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Bond Liquidity Indicators: Can New Thomson Reuters Indices explain Difference in Bond Returns?

Tamara V. TEPLOVA
Faculty of Economics

National Research University «Higher School of Economics», Moscow, Russian Federation
toma@sani-k.ru

Tatiana V. SOKOLOVA
Faculty of Economics

National Research University «Higher School of Economics», Moscow, Russian Federation
sokol-t@yandex.ru

Abstract

The rapidly growing Russian national currency bond market is demonstrating attractive yield levels after global crisis 2008-2009. A significant share of ruble bond issues has relatively low trading volume, so liquidity risk is of particular importance for potential investors.

This article provides an analysis of theoretical approaches to the construction of bond liquidity integral indices and reviews existing practice in the Russian market. First, it compares methodologies of Russian investment banks (Trust, Gazprombank, Zenith and others) and a new cyclic algorithm introduced by Thomson Reuters Agency (TRLI 2015). In empirical part of our research Thomson Reuters' integral indices of bond liquidity (weighted and non-weighted) are tested in the context of explaining the difference in yields of 1118 Russian national currency bonds outstanding (including government, municipal and corporate bonds). The multi-factor cross-sectional regression analysis results show that the influence of both Thomson Reuters liquidity indices on Russian bond yields is fairly stable. Duration and S&P rating also exert stable influence on bond yields. The non-weighted liquidity index has better explanatory power than the weighted one.

Keywords: Russian bond market, liquidity indices, bond returns, YTM

JEL Classification: G12

1. Introduction

Liquidity of a financial asset is an important characteristic determining its investment attractiveness (Chen *et al.* 2007, Chordia *et al.* 2005, Schultz 2001, Tychon and Vannetelbosch 2005). Depending on an asset liquidity level an investor faces certain risks of loss in the situation demanding immediate trading position closure. For instance, there may be financial losses in case an asset sale price turns out to be lower than the price at which it was purchased, even if its median price for the day or certain period considered is even higher than the price of initial purchase. Traditionally this risk of suffering losses in trading due to low liquidity is called liquidity risk. As may be expected the lower the liquidity of an asset the higher is the yield investors demand to compensate for this risk. The investigatory task arises from the fact that liquidity is a very multilateral concept and providing a quantitative integral index for ranking assets (bonds, in our case) by their liquidity is far from easy. In this article we shall compare such bond liquidity indices that are already presented in literature and used by practical analysts in investment companies, as well as analyze new liquidity index, offered by Thomson Reuters analysts for Russian market, in its explanatory potential for differences in bond returns (yield to maturity, YTM).

Our motivation is related to the fact that different investment companies develop their own techniques for bond liquidity indices. A wide range of original techniques is considered in academic literature. The question 'which approach does better explain differences in bond returns?' is open to discussion.

The objective of our research is to test new Thomson Reuters' integral indices of bond liquidity in the context of explaining the differences in bond returns (YTM) in the Russian market. This paper is organized as follows. Literature review is given in Section 2. Investment companies' approaches to building integral liquidity indices for the Russian bond market are compared in Section 3. Section 4 introduces hypotheses of our research and describes empirical methodology and data. Regression analysis results are given in Section 5 and 6. Finally, our conclusions are presented.

2. Literature review. Previous researches regarding bond liquidity indices

Liquidity is a complex characteristic of financial assets. Some papers are devoted to equity markets (Amihud *et al.* 2005). Most specialists underline its general property - rapid transformation of asset into money. The less time it takes to strike a deal, the more liquid the asset is. But this is only the first approach towards

understanding this complex issue (Longstaff *et al.* 2005). The second matter is forming a system of indices or one integrative index to measure assets' liquidity (in our research it will be bonds) for solving a variety of problems.

Following Pastor and Stambaugh (2003) we spell out four following projections in liquidity: time, trading volume, costs and price of an asset. Specifying liquidity characteristics allows us to put forward the following definition: bond liquidity means the ability to buy or sell this or that bond in relatively big quantities (considering specific features of any given market) at a price close to the market one and without significant influence of transactions on this price.

Comprehension of qualitative sense of four projections outlined allows us to propose quantitative measures for collating assets with respect to their liquidity. Depth shows possible trading volume without seriously affecting the price; tightness is connected with transaction costs and shows the distance between transaction prices and median market ones; resiliency reflects speed at which prices reach new equilibrium level after strong fluctuations caused by effecting major transactions; immediacy registers time necessary for transaction settlement. Each of projections presented is matched with a set of indices calculated, as a rule, on the basis of intra-day data of deals and "blotter" condition.

However, calculating liquidity indices within the framework of projections specified does not constitute the final step for assets' ranking. Further, transformation from quantitative to qualitative form is required to assign valid meaning to indices' values.

Recognizing trade turnover as key liquidity index has its traps, at some periods high turnovers cannot be the foundation for considering an issue liquid. Thus trading volumes may also be high in periods of low liquidity, for instance, in times of market recession and high price volatility. Moreover, we need to consider that high securities turnover is observed in periods preceding disclosure of information about companies' incomes due to speculative demand. Díaz (2006) shows that high relative market turnover index reduces risk premium for bonds.

The number of transaction for a definite period is the simplest liquidity index widely used in practice (Eltra invest company 2007, Micex rules for liquidity index calculation 2003, 2009 (Russia)). Big transaction numbers imply good trading activity and high liquidity (Biass 2007; Lawrence 2006). On the other hand, transactions volumes in highly volatile periods may increase even under low bond liquidity. The problem with this index is that, similar to trade turnover, it may signify both high liquidity and high market volatility. Han and Zhou (2006) showed strong correlation of this index with other liquidity indicators describing bond characteristics: issue volume, coupon rate, time after issue, time before redemption. So far as Russian market is concerned, there is practically positive correlation between the number of transactions at government bonds market and trading turnover.

Another popular liquidity index is the number of missing prices (Lesmond 2005) and zero-yield days (or simply "zeros"). Dokhod investment company (Russia) uses proportion of trading days over a security to overall number of days in circulation as the basic liquidity indicator (Table 1).

The next index traditionally characterizing potential investor costs is bid-ask spread. Amihud and Mendelson (1991) found positive correlation between bid-ask spread and bonds yield. But bid-ask spread index also has its limitations in practical use. Firstly, this index is good at diagnosing situation for small transactions volume, since big-scale transactions are, as a rule, conducted in negotiation mode and are, therefore, not reflected in recorded spreads. Secondly, big spreads are typical for volatile periods with increasing uncertainty about bond price. For example spreads tend to get narrower in periods preceding disclosure of important information about the issuer.

