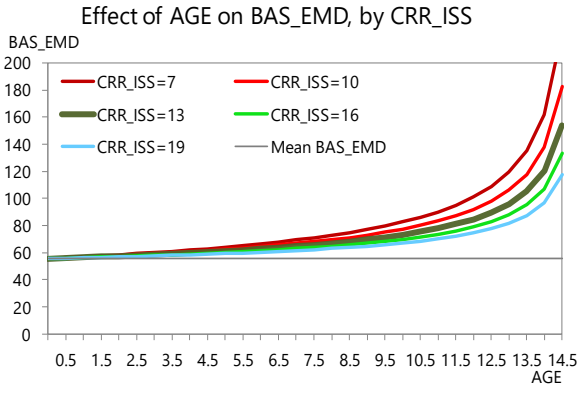












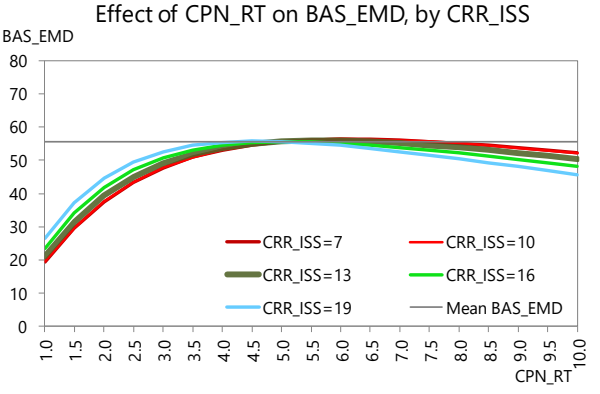
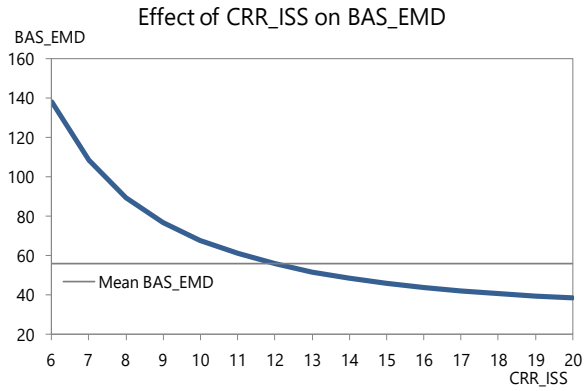
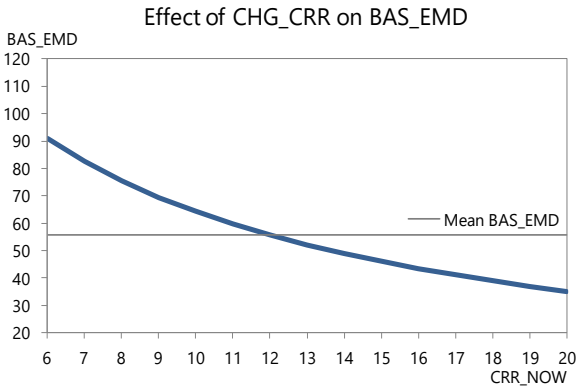
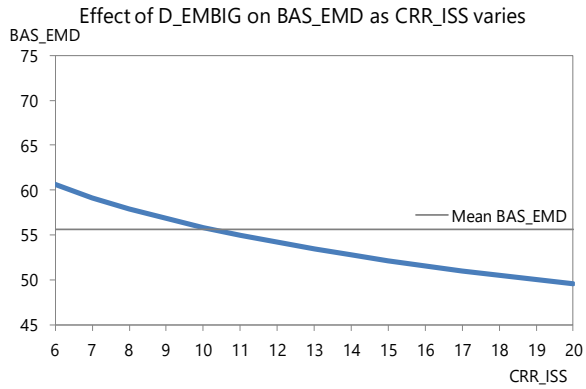
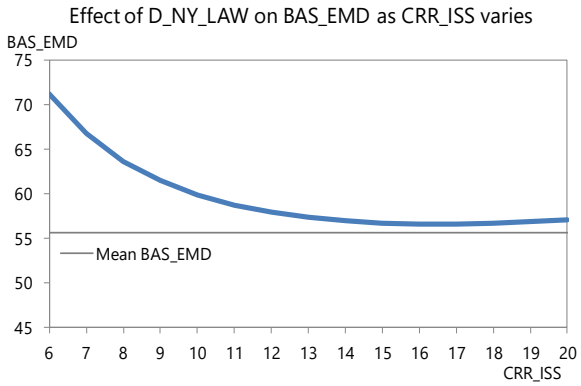


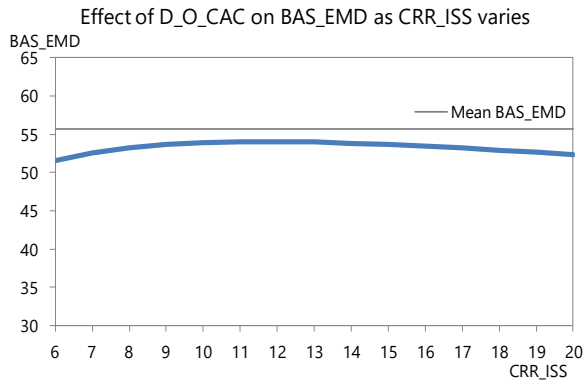
Figure 2. Bid-Ask Spread Determinants; Reduced Form Regressions (Continued)

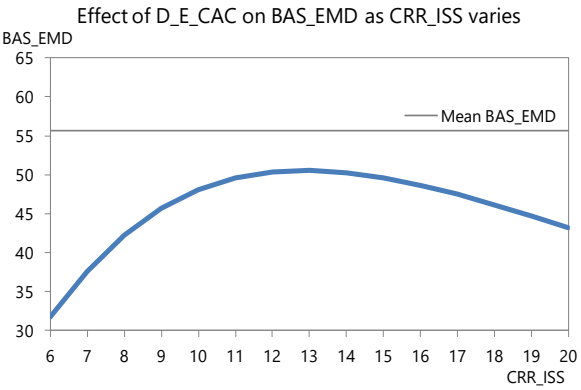


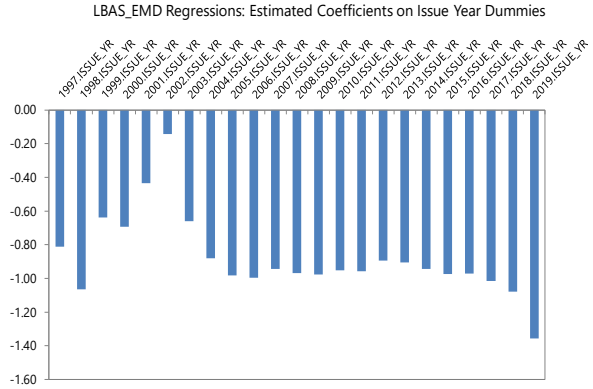












Undertaking an LMO that reduce the amount outstanding does reduce liquidity as measured by the bid-ask spread, but the effect is not very pronounced until only a third or less of the initial volume remains (top right chart in Figure 2). Highly-rated bonds are less affected, possibly because they enjoy strong demand among "buy and hold" investors, who do not much care about market liquidity. One implication is that choice of the initial volume has a distinct and persistent effect on liquidity; once the investor base is established, the market remains fairly stable. The current volume outstanding is significant but less important.

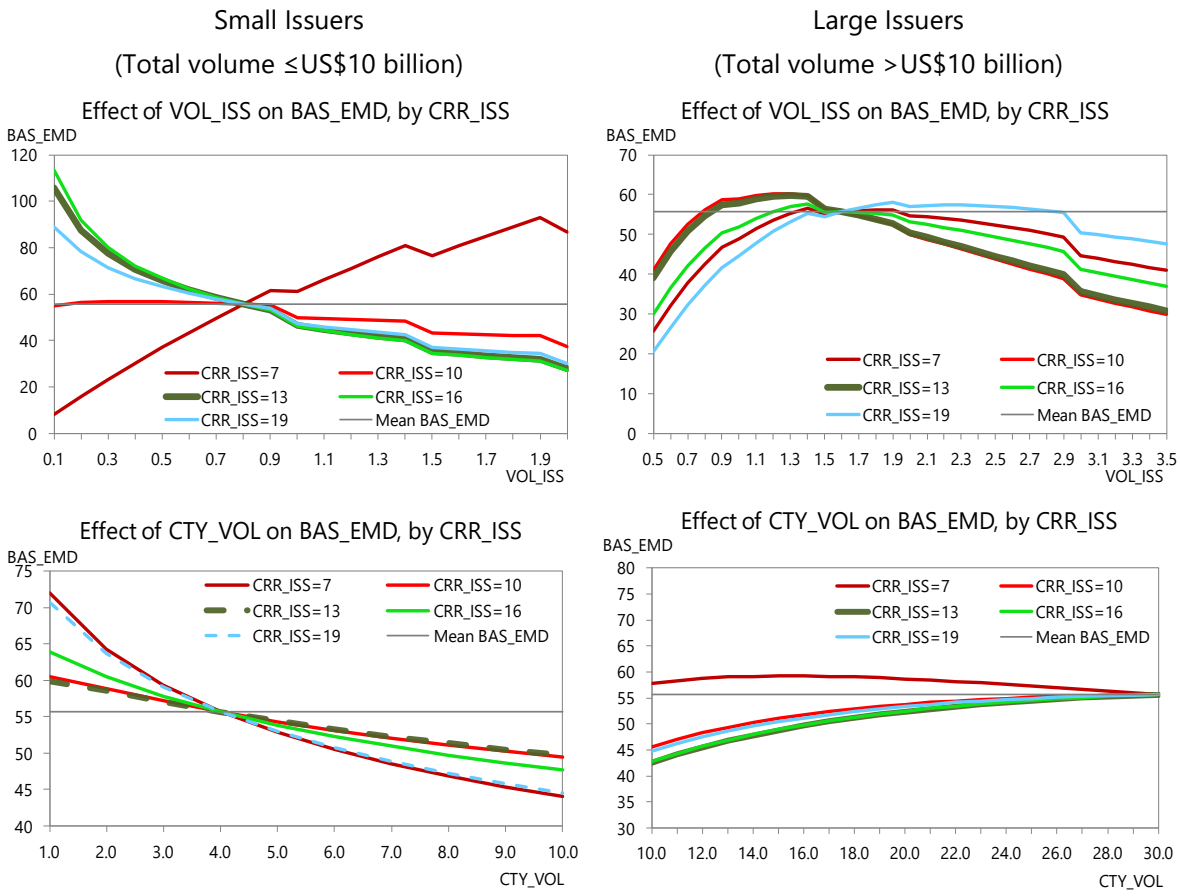
Based on estimates for the whole sample, the total volume of issuance by a country is not a powerful determinant of the bid-ask spread, at least once the total exceeds US$5 billion (second row left-hand chart).[25] A smaller, lower-rated issuer can achieve a somewhat narrower bid-ask spread when the total volume increases. A medium- to highly-rated issuer does not need to be much concerned about this aspect of market presence. The parameter estimates are individually statistically insignificant, but collectively they differ significantly from zero.

This result is perhaps surprising: one might expect that more investors would be prepared to cover the fixed costs of analyzing the risk-return characteristics of an issuer when that issuer has a large volume of securities outstanding, and especially when the issuer is regularly in the market. Hence, the Eurobonds of frequent, large-volume issuers should be more liquid than those of sporadic, small-volume issuers, and have correspondingly narrower bid-ask spreads.[26]

The modest estimated importance of a country's total issuance volume may be a statistical artifice, or reflect underlying differences the situation facing small versus large issuers. On the one hand, the correlation between total country volume and individual issue volume is about 0.6 (but is lower for large issuers); possibly the estimated coefficient on the latter captures the effects of both.[27] On the other, some additional regression results based on splitting the sample suggest that increasing total country volume does decrease bid-ask spreads substantially for small issuers, but not for large issuers (Figure 3 and Table 4, first four columns of the continuation).[28] Also, for large issuers, individual issue size has only a modest effect on bid-ask spreads, but they do continue to narrow noticeably even as the volume increases beyond US$2.0 billion.[29]

[25] The existing literature concentrates on individual issue size, neglecting the total outstanding for issuer or number of issues.
[26] However, Tanner and Kochin (op. cit.) and Bildersee (1979 and 1980) find that individual issue size matters for the bid-ask spread even on Canadian, agency, or U.S. government bonds, respectively.
[27] Already the summary statistics presented in Table 3c suggested that small issuers are distinctive.
[28] The dividing line was set at total country issuance of US$10 billion, which yields a large number of observations from diverse countries in both sub-samples. Results were not very sensitive to the choice criterion. Broadly similar results were obtained when the sample was split by the total number of issues per country, but that criterion aggregated very small, sporadic issuers such as the Maldives and some very large Middle Eastern issuers who issued their first Eurobonds during the sample period.
[29] Large issuers offer very few securities with an individual volume below US$0.75 billion. Therefore, the non-monotonicity of the curve is not problematic in economic terms.

Figure 3. Effects of Issue Volume and Country Volume on the Bid-Ask Spread by Issuer Size



For a country with a credit rating in the range of 9 to 15, issuing somewhat less than its average issue size can slightly narrow the bid-ask spread, but a very large issuance will be penalized (second row right-hand chart). Consistency is more important for a country with a low credit rating: issuing an unusually small amount may be taken as an adverse signal, and being able to issue an unusually large amount may expand the investor base and generate much price discovery through trading in the initial allocation.

The estimated parameters on current yield curve variables are individually insignificant, and the overall effect is very small (third row, left-hand chart). The estimated coefficients on the log-level and its square are jointly insignificant (Table 5). Possibly, U.S. interest rates and especially longer-term rates were sufficiently stable during the sample period that changes in “search for yield” behavior were not pronounced.

An examination of the parameter estimates and the results of various Wald tests (Table 5) reveals that the initial maturity significantly affects the bid-ask spread.[30] The effect of initial maturity on the bid-ask spread is well-captured by the quadratic terms, with almost no difference by credit rating (third row right-hand chart). The estimated parameters on the linear terms and the cross-products with the credit rating are insignificant individually and collectively (Tables 4 and 5).

[30] Analogous results for other markets or other samples are found in Amihud and Mendelsohn (1991), Chakravarty and Sarkar (op. cit.), and Hund and Lesmond (op. cit.), for example.

As seen in results from other markets summarized above, age (time elapsed since issuance) does affect the bid-ask spread, but in a highly non-linear way (fourth row left-hand chart). Once only about a quarter of the initial maturity remains, spreads increase sharply. The effect is much more pronounced for bonds with a low credit rating. For top-rated bonds, liquidity dries up when only about a tenth of initial maturity remains.

The overall effect of the initial credit rating on the bid-ask spread is represented in the top left-hand chart on the second page of Figure 2. This projection takes into account the indirect effect of the credit rating working through cross-product terms, where the other explanatory variables are assumed to take typical values (e.g., an issue volume of US$1.5 billion). Again, the relationship is non-linear: a low rating has a disproportionate effect on the spread. Spreads are not much affected by the credit rating in the range 9 to 18. A slight uptick can be seen in the spread for top-rated issues. Possibly, the typical investor for Eurobonds focuses on issuers with medium ratings, and is less interested in Eurobonds that are very close substitutes for advanced economy bonds.

The distinct effects of the initial and current ratings are both economically significant, and therefore the change in the rating since issuance has a strong effect (top right-hand chart on the second page of Figure 2).[31] The initial rating matters for countries with below-average credit ratings; once that mid-point is reached, the effect is minimal. A deteriorating credit rating may reduce demand and shrink the investor base, resulting in wide bid-ask spreads, and likewise an upgrade may make a bond attractive to many more investors. Interestingly, this relationship has little convexity: the initial rating matters most for low-rated issuers, but the change affects all bond roughly equally.

The coupon rate has a distinctly positive but nonlinear relationship with the bid-ask spread, largely independent of the credit rating (bottom row right-hand chart). A coupon rate of 1.5 percent is associated with a bid-ask spread about 25 basis points lower than in the case of a coupon rate of 5 percent. Thus, the greater duration implied by a low coupon rate does not translate into reduced market liquidity—unlike what was found in other markets in the studies cited above. The coupon rate on a Eurobond strongly may signal creditworthiness in a way that goes beyond the credit rating; perhaps only a very well-regarded issuer can offer a low coupon rate.

Inclusion of a bond in the EMBIG has a small effect on the bid-ask spread, positive for low-rated issuers and negative for medium- to high-rated issuers (middle left-hand chart on the second page of Figure 2). The estimated parameters are not individually significantly different from zero, but they are jointly significant (Table 5).

Rather more important is choice of jurisdiction: issuance under New York is found to increase the bid-ask spread for low-rated bonds, that is, those for whom restructuring and court involvement is relatively likely. The prevalence of trust arrangements under New York law and experience during the Argentine and Greek restructurings (see Box 1 above) may encourage existing investors to hold on to risky bonds even in the face of news events, and thus reduce market liquidity, ceteris paribus. Lower market liquidity is reflected in wider spreads. Issuance jurisdiction has no significant effect on the bid-ask spread of medium- to high-rated bonds, which are presumably remote from restructuring.

Inclusion of an original CAC seems to have only a slight negative effect on bid-asks spreads, and indeed the estimated parameters are insignificant. However, the effect of inclusion of an enhanced CAC is highly significant and in line with the prediction: an enhanced CAC seems to make a low-rated bond attractive to a wider investment base, thus increasing its liquidity and narrowing the bid-ask spread. In case of very low rating, the bid-ask spread can be reduced by about 20 basis points, compared to a sample average spread of 55 basis points. Even spreads on medium-rated bonds are reduced by about 5 basis points. Thus, the

[31] The relevant F tests presented in Table 5 need to be interpreted with care because LCRR_ISS enters as a cross-product with many other explanatory variables.

influence of CAC inclusion on the yields of lower rated bonds is complicated by the effect on bid-ask spreads found here.

Most estimated parameters on the issue year dummies are at roughly the same level across the sample, but there seems to have been some better and worse “vintages” (bottom row). Bonds issued in 1999-2003 seem to have unusually large bid-ask spreads, but 1998 seems to have been a good year to issue. The stability of the estimated parameters from 2004—even during the global financial crisis—may reflect the maturation of the market.

The results are reasonably robust. The parameter estimates generated by the robust regression procedure are mostly close to the OLS estimates, as are the estimates obtained from splitting the sample into early and late observation periods, or including only bonds issued after 2009. When more “tail” observations are trimmed (included), the estimated parameters on the log-linear and the log-quadratic terms tend to be smaller (larger) in absolute value, which is as expected: the trimmed (extended) sample should give less (more) prominence to curvature in relationships. The individual parameter estimates on remaining maturity and the change in maturity (i.e., age) are relatively unstable, but calculations showed that the overall effects are similar; such sensitivity is unsurprising given the degree of multicollinearity.

Inclusion of country dummies increases the R^2 statistic by about 10 percentage points, to 0.77, and also reduces the magnitude and significance of many estimated parameters on individual variables. However, the sign of the overall effect of different explanatory variables is mostly preserved. For example, the overall effect of increasing issue volume is still negative, but reduced to about 20 basis points, independent of country rating. Deviation from the country average issue volume still tends to increase spreads, now also for lowest-rated countries. Inclusion in the EMBIG reduces spreads slight for all but countries with very low credit ratings, and the presence of an enhanced CAC reduces spreads significantly and especially for low-rated issuers.

The results for the full sample and those for bonds with a credit rating below BBB+ (=15) are quite similar, but the estimates for bonds with higher ratings are often rather different. Often pairs of variables will have parameter estimates that are large in absolute terms but of opposite sign (such as in the case of LVOL_ISS and LVOL_ISS_LCRR_I). As indicated before and hinted at in the summary statistics presented in Table 3b, it seems that less weight is attached to the exact specification of a bond’s design when that bond is very highly rated; idiosyncratic characteristics matter less—a result similar to that in Schultz (op. cit.).

