Improving the Tools Used in Computer Modelling of the Bond Liquidity Assessment on the Russian Market

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Abstract. Assessment of the liquidity level of Russian bonds using the computer modeling is an extremely important task which involves development of appropriate measures of bond liquidity. We found that the liquidity measures (proxies) used by academic researchers and professional portfolio managers have some shortcomings: serious interpretation difficulties which reduce practical applicability; absence of hierarchy of the liquidity "dimensions"; too much data necessary to properly assess the level of liquidity. We propose a system of indicators to assess the liquidity in the bond market which consider volume being the highest level of the hierarchy of the of liquidity "dimensions", time being the second highest level of the hierarchy, and price being the lowest level of the hierarchy. We suggest calculating the indicators only as averages for the period as indicators at a moment are objectively less informative due to a rather low level of liquidity of the Russian bond market.

Keywords: Liquidity measure, Corporate bonds, Bond market

1 Introduction

Currently, there is a high demand for computer modelling of financial assets management, especially bonds management. As a less risky financial instruments than stocks, bonds are widely used by the Pension Fund of the Russian Federation (PFR) and private pension funds, which are legally responsible for reliability, profitability and safety of accumulated pension savings. Implementation of these legal requirements is achieved through comprehensive control over the investment processes of the pension savings which involve modeling in order to determine the expected return, risk, and other important investment characteristics. Quite often bonds form a significant proportion of the investment portfolio of other groups of investors.

The appropriate software should be used to ensure the control and to improve the efficiency of investment decisions. Thus, in the years 2002–2003 PFR has implemented a program named "Stock Portfolio Optimization System", which helps to optimize the model stock portfolio based on historical and forecast data of the relevant stock indices [18].

For investors, one of the most important investment characteristic of a bonds issue is its liquidity. Assessment of the liquidity level of Russian bonds using the computer modeling is an extremely important and urgent task. On the one hand, investors operating on the domestic bond market recognize the growing risk of raising the average global interest rates; hence, they tighten requirements for the liquidity level of the bond issues that they include in the bond portfolios. On the other hand, given the actual "closing" of the external bond markets, the Russian bond issuers are interested in increasing the borrowing volumes at the domestic bond market and, accordingly, are willing to "adjust" to meet the investors' preferences.

However, there is no generally accepted criteria of the bond market liquidity in the existing economic and financial literature. Even the basic term "market liquidity" is, in fact, interpreted by scientists ambiguous. As a result, there is a diversity of liquidity measures (or proxies) suggested by researchers and used by professional investors, but all of the measures have serious shortcomings.

In this article, we define the bond's (bond issue's) liquidity as being an ability to transact a bond issue of a certain volume, during a certain time period, and at a certain price. We develop a system of indicators that helps to solve the problem of assessing the liquidity in the bond market.

2 Literature

Systematizing the existing research, we can distinguish at least two major approaches to understanding the economic essence of the liquidity: i) one-dimensional approach, which treats asset liquidity only as the ability to "be converted in the money" (the very ability to sell the asset on the market is crucial), and ii) multidimensional approach based on the recognition of the complex nature of liquidity. Within the latter approach, the time required to sell the asset and the price at which it (potentially at least) can be sold are taken into account in addition to the actual ability "to be sold".

In this article we use the multidimensional approach that to the greatest extent takes into account the investment preferences of the bond market participants. Hence, following the general definition of the financial asset liquidity, proposed by V. Rodina [17], we consider the bond's (bond issue's) liquidity as an ability to transact a bond issue of "a certain amount, during a certain time period, and at a certain price."

A detailed review of liquidity (or illiquidity) measures used in the literature is presented in van Loon et al. [16]. The authors divide all measures, or proxies, of illiquidity for corporate bonds into three classes. A first class combine measures of illiquidity related to transaction costs including the simple bid-ask spread [4, 10,11]. A second class of illiquidity measures describes market depth by assessing the price impact of trades [15], and trying to capture the daily price response associated with a one currency unit of trading volume [3,5,6,9,12]. A third class of liquidity proxies is referred to as trading intensity variables, which frequently cover both measures based on turnover and zero-trading-days [8]. In addition to using individual liquidity proxies, various aggregate proxies have been used [13].