Hui-Heubel ratio collates the difference between maximum and minimum prices over 5 last days and turnover coefficient over the same period (Sarr and Lybec 2002). We also meet such indices as: price volatility, Martin index, etc. (Aitken 2005; Rinaldo 2001).

If analysts choose only one liquidity characteristic there is no need for transformation, since index values can be directly interpreted by liquidity level scale. A number of works support the position of choosing one key liquidity indicator and rank assets by it exclusively (Crabbe and Turner 1995, Dimson and Hanke 2004, Kempf and Uhrig-Homburg 2000, Chordia *et al.* 2000, Alonso *et al.* 2004). Russian Dokhod investment company estimates liquidity level by trading frequency index: the ratio of trading days over a security to overall number of trading over a period considered, while Trust investment bank (Russia) has developed its own liquidity indicator based on weighting quote volumes according to their bid-ask spreads.

Chen *et al.* (2007) analyze influence of liquidity on corporate bond returns. They use Bloomberg and Datastream data to construct three different liquidity indicators: bid-ask spread, an indicator of zero liquidity costs (zero return method) and an indicator of transaction costs (LOT model). The sample consists of 4000 US high-quality and high-yield bonds. Results show that there is a significant causal relationship between corporate bond return (YTM) and three liquidity indicators: bonds with lower liquidity have higher spreads. Also, Chen *et al.*

(2007) analyze dynamics of liquidity levels and bond spreads. Results of panel regression analysis (9 years) show that liquidity explains more than half of variation in corporate bond yield spreads.

Chung and Hung (2010) build a semiparametric model for government and corporate bonds (from 1997 to 2005, weekly data). They take difference between average yields of 'recently issued' and 'more mature' bonds as liquidity proxy. Convertible bonds and bonds with rating BB- and less were excluded from the sample. The objective of their research was to test explanatory power of liquidity in bond yield spreads.

Fewer studies are devoted to analysis of influence of bond liquidity on their yields in emerging markets. Usually authors investigate US market and underestimate perspectives of emerging markets analysis. It is worth noting that the level of liquidity is directly related to the level of market development. Becaert *et al.* (2007) analyze 19 emerging markets from 1993 to 2003. They use a number of liquidity indicators: their own integral liquidity index, trading volume turnover (total trading volume to total capitalization of securities), the number of days with zero trading volume. Indonesia market characterizes by the least level of liquidity (the maximal number of days with zero trading volume).

Lepone and Wong (2009) investigate factors explaining differences in bond yield spreads in Australia's market (from 2003 to 2007). The explanatory variables were similar to those chosen in (Collin-Dufresne 2001) for the US market. They construct SFF (standardized fund flows) liquidity indicator on the base of inflows in bond funds. SFF shows bond fund capital growth rate (the more capital growth rate, the more is the level of liquidity). Their regression model explains 60% of variation in bond spreads, but liquidity indicators have no significant influence on bond spreads in Australia's market. This result is contrary to previous studies.

Tarek (2009) analyzes relationship between corporate bond price and liquidity level for Tunisian market from 2004 to 2008. Liquidity level is measured as natural logarithm of issue volume (in mln dinars). Average bond duration is 2.5 years (from 0.2 to 5 years), issue volume varies from 2.3 to 3.4 mln dinars. Each year from the issue date reduces bond spread (between yields of corporate and government bond) by 2.5%, which corresponds to one of the hypotheses. But increase in issue volume by 1 mln dinars leads to increase in bond spread by 10%, this positive relationship contradicts to the other hypothesis.

Dick-Nielsen *et al.* (2012) propose their own liquidity index. They analyze not only influence of liquidity on bond yields, but also elasticity measure and its dynamics in crisis periods. The sample comprises noncallable nonconvertible corporate bonds without put option and with fixed coupon from 2005 to 2009. By the principal component analysis Dick-Nielsen *et al.* (2012) defined the most significant indicator explaining bond yield spread – influence of deals on price. This indicator was first included in integral liquidity index. Then other factors were included in the integral liquidity index: transactions costs and their standard deviation.

Houweling *et al.* (2005) consider different proxies to measure euro corporate bond liquidity (including issued amount, yield volatility, age, listed, etc.). Other sources of risk (interest rate, credit risk, maturity and rating differences) also were controlled. Houweling *et al.* (2005) confirmed significant liquidity premia in bond return for eight liquidity proxies.

Aussenegg *et al.* (2015) analyze monthly excess returns for 23 Euro-denominated corporate bond indices and propose a new specification for bond asset pricing models. They also examine term and default risk factors and liquidity risk. They demonstrate different sensitivities of risk factors before and after recent financial crisis.

3. Integral Index of Bond Liquidity. World and Russian Practice

If analysts favor multiple approaches in considering liquidity characteristics, there appears a problem of assigning weights. Determining weight coefficients done either by expert or by mathematical methods. For building comprehensive liquidity indicator equal weights technique may be applied, like, for instance, it is done in European central banks (Bank of England, 2007, European Central Bank, 2007). Russian Expert RA rating agency, ELTRA investment company (Russia), NOMOS bank (2005, Russia) use expert method for assigning weights.

Converting quantitative indices into qualitative form (liquidity level qualitative estimate) may be executed either by expertise or mathematical statistics techniques. Expert method in academic literature is provided in works by Rinaldo (2001), Chacko (2006), Nashikkar *et al.* (2008). Significant advantage in building comprehensive liquidity indicator is provided by factor analysis, when separate liquidity indices are clustered into weakly-correlated groups (factors). E.g., first factor explaining major part of dispersion in liquidity indices is analyzed. For security market such idea is contained in papers by Chen (2005), Korajczyk (2007). On practice this approach is implemented at bond market by Renaissance Capital investment bank (2006, Russia). The

method of Renaissance Capital analysts in forming comprehensive indicator presupposes linear convolution of three first liquidity factor values considering their contribution into explaining overall indices' dispersion.

The Russian national currency bond market is rapidly growing (Teplova and Sokolova 2014). In December 2014 the total volume of ruble government, municipal and corporate bonds outstanding reached 20.5% of GDP (in December 2013 – 17.2% of GDP, in 2006 – 9.5% of GDP). The second peculiarity is that stock exchange trading volume accounts for more than 90% of the total trading volume (for comparison, in China – 3%). In 2013 Russia ranked 11th in the world by stock exchange trading volume to GDP (MICEX - 20.8%, for comparison, Taipei Exchange – 2.9%, National Stock Exchange India – 7.8%). The large share of stock exchange turnover motivates investment companies to construct liquidity indices. In March 2015 the total number of ruble bonds outstanding was 1118, but only 778 could be admitted relatively liquid (their monthly trading volume was non-zero).