The use of conventional t-tests and F-tests seems justified. As seen in Table 4, using conventional estimates of standard errors does not qualitatively affect t-test results. More importantly, the residuals are very close to being normally distributed, possibly with some heteroskedasticity. The cumulative residuals plots in Figure 4 show that the residuals mostly lie very close to the straight lines representing the normal distribution. The right-hand plot shows that there are tails of larger residuals, but they are of limited import: the tails are symmetric, and removing the absolute largest 12 residuals from each (i.e., about 0.5 percent of the sample). This leptokurtosis may reflect heteroskedasticity, which is addressed by the use of robust estimates of the standard errors. In contrast to the distribution of residuals from other samples, the residuals from the regression on bonds with a rating above BBB (=14) show very asymmetric and very large deviations from normality (Figure 5).

Figure 4. Residual Plots for the Reduced Form Regression on the Log Bid-Ask Spread

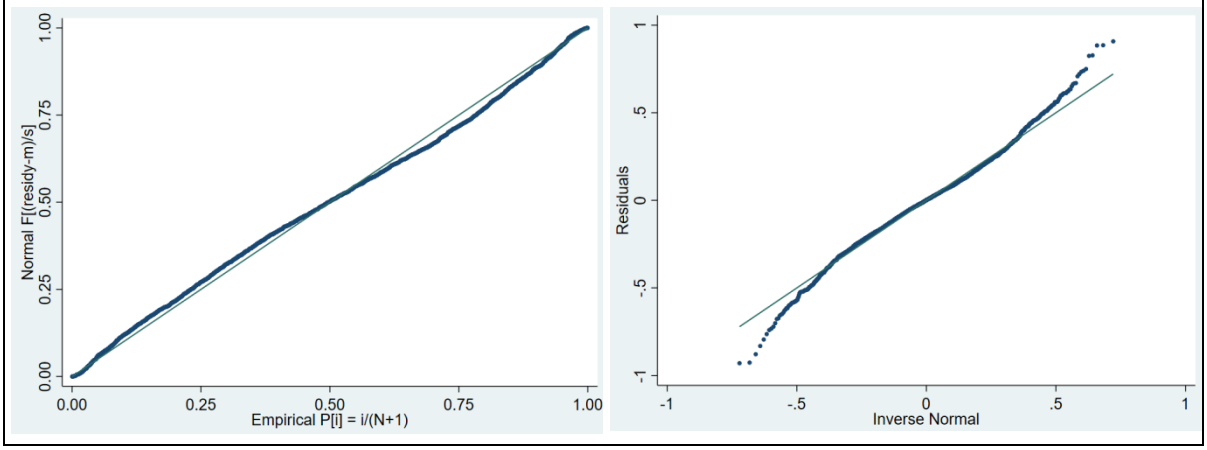
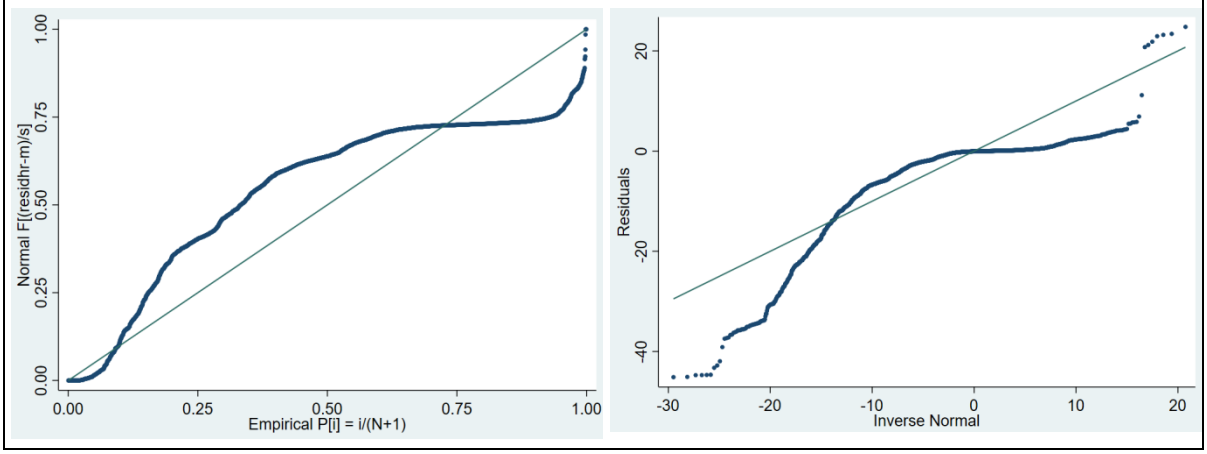


Figure 5. Residual Plots for the Reduced Form Regression on the Log Bid-Ask Spread; Sub-Sample with Rating>14



Using Only Explanatory Variables Known at Time of Issue

The DMO and the initial investors in a new bond have an interest in predicting its performance, in terms of yields and bid-ask spreads. However, at the time of issuance they cannot know the future volume outstanding or credit rating, the U.S. term structure, or any of the fixed effects relating to issue year or observation period.

It turns out that reasonably good predictions can be made based exclusively on explanatory variables known at time of issue (Figure 6 and Table 6). The R^2 of the regression for the full sample is just over 0.5—about 18 percentage points lower than when all explanatory variables are used, but still substantial—and many estimated parameters are significant individually or jointly (Table 7).

Looking at groups of explanatory variables, issue volume continues to have a major influence on the bid-ask spread for issues of less than US$1 billion. The threshold effects are economically and statistically significant, not only at US$500 million but also at higher levels.

The coefficient estimates for variables related to total country volume are significant, but for the full sample the overall effect is modest (Figure 6, second row left-hand chart).[32] However, splitting the sample by country issue volume again reveals that bid-ask spreads narrow with total volume for small issuers (for whom a large issuance size may incentivize more research by investors), but has a modest and slightly positive effect for large issuers (who perhaps eventually risk saturating the market). The relationship between the deviation from the average issue size and the bid-ask spread is consistently preserved and indeed is more pronounced than when all explanatory variables are available.

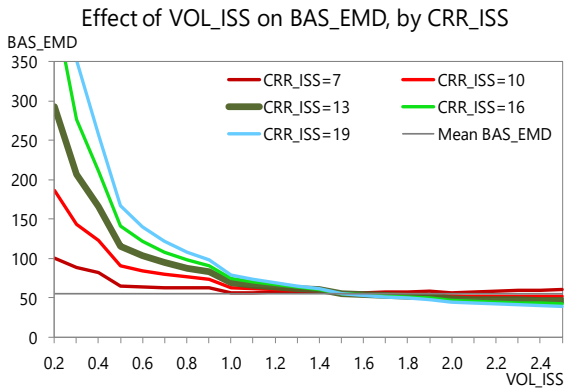
The bid-ask spread continues to be a quadratic function of remaining time to maturity, with little differentiation by credit rating. Likewise, seasoning continues to have a pronounced, non-linear effect: even at time of issuance one can predict that liquidity will dry up in the final few years before the maturation of a bond.

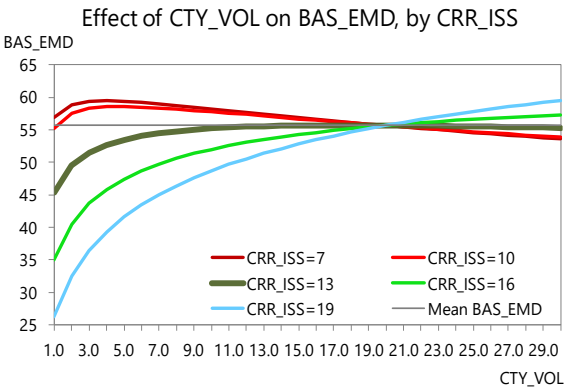
A high credit rating or a low coupon rate helps reduce the predicted bid-ask spread. As before, the credit rating effect is not very pronounced—bonds of quite varied credit ratings can achieve comparable spreads—and the coupon rate effect tapers off sharply for rates above about 3 percentage points.

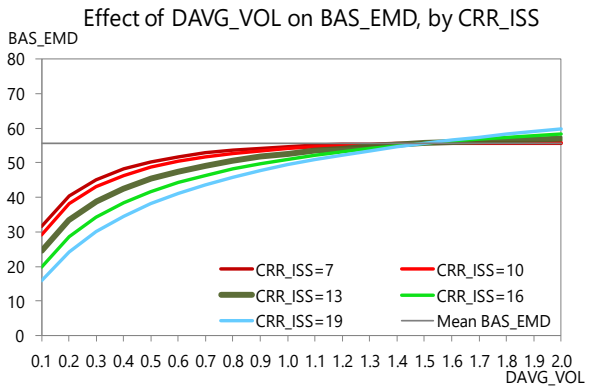
The effects of inclusion in the EMBIG; issuance under New York law; inclusion of an original CAC; or inclusion of an enhanced CAC are well-predictable at the time of issuance. For example, issuing under New York law widens the bid-ask spread of a bond with a low credit rating, but that increase can be more than offset by inclusion of an enhanced CAC.

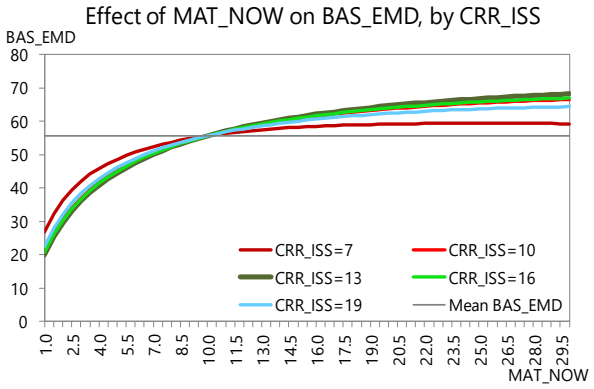
[32] Note that current country volume and average issue size are used in the regressions: data on these variables at the time of issuance are not available. However, these variables presumably change relatively slowly and predictably.

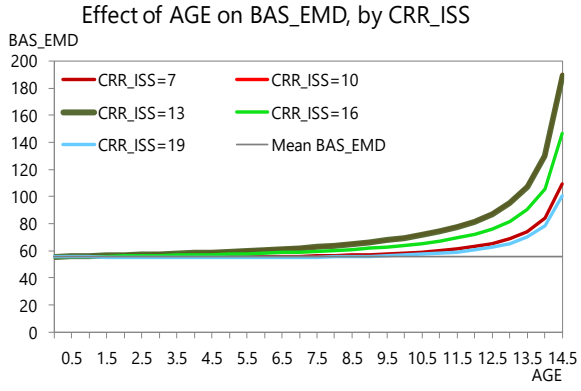
Figure 6. Bid-Ask Spread Determinants; Reduced Form Regressions Using Only Explanatory Variables Known at Time of Issue











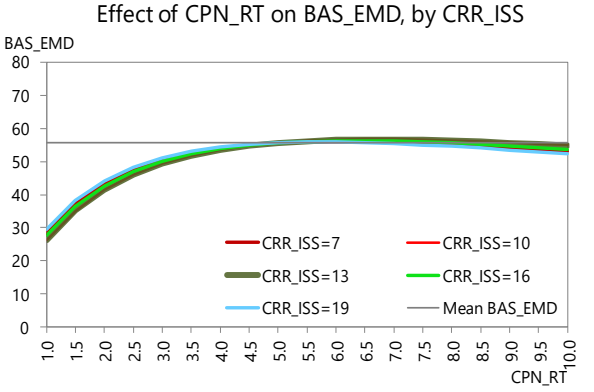
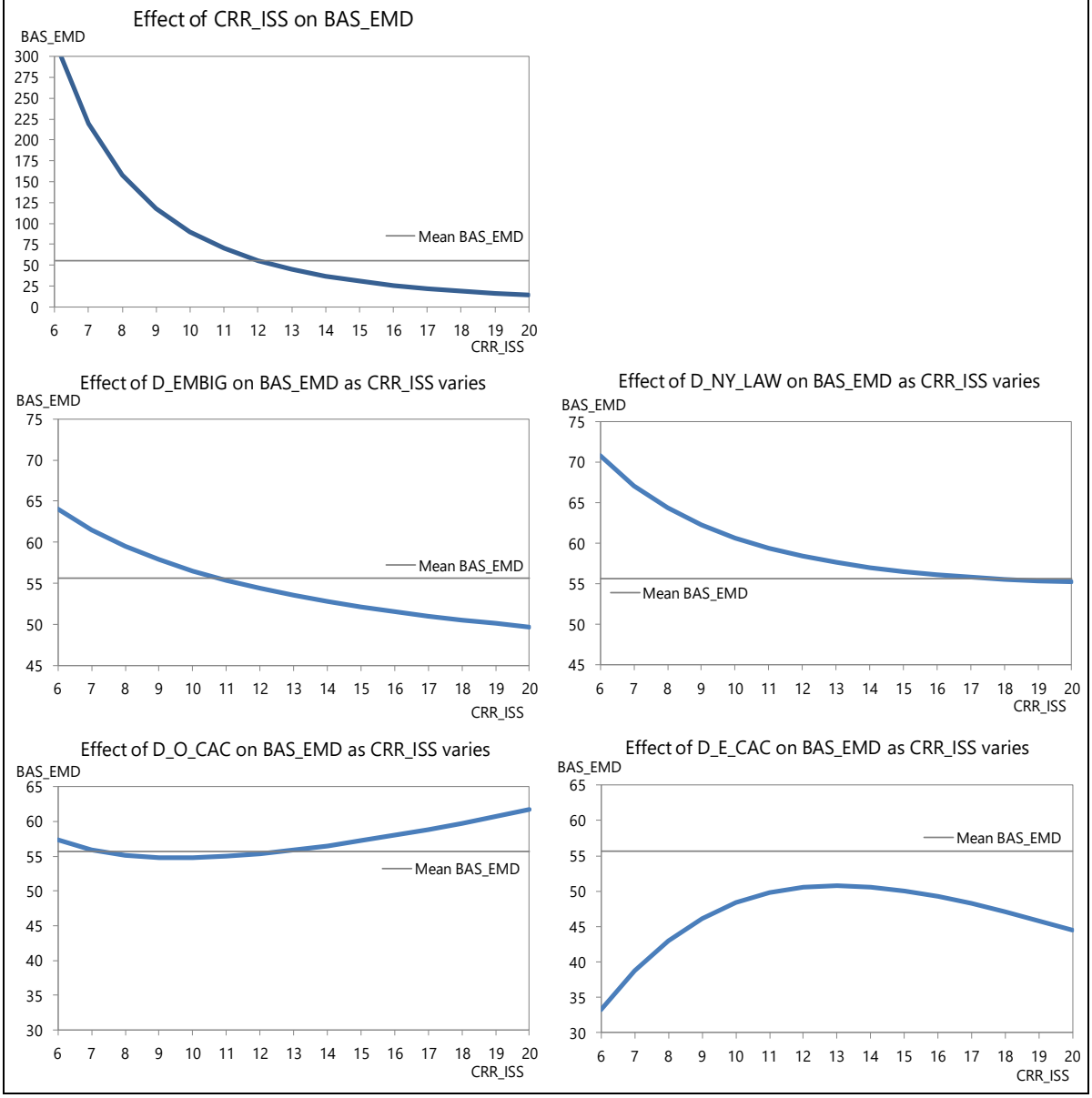


Figure 6. Bid-Ask Spread Determinants; Reduced Form Regressions
Using Only Explanatory Variables Known at Time of Issue (Continued)



Results from the regressions using the restricted set of explanatory variables are mostly robust, as can be seen by comparing the columns of Table 6.[33] Parameter estimates and t-statistics obtained using the robust regression technique are often larger in absolute terms than those obtained using OLS. However, the estimates for bonds with high ratings again exhibit the effects of strong multicollinearity, and the associated residuals are far from normally distributed.

[33] Regressions were performed for a full range of samples; for concision, only the moist relevant are reported.

B. Yields

Using all Explanatory Variables

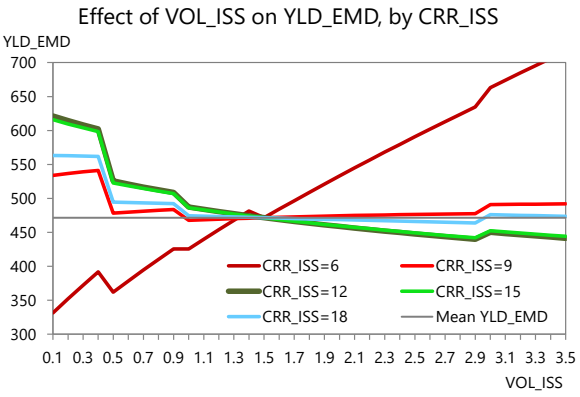
The regressions for log yields achieve R^2 statistics of around 0.85, even higher than those achieved in the regressions for the log bid-ask spreads (Table 8). Many parameter estimates and groups of estimates are highly significant (Table 9), and they are economically consistent with those obtained from the bid-ask spread regression.

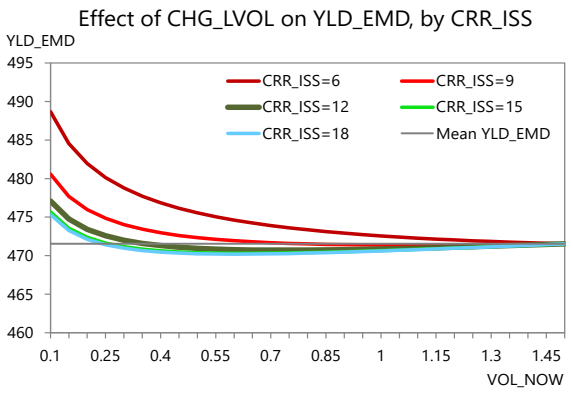
The issue volume is an important determinant of the yield, especially for bonds with middle range ratings and for volumes below US$1 billion (Figure 7, top left-hand chart). Reducing the volume from US$1.5 billion to US$750 billion raises the yield by over 60 basis points for a mid-rating bond. Threshold effects can be seen, the most pronounced being at the US$500 million mark; there is a small penalty for very large issue sizes. Issue volume is not important for bonds with very high ratings, and yields on the lowest-rated rise with volume; the price elasticity effect predominates for the riskiest issuers. A modest reduction in the volume outstanding (relative to the initial volume) has a minor effect, but once the remaining volume falls below a third or a quarter of the initial amount, rates rise steeply. All these results are consistent with the hypothesis that restricted liquidity (as signaled by a higher bid-ask spread) reduces demand and thus causes yields to rise.

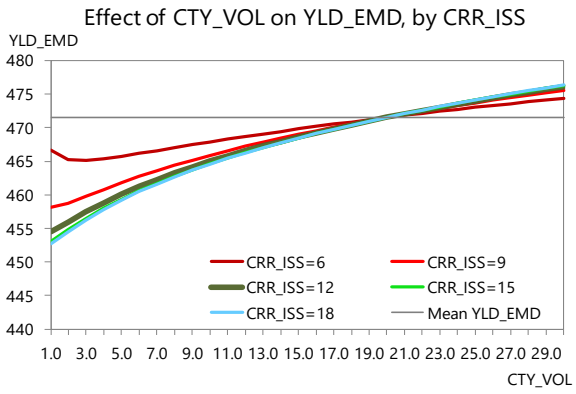
For most countries, the yield tends to increase with the total amount of bonds outstanding, but the effect is not very large and the individual relevant coefficient estimates mostly do not differ significantly from zero (Figure 7, second row left-hand chart). Possibly, any liquidity effect is offset by the price elasticity effect, and the credit rating variable captures any influence of higher total volume on credit risk. When the sample is split between small and large issuers, the positive relationship is maintained, except in for smaller, lower-rated issuers, where an increase in the aggregate volume from very low levels is associated with a marked decrease in yields, possibly because of interest from a wider investor base and thus improved market liquidity.

