Journal of Asset Management (2023) 24:346–352
https://doi.org/10.1057/s41260-023-00305-4

ORIGINAL ARTICLE

Determinants of bid-ask spread in emerging sovereign bond markets

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Revised: 18 November 2022 / Accepted: 18 November 2022 / Published online: 18 February 2023

Abstract
Major emerging market countries issue significant amounts of local currency bonds in order to finance their budget deficits. As liquidity is a substantial feature of the financial markets, understanding bond liquidity dynamics is essential. The bid-ask spread is an important measure of bond liquidity and reflects explicit transaction costs. We apply a panel regression model in order to analyze bond-level and country-level characteristics' effects on bond liquidity and bid-ask spread. Results show that volatility, credit risk and duration have significant effects on emerging market bond liquidity. Emerging market sovereign bonds with lower volatility, lower credit risk and shorter duration have narrower bid-ask spreads, on average.

Keywords Bid-ask spread · Market liquidity · Emerging markets · Sovereign bond market

Introduction

Emerging market (EM) sovereign bonds have notable improvements within the last decades. Plenty of EM treasuries have issued significant amounts of fixed-income securities in order to finance their budget deficits. Especially, the global financial crisis had steered capital flows into the EM economies.

As investor attention and market size have been increased for the EM sovereign bonds, liquidity measurement and identifying liquidity determinants in such markets gain importance.

Liquidity is defined as ease of trade (Stange and Kaserer 2009), and it represents how fast an investor could dispose large amounts of a financial security at a fair price (Lybek and Sarr 2002). As liquidity is a significant aspect of financial markets, liquidity measurement is critical for all market participants.

The main motivation of this study is to analyze the effects of bond-level and country-level characteristics on the bid-ask spread and liquidity for the EM sovereign bonds.

Bid-ask spread is the difference between the best buy and sell orders at a certain point of time. It is an explicit transaction cost and directly related to trading activity. Amihud and Mendelson (1986) assert that the bid-ask spread is a measure of liquidity and represents the immediate execution cost. According to Fleming (2001), the bid-ask spread is a useful measure to evaluate and monitor bond liquidity.

Plenty of previous studies in the literature describe and model the relation of liquidity and asset features for different asset classes, and the main focus of previous studies is on the stock markets or developed markets (DM). However, there is no research in the literature that focus on the EM bond markets, as far as we know. This paper aims to contribute to the literature of liquidity and bid-ask spread effects on pricing and financing decisions for the EM sovereign bonds. Therefore, we examine sovereign bond liquidity and its determinants for our sample of the EM sovereign bonds. The evidence of liquidity effect on bond returns and yield spreads (Lesmond 2005) increases the importance of understanding the determinants of bond liquidity and bid-ask spread.

Our findings may have important implications for all market participants. As liquidity affects the secondary market trading costs, an asset's return is dependent on its liquidity. Hence, liquidity measurement and estimation become important for investors and traders. Moreover, since liquidity affects asset returns, the cost of capital of bond issuers may depend on secondary market liquidity. Additionally, as market regulators aim to decrease market frictions and

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improve efficiency, analysis of liquidity components and determinants could be helpful.

The rest of this article is structured as follows: Sect. 2 contains the literature review, Sect. 3 describes the data set and empirical methodology, Sect. 4 represents results of the applied regression model, and Sect. 5 concludes the study.

Literature review

Liquidity dimensions and measurement

Liquidity is defined as an ambiguous and shady concept (Kyle 1985). Schwartz and Francioni (2004) assert that easy conversion of a security into cash is a requisite for being liquid. There are numerous definitions of liquidity in the literature.

In addition to the definitions of liquidity in the literature, many scholars mention about dimensions of market liquidity. Garbade (1982), Kyle (1985), and Holden (1990) assert that there are three dimensions of the market liquidity; tightness, depth, and resiliency. Tightness is related to the execution cost of a trade within a short time period, depth refers to the volume in a market and shows the ability of trading large quantities without causing significant price movements, and resiliency indicates the degree and speed of price recovery after an abrupt shock. In addition to these three dimensions, Lybek and Sarr (2002) refer to two additional dimensions of market liquidity, which are immediacy and breadth. Breadth refers to the availability of enough order volume at different price levels for a security, and immediacy indicates to the efficiency of a trading environment and the speed of order execution.

According to Díaz and Escribano (2020), measuring each of the dimensions becomes essential and required, as there are significant relations between the liquidity dimensions. Also, these relations indicate that different dimensions should be measured simultaneously.