In the Russian research literature, studies of the bond market liquidity measurement are rather new (started from late 1990s) and in fact represented by very few specialized research and also by developments of the professional securities market participants. It is noteworthy that many of those Russian researchers who recognize the multiplicity of liquidity measurement use sets of only few of all possible bond market liquidity measurements and ignore the other. The most systematic studies in this area are the works of A. N. Chaykun [7] and P. F. Kolesov [14], which will be later discussed in details.

3 Liquidity Measures for Bond Issue

A.N. Chaykun examines the bond market liquidity in the context of its "projections" (in fact, the term "projection" is synonymous with the term "dimension"), each of which has its own set of indicators:

1. the "time" projection:
   - "number of transactions" during a certain time period M;
   - "trading frequency" T_F, which is determined by the following formula:

   $$T_F = \frac{N_{TD}}{N_{SD}} \tag{1}$$

   where N_{TD} – number of trading[1] days with the bond issue since it was issued; N_{SD} – total number of days since the bond issue was issued;
2. the "price" projection:
   - "Illiquidity ratio"[2] (Amihud's ratio) K_A defined by the formula:

   $$K_A = \frac{|\Delta P|}{V} \tag{2}$$

   where $|\Delta P|$ – the bond issue's price change (range of price variation) for a certain period of time; V – bond issue's trading volume for the same period of time;
   - "price volatility" for a period δ (usually a year), calculated as:

   $$\delta = \frac{\delta_D}{\sqrt{R}} \tag{3}$$

   where δ_D – standard deviation of the yield of the bond issue; R – time period, expressed in years;

[1] Here, a trading day refers to a day when at least one transaction was made with the bond issue.

[2] In some studies, this ratio is called the liquidity coefficient, with the methodology of its calculation remains unchanged.

3. the “volume” projection:
   – “turnover” (or trading volume) V;
   – “size of transaction” $\overline{V}_M$, defined as:

$$\overline{V}_M = \frac{V}{M} \tag{4}$$

   – “turnover ratio” K_T, which is calculated by the formula:

$$K_T = \frac{V}{C_{BI}} \tag{5}$$

   C_{BI} – the nominal volume of the bond issue;
4. the “transaction cost” projection:
   – bid-ask spread S, which is calculated as:

$$S = P_{S\,\min} - P_{D\,\max}, \tag{6}$$

   where $P_{S\,\min}$ – the best price asked for the bond issue; $P_{D\,\max}$ – the best price bid for the bond issue.

The majority of other researchers, recognizing “multidimensionality” of the bond market liquidity in general, try to measure it using a “narrow” set of indicators. In particular, P.F. Kolesov [15] considers it possible to measure the bond market liquidity in a somewhat different way, proposing to use the ”two basic indicators of securities liquidity:

1. time during which the security can potentially be sold;
2. potential financial losses when it is sold.

Without offering a clear algorithm for calculating the first indicator (time of the bond sale – E_S), he considers it possible to calculate the potential financial losses through the relative spread S_R (or the relative bid-ask spread) by using the following formula:

$$S_R = \frac{P_{S\,\min} - P_{D\,\max}}{P_{S\,\min}} \cdot 100\%. \tag{7}$$

In addition, the researcher suggests to use such an indicator as the average spread $\bar{S}$ for the period:

$$\bar{S} = \frac{\sum_{i=1}^{n} (P_{S\,\min} - P_{D\,\max})}{n}, \tag{8}$$

where n – the number of observations.