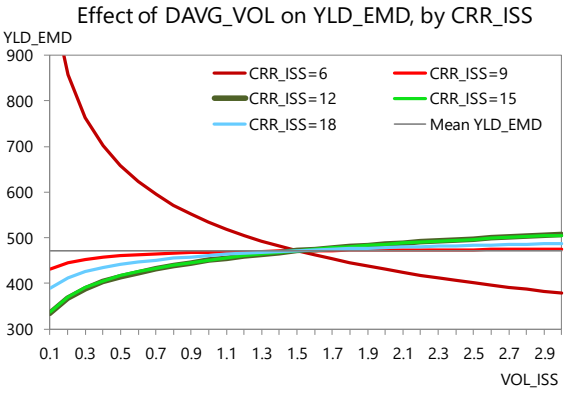
A bond issue that is small (large) relative to the amount that a country typically issues can achieve a somewhat lower (higher) yield. The relevant coefficient estimates are highly significant, but the overall effect is modest, especially for highly rated bonds. Again, the relationship is very different for bonds with very low ratings, where the signaling effect of deviating from the country average is very prominent. For example, an exceptionally large issue may be interpreted as a sign of a desperate need for financing.

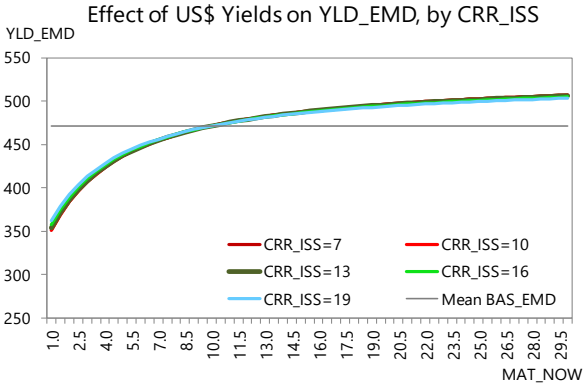
Figure 7. Yield Determinants; Reduced Form Regressions

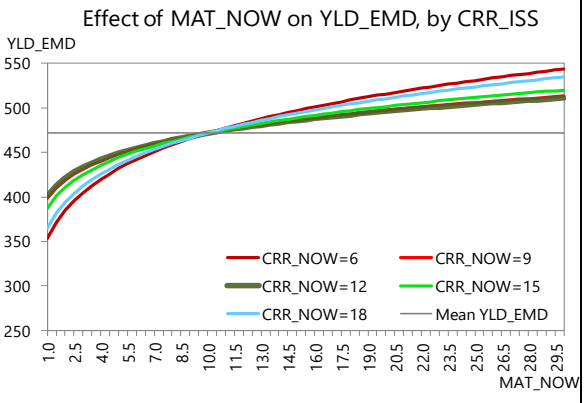


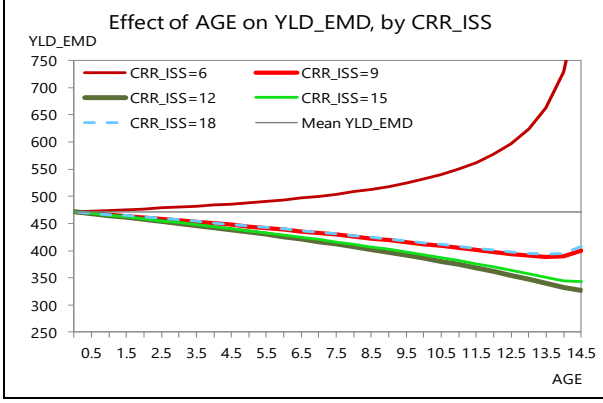












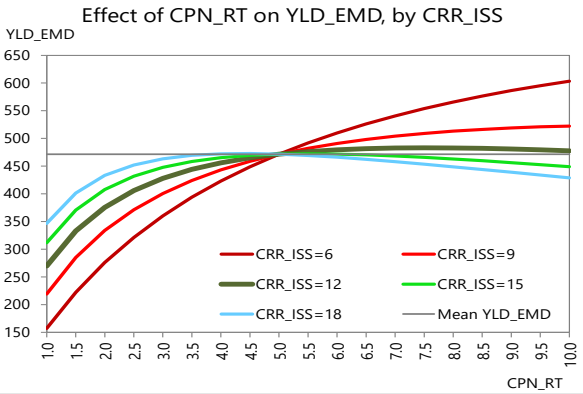
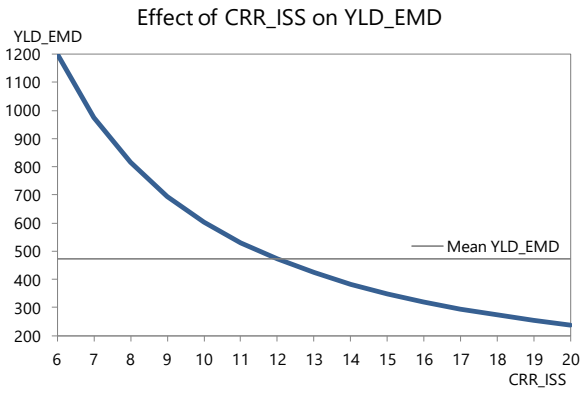
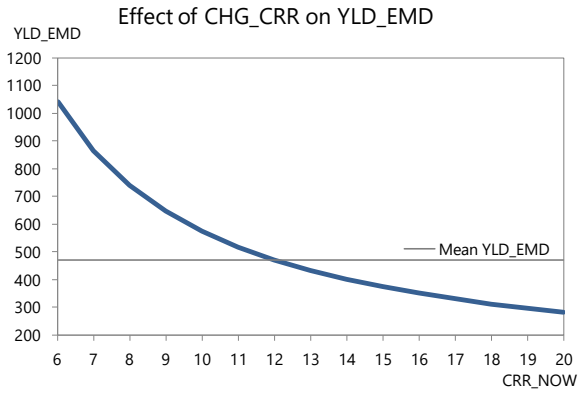
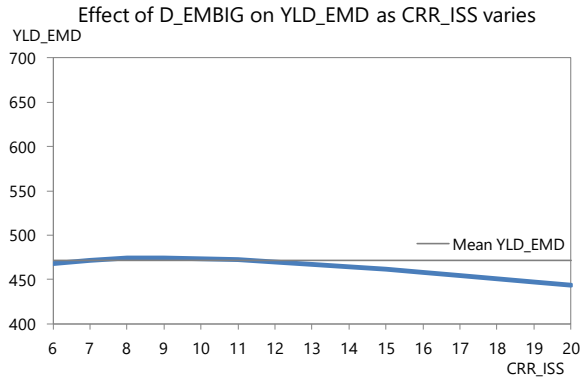
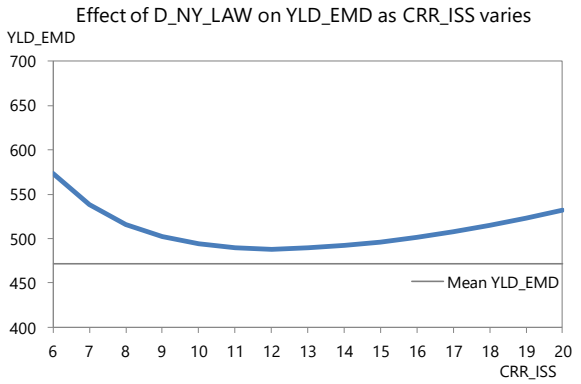


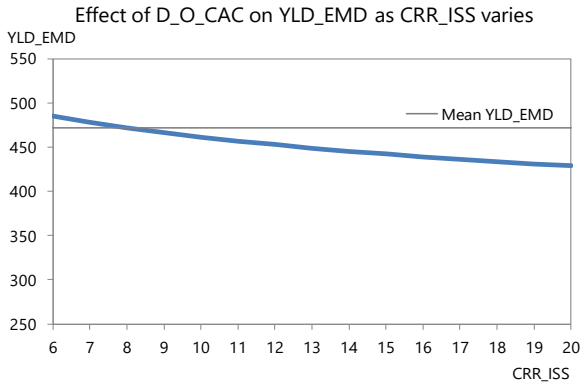
Figure 7. Yield Determinants; Reduced Form Regressions (Continued)

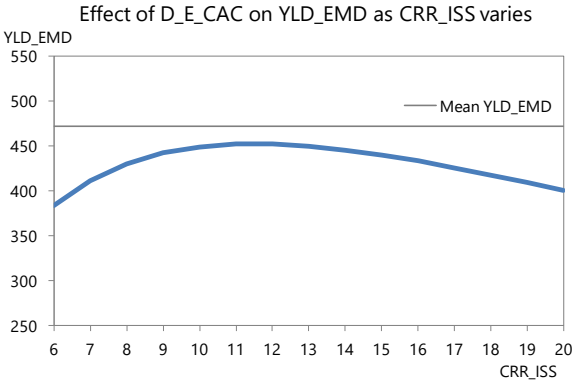


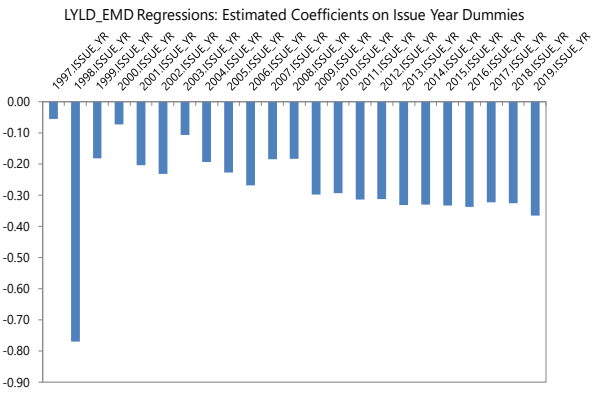












The effect of current U.S. bond yields is very pronounced, as expected, and independent of credit rating. Even after allowing for the current yield curve, remaining maturity affects the yield monotonically and largely independent of credit rating, as was seen for the bid-ask spread. The effect of seasoning is non-monotonic: for a bond with an initial term of 15 years, for example, the yield tends to fall for the first decade or so, suggesting that the supply effect predominates, and then rises sharply as the maturity date approaches, suggesting that diminishing market liquidity gains influence (Figure 7, fourth row left-hand chart).
Unsurprisingly, a lower credit rating is associated with a higher yield (Figure 7 continued, top row). Looking more closely at the parameter estimates for the when-issued rating variables (LCRR_ISS, etc.) and the change in the rating (CHG_LCRR, etc.), it is clear that the current rating matters most. The F tests indicate that the estimated coefficients on the two when-issued credit rating variables are jointly insignificantly different from zero in the yields regression, but that test does not allow for the influence working through cross-products.

A low coupon rate is associated with low yields, whereas the effect working through longer duration is not prominent (Figure 7, bottom row, right-hand chart). The sharp curvature of the effect shape—rising steeply then almost flat for coupon rates above 4.5 percent for most rating levels—mirrors that seen in the bid-ask spread regressions. Possibly, causation runs from the coupon rate to the bid-ask spread, and then to the yield.

Inclusion in the EMBIG has a significant but modest overall effect on yields. The estimated effect has the same sign but is smaller than that found by Calomiris et al (op. cit.), who looked though at corporate Eurobonds and employed a simpler specification.

Issuance under New York law raises yields markedly, especially for low-rated bonds, possibly to compensate for the higher bid-ask spreads projected above but also possibly because, should it come to restructuring, resolution under New York law is expected to be relatively expensive for most investors.[34] Ratha et. al (op. cit.) finds that issuance under New York law lowers yields, but that study employs fewer controls for other effects, such as differences in volume and credit rating.

Parallel to what was seen for bid-ask spreads, inclusion of an original CAC seems to have only a small but negative effect on yields, though the estimated parameters are jointly significant (Table 8). In contrast, an enhanced CAC markedly reduces yields, especially on low-rated bonds (Figure 7 continued, third row); depending on the rating, yields can be reduced by tens of basis points.

The good and bad “vintages” of issue, as captured by the year dummies, largely coincide with those seen for the bid-ask spread (Figure 7 continued, last row). Bonds issued in 1999-2003 seem to have both large bid-ask spreads and high yields.

Results are qualitatively robust across most variations in the sample definition (e.g., trimming the sample more or less severely; splitting the sample by observation period; looking only at bonds issued after 2009). Including country dummies increases the R^2 by about 7 percentage points but leaves most estimated parameters on retained explanatory variables qualitatively little affected. For example, higher issue volume is associated with lower yields, the maximum effect being about 110 bps. The estimated parameters on term structure and maturity variables are notably stable. However, the estimated parameters for the contractual terms (jurisdiction of issuance, etc.) are rather different. Their large values are economically unintuitive, suggesting that they are highly affected by collinearity with the country dummies. The regression for the sample of observations with a credit rating greater than BBB (=14) explains a high proportion of variance, but many of the parameter estimates seem exaggerated and some are of the wrong sign.

[34] The extra cost may reflect a lower final recovery rate or a lengthier process.

The distribution of residuals is close to being symmetric and displays modest leptokurtosis (Figure 8); only about 0.5 percent of the residuals lie noticeably far from the normal distribution. Hence, conducting significance tests based on heteroskedasticity-robust standard errors should yield meaningful results. However, again the regression on the sample of observations with a credit rating greater than BBB (=14) yields residuals with a highly non-normal, asymmetric distribution (Figure 9). Hence, the corresponding t-statistics cannot readily be interpreted.

Figure 8. Residual Plots for the Reduced Form Regression on the Log Yield

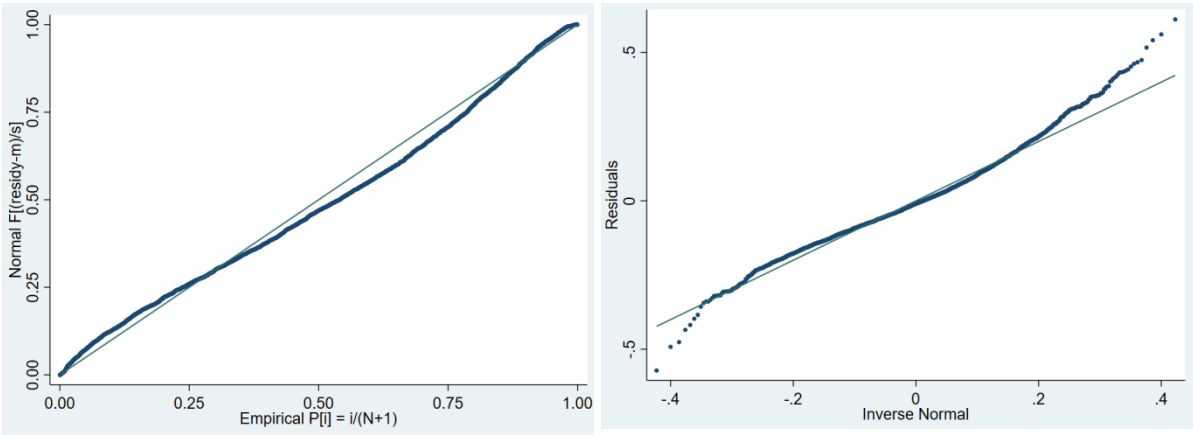
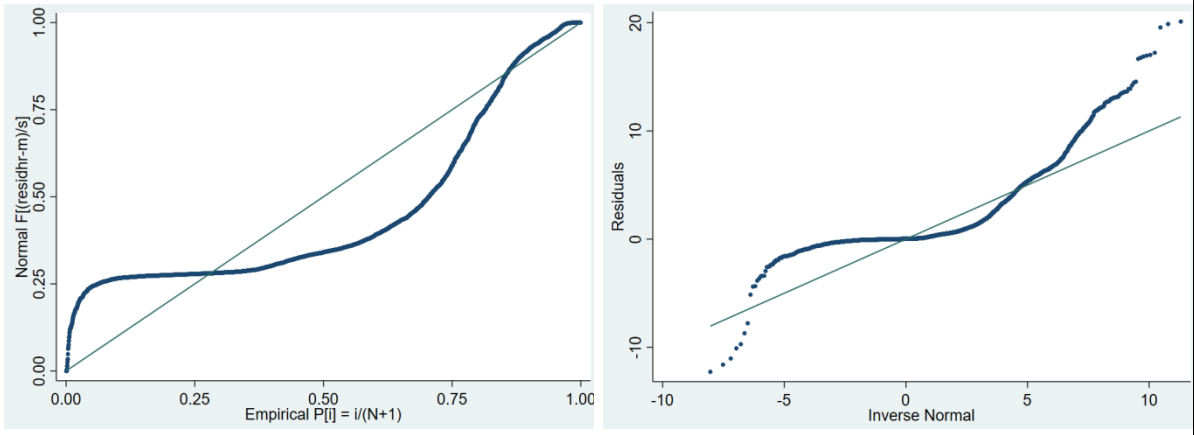


Figure 9. Residual Plots for the Reduced Form Regression on the Log Yield; Sub-Sample with Rating>14



Using Only Explanatory Variables Known at Time of Issue

Excluding explanatory variables that cannot be known at the time of issuance, including fixed effects, reduces the R^2 of the regression on LYLD_EMD to around 0.6, which is satisfactory for a long-range forecast. The qualitative relationships to most remaining explanatory variables are preserved (Tables 10 and 11, and Figure 10).

The initial issue volume remains a major predictor of the bond performance, and especially for smaller issues. As was seen for the bid-ask spread, the peak effect at low issuance volumes, and the threshold

effects at US$500 million, etc. are larger when the specification includes only explanatory variables known at time of issue than when contemporaneous variables are included.

The slopes of the projected effects of total country volume and the deviation from the country average issue size are positive, and the individual parameter estimates do not differ greatly from those obtained under the full specification. Moreover, the parameter estimates for the country volume terms are mostly insignificant. When the regression is run for smaller issuers only, again a negative relationship is found between yields and country volume, which effect may reflect the increased convenience yield on bonds as they become more widely available and more liquid. The projected effects on highly rated bonds are always minor.

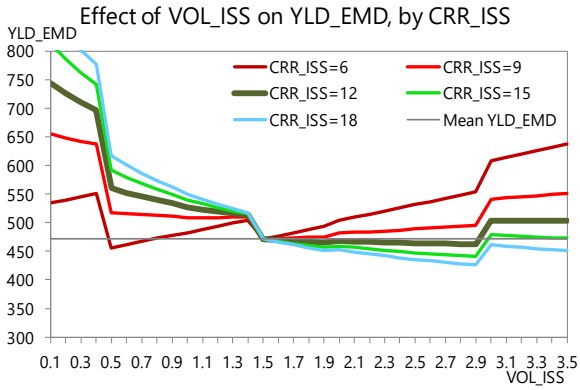
Residual maturity has the familiar, quadratic relationship to the projected yield. Likewise, the rise in yields as a bond approaches maturity and market liquidity dries up can be well-predicted.

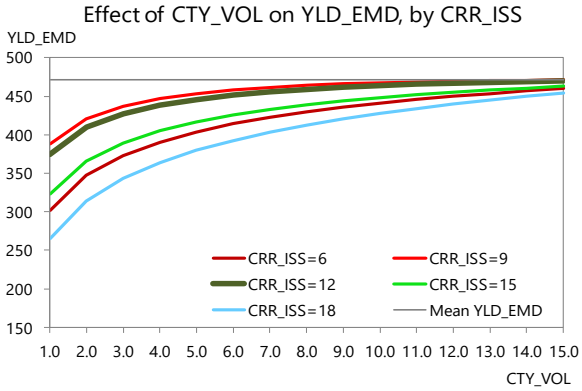
A higher coupon rate remains clearly associated with persistently higher yields. The projected effect of the credit rating is as expected, but the individual parameters are not precisely estimated.

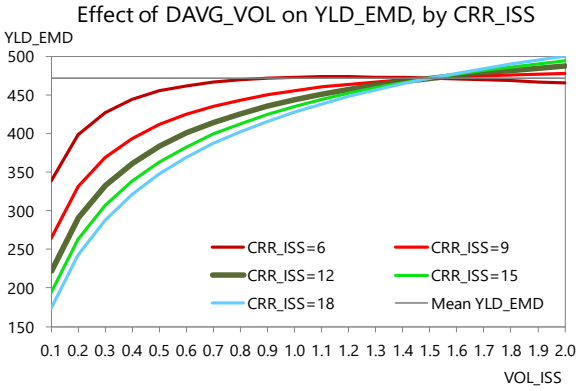
Perhaps surprisingly, inclusion in the EMBIG is not a reliable indicator of future yields. However, the effects of issuance under New York law and inclusion of the enhanced CAC remain significant and similar to what was found using the full specification.