In Russian practice, expert method is used to calculate corporate bond index in Zenith Bank and Dokhod Investment Company (see Appendix). Analysts of Renaissance Capital used a combination of mathematical statistics (discriminate and cluster analysis) and expert methods to differentiate bonds by liquidity groups.

We consider the best market practices; brought to Russian market by Gazprombank, Trust bank and Dokhod Investment Company in 2006-2007 (Table 1), as well Thomson Reuters analysts' technique, open to practitioners since 2015. A more detailed calculation of liquidity indices is shown in Appendix 1.

Table 1 - Acting Russian market practices comparison. Liquidity ratios calculations for bond market

Description	Gazprombank	Trust (free-access liquidity estimates are not cited)	Dokhod
Time interval	1 month (20 working days)	1 month	5 last working days
Bid-ask spread	Weighted by volume (minimum asks and bids)	Weighted by volume (minimum asks and bids)	bid-ask spread is not used
	Relative spread (in % from median price) is used, weighted by trade period time share	Not weighted by trade period time share	-
		Absolute spread is used	-
Trading volume (for overall time interval)	Trading volume is multiplied on ratio obtained by principal components method	Not used	Ratio of daily average volume for a bond to daily average volume for all bonds of the same quotation list
Number of transactions (for overall time interval)	Number of transactions is multiplied on ratio obtained by principal components method	Not used	Ratio of daily average volume for a bond to daily average volume for all bonds of the same quotation list is used. By comparing Dokhod IC indicator (LI) to one it is convenient to compare liquidity level of a bond to market (quotation list) liquidity level.
Zero days account	Percentage of days to trading time interval is multiplied on ratio obtained by principal components method	Not used	Not used

Source: Gazprombank (2012, 2015), Trust (2007), Dokhod Investment Company (2006, 2007)

For its indicator Gazprombank uses a scale with five liquidity level grades (from 0 (min) to 4 (max)). Instruments having equal liquidity level are not graded between themselves. Number of securities having liquidity level 4 is 10 units, 9 for level 3, 8 for level 2, 18 for level 1, all the rest are assigned level 0. Dokhod Investment Company builds an indicator displaying how many times liquidity of a particular security exceeds the average market figure. At that, all sample bonds are ranked, as opposed to ranking by groups (as they do it in Gazprombank). It should be noted that comparison of ratings assigned on the basis of Gazprombank and Dokhod investment company estimates in Top-10 and Top-45 clusters shows that the estimates coincide in 30% and 35% of cases respectively.

4. Empirical Methodology: Hypotheses of Our Original Research, Data and Control Variables

Hypotheses of our investigation:

- H1. New bond liquidity indices developed by Thomson Reuters analysts are significant for explaining bonds' yield under control of traditionally used duration, rating, etc.
- H2. Liquidity index and weighted liquidity index are good for explaining differences in bonds' yield at Russian market, but they differ in their explanatory power. Non-weighted liquidity index explains differences in bonds' yield better.

Thomson Reuters analysts use a cyclic algorithm with a few components in an order book: bid volume, ask volume, total accumulated volume and relative bid-ask spread. Two estimates (Liquidity Index and Weighted Liquidity Index) are employed by Thomson Reuters in projecting Yield Map for dynamic filtering and other applications, such as Bond Liquidity Board. $L(t)$ by Thomson Reuters technique indicates how fast an investor can execute a certain trading volume at minimum cost. It is the instantaneous liquidity ratio and it equals 0 at initiation of the calculation.

The idea of Weighted Liquidity Index is similar to traditional liquidity index calculation, but with one exception: analyst or investor use summary accumulated as weight rather than as an averaged component (Eq. (1)):

$$LQX_w(t) = L(t) \times \text{Total Accumulated Volume (\%)} \quad (1)$$

As basic explanatory variables our research uses Ln_YTM и Ln_YTM_filt (see Table 2). When using Ln_YTM 5% of observations with maximum YTM (over 45%) are excluded from consideration. With Ln_YTM_filt no upper limitations are imposed, since $YTM > 45\%$ values are substituted for 45%. For all regressions we also exclude values of $YTM < 3\%$ (only 2 observations, RU000A0JTD37 и RU000A0JSLR8; the next minimal YTM value being bigger than 6%).

Since explanatory variables Vol_main , Vol_main_NDM and $Issue_vol$ are calculated in rubles, we introduce natural Logarithms into our regression. But variables Vol_main and Vol_main_NDM contain many enough zero values, which leads to the loss of some part of observation in taking a logarithm, therefore we conduct calculation in two versions; excluding zero variables and keeping them. The version with keeping zero values is realized in the following way: all values of Vol_main and Vol_main_NDM before taking a logarithm from them are increased to minimum observable value of appropriate variables in a sample.

Variables Liq and Liq_w also have many zero values. Calculations demonstrate the expediency of placing them into a separate group. Hence, we introduced appropriate dummy variables taking the value of 1 in case of non-zero values and 0 for zero ones.

We construct different specifications of the following multifactor linear regression model (2):

$$\begin{aligned} \text{Bond RETURN} = & \alpha + \sum_i \beta_{1,i} \cdot \text{Bond Characteristic}_i + \\ & + \sum_j \beta_{2,j} \cdot \text{Liquidity Characteristic}_j + \varepsilon \end{aligned} \quad (2)$$

We consider the following bond characteristics: industry, indicator of repo eligibility, coupon, duration, S&P rating (Table 2). Liquidity characteristics (trading volume, Thomson Reuters liquidity indices – see Table 2) are also included in the model (2).

Similar linear regression models were constructed by Amihud *et al.* (2005), Aitken (2005) for the equity market, Amihud and Mendelson (1991) for the bond market. Amihud and Mendelson (1991) used bid-ask spread as a liquidity indicator for the bond market. Chen *et al.* (2007) as well as Ericsson and Renault (2006) tested bond liquidity in the context of explaining time-series variation of spreads. Houweling *et al.* (2005) tested influence of nine liquidity proxies of corporate bonds on yield spreads. They constructed a four-variable model to control for other risk factors (see also Section 2 for details).

Unlike previous papers, we focus on new Thomson Reuters indices as bond liquidity measure. We include in the model a number of original factors – industry and sector dummy, S&P rating, repo eligibility.