For the different dimensions of liquidity, numerous measurement models are developed in the literature. The foremost liquidity measures in the literature are summarized in Table 1. The models differentiate due to the underlying rationale on which the models are built, and the data they use. Data are mainly classified into two groups based on frequency, low-frequency and high-frequency. Low-frequency data are daily or less frequent, and high-frequency data include intraday data points. High-frequency data may not always be available or access to such data may be expensive. Additionally, high-frequency data are also associated with higher computational burden and requires higher effort for data handling. On the other hand, access to low-frequency data is easier and cheaper, even it is public and free for most of the time. Moreover, low-frequency data involve lesser computational burden and easier data handling. Additionally,

Table 1 Liquidity measures

Liquidity measure	Author	Formula*	Dimension
Quoted spread	Stoll (1989)	$\text{Ask}_t - \text{Bid}_t$ [1]	Tightness
Effective spread	Lee (1993)	$\frac{2\Sigma\lvert P_i - (\text{Ask}_i + \text{Bid}_i)/2\rvert Q_i}{\Sigma Q_i}$	Tightness
Imputed roundtrip	Dick-Nielsen et al. (2012)	$\frac{P_{\max} - P_{\min}}{P_{max}}$ [3]	Tightness
Quote size	Fleming (2001)	$\text{QuoteSize}_{k,t}$ [3]	Depth
Trade size	Fleming (2001)	TradeSize_t	Depth
Interquartile range	Han and Zhou (2007)	$\frac{p_t^{75th} - p_t^{25th}}{\overline{p_t}}$	Resilience
Range measure	Downing et al. (2005)	$\frac{\frac{P_{\max,i} - P_{\min,i}}{\overline{p_i}}}{\text{Volume}_i} * 100$	Breadth

* Ask_t : *Best* Ask *price at time t*, Bid_t : *Best* Bid *price at time t*

P_i: *Price of trade i*, Ask_i: Ask *quote in effect when trade i was transacted*, Bid_i: Bid *quote in effect when trade i was transacted*, Q_i: *number of securities transacted in trade i*

$P_{\max}$: *Maximum price in a roundtrip trade*, P_{min} : *Minimum price in a roundtrip trade*

QuoteSize_i : *Average daily quote size in week i*

TradeSize_i : *Average daily trade size in week i*

p_t^{75th} : 75*th percentile of trade prices in day t*, p_t^{25th} : 25*th percentile of trade prices in day t*, $\overline{p_t}$: *Average trade price in day t*

$P_{\max,i}$: *Maximum price in week i*, $P_{\min,i}$: *Minimum price in week i*, $\overline{p_i}$: *Average price in week i*, $Volume_i$: *Total face value traded in week i*

data frequency selection should also depend on the aim of the analysis in order to ensure that the data frequency is consistent with model and its output.

Market microstructure

Market microstructure is a subject of finance which deals with organization of markets, trade processes, and how exchanges occur. Market microstructure covers market design, price formation, transaction costs, trader behavior, and market efficiency, and tries to understand determinants of such topics. As liquidity is an important aspect of financial markets, market microstructure strives to understand, analyze, and model liquidity. As data availability and computational power have increased over last decades, the number of market microstructure literature focuses on liquidity has soared. Even different measures exist, not all of them may be applicable to specific asset classes, due to data availability or market microstructure. According to Díaz and Escribano (2020), there is no agreement on the most suitable liquidity measure which comprehends each liquidity dimension, and they assert that the measure should be selected with regard to the market characteristics and the research question. As mentioned above, different dimensions of liquidity represent distinct characteristics of the market microstructure.

Even there are multiple dimensions of liquidity and plenty of liquidity measures, applying these measures in bond markets may be suspicious or biased, as most of the measures primarily designed for the equity markets. There are significant structural differences between the bond and equity markets. For instance, the topmost trading system for sovereign bonds in Europe, Mercato dei Titoli di Stato, has quite low number of transactions per bond with comparison to equities, yet the total volume for bonds is much higher than the equity markets (Darbha and Dufour 2013).

Bond trades generally happen in over-the-counter (OTC) markets, rather than organized markets. Also, an issuer issues a variety of bonds which differ in time to maturity, coupon frequency, interest rate, interest type, etc., while an issuer mostly has a single stock type. Additionally, bond investors generally buy and hold a bond until its maturity. These situations lead to lower number of trades and lower liquidity in bond markets.