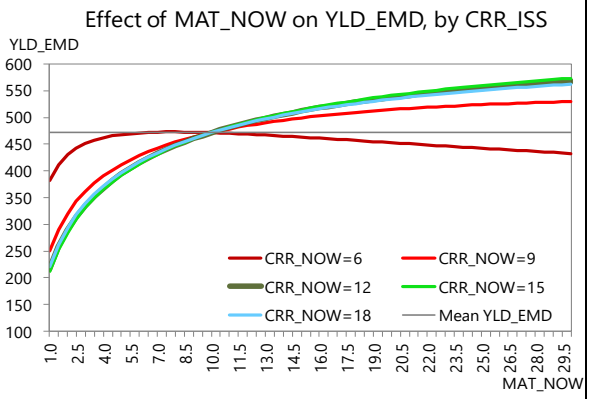
These results are not greatly affected when the equation is estimated using a robust technique, or the sample is restricted to bonds issued after 2009 or with a credit rating below 15. As before, estimates obtained from the higher rated bonds (amounting to one fifth of the sample) seem considerably less reliable.

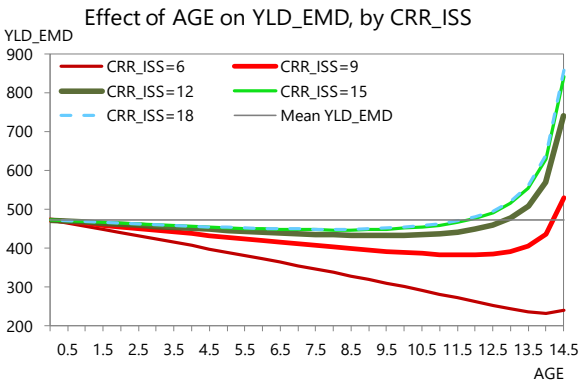
Figure 10. Yield Determinants; Reduced Form Regressions Using Only Explanatory Variables Known at Time of Issue











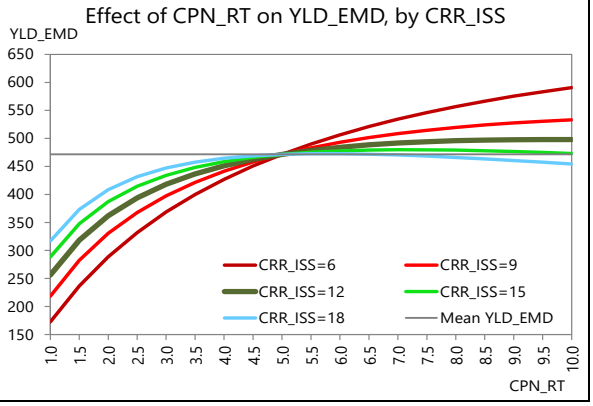
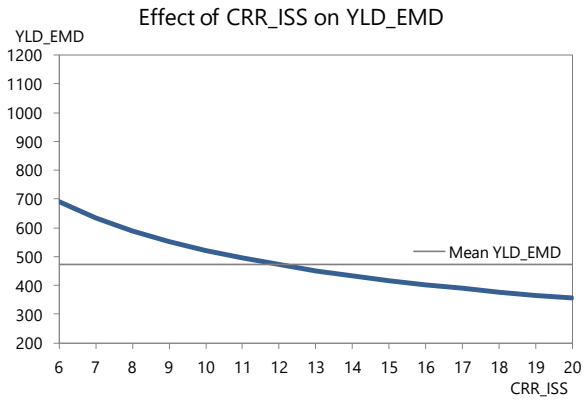
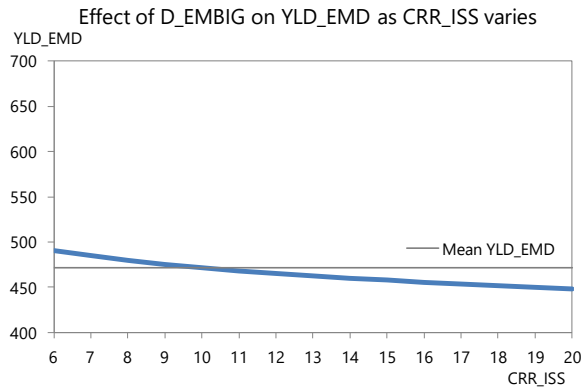
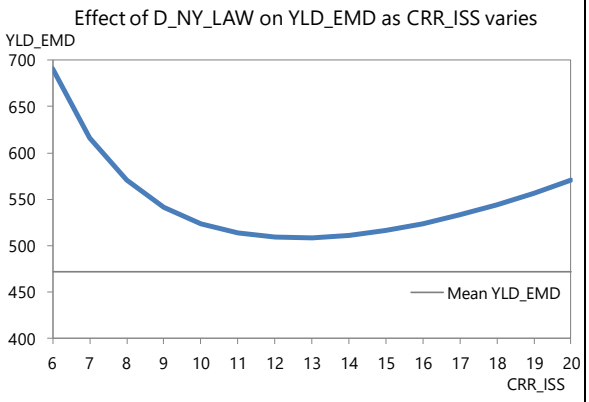
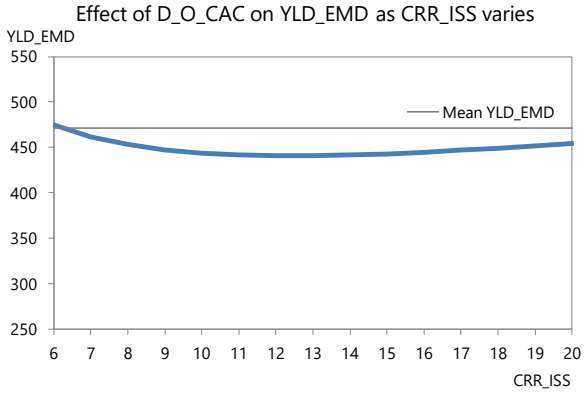


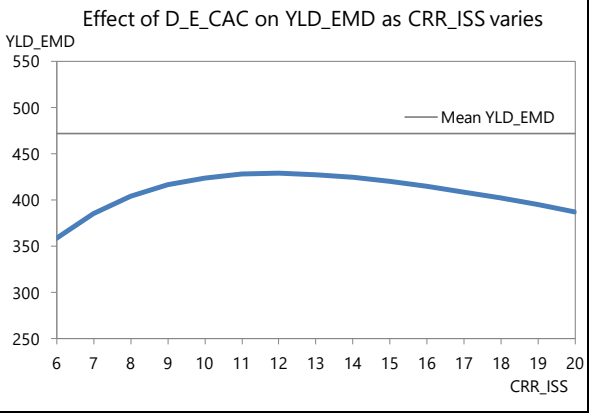
Figure 10. Yield Determinants; Reduced Form Regressions
Using Only Explanatory Variables Known at Time of Issue (Continued)











VII. Interaction of Bid-Ask Spreads and Yields

It would be of interest to investigate the direct relationship between yields and market liquidity as captured by the bid-ask spread. So far it has been established that certain bond and country characteristics affect both dependent variables. For example, bonds with better credit ratings should have lower yields and also a wider investor base, and therefore narrower bid-ask spreads. Also, the signs of the estimated coefficients are generally consistent with a strong interaction between the two. For example, a higher issue volume is associated with a narrower bid-ask spread, which one would expect to lead to a lower yield. The rise in yield when a bond approaches maturity or when only a small portion of its initial volume remains outstanding can be explained by its sharply declining market liquidity. However, the reduced form

regressions can be no more than suggestive, and they cannot reveal any relationship between the dependent variables that does not work through the explanatory variables.

The available explanatory variables do not allow for an instrumental variables approach to estimation of the relationship between yields and spreads. The former variables are mostly very effective in explaining both yields and spreads. Some experimentation revealed that candidate instruments mostly failed the over-identification test. When it was possible to find a sub-set of variables that passed the over-identification test for a certain specification, the composition of the sub-set was without economic rationale, and the set would fail the test when the specification or sample was changed slightly.

In the circumstances, a more modest objective was set, namely, to investigate the relationship between yields and spreads after controlling for the effects of all available explanatory variables on both. The relationship may be viewed as a lower bound on the extent of feedback between yields and market liquidity because all effects working through other variables (for example, if the volume issued has less effect on the yield, the more liquid the instrument) are filtered out.[35]

To this end, regressions were run for the log yield; the log bid-ask spread; the square of the log bid-ask spread; the cross-product of the log bid-ask spread and the log initial rating; and the cross-product of the log bid-ask spread and the squared log initial rating on all the explanatory variables. The residuals were calculated; by construction they are orthogonal to all the explanatory variables.[36] Then the yield residual was regressed on the four bid-ask spread-related residuals.[37] The procedure was repeated for various data samples.

The results presented in Table 12 and illustrated in Figure 11 show strongly that the bid-ask spread is strongly and positively related to the yield, even after controlling for the available explanatory variables. An increase (decrease) in the bid-ask spread of 10 basis points, starting from the sample mean of 55 basis points, increases (decreases) the yield by about 20 basis points for a typical bond with a mid-range credit rating. The results of F tests show that parameter estimates for groups of variables are highly significant even if some are individually insignificant. The estimated parameters on terms involving cross-products with the credit rating are jointly significant in several sub-samples, but they do not strongly affect the overall relationship. The results are fairly robust to variations in the sample: individual parameter estimates may differ, but the overall effect is similar, except when the sample is restricted to very highly-rated bonds.[38]

These results are comparable to those found by others, allowing for differences in samples and methodologies. Hund and Lesmond (op. cit) look at 8 years of data on bonds from 16 EMDCs. Working with annual changes, they find that a 1 bp. increase in the bid-ask spread raises corporate bond yield spreads by 3.13 bps. for corporate bonds and 5.67 bps. for government bonds, after controlling for credit risk and other macroeconomic and political factors.[39] Changes in bid-ask spreads account for over 10 percent of total variation in yield spreads. Chen et al (op. cit.) find that a 1 bp. increase in the bid-ask spread of US corporate bonds increases yield spreads by 0.42 bps. for investment grade bonds, and by 2.30 bps. for speculative grade bonds. When they allow for the endogeneity of the bid-ask spread, the coefficient falls to about 0.2 for both bond categories. The range of effects, from most to least liquid bonds, is estimated here at about 160 basis points, roughly half that which prevailed in the last nineteenth century (Alquist, op. cit.).

[35] Ultimately, neither spreads nor yields are exogenous. There may be still other explanatory variables, besides those in the sample, the inclusion of which would attenuate the estimated direct, independent interaction between the bid-ask spread and the yield. The results presented in this section may be interpreted as a reflection of the effects of these unobserved variables.

[36] The variables are denoted by R_LYLD; R_LBAS; R_LBAS_SQ; R_LBAS_LCRR; and R_LBAS_LCRR_SQ, respectively.

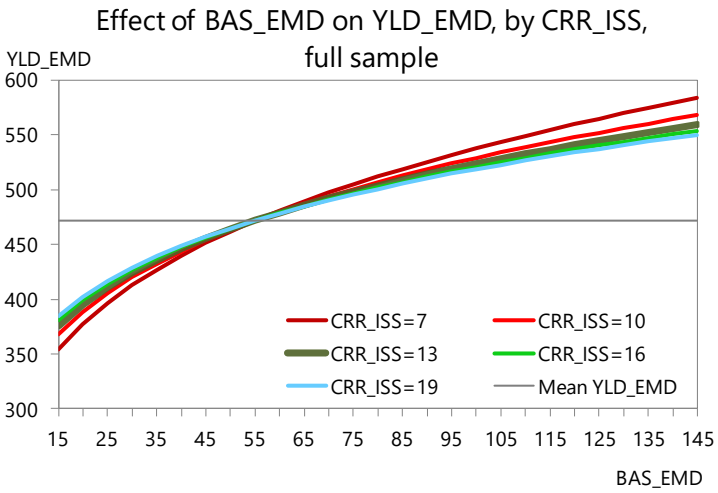
[37] The same procedure was applied, mutatis mutandis, to relate R_LBAS to residuals from regressions for the four analogous yield-based variables. Results are comparable.

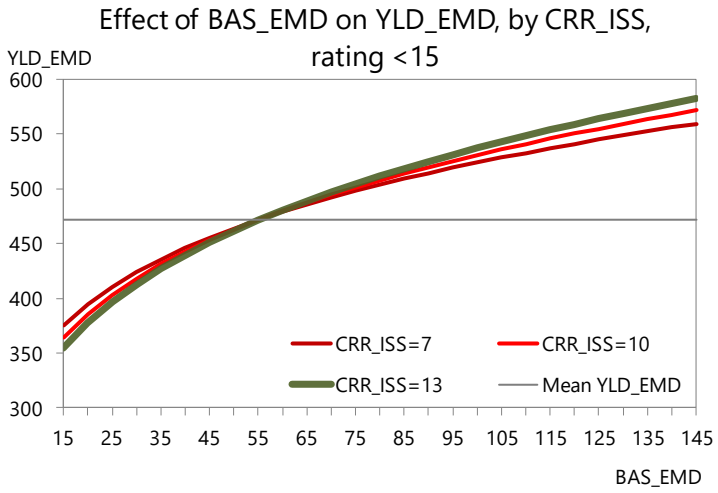
[38] That sub-sample again generates residuals that are far from normally distributed.

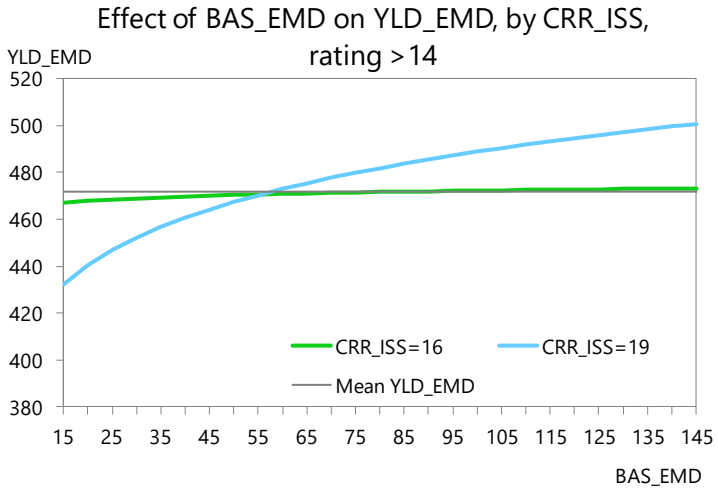
[39] Their estimated sensitivities obtained from OLS and GLS are even higher.

In addition, a “naïve” regression was run, of LYLD_EMD on all explanatory variables and also the four log bid-ask spread-based variables. The individual parameter estimates are certainly biased. However, F tests for the joint significance of the parameter estimates for the bid-ask spread terms are similar to those obtained from the residuals regressions. Results are not reported for reasons of concision.

Figure 11. Yield Determinants; Effect on Yield of the Bid-Ask Spread, Controlling for All Other Explanatory Variables







VIII. Summary and Conclusions

The results presented here show that, for the globally important asset class of Eurobonds, instrument design significantly influence yields and liquidity risk, as captured by bid-ask spreads. In particular, the choice of issue size; maturity; jurisdiction of issuance; and inclusion of an enhanced CAC, are important. Table 13 summarizes the magnitudes of the main effects, separating the marginal effects of continuous variables (such as a bond's remaining maturity) from the step effects of dummy variables (such as whether or not a CAC is included in a bond's terms). The choices made at time of issuance have persistent effects; one can say that yields and spreads "store information about history."[40] However, characteristics of very highly rates bonds are less reliably related to their yields and spreads.

The results are of both academic and practical interest. They broadly corroborate the predictions of models of market liquidity and the relationship between market liquidity and yields: yields reflect not only duration and credit risk, but also liquidity risk. This empirical study, using a novel panel dataset, complements others that have looked at the determinants of market liquidity and the relationship to yields. The estimation approach is distinguished by the special attention paid to the inter-dependence of yields and bid-ask spreads; interactions with credit ratings and issuer size; and the influence of numerous control variables. The flexible function form allows for nonlinear and even non-monotonic relationships, which turn out to be prevalent, while giving rise to approximately normally distributed residuals.

One implication of the revealed relationships is that good debt management—both at initial issuance and through subsequent intervention—can reduce funding costs by tens of basis points, achieving savings of millions of dollars even for a small issuer. The results suggest how an initial investor can predict how long a bond is likely to retain market liquidity. The results also allow an assessment of whether current pricing is in line with market liquidity; divergence may give rise to investment opportunities or occasions for liquidity management operations by the DMO.

[40] Ladyman and Wiesner (op. cit.) discuss how systems can depend on history and memory.

Table 1. Summary of Main Effects 1/		
Explanatory Variable	Marginal Effect	
	Decrease BAS by 10 bps. requires	Decrease YLD by 30 bps. requites
Issuance volume	Increase in issue volume from US$1.1bn. to US$1.5bn.	Increase in issue volume from US$1.3bn. to US$1.5bn.
Total country volume	Increase in country volume from US$1bn. to US$10bn.	Increase in country volume from US$4bn. to US$7bn.
U.S. T-bond yield curve	...	Decrease in maturity from 10 to 5.5 years
Time to maturity	Decrease in maturity from 10 years to 4.5 years	Decrease in maturity from 10 to 4.0 years
Credit rating at time of issue	Increase in rating from BB- to BB+	Increase in rating from BB (positive outlook) to BB+ 2/
Change in credit rating since time of issue	Increase in rating from BB- to BB+	Increase in rating from BB (positive outlook) to BB+ 3/
Coupon rate	Decrease in coupon rate from 5.0 percent to 2.5 percent	Decrease in coupon rate from 5.0 percent to 3.5 percent
Bid-ask spread, ceteris paribus		Decrease in bid-ask spread by 15 bps.
Dummy Variable	Fixed Effect	
	Effect on BAS_EMD	Effect on YLD_EMD
Issue volume ≥US$0.5 bn.	-9.0 bps.	-70 bps.
Issue volume ≥US$1.0 bn.	-5.0 bps.	-18 bps.
Issue volume ≥US$1.5 bn.	-3.0 bps.	-23 bps.
Issue volume ≥US$3.0 bn.	-0.5 bps.	+13 bps.
Included in EMBI Global	-1.5 bps. when CRR=BB+; +3.0 bps. when CRR= B-	-1.5 bps. when CRR= BB+ +0.5 bps. when CRR= B-
Issued under NY law	+2.0 bps. at CRR= BB+ +11.0 bps. when CRR= B-	+17.0 bps. at CRR= BB+ +67.0 bps. when CRR=B-
Inclusion of an original CAC	-1.5 bps. at CRR= BB+ -3.0 bps. when CRR= B-	-19.0 bps. at CRR= BB+ +6.5 bps. when CRR= B-
Inclusion of an enhanced CAC	-5.5 bps. at CRR= BB+ -18.0 bps. when CRR= B-	-19.5 bps. at CRR= BB+ -61.0 bps. when CRR= B-

Source: See text.

1/ Credit rating assumed to be BB+ unless stated otherwise.
2/ One rating grade improvement reduces yield approximately 60 bps.
3/ One rating grade improvement reduces yield approximately 45 bps.

The approach used here could be extended to investigate whether bid-ask spreads vary depending on the degree of global and country-specific stress and volatility, as captured perhaps by risk premia and macro-financial indicator variables. It is at least possible that market liquidity at first improves when there is more "news," until increased risk erodes the investor base. Another refinement would be to include macroeconomic terms as explanatory variables. However, macroeconomic variables are often known only with long lags, and quarterly variables may be hard to interpret even where available. Hence, care would have to be taken to ensure that the macroeconomic variables were known to market participants at the respective observation dates. Alternatively, once could include dummy variables for each country-date combination in order to isolate issue-specific features; investigate country by country how market liquidity varies across issues, focusing on large issuers who each generate enough observations to achieve useable degrees of freedom; or refine the estimates based on a narrow sub-sample of highly comparable countries, which approach may be appropriate for research by an investor or DMO. An alternative strategy would focus on short-term price movements, thus effectively controlling for slow-moving global and country-issuer effects, but that would require a different dataset. Furthermore, more research could be undertaken on the relationship between the size and composition of the investor base, on the one hand, and yield and liquidity, on the other.