Our multi-factor regression constructions include agencies' rating in two ways: as *rating_SP_dummy*, and as a set of separate dummies described above. When employing dummy set as basic category rating BB+ is used.

Bond Issuer Company belonging to a particular economic sector is also taken into account in regression analysis through fitting a company into one of 18 sector groups. "Banks" sector group is taken as basic (as having the biggest number of issuers). Besides, we take into account the division of bonds into corporate, municipal and government. This division is set by three additional dummy variables: 19, 20 and 21. Corporate bonds are taken as basic category.

Among dependent variables used results based on Ln_YTM appear more adequate (see Figure 1-4) but conclusions drawn with using other variables, even YTM и YTM_filt , differ but slightly on the whole.

Table 2 - Notations used (explained and explaining variables)

Variable	Description
Explained Variables	
YTM	Average YTM (March 2015)
YTM_filt	Values of YTM more than 45% are Replaced by 45%
Ln_YTM	Ln(YTM)
Ln_YTM_filt	Ln(YTM_filt)
Explaining Variables	
Repo	Repo Eligible
N_Payments	Coupon Frequency (Number of Payments per Year)
floating	Floating Coupon Rate (0 – No, 1 – Yes)
Vol_main	Trading Volume (Main Trading Mode), Rub bln
Vol_main_NDM	Trading Volume (Main Trading Mode + Negotiated Deal Mode), Rub bln
Ln_Vol_main	Ln(Vol_main)
Ln_Vol_main2	Ln(Vol_main + Minimal Nonzero Value of Vol_main in the Sample)
Ln_Vol_main_NDM	Ln(Vol_main_NDM)
Ln_Vol_main_NDM2	Ln(Vol_main_NDM + Minimal Nonzero Value of Vol_main_NDM in the Sample)
Issue_vol	Issue Volume (Rub bln)
Ln_Issue_vol	Ln(Issue_vol)
Dur	Average Duration, years
Ln_Dur	Logarithm of Average Duration
Liq	Liquidity Index
Liq_w	Weighted Liquidity Index
Liq_dummy	0 – If Liq=0; 1 – Otherwise
Liq_w_dummy	0 – If Liq_w=0; 1 – Otherwise
rating_SP	S&P LT Issuer Rating
rating_SP_dummy	0 – If rating_SP="NR"; 1 – Otherwise
rating_SP_0	1 – If rating_SP="BBB-", "BBB", "AAA"; 0 – Otherwise
rating_SP_1	1 – If rating_SP="BB+"; 0 – Otherwise
rating_SP_2	1 – If rating_SP="BB"; 0 – Otherwise
rating_SP_3	1 – If rating_SP="BB-"; 0 – Otherwise
rating_SP_4	1 – If rating_SP="B+"; 0 – Otherwise
rating_SP_5	1 – If rating_SP="B", "B-", "CCC"; 0 – Otherwise
rating_SP_NR	1 – If rating_SP="NR"; 0 – Otherwise
Industry	Sector Dummy (20-Government, 19-Municipal, Other – Corporate)
gov	1 – If Industry =20; 0 – Otherwise
mun	1 – If Industry =19; 0 – Otherwise
priv	1 – If Industry ≠19 & Industry ≠20; 0 – Otherwise
Ind_1-21	Industry Dummy (21 industries, including banks and non-financial companies)

The analyzed sample includes 1118 ruble bond issues of Russian issuers (government and companies) outstanding in March 2015. The sample consists of 964 corporate, 112 municipal and 42 government bond issues. Descriptive statistics is given in Table 3 (for more details, please refer to Table 4). Total volume of corporate bonds in circulation amounted to RUR 6.4 bln, that of government bonds RUR 6.8 bln, and RUR 0.9 bln for municipal ones. By the number and volume of bond issues in circulation banking sector takes the lead among corporate bond issuers (347 issues with aggregate volume of RUR 1.9 trln).

5. Sample Descriptive Statistics and Regression Analysis Results

The best median yield to maturity (calculated over floating bond issues of sector emitters) in March 2015 was demonstrated by metallurgy and food companies' bonds, as well as developer companies. Median yield to maturity over corporate and municipal bonds' samples was practically similar (15.81% and 15.83% respectively), while median duration over municipal bonds' sample was actually twice higher than that of corporate bonds (1,5 and 0.7 years respectively). Median yield to maturity over government bonds' sample was much lower: 12.85% with 3.6 year duration (Table 3).

Table 3 - Descriptive Statistics

Sector	YTM, % (all bond issues)		YTM, % (bond issues with YTM > 45% are excluded from sample)		Liquidity Index		Weighted Liquidity Index		Duration		Total Number of Bond Issues	Num-ber of Bond Issues with YTM >45%	Total Amount Out-standing, Rub bln
	median	mean	media n	mean	media n	mean	median	mean	median	mean			
Corporate Bonds	15,81	26,54	15,66	16,18	7,0	17,7	0,0	4,7	0,73	1,18	964	45	6 437
Banks	16,17	22,42	16,08	16,43	14,1	19,4	0,0	4,9	0,54	0,87	347	15	1 861
Oil&Gas	13,95	14,14	13,95	14,14	0,0	16,0	0,0	5,9	1,82	1,84	70	0	1 459
Municipal Bonds	15,83	16,16	15,83	16,16	26,6	26,9	0,0	5,5	1,51	1,58	112	0	891
Government Bonds	12,85	13,13	12,85	13,13	60,2	54,0	29,4	44,2	3,56	3,82	42	0	6 785

Source: Cbonds, Thomson Reuters, authors' calculations

Table 4 - Probability Distribution by S&P Rating

rating_SP_name	Frequency	Percent	Cumulative Percent
AAA	7	0.6	0.6
B	35	3.1	3.8
B-	7	0.6	4.4
B+	39	3.5	7.9
BB	37	3.3	11.2
BB-	54	4.8	16.0
BB+	311	27.8	43.8
BBB	9	0.8	44.6
BBB-	3	0.3	44.9
CCC	1	0.1	45.0
NR	615	55.0	100.0
Total	1118	100.0	

Source: Thomson Reuters Eikon, authors' calculations

45 corporate bond issues (including 15 bank bonds) demonstrated extremely high yield to maturity values, over 45% for a year. As an example of bond issues with YTM exceeding 100% we may refer to Svyaznoy Bank, UTAir Finance, Mechel, SU-155 Capital.