Another significant aspect of market microstructure is market makers (or primary dealers), especially for bond markets. Stoll (2003) asserts that bond markets are mostly dealer markets and mainly rely on dealers' buy and sell quotes in order to supply liquidity. Market makers supply buy and sell orders for a security, and they are generally obliged to sustain certain criteria, such as maintaining minimum amounts both at buy and sell sides, or a maximum price difference between buy and sell orders. Thus, the presence of market makers provides liquidity and has positive impact on all dimensions of liquidity, but the effect is more visible for tightness dimension. In sovereign bond markets, market-making activity is generally promoted by local authorities. Hence, market makers presence makes tightness dimension more visible and measurable.

According to Fleming (2001), the bid-ask spread is a useful measure to evaluate and monitor bond liquidity for the US markets. Additionally, Díaz and Escribano (2019) compare the performance of the most commonly used liquidity measures and find that tightness and resilience are able to reflect liquidity differences for the US corporate bonds. As the bond markets have lower number of orders and trades, and greater average trade volume, we expect that tightness would represent liquidity better than the other dimensions. Additionally, data availability and frequency effects the chosen liquidity dimensions and measures. Our data set includes intraday bid and ask prices, but does not involve intraday trade price and volume information, due to data availability. Therefore, a relative intraday bid-ask spread is calculated, and selected as the liquidity measure for our sample.

There are numerous studies in the literature that analyze liquidity measures or liquidity determinants in DM (Díaz and Escribano 2017; Schestag et al. 2016; Langedijk et al. 2018). However, EM bond markets are not covered specifically for the liquidity determinants. Even market microstructures for bond markets may be similar across different countries, there would be differences between EM and DM countries. According to Mohanty (2002), fewer market participants and smaller investor base may limit bond market efficiency, and financial sector policy and monetary policy have important effects on bond markets for smaller economies. For example, the interconnectedness of bond markets and money markets of an EM makes its bond market more vulnerable to monetary policy, currency shocks or economic situation.

Determinants of liquidity

There are plenty of researches in the literature that describe and analyze the relation of bid-ask spread and asset characteristics for fixed-income or equity markets.

Chen et al. (2007) examine corporate bond markets to analyze bond liquidity, bid-ask spread and bond yield. They find a very limited effect of outstanding amount on bond liquidity and assert that there is a strong evidence of significant relation between bond volatility and liquidity. Liquidity effect exists both for the investment-grade and speculative-grade bonds. Additionally, they find that changes in liquidity and yield spreads are highly associated with each other; higher illiquidity is associated with higher yield spread, and a liquidity improvement leads to a reduction in yield spread.

Liquidity costs and yield spreads are higher for bonds with longer time to maturity, and liquidity costs are higher for speculative-grade bonds according to their results. Also, they assert that liquidity and credit rating are crucial determinants of bond yield spreads, yet liquidity effect is greater than the other determinants.

According to Edwards et al. (2007), greater outstanding amount and lower credit risk leads to a decrease in transaction costs. They also assert that transaction costs are at the lowest level just after the issue date and just before the bond maturity. Bao et al. (2011) find that illiquidity decreases with bond's outstanding amount, but increases with a bond's term to maturity and age.

Galliani et al. (2014) investigate the relation between bond characteristics and bond liquidity. They discover that duration, outstanding amount, issuer's credit rating, and time to maturity at issue date have significant influence on the liquidity of the European sovereign bond markets. Their results approve that lower credit rating, smaller outstanding amount and greater duration decrease bond liquidity. Feldhütter and Poulsen (2018) assert that credit risk and maturity reduce liquidity and lead to wider bid-ask spread for the investment-grade corporate bonds.

Even though bond and equity markets have different microstructures, they may have certain similar liquidity characteristics. For example, Chordia et al. (2004) mention that there are significant correlations between bond and equity liquidities, and weekly patterns of both market liquidities are quiet similar. So that, the literature on liquidity and its determinants in equity markets may guide to researches on bond liquidity. Będowska-Sójka (2019) investigates the relation between volatility and liquidity for the European equity markets and discovers that liquidity decreases and bid-ask spread becomes wider when an increase in volatility occurs. She also reports that a financial turmoil leads to higher volatility and greater bid-ask spread. Additionally, Będowska-Sójka and Echaust (2019) analyze volatility and liquidity for the equities of five European countries and discover that there is negative correlation between the global volatility and market liquidity. On the other hand, Batten and Vo (2014) investigate the relation of equity return and liquidity in Vietnam and discover that there is positive correlation. They assert that their results contradict findings in DM countries and report that the difference may be a result of lower level of integration with the global financial markets.