Interesting extensions of this research could include looking at the determinants of the bid-ask spreads and yields of corporate Eurobonds; those of Eurobonds denominated in other currencies; and those of advanced countries issued both domestically and abroad. A question provoked by the results presented here is whether the pricing and bid-ask spreads of bonds issued by very highly-rated EMDCs vary with those of advanced economy bonds (besides U.S. Treasury bond yields that are already included), with little influence from bond-specific characteristics. The approach of this paper could usefully be applied to an investigation of the pricing and liquidity of domestic sovereign securities in emerging markets, an asset class that is of growing importance, and for which the achievement of sustained market liquidity can be a crucial challenge.

Table 2. Credit Ratings and Numerical Codes				
S&P	Moody's	Fitch	Numerical Code	
AA	Aa2	AA	20	High investment grade
AA-	Aa3	AA-	19	
A+	A1	A+	18	Upper medium investment grade
A	A2	A	17	
A-	A3	A-	16	
BBB+	Baa1	BBB+	15	Lower medium investment grade
BBB	Baa2	BBB	14	
BBB-	Baa3	BBB-	13	
BB+	Ba1	BB+	12	Speculative
BB	Ba2	BB	11	
BB-	Ba3	BB-	10	
B+	B1	B+	9	Highly speculative
B	B2	B	8	
B-	B3	B-	7	
CCC+	Caa1	CCC	6	Substantial risks

Table 3a. Summary Statistics;
Full Sample

Variable Tag	Description	No. Obs.	Mean	Std. Dev.	Min.	Max.
BAS_EMD	bid-ask spread, US$ EMDC eurobonds	4,759	62.78	47.49	0.10	1,329
YLD_EMD	yield, US$ EMDC eurobonds	4,759	531.22	506.74	17.40	21,831
VOL_ISS	bond volume, at issue date	4,759	1.62	1.08	0.10	7.00
VOL_NOW	bond volume, at oberservation date	4,759	1.54	1.07	0.00	7.00
CTY_VOL	total value of bonds outstanding, by country	4,759	33.99	33.34	0.10	110.70
CTY_VOL_AVG	average bond volume, by country	4,759	1.62	0.88	0.10	5.83
CTY_I_NUM	number of bond issues, by country	4,759	19.72	19.14	1	71
MAT_NOW_DYC	U.S. Treasury Bond yield, by maturity	4,759	242.48	40.28	50.88	311.69
MAT_ISS	time to maturity, at issue date	4,759	14.93	9.84	4.99	100.07
MAT_NOW	time to maturity, at oberservation date	4,759	10.24	9.45	0.03	93.59
CRR_ISS	country credit rating, at issue date	4,704	12.30	3.45	6	20
CRR_NOW	country credit rating, at oberservation date	4,747	12.01	3.46	2	20
CPN_RT	coupon rate	4,759	5.53	1.95	1.42	13.63
D_EMBIG	dummy=1 if bond included in EMBI	4,759	0.54	0.50	0	1
D_US_LAW	dummy=1 if bond issued under NY law	4,759	0.55	0.50	0	1
D_O_CAC	dummy=1 if bond terms includes an original CAC	4,759	0.50	0.50	0	1
D_E_CAC	dummy=1 if bond terms includes an enhanced CAC	4,759	0.36	0.48	0	1
D_M_PARI_P	dummy=1 if bond terms includes a modified pari-passu clause	4,759	0.40	0.49	0	1

Source: See text.

Table 3b. **Summary Statistics of Transformed Variables; Main Regression Sample**

Variable Tag	Description	No. Obs.	Mean	Std. Dev.	Min.	Max.
LBAS_EMD	log of bid-ask spread, US$ EMDC eurobonds	4,363	4.018	0.371	3.220	5.162
LYLD_EMD	log of yield, US$ EMDC eurobonds	4,363	6.156	0.341	4.867	7.019
LVOL_ISS	log of bond volume, at issue date	4,363	0.279	0.649	-2.303	1.946
CHG_LVOL	change in log of bond volume, from issance to oberservation date	4,363	0.051	0.201	0.000	1.940
LCTY_VOL	log of total value of bonds outstanding, by country	4,363	2.949	1.237	-2.303	4.707
DAVG_LVOL	deviation of issue volune from country average, in logs	4,363	-0.052	0.381	-3.020	0.902
LMAT_NOW_DYC	log of U.S. Treasury Bond yield, by maturity	4,363	5.485	0.181	4.055	5.742
LMAT_NOW	log of time to maturity, at oberservation date	4,363	1.968	0.956	-1.930	4.539
CHG_LMAT	change in log of time to maturity, from issance to oberservation date	4,363	-0.566	0.631	-4.205	0.000
LCRR_ISS	log of country credit rating, at issue date	4,363	2.474	0.275	1.792	2.996
CHG_LCRR	change in log of country credit rating, from issuance to oberservation date	4,363	-0.019	0.135	-0.531	0.619
LCPN_RT	log of coupon rate	4,363	1.641	0.353	0.560	2.546
D_EMBIG	dummy=1 if bond included in EMBI	4,363	0.551	0.497	0	1
D_NY_LAW	dummy=1 if bond issued under NY law	4,363	0.547	0.498	0	1
D_O_CAC	dummy=1 if bond terms includes an original CAC	4,363	0.489	0.500	0	1
D_E_CAC	dummy=1 if bond terms includes an enhanced CAC	4,363	0.383	0.486	0	1
D_M_PARI_P	dummy=1 if bond terms includes a modified pari-passu clause	4,363	0.421	0.494	0	1
D_M_PARI_P_NCAC	dummy=1 if bond terms includes a modified pari-passu clause but no CAC	4,363	0.020	0.141	0	1

Source: See text.

Table 3c. Summary Statistics of Transformed Variables; Sub-Sample with Credit Rating > 14

Variable Tag	Description	No. Obs.	Mean	Std. Dev.	Min.	Max.
LBAS_EMD	log of bid-ask spread, US$ EMDC eurobonds	978	3.904	0.373	3.220	5.130
LYLD_EMD	log of yield, US$ EMDC eurobonds	978	5.944	0.249	5.048	6.515
LVOL_ISS	log of bond volume, at issue date	978	0.638	0.744	-2.303	1.872
CHG_LVOL	change in log of bond volume, from issance to oberservation date	978	0.034	0.115	0.000	0.757
LCTY_VOL	log of total value of bonds outstanding, by country	978	3.266	1.085	-2.303	4.575
DAVG_LVOL	Deviation of issue volune from country average, in logs	978	-0.097	0.441	-3.020	0.833
LMAT_NOW_DYC	log of U.S. Treasury Bond yield, by maturity	978	5.495	0.162	4.881	5.742
LMAT_ISS	log of time to maturity, at issue date	978	2.581	0.623	1.610	4.606
LMAT_NOW	log of time to maturity, at oberservation date	978	2.043	0.991	-1.822	4.539
CHG_LMAT	change in log of time to maturity, from issance to oberservation date	978	-0.538	0.604	-4.125	0.000
LCRR_ISS	log of country credit rating, at issue date	978	2.849	0.120	2.708	2.996
CHG_LCRR	change in log of country credit rating, from issuance to oberservation date	978	-0.084	0.109	-0.531	0.223
LCPN_RT	log of coupon rate	978	1.307	0.331	0.754	2.277
D_EMBIG	dummy=1 if bond included in EMBI	978	0.498	0.500	0	1
D_NY_LAW	dummy=1 if bond issued under NY law	978	0.497	0.500	0	1
D_O_CAC	dummy=1 if bond terms includes an original CAC	978	0.443	0.497	0	1
D_E_CAC	dummy=1 if bond terms includes an enhanced CAC	978	0.442	0.497	0	1

Source: See text.

Table 3d. Summary Statistics of Transformed Variables; Sub-Sample with Total Country Volume ≤ US$10 billion

Variable Tag	Description	No. Obs.	Mean	Std. Dev.	Min.	Max.
LBAS_EMD	log of bid-ask spread, US$ EMDC eurobonds	1,222	4.218	0.334	3.240	5.162
LYLD_EMD	log of yield, US$ EMDC eurobonds	1,222	6.256	0.314	5.005	7.007
LVOL_ISS	log of bond volume, at issue date	1,222	-0.300	0.495	-2.303	0.934
CHG_LVOL	change in log of bond volume, from issance to oberservation date	1,222	0.055	0.186	0.000	1.825
LCTY_VOL	log of total value of bonds outstanding, by country	1,222	1.348	0.708	-2.303	2.303
DAVG_LVOL	Deviation of issue volune from country average, in logs	1,222	-0.032	0.301	-1.946	0.762
LMAT_NOW_DYC	log of U.S. Treasury Bond yield, by maturity	1,222	5.468	0.188	4.369	5.729
LMAT_ISS	log of time to maturity, at issue date	1,222	2.413	0.479	1.610	3.690
LMAT_NOW	log of time to maturity, at oberservation date	1,222	1.830	0.832	-1.710	3.516
CHG_LMAT	change in log of time to maturity, from issance to oberservation date	1,222	-0.583	0.569	-3.899	0.000
LCRR_ISS	log of country credit rating, at issue date	1,222	2.346	0.258	1.946	2.996
CHG_LCRR	change in log of country credit rating, from issuance to oberservation date	1,222	-0.044	0.117	-0.452	0.310
LCPN_RT	log of coupon rate	1,222	1.794	0.294	0.754	2.464
D_EMBIG	dummy=1 if bond included in EMBI	1,222	0.466	0.499	0	1
D_NY_LAW	dummy=1 if bond issued under NY law	1,222	0.510	0.500	0	1
D_O_CAC	dummy=1 if bond terms includes an original CAC	1,222	0.514	0.500	0	1
D_E_CAC	dummy=1 if bond terms includes an enhanced CAC	1,222	0.373	0.484	0	1

Source: See text.

Table 4: Log Bid-Ask Spread Determinants; Reduced Form Regressions

	Full sample			Robust regression		Trimmed sample		Extended sample		First half of sample		Second half of sample	
	coef.	s.e.	conventional s.e.	coef.	s.e.	coef.	s.e.	coef.	s.e.	coef.	s.e.	coef.	s.e.
LVOL_ISS	6.578***	1.473	0.987	6.305***	0.917	4.302***	1.063	8.595***	1.609	6.441***	2.006	9.858***	1.291
LVOL_ISS_SQ	0.007	0.018	0.017	0.044***	0.016	-0.020	0.015	0.001	0.020	-0.000	0.025	0.015	0.029
LVOL_ISS_LCRR_I	-5.106***	1.153	0.802	-4.822***	0.744	-3.351***	0.841	-6.672***	1.265	-4.867***	1.571	-7.820***	1.041
LVOL_ISS_LCRR_I_SQ	0.951***	0.224	0.162	0.879***	0.150	0.635***	0.165	1.243***	0.247	0.871***	0.305	1.511***	0.209
CHG_LVOL	-25.988***	3.892	2.850	-17.613***	2.646	-17.468***	4.134	-23.157***	3.988	-24.603***	4.827	-27.065***	5.822
CHG_LVOL_SQ	0.113**	0.050	0.036	0.121***	0.034	0.082*	0.043	0.123**	0.052	0.159**	0.065	0.050	0.074
CHG_LVOL_LCRR_I	21.455***	3.049	2.261	14.902***	2.099	14.243***	3.305	19.321***	3.135	20.269***	3.812	22.334***	4.566
CHG_LVOL_LCRR_I_SQ	-4.390***	0.592	0.445	-3.139***	0.413	-2.883***	0.654	-3.993***	0.610	-4.141***	0.748	-4.562***	0.884
D_VOL_ISS_500	-0.135***	0.037	0.036	-0.112***	0.034	-0.086***	0.033	-0.107**	0.046	-0.188***	0.047	-0.089	0.059
D_VOL_ISS_1000	-0.087***	0.019	0.018	-0.069***	0.016	-0.073***	0.016	-0.080***	0.021	-0.134***	0.024	-0.054*	0.029
D_VOL_ISS_1500	-0.045***	0.013	0.013	-0.038***	0.013	-0.032***	0.012	-0.032**	0.015	-0.033*	0.018	-0.044**	0.019
D_VOL_ISS_2000	-0.002	0.014	0.015	-0.011	0.014	0.004	0.012	-0.027*	0.015	-0.030	0.020	0.018	0.019
D_VOL_ISS_3000	-0.005	0.023	0.020	-0.012	0.018	0.031	0.021	-0.019	0.025	-0.004	0.032	-0.008	0.033
LCTY_VOL	-0.106	0.509	0.430	-0.116	0.399	-0.371	0.392	-0.543	0.572	0.534	0.794	-1.379***	0.460
LCTY_VOL_SQ	0.003	0.004	0.003	0.003	0.003	0.005*	0.003	0.006	0.004	-0.009*	0.005	0.014***	0.005
LCTY_VOL_LCRR_I	-0.023	0.407	0.352	-0.031	0.326	0.222	0.315	0.286	0.460	-0.673	0.637	1.058***	0.378
LCTY_VOL_LCRR_I_SQ	0.023	0.079	0.071	0.027	0.066	-0.040	0.062	-0.030	0.090	0.190	0.125	-0.213***	0.076
DAVG_LVOL	-3.483**	1.413	1.145	-3.905***	1.063	-3.207***	1.116	-4.073***	1.569	-2.764	1.920	-6.892***	1.385
DAVG_LVOL_SQ	0.019	0.017	0.016	-0.011	0.014	0.017	0.014	0.041**	0.019	0.026	0.023	0.004	0.027
DAVG_LVOL_LCRR_I	2.851***	1.106	0.925	3.069***	0.859	2.683***	0.880	3.224***	1.236	2.174	1.499	5.648***	1.111
DAVG_LVOL_LCRR_I_SQ	-0.562***	0.215	0.186	-0.581***	0.172	-0.553***	0.172	-0.612**	0.242	-0.401	0.290	-1.135***	0.221
LMAT_NOW_DYC	1.180	1.683	1.832	2.427	1.701	-0.124	1.839	-1.836	1.777	0.842	2.783	-26.270**	13.389
LMAT_NOW_DYC_SQ	-0.046	0.096	0.101	-0.161*	0.094	-0.013	0.115	0.106	0.104	-0.158	0.167	2.050*	1.049
LMAT_N_DYC_LCRR_I	-0.188	1.116	1.205	-0.343	1.119	0.491	1.059	0.954	1.132	0.448	1.875	3.112	4.771
LMAT_N_DYC_LCRR_I_SQ	-0.034	0.222	0.242	0.002	0.225	-0.161	0.212	-0.243	0.228	-0.052	0.374	-0.628	0.953
LMAT_NOW	0.495	0.462	0.507	-0.079	0.471	1.043**	0.413	0.030	0.497	0.429	0.678	0.360	0.633
LMAT_NOW_SQ	-0.060***	0.013	0.011	-0.056***	0.011	-0.048***	0.010	-0.055***	0.014	-0.044**	0.020	-0.080***	0.016
LMAT_NOW_LCRR_I	0.003	0.381	0.416	0.460	0.386	-0.519	0.341	0.313	0.410	0.063	0.554	0.207	0.520
LMAT_NOW_LCRR_I_SQ	-0.001	0.076	0.083	-0.092	0.077	0.102	0.067	-0.054	0.082	-0.025	0.111	-0.048	0.104
CHG_LMAT	-0.625	0.826	0.859	0.432	0.797	-1.853**	0.783	0.219	0.924	0.264	1.299	0.034	0.976
CHG_LMAT_SQ	0.021**	0.009	0.008	0.027***	0.008	0.002	0.009	0.016*	0.010	-0.008	0.016	0.039***	0.011
CHG_LMAT_LCRR_I	0.022	0.673	0.696	-0.815	0.646	1.052	0.646	-0.532	0.751	-0.709	1.055	-0.570	0.795
CHG_LMAT_LCRR_I_SQ	0.034	0.134	0.139	0.200	0.129	-0.165	0.130	0.128	0.150	0.202	0.212	0.148	0.159
LCRR_ISS	-6.031	6.063	6.422	-15.218**	5.962	-12.408**	6.033	-12.696**	6.016	-7.740	10.377	-26.269	27.176
LCRR_ISS_SQ	1.621	1.207	1.293	3.246***	1.200	2.723**	1.206	2.950**	1.220	1.287	2.061	5.334	5.410
CHG_LCRR	-0.025	0.487	0.431	0.442	0.400	0.883**	0.408	-0.046	0.522	-1.503**	0.604	1.746**	0.744
CHG_LCRR_SQ	-0.159	0.103	0.090	-0.247***	0.083	-0.322***	0.087	-0.153	0.111	0.225*	0.128	-0.585***	0.157
LCPN_RT	-0.101	1.196	0.867	-5.857***	0.805	-4.005***	1.110	1.497	0.951	0.674	1.557	0.553	1.829
LCPN_RT_SQ	-0.325***	0.043	0.037	-0.144***	0.034	-0.065	0.041	-0.564***	0.050	-0.300***	0.056	-0.343***	0.062
LCPN_RT_LCRR_I	1.220	0.903	0.724	4.893***	0.672	3.179***	0.828	1.041	0.884	0.321	1.246	0.805	1.307
LCPN_RT_LCRR_I_SQ	-0.289	0.176	0.148	-0.930***	0.138	-0.586***	0.161	-0.345*	0.187	-0.062	0.251	-0.223	0.247
D_EMBIG	0.409	0.448	0.505	0.388	0.469	0.247	0.399	0.261	0.492	0.799	0.659	-0.089	0.554
D_EMBIG_LCRR_I	-0.120	0.362	0.410	-0.145	0.381	-0.063	0.323	0.023	0.400	-0.435	0.533	0.284	0.451
D_EMBIG_LCRR_I_SQ	-0.010	0.072	0.082	0.004	0.077	-0.005	0.065	-0.045	0.080	0.054	0.107	-0.092	0.091
D_NY_LAW	1.679***	0.582	0.567	2.032***	0.526	0.755	0.483	2.171***	0.626	1.353	0.844	2.784***	0.690
D_NY_LAW_LCRR_I	-1.268***	0.474	0.466	-1.577***	0.433	-0.636	0.392	-1.631***	0.511	-0.935	0.689	-2.222***	0.563
D_NY_LAW_LCRR_I_SQ	0.226**	0.095	0.095	0.293***	0.088	0.128	0.079	0.290***	0.103	0.150	0.139	0.426***	0.113
D_O_CAC	-0.610	0.731	0.782	-2.797***	0.726	-1.856**	0.800	0.150	0.774	-0.706	0.959	-0.615	1.043
D_O_CAC_LCRR_I	0.525	0.589	0.638	2.270***	0.592	1.605**	0.642	-0.144	0.625	0.518	0.778	0.577	0.840
D_O_CAC_LCRR_I_SQ	-0.107	0.117	0.129	-0.449***	0.120	-0.339***	0.127	0.036	0.125	-0.088	0.156	-0.129	0.168
D_E_CAC	-5.131***	0.872	0.848	-7.592***	0.787	-4.947***	0.860	-5.406***	0.952	-4.870***	1.254	-5.880***	1.072
D_E_CAC_LCRR_I	4.111***	0.709	0.698	6.080***	0.648	4.095***	0.695	4.271***	0.776	3.890***	1.023	4.640***	0.877
D_E_CAC_LCRR_I_SQ	-0.805***	0.143	0.142	-1.192***	0.132	-0.831***	0.139	-0.824***	0.157	-0.755***	0.207	-0.902***	0.177
Hidden:													
Obs. period dummies													
Issue year dummies													
Country dummies													
CONS	6.987	7.935	8.405	17.863**	7.803	17.256**	8.252	18.546**	7.937	9.673	13.433	97.297**	48.305
Number of observations	4,363			4,363		3,226		4,561		2,243		2,120	
Adjusrted R2	0.687			0.723		0.610		0.694		0.683		0.710	