The influence of variables built in liquidity ratios is fairly stable (calculation results are shown in Table 5, 6). In multi-factor regression *Liq* has negative coefficient and *Liq_dummy* positive one. Due to this inclusion of only one *Liq* variable without *Liq_dummy* is incorrect (i.e., in setting zero liquidity in regression *YTM* is, on the average, lower). But if liquidity ratio is positive (non-zero) the bigger it is the lower the *YTM*, which corresponds to our expectations and earlier studies.

Liq_w shows much weaker results in all regressions. In some specifications both ratios at *Liq_w* and *Liq_w_dummy* turn out to be insignificant.

Also stable influence on *YTM* is exerted by *Ln_Dur* and S&P rating variables. Ratio at *Ln_Dur* is significantly negative in all regressions. Credit rating diminishes *YTM*. Rating quantitative value also influences *YTM*, but statistically significant difference is observed only in some rating categories. *YTM* values in 0 category (AAA, BBB, BBB-) do not differs from those in category 1 (BB+). In other categories *YTM* is higher though differences from category 3 (BB-) are statistically insignificant in some regression model specifications.

Among trade volume variables indices based on overall volume (master mode and negotiation deals mode) are preferable. On the whole they exert positive influence on *YTM* but with trade volume zero values excluded statistical significance is not constant. I.e., under zero trade volume *YTM* level is lower but the size of positive volume does not influence *YTM* significantly. Ratios at *N_Payments*, *floating* and *Ln_Issue_vol* are also inconstant. We should note relatively lower *YTM* value of municipal bonds (differences in some specifications are statistically insignificant) and higher *YTM* values of construction and developer companies.

Statistical significance of *Repo* explanatory variable is also unstable. Its exchangeability with S&P rating variables was not revealed because it can both be significant under these variables inclusion and insignificant even after their exclusion.

Residue distribution in regression cannot be fully characterized as normal, though deviation from normality is not particularly expressed (see histograms Figure 1). We also realize possible endogeneity problem in regression analysis conducted. Bad news on a company's financial solvency may simultaneously raise both bond trade volumes (holders actively sell) and yield to maturity. One of the paradoxical results of calculations that *YTM* is lower under zero liquidity ratios may be caused by the influence of some unaccounted-for factors both on liquidity and on *YTM*.

Table 5 – Calculation Results. Bonds with Zero and Positive Liquidity Indices (4 Model Specifications)

Calculation Number Variable	1 Ln_YTM	2 Ln_YTM	3 Ln_YTM	4 Ln_YTM
N	848	848	689	846
R2adj	0,182	0,035	0,291	0,292
Constant	161,3***	249,5***	48,4***	50,4***
Repo			1	2,2**
N_Payments			1,3	1,2
floating			1,8*	1,3
Ln_Vol_main				
Ln_Vol_main2				
Ln_Vol_main_NDM			1,9*	
Ln_Vol_main_NDM2				3,4***
Ln_Issue_vol			-0,5	0,5
Dur				
Ln_Dur			-5,1***	-6,6***
Liq	-4***		-3,1***	-3,2***
Liq_w		-3,3***		
Liq_dummy	12,9***		9,7***	9,8***
Liq_w_dummy		5,7***		
rating_SP_dummy				
rating_SP_0			0,3	0,1
rating_SP_1				
rating_SP_2			2,4**	2,3**
rating_SP_3			1,7*	1,7*
rating_SP_4			4***	3,5***
rating_SP_5			5***	4,3***
rating_SP_NR			4,3***	4,4***
gov				
mun				
priv				
Ind_1				
Ind_2			-0,4	0,8
Ind_3			0,2	0,3
Ind_4			0,7	0,6
Ind_5			1,2	1,4
Ind_6			-1,4	-1,7*
Ind_7			0,2	0,9
Ind_8			1	0,4

Calculation Number Variable	1 Ln_YTM	2 Ln_YTM	3 Ln_YTM	4 Ln_YTM
Ind_9			1	0,5
Ind_10			1,5	1,4
Ind_11			2,4**	2,4**
Ind_12			-0,6	-0,1
Ind_13			0,2	-0,2
Ind_14			2,1**	2,1**
Ind_15			0,8	1,1
Ind_16				0
Ind_17			-0,7	-0,6
Ind_18				
Ind_19			-1	-0,8
Ind_20			-0,2	-0,7
Ind_21			0,4	1,5

Note. * - 10%, ** - 5%, *** - 1% significance level

Table 6 – Calculation Results. Bonds with Positive Liquidity Indices (8 Model Specifications)

Calculation Number Variable	1 Ln_YTM	2 Ln_YTM	3 Ln_YTM _filt	4 Ln_YT M_filt	5 Ln_YTM	6 Ln_YTM	7 Ln_YTM _filt	8 Ln_YTM _filt
N	605	236	634	253	605	236	634	253
R2adj	0,029	0,088	0,032	0,095	0,245	0,53	0,305	0,541
Constant	181,4***	162,8***	142,7***	110***	49,4***	37***	43***	28,3***
Repo					-0,8	-2,6***	-3,2***	-4,2***
N_Payments floating					0,4	0,6	0	-0,9
Ln_Vol_mai n_NDM2					1,4	0,5	0,7	0,3
Ln_Issue_v ol					4,8***	3,7***	4,6***	1
Dur					-2**	-2,7***	-2,4**	-2,5**
Ln_Dur								
Liq					-4,1***	-0,5	-5,2***	-0,3
Liq_w	-4,3***		-4,7***		-3***		-2,6***	
Liq_w		-4,9***		-5,2***		-1,3		-0,9
rating_SP_0					0,7	-1,3	1	-0,2
rating_SP_1								
rating_SP_2					2**	1,9*	1,7*	1,3
rating_SP_3					1,5	1,3	1,3	0,1
rating_SP_4					3,7***	2,3**	2,4**	0,7
rating_SP_5					3,3***	4,2***	2,4**	2,7***
rating_SP_ NR					4***	2,3**	4,1***	1,7*
Ind_1								
Ind_2					0,1	4,8***	0,1	2,7***
Ind_3					0,9	1	0,7	0,7
Ind_4					1,1	0,2	0,8	-0,5
Ind_5					1,6	2,9***	1,1	1,3
Ind_6					-1,5	-0,7	-1,6	-1,5
Ind_7					0,9	-0,5	5,2***	6,8***
Ind_8					1,3	3,3***	0,7	1,6
Ind_9					3,7***		1,9*	
Ind_10					1,8*	1,4	0,7	-0,1