Data and methodology

Data

Our data set includes data of thirty-three local currency (LC) sovereign benchmark bonds from six EM countries, which are Brazil, India, Indonesia, Russia, South Africa and Turkey. The sampling period, which consists of 64 business days, starts from June 21, 2019, and ends in September 18, 2019.

The data set includes intraday bond quotes, daily frequent bond and market characteristics data, such as option asset swap spread, basis point value, mid-yield, duration, historical volatility, credit default swap of the issuer country, daily market return in the issuer country, and issuer country. The whole data set is obtained from Bloomberg Terminal and Thomson Reuters Eikon.

Methodology

In order to obtain a benchmark liquidity measure, we calculate daily average relative bid-ask spread for each bond. The difference between the best buy and sell quotes at a certain point of time is called as the quoted spread. We compute relative quoted spread in order to have a relative measure. The relative quoted spread equals to quoted spread divided by the average of best buy and sell quotes. As the best quotes available in the market changes within a day, we calculate an average relative spread for each trading date, using intraday quote data. Equation 1 represents average daily relative quoted spread (RS).

$$\mathrm{RS} = \frac{1}{N}\sum_{n=1}^{N}\frac{\text{Ask Quote}_n - \text{Bid Quote}_n}{(\text{Ask Quote}_n + \text{Bid Quote}_n)/2} \tag{1}$$

where N is the number of updates in best bid or ask orders in a trading day.

To analyze the effects of bond characteristics on the bid-ask spread, we apply regression analysis. Pooled ordinary least squares (OLS) regression has drawbacks when heterogeneity across groups exists. Panel regression models have advantages to inspect heterogeneity and unobserved effects. According to Hsiao (2014), panel data analysis is more advantageous than OLS, since it allows to handle heterogeneity and is able to detect effects that are not possible to observe via cross-sectional or time series regression analysis. Additionally, random effect components of mixed-effects panel regression models allow to include time-invariant independent variables. Therefore, we employ a mixed-effect panel data regression model which is given in Equation 2. We use daily RS of each bond as the dependent variable and the bond characteristics as the independent regression variables, which are defined in Table 2. AS, DUR, BPV, MY, VOL, CDS and MKT are daily frequent time variant and continuous variables, while COU is a time-invariant variable.

Table 2 Definitions of panel regression variables

Variable	Definition
RS	Relative quoted spread
AS	Asset swap spread
DUR	Duration
BPV	Basis point value
MY	Mid yield
VOL	Historical volatility
CDS	Entry price of issuer Country's credit default swap
MKT	Daily market return in issuer country
COU	Issuer country

$$\begin{aligned} RS_{ij} &= \mu + \beta_1 AS_{ij} + \beta_2 DUR_{ij} + \beta_3 BPV_{ij} \\ &\quad + \beta_4 MY_{ij} + \beta_5 VOL_{ij} \\ &\quad + \beta_6 CDS_{ij} + \beta_7 MKT_{ij} \\ &\quad + COU_{Indonesia} + COU_{India} \\ &\quad + COU_{Russia} + COU_{Turkey} + COU_{SouthAfrica} \\ &\quad + b_{1i} + b_{2j} + e_{ij} \end{aligned} \tag{2}$$

where i refers to each trading day of the sampling period, j refers to each bond, b_{1i} and b_{2j} are the random intercepts, and e_{ij} is the random error.

Results

The descriptive statistics of the panel regression variables are given in Table 3. Our sample has an average relative spread of 0.219%, which means a round trip bond trade with value of 100,000 LC generates a transaction cost of 219 LC on average, due to the bid-ask spread. The correlation coefficients of the variables are represented in Table 4. VOL has the greatest correlation coefficient against RS with 0.643. AS, MY, DUR, CDS and MKT are positively correlated with the bid-ask spread, and their correlation coefficients range from 0.022 to 0.446. Only BPV has a negative coefficient, which is very close to zero, against RS.

The results of regression model are represented in Table 5. According to the results, DUR, VOL and CDS have statistically significant coefficients, while AS, BPV, MY and MKT have limited effects on the bid-ask spread. Greater volatility and duration lead to greater bid-ask spread, and countries with higher CDS have wider bid-ask spread. Also, there are differences between the countries. South Africa has significantly narrower bid-ask spread, while Indonesia have greater bid-ask spreads than other countries, on average.