Source: See text.
Note: *** p<0.01, ** p<0.05, * p<0.1

Table 4 (Continued): Log Bid-Ask Spread Determinants; Reduced Form Regressions

	Small issuers		Large issuers		Issued after 2009		With country dummies		Sub-sample with rating<15		Sub-sample with rating>14	
	coef.	s.e.	coef.	s.e.	coef.	s.e.	coef.	s.e.	coef.	s.e.	coef.	s.e.
LVOL_ISS	10.819***	3.213	6.725***	1.592	5.790***	1.433	-1.442	1.250	3.438	3.058	-261.367***	48.717
LVOL_ISS_SQ	0.073	0.094	-0.223***	0.051	-0.014	0.021	0.003	0.028	-0.042	0.033	-0.206***	0.064
LVOL_ISS_LCRR_I	-8.319***	2.795	-5.400***	1.256	-4.460***	1.122	1.139	1.050	-2.438	2.581	180.291***	33.876
LVOL_ISS_LCRR_I_SQ	1.571***	0.595	1.093***	0.249	0.823***	0.218	-0.251	0.218	0.393	0.543	-31.057***	5.877
CHG_LVOL	-9.237	7.308	-2.052	9.306	-21.367***	4.318	-13.291***	4.467	1.817	10.021	-45.468	175.896
CHG_LVOL_SQ	0.151	0.239	0.078	0.068	1.331***	0.276	-0.019	0.059	0.083*	0.048	0.840*	0.495
CHG_LVOL_LCRR_I	7.576	5.799	1.792	7.624	17.503***	3.401	11.755***	3.501	-1.934	8.395	33.042	124.462
CHG_LVOL_LCRR_I_SQ	-1.565	1.124	-0.367	1.560	-3.680***	0.665	-2.502***	0.683	0.520	1.753	-6.087	21.998
D_VOL_ISS_500	0.007	0.059	-0.242***	0.067	-0.083**	0.037	-0.145***	0.048	-0.301***	0.040	0.753***	0.145
D_VOL_ISS_1000	-0.098***	0.037	-0.026	0.026	-0.090***	0.020	-0.012	0.022	-0.128***	0.020	-0.102	0.072
D_VOL_ISS_1500	-0.111*	0.067	-0.046***	0.015	-0.028**	0.014	-0.002	0.013	-0.023	0.015	0.144***	0.039
D_VOL_ISS_2000	-0.111	0.090	-0.025*	0.015	-0.012	0.014	-0.019	0.012	0.031*	0.017	0.080**	0.036
D_VOL_ISS_3000	...		-0.086***	0.024	-0.030	0.023	-0.035	0.021	0.044	0.037	0.067	0.042
LCTY_VOL	-3.208**	1.398	-2.991***	0.765	0.220	0.500	...		-0.859	1.045	33.827	22.089
LCTY_VOL_SQ	-0.030*	0.018	-0.138***	0.012	0.014***	0.004	...		0.001	0.004	0.100***	0.016
LCTY_VOL_LCRR_I	2.607**	1.217	3.043***	0.603	-0.297	0.401	...		0.710	0.884	-23.042	15.400
LCTY_VOL_LCRR_I_SQ	-0.530**	0.266	-0.575***	0.115	0.068	0.079	...		-0.150	0.186	3.836	2.681
DAVG_LVOL	-4.947	3.141	-5.262***	1.521	-4.783***	1.411	4.430***	1.328	-6.058*	3.279	160.470***	59.335
DAVG_LVOL_SQ	0.103	0.065	0.280***	0.050	0.020	0.022	0.024	0.028	-0.012	0.031	0.407***	0.060
DAVG_LVOL_LCRR_I	3.651	2.672	4.436***	1.204	3.830***	1.108	-3.488***	1.109	5.204*	2.788	-110.486***	41.290
DAVG_LVOL_LCRR_I_SQ	-0.641	0.566	-0.958***	0.239	-0.742***	0.216	0.688***	0.229	-1.094*	0.590	18.936***	7.171
LMAT_NOW_DYC	-11.309***	4.304	0.801	1.993	-1.465	2.197	1.145	1.039	7.563**	3.306	27.659	51.856
LMAT_NOW_DYC_SQ	0.690**	0.270	-0.000	0.097	0.052	0.140	-0.023	0.093	-0.306***	0.102	0.823**	0.353
LMAT_N_DYC_LCRR_I	4.364*	2.303	-0.502	1.422	1.104	1.214	-0.561	0.378	-3.786	2.654	-26.463	36.653
LMAT_N_DYC_LCRR_I_SQ	-1.037**	0.476	0.049	0.280	-0.293	0.246	0.077	0.076	0.793	0.575	4.858	6.425
LMAT_NOW	1.675	1.210	-0.442	0.524	0.995**	0.470	-0.403	0.462	2.145*	1.272	-4.565	15.616
LMAT_NOW_SQ	-0.026	0.041	-0.044***	0.015	-0.043***	0.014	-0.025*	0.013	-0.076***	0.014	0.008	0.022
LMAT_NOW_LCRR_I	-1.323	1.034	0.677	0.424	-0.445	0.394	0.428	0.377	-1.440	1.109	3.483	10.981
LMAT_NOW_LCRR_I_SQ	0.305	0.215	-0.132	0.083	0.080	0.078	-0.059	0.075	0.330	0.238	-0.648	1.924
CHG_LMAT	-6.482***	2.093	1.476	0.907	-1.529*	0.928	1.491*	0.773	-2.913	1.969	32.122	39.890
CHG_LMAT_SQ	0.037	0.048	0.070***	0.020	0.042***	0.009	0.050***	0.017	0.029***	0.009	-0.009	0.021
CHG_LMAT_LCRR_I	5.366***	1.775	-1.585**	0.732	0.832	0.770	-1.276**	0.625	1.961	1.713	-23.537	28.009
CHG_LMAT_LCRR_I_SQ	-1.125***	0.376	0.349**	0.146	-0.124	0.157	0.245**	0.125	-0.387	0.369	4.303	4.903
LCRR_ISS	-36.405***	13.314	-9.488	7.126	-11.512*	6.434	...		20.387	13.874	7.690	193.677
LCRR_ISS_SQ	8.192***	2.724	2.071	1.405	2.851**	1.304	...		-4.258	3.016	-1.977	33.958
CHG_LCRR	1.052	1.093	-1.698***	0.630	1.656***	0.516	-0.941	0.833	1.437**	0.605	-9.642***	2.752
CHG_LCRR_SQ	-0.340	0.243	0.195	0.130	-0.538***	0.111	-0.029	0.178	-0.471***	0.131	1.685***	0.521
LCPN_RT	-1.022	2.539	1.586	1.139	-0.282	1.023	0.996	0.988	3.750*	2.260	-54.849	50.359
LCPN_RT_SQ	-0.552**	0.258	-0.045	0.043	-0.451***	0.041	-0.101***	0.038	-0.298***	0.045	-0.674***	0.174
LCPN_RT_LCRR_I	2.709	2.107	-1.023	0.915	2.020**	0.810	-0.477	0.781	-1.926	2.052	39.402	35.379
LCPN_RT_LCRR_I_SQ	-0.597	0.450	0.204	0.183	-0.524***	0.163	0.088	0.156	0.327	0.452	-6.821	6.208
D_EMBIG	-2.095**	0.842	2.166***	0.530	0.113	0.443	0.633*	0.372	1.079	1.032	-10.720	12.847
D_EMBIG_LCRR_I	1.912***	0.728	-1.575***	0.420	0.103	0.359	-0.417	0.301	-0.719	0.894	7.408	9.034
D_EMBIG_LCRR_I_SQ	-0.418***	0.156	0.289***	0.083	-0.050	0.072	0.074	0.060	0.123	0.193	-1.274	1.585
D_NY_LAW	-0.221	1.380	4.367***	0.732	1.328**	0.579	0.078	0.903	-0.358	1.190	143.374***	23.757
D_NY_LAW_LCRR_I	0.121	1.223	-3.284***	0.582	-0.941**	0.473	-0.367	0.724	0.568	1.034	-100.981***	16.618
D_NY_LAW_LCRR_I_SQ	-0.021	0.269	0.599***	0.115	0.154	0.096	0.119	0.145	-0.185	0.223	17.735***	2.901
D_O_CAC	-7.829***	2.881	0.094	0.740	-0.388	0.755	-0.819	0.771	-5.793***	1.817	-43.767	41.566
D_O_CAC_LCRR_I	6.736***	2.467	-0.003	0.592	0.321	0.614	0.742	0.635	4.985***	1.579	30.956	29.181
D_O_CAC_LCRR_I_SQ	-1.441***	0.527	-0.012	0.118	-0.062	0.124	-0.163	0.130	-1.058***	0.341	-5.458	5.110
D_E_CAC	-7.648**	3.361	-2.596**	1.081	-4.653***	0.914	-2.097**	0.890	-7.714***	1.874	-3.684	34.695
D_E_CAC_LCRR_I	6.462**	2.860	2.148**	0.865	3.628***	0.748	1.890***	0.732	6.292***	1.637	3.665	24.345
D_E_CAC_LCRR_I_SQ	-1.364**	0.607	-0.422**	0.172	-0.690***	0.152	-0.403***	0.149	-1.259***	0.355	-0.822	4.264
Hidden:												
Obs. period dummies												
Issue year dummies												
Country dummies												
CONS	58.522***	18.673	13.723	9.157	14.858	9.154	3.769	2.356	-28.153*	16.358	15.774	274.506
Number of observations	1,222		3,141		3,804		4,363		3,385		978	
Adjusrted R2	0.716		0.694		0.709		0.772		0.695		0.813	

Source: See text.
Note: *** p<0.01, ** p<0.05, * p<0.1

Table 5. Log Bid-Ask Spread Reduced Form Regressions; F Test Results, Full Sample

H0:	F test degrees of freedom	F test value	Probability>F
LVOL_ISS=0; LVOL_ISS_SQ=0; LVOL_ISS_LCRR_I=0; LVOL_ISS_LCRR_I_SQ=0	F(4, 4278)	23.49	0.0000
LVOL_ISS_SQ - CHG_LVOL_SQ=0	F(1, 4278)	4.19	0.0407
CHG_LVOL=0; CHG_LVOL_SQ=0; CHG_LVOL_LCRR_I=0; CHG_LVOL_LCRR_I_SQ=0	F(4, 4278)	39.89	0.0000
D_VOL_ISS_500=0; D_VOL_ISS_1000=0; D_VOL_ISS_1500=0; D_VOL_ISS_2000=0; D_VOL_ISS_3000=0	F(5, 4278)	5.67	0.0001
LCTY_VOL=0; LCTY_VOL_SQ=0; LCTY_VOL_LCRR_I=0; LCTY_VOL_LCRR_I_SQ=0	F(4, 4278)	6.63	0.0000
DAVG_LVOL=0; DAVG_LVOL_SQ=0; DAVG_LVOL_LCRR_I=0; DAVG_LVOL_LCRR_I_SQ=0	F(4, 4278)	11.10	0.0000
LMAT_NOW_DYC = 0; LMAT_NOW_DYC_SQ = 0; LMAT_N_DYC_LCRR_I = 0; LMAT_N_DYC_LCRR _I_SQ = 0	F(4, 4278)	7.12	0.0000
LMAT_NOW_DYC = 0; LMAT_NOW_DYC_SQ = 0	F(2, 4278)	0.25	0.7781
LMAT_N_DYC_LCRR_I = 0; LMAT_N_DYC_LCRR _I_SQ = 0	F(2, 4278)	11.75	0.0000
LMAT_NOW=0; LMAT_NOW_SQ=0; LMAT_NOW_LCRR_I=0; LMAT_NOW_LCRR_I_SQ=0	F(4, 4278)	75.20	0.0000
LMAT_NOW_LCRR_I = 0; LMAT_NOW_LCRR_I_SQ = 0	F(2, 4278)	0.00	0.9993
CHG_LMAT=0; CHG_LMAT_SQ=0; CHG_LMAT_LCRR_I=0; CHG_LMAT_LCRR_I_SQ=0	F(4, 4278)	10.63	0.0000
LMAT_NOW + CHG_LMAT = 0	F(1, 4278)	0.06	0.8051
LMAT_NOW_SQ + CHG_LMAT_SQ = 0	F(1, 4278)	9.22	0.0024
LMAT_NOW_LCRR_I + CHG_LMAT_LCRR_I=0	F(1, 4278)	0.00	0.9529
LMAT_NOW_LCRR_I_SQ + CHG_LMAT_LCRR_I_SQ=0	F(1, 4278)	0.16	0.6937
LMAT_NOW=0; LMAT_NOW_SQ=0; LMAT_NOW_LCRR_I=0; CHG_LMAT=0; CHG_LMAT_SQ=0; CHG_LMAT_LCRR_I=0; CHG_LMAT_LCRR_I_SQ=0LMAT_NOW_LCRR_I_SQ=0;	F(8, 4278)	65.47	0.0000
LCRR_ISS=0; LCRR_ISS_SQ=0; CHG_LCRR=0; CHG_LCRR_SQ=0	F(4, 4278)	97.35	0.0000
LCRR_ISS=0; LCRR_ISS_SQ=0	F(2, 4278)	13.56	0.0000
CHG_LCRR=0; CHG_LCRR_SQ=0	F(2, 4278)	189.88	0.0000
LCRR_ISS - CHG_LCRR = 0	F(1, 4278)	0.95	0.3295
LCRR_ISS_SQ - CHG_LCRR_SQ = 0	F(1, 4278)	2.10	0.1472
LCPN_RT=0; LCPN_RT_SQ=0; LCPN_RT_LCRR_I=0; LCPN_RT_LCRR_I_SQ=0	F(4, 4278)	30.70	0.0000
D_EMBIG=0; D_EMBIG_LCRR_I=0; D_EMBIG_LCRR_I_SQ=0	F(3, 4278)	38.60	0.0000
D_NY_LAW=0; D_NY_LAW_LCRR_I=0; D_NY_LAW_LCRR_I_SQ=0	F(3, 4278)	21.63	0.0000
D_O_CAC=0; D_O_CAC_LCRR_I=0; D_O_CAC_LCRR_I_SQ=0	F(3, 4278)	1.61	0.1855
D_E_CAC=0; D_E_CAC_LCRR_I=0; D_E_CAC_LCRR_I_SQ=0	F(3, 4278)	15.55	0.0000

Source: See text.

Table 6: Log Bid-Ask Spread Determinants; Reduced Form Regressions Using only Explanatory Variables Known at Time of Issue

	Full sample		Robust regression		Issued after 2009		Sub-sample with rating<15		Sub-sample with rating>14	
	coef.	s.e.	coef.	s.e.	coef.	s.e.	coef.	s.e.	coef.	s.e.
LVOL_ISS	2.776	1.703	7.595***	1.107	5.087***	1.664	1.723	4.215	-269.991***	51.21
LVOL_ISS_SQ	0.071***	0.019	0.050**	0.020	0.002	0.024	0.097**	0.040	-0.303***	0.06
LVOL_ISS_LCRR_I	-1.845	1.338	-5.685***	0.895	-3.668***	1.307	-0.984	3.537	184.289***	35.70
LVOL_ISS_LCRR_I_SQ	0.253	0.261	1.010***	0.180	0.618**	0.255	0.071	0.740	-31.364***	6.20
D_VOL_ISS_500	-0.206***	0.038	-0.257***	0.041	-0.266***	0.044	-0.228***	0.044	-0.350***	0.09
D_VOL_ISS_1000	-0.130***	0.021	-0.124***	0.020	-0.135***	0.023	-0.128***	0.024	-0.384***	0.05
D_VOL_ISS_1500	-0.058***	0.016	-0.055***	0.015	-0.062***	0.016	-0.051***	0.019	0.046	0.03
D_VOL_ISS_2000	-0.044***	0.017	-0.034**	0.017	-0.042**	0.017	-0.026	0.021	-0.114***	0.03
D_VOL_ISS_3000	0.054*	0.027	0.056**	0.023	0.012	0.027	0.119***	0.046	-0.054	0.04
LCTY_VOL	1.617***	0.627	0.731	0.489	2.189***	0.601	2.939**	1.446	153.098***	22.18
LCTY_VOL_SQ	-0.025***	0.004	-0.023***	0.003	-0.013***	0.004	-0.032***	0.004	0.080***	0.01
LCTY_VOL_LCRR_I	-1.493***	0.503	-0.795**	0.399	-1.967***	0.482	-2.603**	1.217	-105.761***	15.50
LCTY_VOL_LCRR_I_SQ	0.358***	0.099	0.219***	0.080	0.444***	0.094	0.598**	0.254	18.194***	2.70
DAVG_LVOL	1.124	1.676	-3.500***	1.295	-2.632	1.668	-5.425	4.552	234.728***	61.75
DAVG_LVOL_SQ	-0.073***	0.019	-0.041**	0.017	0.013	0.025	-0.169***	0.038	0.329***	0.06
DAVG_LVOL_LCRR_I	-1.065	1.320	2.642**	1.044	2.026	1.312	4.503	3.848	-159.995***	43.02
DAVG_LVOL_LCRR_I_SQ	0.270	0.258	-0.464**	0.209	-0.364	0.256	-0.898	0.810	27.183***	7.47
LMAT_NOW	-1.624***	0.547	-1.883***	0.555	-0.535	0.544	3.475**	1.443	12.916	16.72
LMAT_NOW_SQ	-0.077***	0.014	-0.073***	0.012	-0.063***	0.015	-0.056***	0.017	-0.010	0.02
LMAT_NOW_LCRR_I	1.757***	0.453	1.936***	0.458	0.923**	0.456	-2.830**	1.264	-8.837	11.79
LMAT_NOW_LCRR_I_SQ	-0.344***	0.090	-0.375***	0.092	-0.194**	0.091	0.659**	0.271	1.538	2.07
CHG_LMAT	3.908***	1.014	5.026***	0.869	-0.903	1.115	-2.328	2.385	23.549	30.61
CHG_LMAT_SQ	0.068***	0.017	0.076***	0.015	0.051***	0.018	0.037*	0.021	-0.018	0.03
CHG_LMAT_LCRR_I	-3.639***	0.824	-4.500***	0.716	0.145	0.931	1.957	2.070	-17.607	21.59
CHG_LMAT_LCRR_I_SQ	0.749***	0.164	0.909***	0.145	0.016	0.190	-0.473	0.443	3.266	3.79
LCRR_ISS	-6.394**	2.661	-7.157***	2.053	0.570	2.301	10.392*	6.095	82.330	59.25
LCRR_ISS_SQ	1.154**	0.514	1.278***	0.412	-0.072	0.457	-2.468*	1.304	-13.798	10.35
LCPN_RT	-0.629	1.371	0.823	0.972	3.029***	1.080	-0.022	2.666	-176.763***	50.74
LCPN_RT_SQ	-0.211***	0.045	-0.214***	0.038	-0.345***	0.044	-0.238***	0.057	-0.102	0.10
LCPN_RT_LCRR_I	1.202	1.050	-0.034	0.812	-1.091	0.903	0.855	2.416	124.068***	35.71
LCPN_RT_LCRR_I_SQ	-0.251	0.206	-0.002	0.166	0.143	0.187	-0.200	0.531	-21.672***	6.26
D_EMBIG	0.852	0.611	0.718	0.602	-0.044	0.582	3.941***	1.431	-2.368	16.64
D_EMBIG_LCRR_I	-0.450	0.492	-0.358	0.488	0.287	0.471	-3.174**	1.238	1.671	11.70
D_EMBIG_LCRR_I_SQ	0.050	0.098	0.036	0.098	-0.099	0.095	0.645**	0.266	-0.291	2.05
D_NY_LAW	1.225*	0.732	2.797***	0.662	0.519	0.713	2.687*	1.587	131.741***	20.91
D_NY_LAW_LCRR_I	-0.876	0.592	-2.148***	0.543	-0.188	0.581	-2.166	1.371	-93.045***	14.67
D_NY_LAW_LCRR_I_SQ	0.140	0.119	0.392***	0.111	-0.022	0.117	0.420	0.295	16.378***	2.56
D_O_CAC	1.105	0.944	-0.083	0.873	-1.863*	0.973	1.297	2.342	-31.368	37.26
D_O_CAC_LCRR_I	-0.984	0.760	0.016	0.717	1.373*	0.792	-1.049	2.033	21.993	26.15
D_O_CAC_LCRR_I_SQ	0.218	0.151	0.015	0.146	-0.240	0.160	0.219	0.439	-3.846	4.57
D_E_CAC	-4.553***	1.128	-6.347***	0.981	-4.291***	1.108	-5.495**	2.528	51.083	36.86
D_E_CAC_LCRR_I	3.641***	0.913	5.125***	0.808	3.351***	0.908	4.526**	2.192	-34.369	25.88
D_E_CAC_LCRR_I_SQ	-0.710***	0.183	-1.011***	0.165	-0.632***	0.184	-0.907*	0.472	5.776	4.53
CONS	11.268***	3.396	12.576***	2.488	1.450	2.818	-8.037	7.032	-118.526	84.68
Number of observations	4,365		4,365		3,806		3,387		978	
Adjusrted R2	0.503		0.541		0.535		0.481		0.722	

Source: See text.