Some of the securities market professional participants followed a different way. Accepting the presence of several liquidity “dimensions”, they prefer to develop their own ’universal’ liquidity indicators, trying to “unite” several existing measurements. Thus, the experts of the financial group “DOHOD” offer to use so called “bond liquidity index” (LI), which is an “index for assessing the liquidity of a particular bond in relation to the liquidity of the market (quotation list) on which it is traded on the basis of estimates of the average trading volume and the number of transactions", defined by the formula [2]:

$$LI = \left(\frac{V_i}{\overline{V}}\right)^a \cdot \left(\frac{MT_i}{\overline{MT}}\right)^b, \tag{9}$$

where V_i – "i-th bond average daily trading volume during the previous five trading days"; $\overline{V}$ – "average daily trading volume for all bonds of the same quotation list to which i-th bond belongs during the previous five trading days"; MT_i – "average number of i-th bond transactions during the previous five trading days"; $\overline{MT}$ – "average daily number of trades with all bonds of the same quotation list to which i-th bond belongs during the previous five trading days"; a – special factor equal to 0.3; b – special factor equal to 0.7.

JSC "Gazprombank" uses its own indicator for assessing the national bond market liquidity [1]. The specialists of the bank point out: "In general, liquidity is assessed only on a qualitative level based on expert estimates of the market participants. Subjectivity of the assessments, increase in the number of traded assets, the high volatility of financial markets – all this leads to poor quality of liquidity risk assessment, which is not conducive to effective investment decisions". They offer to use the indicator of financial instrument's market liquidity:

$$L = \sqrt{L_1 \cdot L_2}, \tag{10}$$

where L_1 – "potential liquidity of the instrument", averaged over the last 20 trading days; L_2 – "actual liquidity of the instrument", averaged over the last 20 trading days.

In our view, all of the above elaborations in assessing the liquidity of the bond market have some shortcomings:

- they all have serious interpretation difficulties and, accordingly, are difficult to be applied in practice. In other words, using the above indicators, the investor can identify the bond issue which has the highest liquidity among those for which the calculations are made, but the investor doesn't actually get an answer for a very important question: is the particular bond issue's liquidity level satisfactory for the investor?
- they are characterized by the absence of hierarchy of the liquidity "dimensions": in fact, explicitly or implicitly their equivalence is assumed, which is highly debatable statement due to the possibility of differences among investors' preferences;
- all of the proposed indicators imply that investors have a large enough amount of information (primarily the absolute spread value for bond issues over an extended time period) necessary to properly assess the level of liquidity, which is not always the case, as the vast majority of private investors do not create nor systematically update specialized information databases on the bond market liquidity level.

Given the shortcomings of the listed above indicators, to solve the problem of assessing the liquidity in the bond market, we propose to construct a system of indicators based on the following hierarchy of the of liquidity "dimensions": volume (the highest level of the hierarchy) – time – price (the lowest level of the hierarchy). And we consider reasonable to calculate these indicators only as averages for the period (indicators at a moment are objectively less informative due to a sufficiently low level of liquidity of the national bond market).

Thus, we propose to use the following indicators to assess the potential scope of a transaction with the bond issue:

1. average total value of bonds offered for sale:

$$\overline{TV}_{P_S} = \frac{\sum_{i=1}^{n} \left(\frac{P_{Si}}{100}\right) \cdot F_{Si} \cdot C_{OB}}{n}, \tag{11}$$

   where P_{Si} – ith offer price, expressed as a percentage; F_{Si} – number of bonds in ith offer; C_{OB} – nominal value of one bond; n – number of observations (trading days).
2. average total value of bonds bided:

$$\overline{TV}_{P_D} = \frac{\sum_{i=1}^{n} \left(\frac{P_{Di}}{100}\right) \cdot F_{Di} \cdot C_{OB}}{n}, \tag{12}$$

   where P_{Di} – price of ith bid, expressed as a percentage; F_{Di} – number of bonds in the ith bid;
3. average total value of bonds available for a transaction:

$$\overline{TV} = \frac{\overline{TV}_{P_S} + \overline{TV}_{P_D}}{2}. \tag{13}$$

In this case, a key indicator for the assessment of the amount of bond liquidity is the average market value of bonds available simultaneously to transact, while other indicators are considered as auxiliary, allowing to analyze the liquidity of the bond issue in more detail.