Calculation Number	1	2	3	4	5	6	7	8
Variable	Ln_YTM	Ln_YTM	Ln_YTM_filt	Ln_YT M_filt	Ln_YTM	Ln_YTM	Ln_YTM_filt	Ln_YTM_filt
Ind_11					4,1***	7,2***	6***	6,3***
Ind_12					-0,4	0,4	-0,5	-0,2
Ind_13					0,7	2,9***	-0,5	0,5
Ind_14					1,9*	1,6	0,4	0,1
Ind_15					-0,6	0,4	-1,6	-1,6
Ind_19					-0,7	0,3	-1,1	-0,4
Ind_20					0,5	0,2	1,2	0,6
Ind_21					2,5**	1,8*	1,6	0,4

Note: * - 10%, ** - 5%, *** - 1% significance level

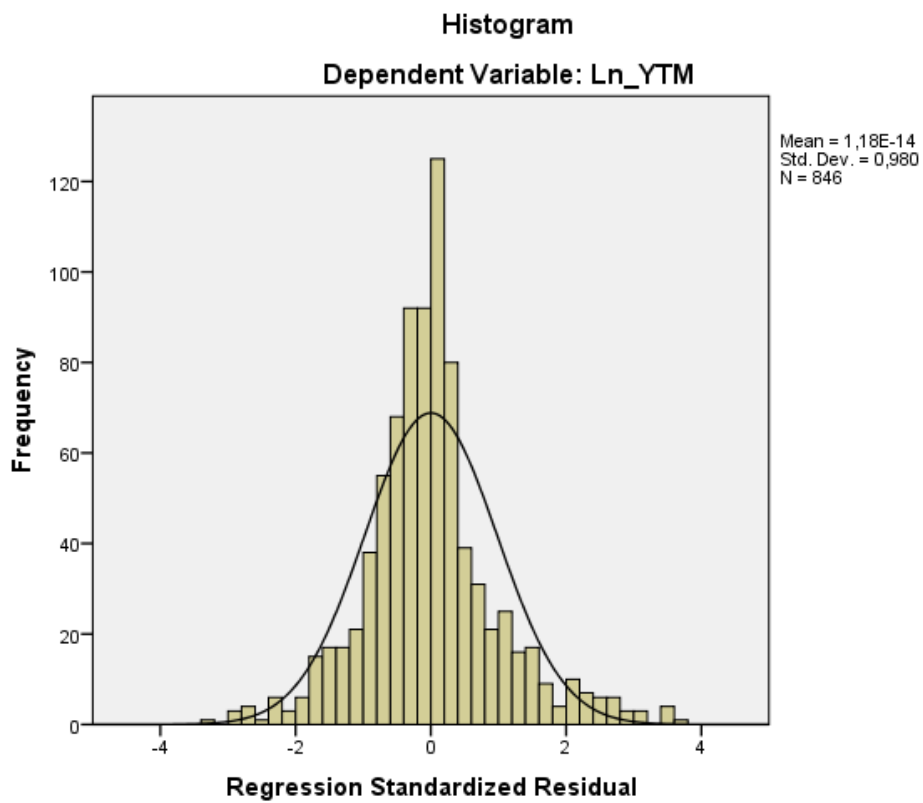


Figure 1 - Histogram. Dependent Variable: Ln_YTM

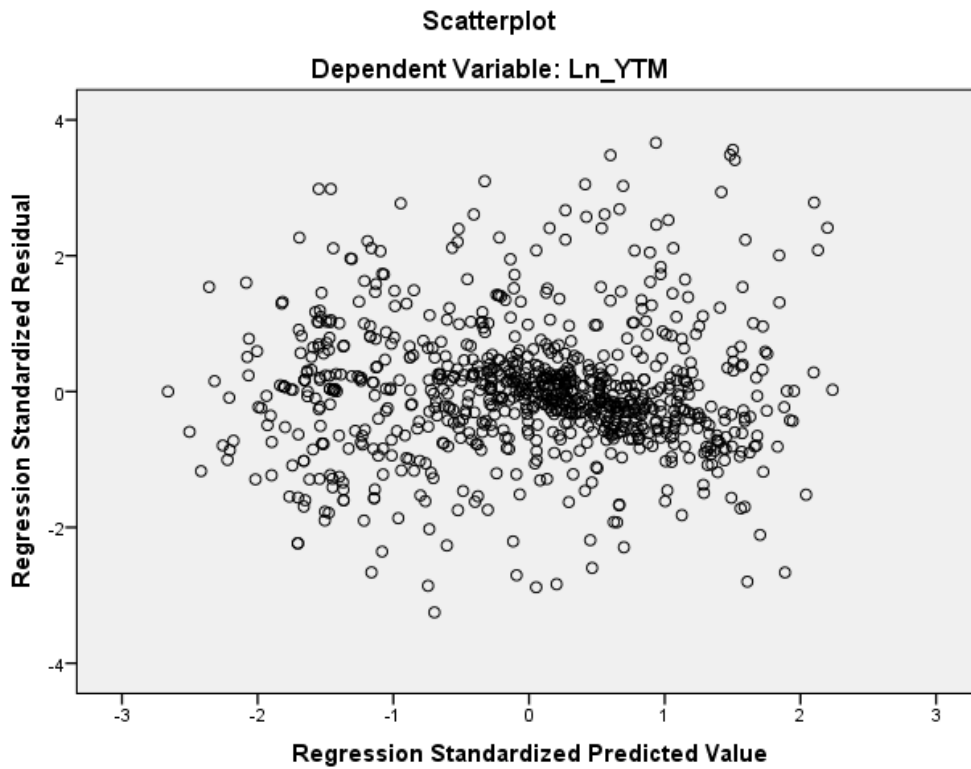


Figure 2 - Regression Standardized Residual and Standardized Predicted Value. Dependent Variable: Ln_YTM