Note: *** p<0.01, ** p<0.05, * p<0.1

Table 7. Log Bid-Ask Spread Reduced Form Regressions Using only Explanatory Variables Known at Time of Issue; F Test Results; Full Sample Regression

H0:	F test degrees of freedom	F test value	Probability>F
LVOL_ISS=0; LVOL_ISS_SQ=0; LVOL_ISS_LCRR_I=0; LVOL_ISS_LCRR_I_SQ=0	F(4, 4321)	26.51	0.0000
D_VOL_ISS_500=0; D_VOL_ISS_1000=0; D_VOL_ISS_1500=0; D_VOL_ISS_2000=0; D_VOL_ISS_3000=0	F(5, 4321)	14.91	0.0000
LCTY_VOL=0; LCTY_VOL_SQ=0; LCTY_VOL_LCRR_I=0; LCTY_VOL_LCRR_I_SQ=0	F(4, 4321)	42.30	0.0000
DAVG_LVOL=0; DAVG_LVOL_SQ=0; DAVG_LVOL_LCRR_I=0; DAVG_LVOL_LCRR_I_SQ=0	F(4, 4321)	16.14	0.0000
LMAT_NOW=0; LMAT_NOW_SQ=0; LMAT_NOW_LCRR_I=0; LMAT_NOW_LCRR_I_SQ=0	F(4, 4321)	131.35	0.0000
LMAT_NOW_LCRR_I = 0; LMAT_NOW_LCRR_I_SQ = 0	F(2, 4321)	7.97	0.0004
CHG_LMAT=0; CHG_LMAT_SQ=0; CHG_LMAT_LCRR_I=0; CHG_LMAT_LCRR_I_SQ=0	F(4, 4321)	18.85	0.0000
LMAT_NOW + CHG_LMAT = 0	F(1, 4321)	10.53	0.0012
LMAT_NOW_SQ + CHG_LMAT_SQ = 0	F(1, 4321)	2.12	0.1452
LMAT_NOW_LCRR_I + CHG_LMAT_LCRR_I=0	F(1, 4321)	11.23	0.0008
LMAT_NOW_LCRR_I_SQ + CHG_LMAT_LCRR_I_SQ=0	F(1, 4321)	13.26	0.0003
LCRR_ISS=0; LCRR_ISS_SQ=0;	F(2, 4321)	5.13	0.0060
LCPN_RT=0; LCPN_RT_SQ=0; LCPN_RT_LCRR_I=0; LCPN_RT_LCRR_I_SQ=0	F(4, 4321)	17.18	0.0000
D_EMBIG=0; D_EMBIG_LCRR_I=0; D_EMBIG_LCRR_I_SQ=0	F(3, 4321)	24.93	0.0000
D_NY_LAW=0; D_NY_LAW_LCRR_I=0; D_NY_LAW_LCRR_I_SQ=0	F(3, 4321)	28.66	0.0000
D_O_CAC=0; D_O_CAC_LCRR_I=0; D_O_CAC_LCRR_I_SQ=0	F(3, 4321)	3.69	0.0115
D_E_CAC=0; D_E_CAC_LCRR_I=0; D_E_CAC_LCRR_I_SQ=0	F(3, 4321)	8.92	0.0000

Source: See text.

Table 8: Log Yield Determinants; Reduced Form Regressions

	Full sample			Robust regression		Trimmed sample		Extended sample		First half of sample		Second half of sample	
	coef.	s.e.	conventional s.e.	coef.	s.e.	coef.	s.e.	coef.	s.e.	coef.	s.e.	coef.	s.e.
LVOL_ISS	4.440***	0.620	0.579	4.253***	0.523	3.728***	0.647	4.628***	0.611	4.884***	0.827	4.735***	0.759
LVOL_ISS_SQ	-0.022**	0.010	0.010	-0.024**	0.009	-0.031***	0.012	-0.022**	0.010	-0.012	0.012	-0.015	0.016
LVOL_ISS_LCRR_I	-3.463***	0.488	0.470	-3.391***	0.425	-2.913***	0.517	-3.614***	0.480	-3.763***	0.651	-3.731***	0.597
LVOL_ISS_LCRR_I_SQ	0.673***	0.095	0.095	0.669***	0.086	0.569***	0.103	0.702***	0.094	0.718***	0.127	0.732***	0.117
CHG_LVOL	-11.578***	2.129	1.671	-6.981***	1.510	-10.610***	2.784	-10.928***	2.205	-14.294***	2.614	-11.403***	3.656
CHG_LVOL_SQ	0.184***	0.030	0.021	0.070***	0.019	0.178***	0.035	0.192***	0.029	0.229***	0.039	0.073**	0.034
CHG_LVOL_LCRR_I	8.572***	1.656	1.326	5.221***	1.199	7.835***	2.197	8.007***	1.712	10.833***	2.040	8.402***	2.845
CHG_LVOL_LCRR_I_SQ	-1.612***	0.320	0.261	-0.993***	0.236	-1.478***	0.430	-1.492***	0.330	-2.085***	0.397	-1.556***	0.547
D_VOL_ISS_500	-0.127***	0.023	0.021	-0.095***	0.019	-0.085***	0.026	-0.111***	0.025	-0.177***	0.028	-0.053	0.037
D_VOL_ISS_1000	-0.035***	0.011	0.010	-0.014	0.009	-0.020	0.013	-0.034***	0.011	-0.044***	0.014	-0.023	0.016
D_VOL_ISS_1500	-0.048***	0.008	0.008	-0.042***	0.007	-0.036***	0.009	-0.047***	0.008	-0.059***	0.011	-0.029***	0.010
D_VOL_ISS_2000	0.001	0.008	0.009	0.005	0.008	0.013	0.009	-0.002	0.008	-0.015	0.012	0.010	0.011
D_VOL_ISS_3000	0.027**	0.011	0.012	0.051***	0.011	0.033**	0.013	0.025**	0.010	0.023*	0.014	0.029*	0.016
LCTY_VOL	-0.068	0.252	0.252	0.074	0.228	-0.609**	0.277	-0.152	0.254	-0.668*	0.380	0.053	0.292
LCTY_VOL_SQ	0.003	0.002	0.002	0.005**	0.002	0.009***	0.003	0.003	0.002	-0.008**	0.004	0.014***	0.003
LCTY_VOL_LCRR_I	0.049	0.203	0.206	-0.055	0.186	0.476**	0.224	0.112	0.204	0.497	0.308	-0.039	0.236
LCTY_VOL_LCRR_I_SQ	-0.009	0.040	0.041	0.010	0.037	-0.097**	0.044	-0.020	0.040	-0.080	0.060	-0.001	0.046
DAVG_LVOL	-4.411***	0.650	0.671	-4.745***	0.607	-5.036***	0.723	-4.331***	0.653	-4.254***	0.836	-4.770***	0.823
DAVG_LVOL_SQ	-0.007	0.009	0.009	-0.002	0.008	0.001	0.012	-0.008	0.009	-0.013	0.011	-0.015	0.015
DAVG_LVOL_LCRR_I	3.507***	0.511	0.543	3.806***	0.490	3.992***	0.575	3.437***	0.513	3.344***	0.659	3.792***	0.646
DAVG_LVOL_LCRR_I_SQ	-0.678***	0.100	0.109	-0.744***	0.098	-0.776***	0.114	-0.664***	0.100	-0.632***	0.128	-0.738***	0.126
LMAT_NOW_DYC	-2.495**	1.112	1.075	2.119**	0.971	-3.427**	1.637	-3.497***	1.295	2.119	1.722	7.078	7.826
LMAT_NOW_DYC_SQ	0.240***	0.064	0.059	-0.245***	0.054	0.380***	0.116	0.343***	0.098	-0.028	0.101	-1.129*	0.596
LMAT_N_DYC_LCRR_I	0.808	0.757	0.707	1.125*	0.639	0.365	0.840	0.788	0.661	-1.438	1.190	4.111	2.879
LMAT_N_DYC_LCRR_I_SQ	-0.186	0.150	0.142	-0.249*	0.128	-0.104	0.168	-0.185	0.133	0.382	0.237	-0.739	0.566
LMAT_NOW	1.012***	0.272	0.298	0.818***	0.269	1.580***	0.298	0.803***	0.269	0.931***	0.344	1.011***	0.368
LMAT_NOW_SQ	0.001	0.007	0.007	-0.001	0.006	-0.006	0.008	0.003	0.006	-0.018*	0.011	-0.005	0.009
LMAT_NOW_LCRR_I	-0.795***	0.224	0.244	-0.605***	0.220	-1.236***	0.246	-0.646***	0.220	-0.585**	0.287	-0.696**	0.300
LMAT_NOW_LCRR_I_SQ	0.167***	0.044	0.049	0.128***	0.044	0.253***	0.049	0.140***	0.043	0.117**	0.057	0.139**	0.059
CHG_LMAT	-3.343***	0.535	0.503	-2.981***	0.455	-3.879***	0.725	-2.905***	0.493	-4.222***	0.655	-2.339***	0.665
CHG_LMAT_SQ	0.032***	0.012	0.010	0.049***	0.009	0.054***	0.015	0.022*	0.012	0.077***	0.024	0.031**	0.014
CHG_LMAT_LCRR_I	2.671***	0.435	0.408	2.377***	0.369	3.066***	0.595	2.361***	0.399	3.389***	0.537	1.832***	0.540
CHG_LMAT_LCRR_I_SQ	-0.526***	0.087	0.082	-0.471***	0.074	-0.602***	0.119	-0.471***	0.079	-0.688***	0.107	-0.357***	0.107
LCRR_ISS	-1.380	4.333	3.766	-8.692**	3.404	-5.948	4.752	-1.475	3.582	8.745	6.858	-19.833	16.524
LCRR_ISS_SQ	0.397	0.854	0.758	1.715**	0.685	1.180	0.947	0.464	0.719	-2.300*	1.353	3.521	3.241
CHG_LCRR	-1.627***	0.282	0.253	-0.963***	0.228	-0.240	0.297	-1.687***	0.281	-2.511***	0.369	-0.346	0.416
CHG_LCRR_SQ	0.113*	0.058	0.053	-0.018	0.048	-0.175***	0.062	0.129**	0.058	0.327***	0.076	-0.176**	0.086
LCPN_RT	2.196***	0.773	0.509	-1.406***	0.460	-3.764***	0.859	2.624***	0.486	1.376	1.047	2.769**	1.154
LCPN_RT_SQ	-0.143***	0.027	0.022	0.004	0.020	0.052*	0.028	-0.204***	0.025	-0.078**	0.035	-0.239***	0.040
LCPN_RT_LCRR_I	-0.882	0.567	0.425	1.241***	0.384	2.919***	0.646	-0.928**	0.436	-0.402	0.786	-1.037	0.820
LCPN_RT_LCRR_I_SQ	0.093	0.108	0.087	-0.252***	0.079	-0.565***	0.125	0.077	0.091	0.011	0.152	0.101	0.153
D_EMBIG	-0.457*	0.260	0.296	-0.288	0.268	-0.655**	0.284	-0.480*	0.262	-0.553*	0.320	-0.431	0.347
D_EMBIG_LCRR_I	0.433**	0.209	0.240	0.271	0.217	0.569**	0.229	0.450**	0.210	0.508*	0.259	0.412	0.277
D_EMBIG_LCRR_I_SQ	-0.099**	0.041	0.048	-0.063	0.044	-0.122***	0.046	-0.103**	0.042	-0.115**	0.052	-0.095*	0.055
D_NY_LAW	1.989***	0.310	0.332	1.775***	0.300	1.561***	0.335	2.026***	0.308	2.666***	0.409	1.477***	0.396
D_NY_LAW_LCRR_I	-1.650***	0.252	0.273	-1.521***	0.247	-1.334***	0.273	-1.670***	0.251	-2.234***	0.336	-1.198***	0.319
D_NY_LAW_LCRR_I_SQ	0.332***	0.051	0.056	0.313***	0.050	0.273***	0.055	0.334***	0.050	0.452***	0.068	0.237***	0.063
D_O_CAC	0.274	0.465	0.458	-0.793*	0.414	0.501	0.556	0.495	0.452	-0.493	0.532	1.221*	0.670
D_O_CAC_LCRR_I	-0.079	0.371	0.374	0.765**	0.338	-0.251	0.447	-0.250	0.360	0.558	0.428	-0.881*	0.533
D_O_CAC_LCRR_I_SQ	-0.005	0.073	0.076	-0.169**	0.068	0.024	0.089	0.028	0.071	-0.132	0.085	0.158	0.105
D_E_CAC	-2.298***	0.496	0.497	-3.174***	0.449	-1.812***	0.565	-2.358***	0.485	-2.579***	0.611	-2.433***	0.685
D_E_CAC_LCRR_I	1.924***	0.401	0.409	2.609***	0.370	1.506***	0.460	1.971***	0.393	2.162***	0.499	1.938***	0.551
D_E_CAC_LCRR_I_SQ	-0.394***	0.080	0.083	-0.526***	0.075	-0.308***	0.093	-0.402***	0.079	-0.440***	0.100	-0.384***	0.110
Hidden:													
Obs. period dummies													
Issue year dummies													
Country dummies													
CONS	8.754	5.605	4.929	6.268	4.455	19.870***	6.810	10.942**	5.151	-5.734	8.763	-2.320	29.010
Number of observations	4,363		4,363	4,363		3,226		4,561		2,243		2,120	
Adjusted R2	0.873		0.873	0.895		0.830		0.880		0.882		0.867	

Source: See text.

Note: *** p<0.01, ** p<0.05, * p<0.1

Table 8: Log Yield Determinants; Reduced Form Regressions (Continued)

	Small issuers		Large issuers		Issued after 2009		With country dummies		Sub-sample with rating<15		Sub-sample with rating>14	
	coef.	s.e.	coef.	s.e.	coef.	s.e.	coef.	s.e.	coef.	s.e.	coef.	s.e.
LVOL_ISS	1.998	1.566	4.896***	0.833	4.130***	0.592	0.280	0.705	2.191*	1.293	40.621***	15.120
LVOL_ISS_SQ	-0.107**	0.044	0.133***	0.033	-0.016	0.012	0.008	0.008	-0.083***	0.026	0.020	0.025
LVOL_ISS_LCRR_I	-0.942	1.346	-3.756***	0.662	-3.260***	0.469	-0.089	0.552	-1.653	1.135	-29.368***	10.472
LVOL_ISS_LCRR_I_SQ	0.034	0.287	0.680***	0.133	0.638***	0.092	-0.010	0.108	0.317	0.248	5.281***	1.810
CHG_LVOL	6.653	4.152	-32.799***	5.384	5.936*	3.192	-10.347***	1.957	-17.222***	5.860	-226.873***	87.046
CHG_LVOL_SQ	0.492***	0.099	0.329***	0.033	0.520***	0.147	0.048**	0.021	0.182***	0.032	0.019	0.164
CHG_LVOL_LCRR_I	-4.985	3.288	25.393***	4.356	-4.753*	2.490	7.935***	1.525	13.054***	4.807	158.630***	61.227
CHG_LVOL_LCRR_I_SQ	0.868	0.636	-4.972***	0.877	0.878*	0.483	-1.516***	0.296	-2.488**	0.985	-27.720***	10.756
D_VOL_ISS_500	-0.036	0.027	-0.081**	0.040	-0.177***	0.025	0.018	0.024	-0.163***	0.029	-0.243***	0.058
D_VOL_ISS_1000	-0.003	0.020	-0.050***	0.017	-0.022*	0.013	-0.005	0.010	-0.027*	0.014	-0.001	0.021
D_VOL_ISS_1500	-0.057*	0.032	-0.040***	0.009	-0.035***	0.008	0.006	0.006	-0.032***	0.010	-0.015	0.015
D_VOL_ISS_2000	0.049	0.040	-0.003	0.009	0.013	0.009	0.003	0.006	0.023**	0.011	-0.013	0.012
D_VOL_ISS_3000	...		-0.002	0.011	0.025**	0.011	-0.014*	0.008	0.069***	0.019	0.022	0.014
LCTY_VOL	0.674	0.783	0.503	0.454	-0.092	0.248	...		-2.525***	0.532	-3.951	7.530
LCTY_VOL_SQ	0.074***	0.010	-0.112***	0.008	0.003	0.003	...		0.014***	0.003	-0.013**	0.006
LCTY_VOL_LCRR_I	-1.068	0.675	0.262	0.358	0.086	0.200	...		2.238***	0.456	2.980	5.238
LCTY_VOL_LCRR_I_SQ	0.300**	0.145	-0.052	0.068	-0.019	0.039	...		-0.504***	0.097	-0.537	0.910
DAVG_LVOL	3.063*	1.674	-6.191***	0.802	-4.354***	0.666	-0.911	0.739	-1.184	1.593	-64.543***	19.295
DAVG_LVOL_SQ	0.189***	0.026	-0.153***	0.031	-0.028**	0.012	-0.011	0.008	0.051**	0.025	-0.051**	0.022
DAVG_LVOL_LCRR_I	-3.218**	1.421	4.823***	0.635	3.394***	0.526	0.571	0.581	0.891	1.393	46.227***	13.349
DAVG_LVOL_LCRR_I_SQ	0.826***	0.299	-0.881***	0.127	-0.642***	0.103	-0.076	0.114	-0.162	0.304	-8.235***	2.305
LMAT_NOW_DYC	-3.722	2.439	-0.505	1.507	-0.901	1.536	-3.565***	0.555	3.145	2.144	-65.620***	17.088
LMAT_NOW_DYC_SQ	0.505***	0.163	0.108	0.090	0.071	0.109	0.239***	0.049	0.211***	0.072	-0.756***	0.127
LMAT_N_DYC_LCRR_I	-1.037	1.252	0.320	0.930	0.902	0.774	1.488***	0.206	-4.030**	1.704	51.991***	12.105
LMAT_N_DYC_LCRR_I_SQ	0.287	0.255	-0.086	0.182	-0.201	0.155	-0.289***	0.041	0.896**	0.368	-9.063***	2.123
LMAT_NOW	-3.062***	0.677	1.203***	0.317	1.435***	0.287	0.853***	0.244	-0.365	0.823	10.409**	5.126
LMAT_NOW_SQ	-0.083***	0.024	0.008	0.006	0.004	0.006	-0.001	0.005	-0.015	0.010	-0.010	0.007
LMAT_NOW_LCRR_I	2.965***	0.593	-0.957***	0.256	-1.127***	0.236	-0.651***	0.199	0.427	0.725	-6.942*	3.582
LMAT_NOW_LCRR_I_SQ	-0.603***	0.120	0.194***	0.050	0.230***	0.046	0.137***	0.039	-0.086	0.156	1.179*	0.624
CHG_LMAT	1.976	1.258	-3.952***	0.559	-4.505***	0.639	-3.038***	0.498	-2.499*	1.459	-47.813***	12.292
CHG_LMAT_SQ	0.099***	0.027	0.025**	0.012	0.038***	0.011	0.033***	0.010	0.046***	0.016	0.006	0.011
CHG_LMAT_LCRR_I	-2.027*	1.075	3.096***	0.454	3.659***	0.518	2.444***	0.404	1.888	1.267	32.965***	8.595
CHG_LMAT_LCRR_I_SQ	0.417*	0.224	-0.593***	0.090	-0.732***	0.104	-0.488***	0.080	-0.363	0.271	-5.679***	1.499
LCRR_ISS	-0.424	7.231	6.583	4.598	-0.611	4.308	...		21.761**	9.264	-272.187***	64.063
LCRR_ISS_SQ	-0.629	1.469	-1.171	0.901	0.241	0.854	...		-4.723**	1.997	47.557***	11.241
CHG_LCRR	-0.397	0.569	-1.842***	0.345	-1.833***	0.312	-2.165***	0.462	-0.336	0.400	-1.992*	1.171
CHG_LCRR_SQ	-0.111	0.124	0.203***	0.070	0.146**	0.065	0.372***	0.097	-0.176**	0.085	0.265	0.221
LCPN_RT	2.554*	1.376	5.480***	0.698	2.055***	0.689	4.005***	0.582	6.162***	1.409	-37.664**	17.473
LCPN_RT_SQ	0.030	0.116	-0.004	0.027	-0.141***	0.026	-0.078***	0.020	-0.112***	0.027	0.113*	0.066
LCPN_RT_LCRR_I	-2.139*	1.197	-4.037***	0.553	-0.717	0.515	3.007***	0.444	-4.320***	1.257	26.329**	12.203
LCPN_RT_LCRR_I_SQ	0.449*	0.252	0.755***	0.110	0.048	0.100	3.996***	0.087	0.804***	0.274	-4.607**	2.131
D_EMBIG	-1.562***	0.451	0.194	0.313	-0.334	0.262	4.985***	0.203	-0.885	0.656	7.380	4.910
D_EMBIG_LCRR_I	1.370***	0.388	-0.097	0.247	0.318	0.211	5.974***	0.162	0.805	0.568	-5.067	3.457
D_EMBIG_LCRR_I_SQ	-0.300***	0.083	0.009	0.048	-0.073*	0.042	6.964***	0.032	-0.180	0.122	0.867	0.607
D_NY_LAW	2.522***	0.826	2.223***	0.394	2.134***	0.311	7.953***	0.624	1.035	0.715	67.639***	8.103
D_NY_LAW_LCRR_I	-1.989***	0.739	-1.775***	0.312	-1.763***	0.254	8.942***	0.493	-0.794	0.624	-47.655***	5.669
D_NY_LAW_LCRR_I_SQ	0.357**	0.164	0.347***	0.061	0.353***	0.051	9.932***	0.097	0.139	0.135	8.377***	0.990
D_O_CAC	-2.788*	1.642	0.696	0.442	0.721	0.495	10.921***	0.479	-4.229***	1.210	-64.971***	13.748
D_O_CAC_LCRR_I	2.043	1.398	-0.428	0.349	-0.413	0.397	11.910***	0.385	3.819***	1.051	45.730***	9.660
D_O_CAC_LCRR_I_SQ	-0.346	0.297	0.062	0.068	0.057	0.079	12.899***	0.077	-0.845***	0.227	-8.030***	1.693
D_E_CAC	-4.659**	1.816	-1.541***	0.574	-1.795***	0.526	13.889***	0.542	-3.903***	1.230	-27.486**	11.943
D_E_CAC_LCRR_I	3.708**	1.536	1.339***	0.456	1.529***	0.427	14.878***	0.434	3.227***	1.075	19.933**	8.394
D_E_CAC_LCRR_I_SQ	-0.725**	0.324	-0.280***	0.090	-0.316***	0.086	0.330***	0.087	-0.658***	0.233	-3.602**	1.473
Hidden:												
Obs. period dummies												
Issue year dummies												
Country dummies												
CONS	19.801*	10.145	-6.293	6.347	3.149	6.304	8.093***	1.312	-17.734	10.963	368.401***	90.645
Number of observations	1,222		3,141		3,804		4,363		3,385		978	
Adjusted R2	0.899		0.902		0.874		0.946		0.861		0.948	