To evaluate the potential time to transact bonds, we propose to use the percentage of trading days characterized by a satisfactory level of liquidity:

$$W_{SL} = \frac{n_{SL}}{n} \cdot 100\%, \tag{14}$$

where n_{SL} – number of trading days characterized by a satisfactory level of liquidity.[3]

To assess such a measurement of bond liquidity as a price, we suggest to calculate the average spread corresponding to the required volume of the transaction:

$$\bar{S}_{RV} = \frac{\sum_{i=1}^{n} (\bar{P}_{S_{RV}} - \bar{P}_{D_{RV}})}{n}, \tag{15}$$

[3] The level of liquidity is satisfactory when actual average total value of bonds available for a transaction exceeds the required by the investor.

where $\bar{P}_{S_{RV}}$ – average ask price of bonds corresponding to the required transaction volume, which is determined by the formula:

$$\bar{P}_{S_{RV}} = \frac{\sum_{i=1}^{RV} P_{Si} \cdot F_{Si} \cdot C_{OB}}{\sum_{i=1}^{RV} F_{Si} \cdot C_{OB}}, \tag{16}$$

$\bar{P}_{D_{RV}}$ – average bid price of bonds corresponding to the required transaction volume, which is determined by the formula:

$$\bar{P}_{D_{RV}} = \frac{\sum_{i=1}^{RV} P_{Di} \cdot F_{Di} \cdot C_{OB}}{\sum_{i=1}^{RV} F_{Di} \cdot C_{OB}}. \tag{17}$$

If the value of bonds offered for purchase or sale does not reach the required volume, the indicator's value can not be identified correctly, and the bonds issue is not considered as the one that meets the investor's liquidity requirements (for the price "dimension").

The specifics of this indicator is a greater representativeness that allows more than just a comparison of the bonds' best bids and asks (such a comparison does not take into account the actual ask and bid volumes) through comparing the average prices that would realize if the required bond volume were transacted.

4 Empirical example

We have applied the suggested set of indicators to the bond market by using a hypothetical example. Suppose that a private investor operating on the Russian bond market needs to purchase short-term bonds (with maturity date is up to August 31, 2016, inclusively). His required liquidity volume ($\overline{TV}$) is not less than 1,000,000 rubles; the percentage of trading days characterized by a satisfactory liquidity level (W_{SL}) is not less than 40%, with a maximum term of a position opening equals to five trading days; average spread for the required transaction volume ($\bar{S}_{RV}$) is no more than 0.50%, and the required transaction volume is equal to 200,000 rubles.

At the calculation time (July 25, 2016) the investor's maturity requirements were met by 8 bond issues, but for the two of them – AbsolyutB-5 with the maturity date of July 27, 2016, and GPB BO-05 with the maturity date of August 1, 2016 – the trading was stopped ("frozen") because the maturity date was close. Calculations of the proposed indicators for the remaining 6 bond issues are given in Table 1.

Results of the bonds' liquidity evaluation clearly show that all investor's requirements are satisfied by only one bond issue (Alpha BO-9) within the analyzed bond issues totality formed by the term to maturity.

[4] Source: The Moscow Exchange, http://moex.com/ru/marketdata/bulletins/

Table 1. Calculations of the liquidity indicators for bond issues being traded at the Moscow Stock Exchange, with a maturity up to August 31, 2016, inclusive[4]

Bond Issue	Maturity Date	$\overline{TV}$, rubles	W_{SL}, %	$\bar{S}_{RV}$, %
AkBars-BO3	August 18. 2016	2 632 364,98	80	Undefined
MSPBankBO1	August 19.2016	0	–	–
MSPBankBO2	August 19.2016	0	–	–
Alpha BO-9	August **20.2016**	**6 948 127,42**	**100**	**0,4500**
MedvedF2	August 22.2016	1 065,89	–	–
MegtopEnB1	August 31.2016	1 071 312,70	80	0,8777

5 Conclusion

The system of indicators and bond liquidity analysis algorithm proposed in the paper can be embedded in a computer decision support system designed for selection and ranking bonds by the liquidity criteria. The computer support will significantly increase the efficiency of decision-making when investing in bonds, making it easier for investors to assess a large number of simultaneously traded securities. In the proposed algorithm, using system of liquidity indicators instead of one criteria will boost the efficiency of investment decisions and, on the other hand, requires computer support for technical simplification and improvement of assessment reliability.

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