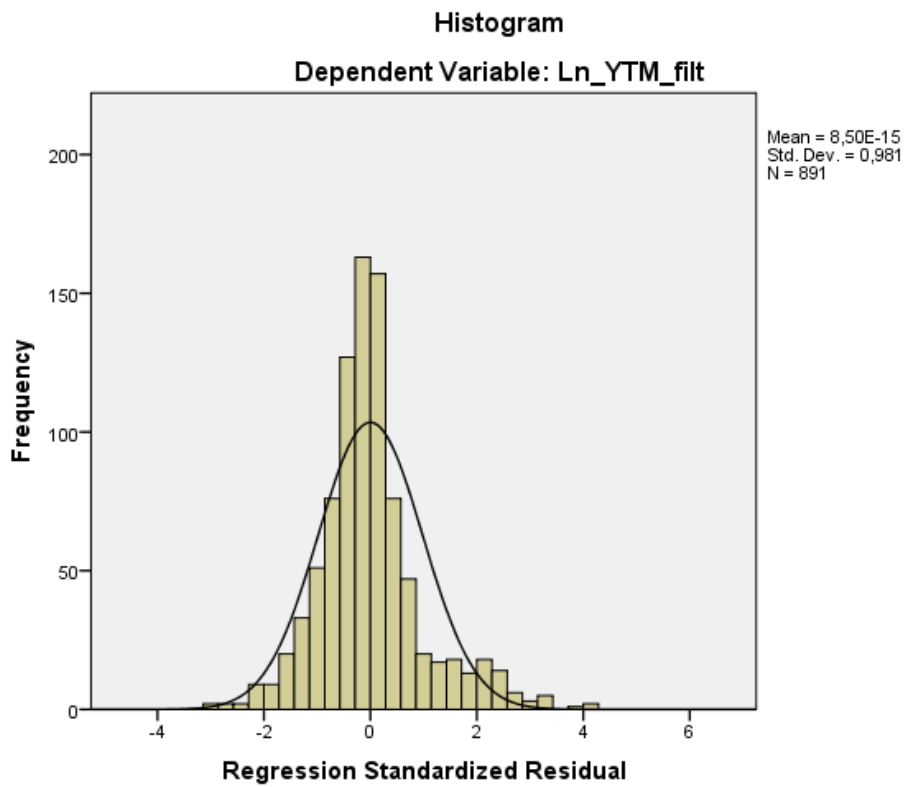


Figure 3 - Histogram. Dependent Variable: Ln_YTM_fit

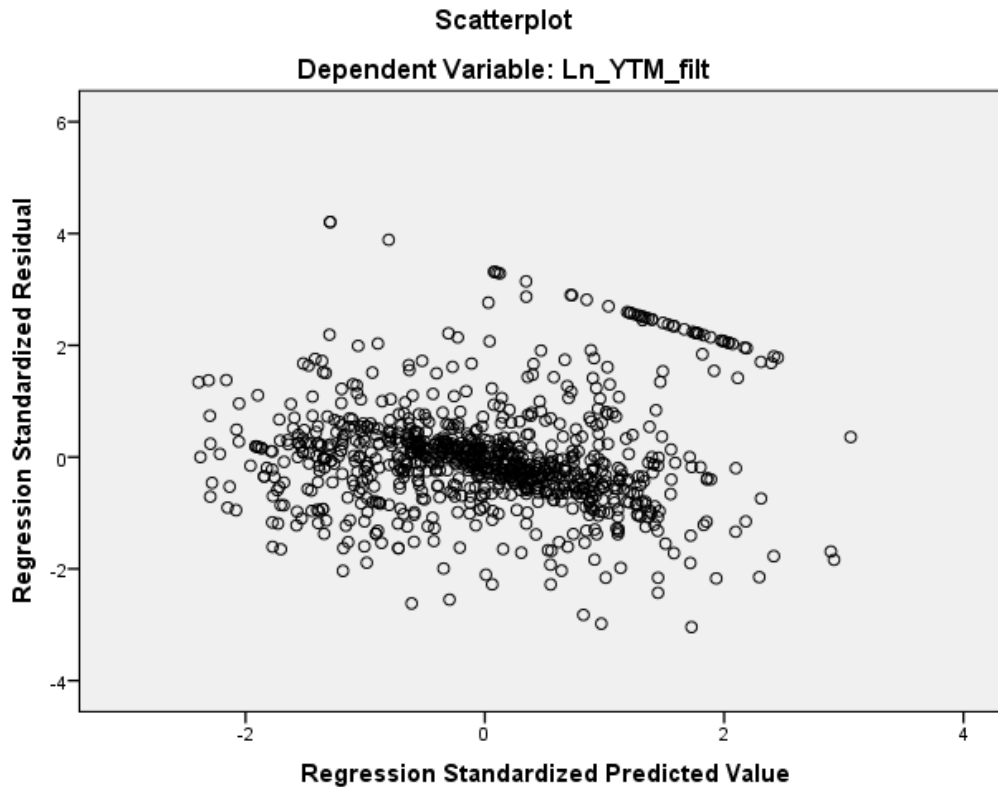


Figure 4 - Regression Standardized Residual and Standardized Predicted Value. Dependent Variable: Ln_YTM_filt

6. Comparing two Thomson Reuters indices by explanatory power on bond yields

In treating the sample at large, including zero liquidity observations, we see that the *Liq* variable describes dependent variables better. To estimate liquidity influence on exclusively positive liquidity sample eight additional regressions were built, including coupled and multi-factor regressions from *Liq* and *Liq_w* for dependent variables *Ln_YTM* and *Ln_YTM_filt* (see Table 6).

In coupled regressions *Liq_w* results are somewhat better than those of *Liq* (R^2 is noticeably higher, ratio t-statistics is slightly higher), but the samples differ strongly: over 600 observations for *Liq* against 250 for *Liq_w* (in initial data *Liq_w* zero values twice exceed those in *Liq*: 855 against 427). In multi-factor regressions ratio is significant at *Liq* and insignificant at *Liq_w*, but resultant R^2 in *Liq_w* is significantly higher. I.e., comparatively better results of *Liq_w* in coupled regressions are explained, most likely, by difference in sample size. To check this assumption fore more regressions from *Liq* were built but on the sample previously used to check *Liq_w* influence, i.e., under condition $Liq_w \neq 0$. *Liq* results in all cases (two dependent variables, coupled and multi-factor regressions) are better than *Liq_w*.

Conclusion

The Russian bond market is one of the biggest in the world by stock exchange trading volume (95% on exchange trading, \$184 billion on the end of 2014). Yield levels in the Russian bond market in 2014-2015 looked attractive to investors, given low return rates in the European and American markets (in euro and dollars). One of the important risk factors that prospective investors should consider is the difference in bond liquidity. Another factor of risk is currency risk.

Liquidity is significantly different for government, municipal and corporate bonds. The share of bond issues with zero trading volume is high (340 from 1118 bond issues in March 2015). Our study analyzes several liquidity projections which can rank differently bond issues when constructing an integral liquidity indicator. Practices of major Russian investment companies in the bond market are compared. The empirical part of this investigation is devoted to testing of the explanatory power and the comparison of the two liquidity indices (the cyclic algorithm) proposed by Thomson Reuters analysts to Russian investors in 2015.