Source: See text.

Note: *** p<0.01, ** p<0.05, * p<0.1

Table 9. Log Yield Reduced Form Regressions; F Test Results, Full Sample

H0:	F test degrees of freedom	F test value	Probability>F
LVOL_ISS=0; LVOL_ISS_SQ=0; LVOL_ISS_LCRR_I=0; LVOL_ISS_LCRR_I_SQ=0	F(4, 4278)	14.42	0.0000
CHG_LVOL=0; CHG_LVOL_SQ=0; CHG_LVOL_LCRR_I=0; CHG_LVOL_LCRR_I_SQ=0	F(4, 4278)	30.63	0.0000
D_VOL_ISS_500=0; D_VOL_ISS_1000=0; D_VOL_ISS_1500=0; D_VOL_ISS_2000=0; D_VOL_ISS_3000=0	F(5, 4278)	15.41	0.0000
LCTY_VOL=0; LCTY_VOL_SQ=0; LCTY_VOL_LCRR_I=0; LCTY_VOL_LCRR_I_SQ=0	F(4, 4278)	15.49	0.0000
DAVG_LVOL=0; DAVG_LVOL_SQ=0; DAVG_LVOL_LCRR_I=0; DAVG_LVOL_LCRR_I_SQ=0	F(4, 4278)	21.25	0.0000
LMAT_NOW_DYC=0; LMAT_NOW_DYC_SQ=0; LMAT_N_DYC_LCRR_I=0; LMAT_N_DYC_LCRR_I_SQ=0	F(4, 4278)	142.20	0.0000
LMAT_NOW_DYC=0; LMAT_NOW_DYC_SQ=0	F(2, 4278)	7.07	0.0009
LMAT_N_DYC_LCRR_I=0; LMAT_N_DYC_LCRR_I_SQ=0	F(2, 4278)	5.81	0.0037
LMAT_NOW=0; LMAT_NOW_SQ=0; LMAT_NOW_LCRR_I=0; LMAT_NOW_LCRR_I_SQ=0	F(4, 4278)	70.13	0.0000
CHG_LMAT=0; CHG_LMAT_SQ=0; CHG_LMAT_LCRR_I=0; CHG_LMAT_LCRR_I_SQ=0	F(4, 4278)	14.99	0.0000
LCRR_ISS=0; LCRR_ISS_SQ=0; CHG_LCRR CHG_LCRR_SQ=0	F(4, 4278)	553.88	0.0000
LCRR_ISS=0; LCRR_ISS_SQ=0	F(1, 4278)	3.37	0.0346
LCRR_ISS - CHG_ LCRR=0	F(1, 4278)	0.00	0.9555
LCRR_ISS_SQ - CHG_LCRR_SQ=0	F(1, 4278)	0.11	0.7448
LCPN_RT=0; LCPN_RT_SQ=0; LCPN_RT_LCRR_I=0; LCPN_RT_LCRR_I_SQ=0	F(4, 4278)	35.91	0.0000
D_EMBIG=0; D_EMBIG_LCRR_I=0; D_EMBIG_LCRR_I_SQ=0	F(3, 4278)	12.65	0.0000
D_NY_LAW=0; D_NY_LAW_LCRR_I=0; D_NY_LAW_LCRR_I_SQ=0	F(3, 4278)	27.05	0.0000
D_O_CAC=0; D_O_CAC_LCRR_I=0; D_O_CAC_LCRR_I_SQ=0	F(3, 4278)	16.18	0.0000
D_E_CAC=0; D_E_CAC_LCRR_I=0; D_E_CAC_LCRR_I_SQ=0	F(3, 4278)	9.26	0.0006

Source: See text.

Table 10. Log Yield Determinants; Reduced Form Regressions Using only Explanatory Variables Known at Time of Issue

	Full sample		Robust regression		Issued after 2009		Sub-sample with rating<15		Sub-sample with rating>14	
	coef.	s.e.	coef.	s.e.	coef.	s.e.	coef.	s.e.	coef.	s.e.
LVOL_ISS	1.220	1.072	5.574***	0.843	3.727***	1.107	-0.756	2.637	-35.265	30.638
LVOL_ISS_SQ	0.056***	0.017	0.044***	0.015	0.042**	0.021	0.058*	0.035	-0.118***	0.032
LVOL_ISS_LCRR_I	-0.821	0.844	-4.155***	0.682	-2.634***	0.866	0.853	2.255	22.285	21.333
LVOL_ISS_LCRR_I_SQ	0.108	0.165	0.746***	0.137	0.445***	0.169	-0.247	0.481	-3.472	3.708
D_VOL_ISS_500	-0.201***	0.031	-0.201***	0.031	-0.263***	0.034	-0.176***	0.041	-0.431***	0.055
D_VOL_ISS_1000	-0.005	0.017	-0.024	0.015	-0.045**	0.020	0.025	0.021	-0.164***	0.033
D_VOL_ISS_1500	-0.080***	0.013	-0.099***	0.012	-0.100***	0.013	-0.063***	0.017	-0.035	0.022
D_VOL_ISS_2000	0.010	0.014	0.008	0.013	0.007	0.014	0.013	0.018	-0.075***	0.022
D_VOL_ISS_3000	0.085***	0.017	0.107***	0.017	0.060***	0.017	0.130***	0.029	-0.013	0.024
LCTY_VOL	1.981***	0.424	0.636*	0.372	1.849***	0.423	1.610*	0.953	45.311***	13.893
LCTY_VOL_SQ	-0.023***	0.003	-0.025***	0.003	-0.020***	0.004	-0.016***	0.004	0.018**	0.007
LCTY_VOL_LCRR_I	-1.621***	0.341	-0.565*	0.304	-1.541***	0.339	-1.250	0.809	-30.949***	9.694
LCTY_VOL_LCRR_I_SQ	0.355***	0.067	0.151**	0.061	0.341***	0.066	0.257	0.170	5.281***	1.688
DAVG_LVOL	-0.391	1.155	-4.328***	0.986	-2.856**	1.202	-0.388	3.003	3.173	35.896
DAVG_LVOL_SQ	-0.056***	0.016	-0.060***	0.013	-0.061***	0.021	-0.036	0.032	0.053*	0.031
DAVG_LVOL_LCRR_I	0.230	0.910	3.282***	0.795	2.063**	0.944	0.215	2.586	0.684	24.931
DAVG_LVOL_LCRR_I_SQ	-0.001	0.178	-0.589***	0.159	-0.345*	0.184	-0.002	0.554	-0.608	4.322
LMAT_NOW	-1.959	0.455	-1.523	0.423	0.207***	0.402	-1.237	1.274	10.144***	9.156
LMAT_NOW_SQ	-0.050***	0.010	-0.042***	0.009	-0.065***	0.010	-0.069***	0.015	-0.058***	0.013
LMAT_NOW_LCRR_I	1.824***	0.375	1.455***	0.349	0.209	0.336	1.242	1.115	-6.424	6.433
LMAT_NOW_LCRR_I_SQ	-0.343***	0.074	-0.272***	0.070	-0.032	0.066	-0.208	0.239	1.067	1.128
CHG_LMAT	2.401**	1.027	4.000***	0.662	-5.685***	0.905	-1.746	2.332	-17.513	22.764
CHG_LMAT_SQ	0.092***	0.013	0.073***	0.011	0.091***	0.015	0.117***	0.019	0.081***	0.018
CHG_LMAT_LCRR_I	-1.945**	0.820	-3.124***	0.545	4.383***	0.743	1.681	2.012	11.528	16.004
CHG_LMAT_LCRR_I_SQ	0.342**	0.161	0.565***	0.110	-0.902***	0.150	-0.465	0.428	-1.939	2.806
LCRR_ISS	1.501	2.209	-0.106	1.563	9.822***	1.938	-5.190	5.493	88.481***	30.950
LCRR_ISS_SQ	-0.414	0.430	-0.131	0.314	-2.039***	0.377	1.133	1.175	-14.824***	5.389
LCPN_RT	1.594	1.088	3.093***	0.740	4.136***	0.945	-6.507***	2.375	-59.398*	32.433
LCPN_RT_SQ	-0.131***	0.036	-0.077***	0.029	-0.006	0.038	-0.233***	0.043	-0.300***	0.073
LCPN_RT_LCRR_I	-0.472	0.833	-1.832***	0.618	-2.767***	0.722	7.147***	2.084	44.251*	22.761
LCPN_RT_LCRR_I_SQ	0.027	0.162	0.302**	0.126	0.484***	0.142	-1.674***	0.449	-8.088**	3.986
D_EMBIG	0.230	0.479	-0.148	0.459	-0.199	0.419	1.317	1.197	37.859***	10.129
D_EMBIG_LCRR_I	-0.092	0.382	0.165	0.372	0.253	0.337	-1.020	1.032	-26.395***	7.121
D_EMBIG_LCRR_I_SQ	0.004	0.075	-0.041	0.075	-0.066	0.067	0.200	0.221	4.593***	1.250
D_NY_LAW	3.416***	0.548	3.186***	0.504	2.635***	0.505	4.998***	1.226	29.661**	14.441
D_NY_LAW_LCRR_I	-2.804***	0.444	-2.689***	0.414	-2.092***	0.409	-4.164***	1.059	-21.314**	10.130
D_NY_LAW_LCRR_I_SQ	0.552***	0.089	0.542***	0.084	0.397***	0.082	0.843***	0.227	3.810**	1.774
D_O_CAC	0.962	0.867	-1.536**	0.665	-1.418*	0.770	6.331***	2.129	-47.623**	22.245
D_O_CAC_LCRR_I	-0.701	0.695	1.271**	0.546	1.139*	0.624	-5.404***	1.836	33.488**	15.615
D_O_CAC_LCRR_I_SQ	0.139	0.138	-0.246**	0.111	-0.216*	0.125	1.159***	0.393	-5.873**	2.736
D_E_CAC	-2.221**	0.917	-4.586***	0.747	-1.052	0.795	4.434*	2.371	-19.269	20.271
D_E_CAC_LCRR_I	1.881**	0.739	3.724***	0.615	0.894	0.650	-4.007*	2.051	13.630	14.254
D_E_CAC_LCRR_I_SQ	-0.379***	0.147	-0.735***	0.125	-0.172	0.131	0.910**	0.440	-2.400	2.503
CONS	3.754	2.796	6.153***	1.895	-6.667***	2.454	10.470*	6.336	-126.865***	44.433
Number of observations	4,365		4,365		3,806		3,387		978	
Adjusted R2	0.629		0.666		0.654		0.581		0.762	

Source: See text.

Note: *** p<0.01, ** p<0.05, * p<0.1

Table 11. Log Yield Reduced Form Regressions Using only Explanatory Variables Known at Time of Issue; F Test Results

H0:	F test degrees of freedom	F test value	Probability>F
LVOL_ISS=0; LVOL_ISS_SQ=0; LVOL_ISS_LCRR_I=0; LVOL_ISS_LCRR_I_SQ=0	F(4, 4321)	13.86	0.0000
D_VOL_ISS_500=0; D_VOL_ISS_1000=0; D_VOL_ISS_1500=0; D_VOL_ISS_2000=0; D_VOL_ISS_3000=0	F(5, 4321)	34.17	0.0000
LCTY_VOL=0; LCTY_VOL_SQ=0; LCTY_VOL_LCRR_I=0; LCTY_VOL_LCRR_I_SQ=0	F(4, 4321)	42.73	0.0000
DAVG_LVOL=0; DAVG_LVOL_SQ=0; DAVG_LVOL_LCRR_I=0; DAVG_LVOL_LCRR_I_SQ=0	F(4, 4321)	24.95	0.0000
LMAT_NOW=0; LMAT_NOW_SQ=0; LMAT_NOW_LCRR_I=0; LMAT_NOW_LCRR_I_SQ=0	F(4, 4321)	209.70	0.0000
CHG_LMAT=0; CHG_LMAT_SQ=0; CHG_LMAT_LCRR_I=0; CHG_LMAT_LCRR_I_SQ=0	F(4, 4321)	25.65	0.0000
LMAT_NOW + CHG_LMAT = 0	F(1, 4321)	0.35	0.5554
LMAT_NOW_SQ + CHG_LMAT_SQ = 0	F(1, 4321)	48.54	0.0000
LMAT_NOW_LCRR_I + CHG_LMAT_LCRR_I=0	F(1, 4321)	0.04	0.8377
LMAT_NOW_LCRR_I_SQ + CHG_LMAT_LCRR_I_SQ=0	F(1, 4321)	0.00	0.9931
LCRR_ISS=0; LCRR_ISS_SQ=0;	F(2, 4321)	9.30	0.0001
LCPN_RT=0; LCPN_RT_SQ=0; LCPN_RT_LCRR_I=0; LCPN_RT_LCRR_I_SQ=0	F(4, 4321)	29.49	0.0000
D_EMBIG=0; D_EMBIG_LCRR_I=0; D_EMBIG_LCRR_I_SQ=0	F(3, 4321)	6.96	0.0001
D_NY_LAW=0; D_NY_LAW_LCRR_I=0; D_NY_LAW_LCRR_I_SQ=0	F(3, 4321)	62.62	0.0000
D_O_CAC=0; D_O_CAC_LCRR_I=0; D_O_CAC_LCRR_I_SQ=0	F(3, 4321)	19.30	0.0000
D_E_CAC=0; D_E_CAC_LCRR_I=0; D_E_CAC_LCRR_I_SQ=0	F(3, 4321)	13.91	0.0000

Source: See text.

Table 12. Log Yield Determinants; Residuals from the Reduced Form Regression for LYLD_EMD Regressed on Residuals from the Reduced Form Regression for LBAS_EMD and Related Variables

	Full sample				Issued after 2009				Sub-sample with rating < 15				Sub-sample with rating > 14			
	coef.	s.e.	coef.	s.e.	coef.	s.e.	coef.	s.e.	coef.	s.e.	coef.	s.e.	coef.	s.e.	coef.	
R_LBAS	0.494	0.720	0.182***	0.011	-1.288*	0.713	0.216***	0.011	0.154***	0.024	0.204***	0.012	0.022	0.017	0.019	0.
R_LBAS_SQ	0.101***	0.035	0.099***	0.036	0.104***	0.040	0.108***	0.040	0.021**	0.010	0.008	0.007	0.023	0.015	0.006	0.
R_LBAS_LCRR	-0.193	0.579	…		1.317**	0.573	…		-0.031	0.061	…		-0.334***	0.084	…	
R_LBAS_LCRR_SQ	0.027	0.116	…		-0.283**	0.114	…		0.022	0.024	…		0.118***	0.030	…	
CONS	-0.004**	0.002	-0.004**	0.002	-0.004*	0.002	-0.004*	0.002	-0.002	0.002	-0.001	0.002	-0.001	0.002	-0.000	0.
Number of observations	4,363		4,363		3,804		3,804		3,385		3,385		978		978	
Adjusted R2	0.100		0.100		0.135		0.133		0.108		0.105		0.017		0.001	
F tests																
R_LBAS=0; R_LBAS_SQ=0; R_LBAS_LCRR=0; R_LBAS_LCRR_SQ=0	F(4, 4358)	80.73***	…	…	F(4, 3799)	102.34***	…	…	F(4, 3380)	75.62***	…	…	F(4, 973)	4.78***	…	
R_LBAS=0; R_LBAS_SQ=0	F(2, 4358)	4.23**	F(2, 4360)	147.58***	F(2, 3799)	4.74***	F(2, 3769)	197.25***	F(2, 3380)	49.54***	F(2, 3382)	140.95***	F(2, 973)	1.34	F(2, 975)	
R_LBAS_LCRR=0; R_LBAS_LCRR_SQ=0	F(2, 4358)	1.22	…	…	F(2, 3799)	6.40***	…	…	F(2, 3380)	3.86**	…	…	F(2, 973)	8.02***	…	

Source: See text.

Note: *** p<0.01, ** p<0.05, * p<0.1

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