According to the results, our findings on volatility and credit risk are coherent with the findings of Chen et al. (2007), who find significant relation between bond liquidity, volatility, credit risk and yield. We find significantly positive coefficients for volatility and credit risk, while yield does not have significant effect for our sample.

Table 3 Descriptive summary statistics of regression variables

	N	Mean	St. Dev.	Pctl(25)	Median	Pctl(75)
RS (%)	1703	0.219	0.21	0.071	0.164	0.295
AS	1703	63,889	77,91	8,28	68,16	134,555
BPV	1703	10,435	14,888	2628	5,99	9,564
MY	1703	8468	3297	6564	7,18	9133
DUR	1703	4944	3256	1,92	4294	7749
VOL	1703	6291	6072	2017	4793	8482
CDS	1703	150,787	100,064	86,775	113,415	165,255
MKT	1703	0.009	0.919	− 0.500	0.050	0.061

Table 4 Correlation coefficients of regression variables

	RS (%)	AS	BPV	MY	DUR	VOL	CDS	MKT
RS(%)	1							
AS	0.402	1						
BPV	−0.098	0.059	1					
MY	0.291	0.308	−0.207	1				
DUR	0.446	0.548	0.165	−0.020	1			
VOL	0.643	0.427	0.090	0.537	0.410	1		
CDS	0.184	0.312	−0.118	0.934	−0.188	0.505	1	
MKT	0.022	−0.010	0.011	0.042	−0.029	0.031	0.037	1

Table 5 Mixed effects panel regression statistics

	Coefficient	Standard error	Lower confident interval (2.5%)	Upper confident interval (2.5%)
(Intercept)	−0.133656	0.0748701	−0.2677922	0.0011849
AS	−0.0001133	0.0001297	−0.0003687	0.000137
BPV	−0.0018965	0.0016681	−0.0047763	0.0010893
MY	0.0074287	0.0049566	−0.0033026	0.0163278
DUR	0.0320953	0.0072829	0.0191804	0.0449543
VOL	0.0055802	0.0010967	0.0036621	0.0080559
CDS	0.0008048	0.0002386	0.0003387	0.00128
MKT	0.0014449	0.0028308	−0.0041149	0.0070011
$COU_{Indonesia}$	0.2110118	0.0811101	0.0707496	0.355221
COU_{India}	0.012163	0.0830125	−0.1317495	0.1606266
COU_{Russia}	−0.0215696	0.0796199	−0.1595439	0.121653
COU_{Turkey}	−0.085473	0.1015766	−0.2669203	0.1082405
$COU_{SouthAfrica}$	−0.1776608	0.0898592	−0.3327271	−0.0173091
Number of observations		1703		
Number of groups: Date		64		
Number of groups: Bond		33		
Akaike information criterion		−2814.1		
Bayesian information criterion		−2727.1		
Intraclass correlation		41%		
Log likelihood		1423.1		
Root mean square error		0.0994		

Our findings on credit risk and duration are parallel to Edwards et al. (2007). Also, our finding on duration is similar with Bao et al.'s (2011) results. Additionally, we find similar results with Feldhütter and Poulsen (2018) and Galliani et al. (2014) for duration and credit risk. Lastly, our finding on volatility is coherent with Będowska-Sójka's (2019) results.

Summary and conclusions

In this research, we look for the determinants of bid-ask spread for the EM sovereign bonds. As liquidity has effects on transactions costs, asset returns are directly related with asset liquidity. Hence, exploring liquidity determinants becomes important for traders, investors and issuers. Also, market regulators are interested in liquidity effects, since they aim to decrease market frictions and increase market efficiency.

In order to explore the relation between bid-ask spread and bond characteristics, we apply a mixed effects panel regression model. According to our results, bond duration, bond volatility and country CDS have significant effects on bid-ask spread. Higher duration, volatility and CDS lead to greater bid-ask spread, on average. Moreover, there are significant differences between the countries.

Our empirical results are similar with findings of Feldhütter and Poulsen (2018) in the US bond markets and Będowska-Sójka (2019) in the EU equity markets. Additionally, the results are partly coherent with results of Galliani et al. (2014) for the EU bond markets, Chen et al.'s (2007), Bao et al.'s (2011) and Edwards et al.'s (2007) findings for the US OTC bond markets.

As our results show that bond-level and country-level characteristics affect bond liquidity and bid-ask spread, the findings could be appealing for market participants and regulators.

Declarations

Conflict of interest The authors declare that they have no conflict of interest.

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