Based on our multi-factor linear regression analysis, we can conclude, that the influence of variables built in liquidity ratios is fairly stable. The objective of our research is to test new Thomson Reuters' integral indices of bond liquidity (TRLI 2015) in the context of explaining the differences in bond returns (YTM) in the Russian market. Among trade volume variables indices based on overall volume (main mode and negotiation deals mode) are preferable. On the whole they exert positive influence on YTM. If Thomson Reuters Liquidity Indices are non-zero, the bigger they are, the lower the YTM. This fact corresponds to our research expectations and earlier studies. Thus, the first hypothesis is confirmed.

One of the paradoxical results of our research is that bond's YTM is lower under zero liquidity ratio. It may be caused by the influence of some unaccounted-for factors both on liquidity and on YTM. It follows that zero-liquidity bonds (observations) form a separate group (separate cluster for analysis).

In the Russian bond market, duration and S&P rating also demonstrate stable influence on YTM (influence of duration is significantly negative in all regressions). YTM values in rating category 0 (AAA, BBB, BBB-) do not differ from those in category 1 (BB+). In other categories YTM is higher though differences from category 3 (BB-) are statistically insignificant in some regression model specifications.

The second hypothesis is confirmed: TR indices - *Liq* and *Liq_w* have different explanatory power. We come to the conclusion that *Liq* index explains the difference in YTM of Russian national currency bonds better than the weighted integral index *Liq_w* (over both samples, one including zero liquidity observations and the other excluding them). It should be noted that although YTM decreases with the growth of liquidity, it is lower under zero liquidity than under positive one (this result is paradoxical).

Results of our research of Russian bond market coincide with the results of Amihud and Mendelson (1991), Houweling *et al.* (2005), Dick-Nielsen *et al.* (2012): the liquidity factor significantly affects bond returns (YTM) and bonds with less liquidity have a risk premium. Similarly, Chen *et al.* (2007) as well as Ericsson and Renault (2006) show bond illiquidity to be positively correlated with default risk and overall bond volatility.

The new result of our investigation is that bonds with zero liquidity form a special cluster. Contribution of our paper is that we first tested explanatory power of new Thomson Reuters' bond liquidity indices (TRLI) for a large sample of bonds outstanding in the Russian market (1118). The sample includes corporate, government and municipal bonds. The regression analysis results show that the influence of both Thomson Reuters liquidity indices on bond yields is fairly stable.

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APPENDIX 1. Different Techniques for Bond Liquidity Integral Measure

Gazprombank's Technique for Liquidity Index

$$L = \sqrt{L1 \times L2} \quad (3)$$

where L is bond's liquidity, while $L1$ and $L2$ stand for its potential and factual liquidity, averaged over last 20 trading days.

$$L1 = \sum_t \frac{V \cdot \Delta t}{\frac{\Delta bid}{ask}} \quad (4)$$

where $L1$ is potential liquidity, V – volume in rubles (minimum value of purchase and sales volume is taken), Δt is time share at which the spread held (in % from trading period), $\frac{\Delta bid}{ask} = 2 \cdot \frac{ask - bid}{ask + bid}$ is relative bid-ask spread (in % from average price).

$$L2 = a \cdot V + b \cdot N + c \cdot D \quad (5)$$

where $L2$ is factual liquidity, V is trade volume over last 20 trading days, in units. D is percentage of days (over last 20 trading days), when transactions for a bond took place, in %; a, b, c – ratios obtained through principal components method.

Trust Bank's Technique for Liquidity Index

$$L(t) = \frac{1}{30} \sum_{i=t}^{t-29} M(i) \quad (6)$$

where $L(t)$ is bond liquidity indicator at day t ,

$M(t)$ is calculated by algorithm:

1. $M(t) = 0$
2. Are there any volumes on both sides (bid or ask)? If none at least on one side, calculation is terminated.
3. Take min.volume = minimum between volume of best bid and that of best offer.
4. Take bid-ask spread = spread between yields of best bid and those of best offer.
5. $M(t) = M(t) + \text{min.volume}/(\text{bid-ask spread})$.
6. Subtract min.volume from best bid and best offer volumes, as if it has been bought (sold).
7. Return to Step 2.

Dokhod investment company's Technique for Liquidity Index

$$LI = \left(\frac{V_i}{\bar{V}} \right)^a \cdot \left(\frac{NT_i}{\bar{NT}} \right)^b \quad (7)$$

where LI is bond liquidity index; V_i – average daily trading volume over i -th bond for 5 past trading days; \bar{V} – average daily trade over all bonds of the same quotation list, to which i -th belongs, for 5 past trading days; NT_i – average daily volume of transactions over all bonds from quotation list to which i -th bond belongs, for past 5 trading days; a, b – coefficients equal to: $a = 0.3, b = 0.7$.

Thomson Reuters' Technique for Liquidity Index. New Liquidity Measure

Thomson Reuters' technique allows to assign liquidity index to each issue considering bid and ask prices in order book and volume of such orders. Liquidity index assigning technique is described below.

As the first step liquidity ratio $L(t)$ for a bond issue is determined by the following formula:

$$L(t) = L(t) + \text{MIN} [\text{Bid Size}, \text{Ask Size}] / [\text{Bid-Ask Yield Spread}] \quad (8)$$

$L(t)$ indicates how fast we can execute a certain trading volume at minimum cost. It is the instantaneous liquidity ratio and it equals 0 at initiation of the calculation.

Then the trading volume adjustment is imposed by calculating the sum of accumulated volumes from the main trading mode and the NDM mode. The results are grouped into percentiles with 100% attributed to bonds with the largest trading volume and 0% to the least traded bond. The Liquidity Index $LQX(t)$ is calculated as an average of the indicator and volume sum values:

$$LQX(t) = [L(t) + \text{Total Accumulated Volume (\%)}] \times 0.5 \quad (9)$$

The Weighted Liquidity Index $LQXw(t)$ is calculated similar to the Liquidity Index, but total accumulated volume is used as a weight:

$$LQXw(t) = L(t) \times \text{Total Accumulated Volume (\%)} \quad (10)$$

First component (market depth) calculation algorithm is given below.

Liquidity rating is used to bring component $L(t)$ to comparable scale. As was described above, $L(t)$ grows with the growth of volume and decrease of bid-ask spread. Normalization is done as follows:

$$LQX_{rating}(t) = \log_{10}(L(t))$$

Essentially, liquidity shows how fast we can realize a certain asset volume at minimum costs.

$L(t)$ is momentary liquidity level that takes zero value at reference point. Since we are attempting to estimate liquidity level at which 2nd-level volumes may "fold up", the calculation is cyclic and initial data for minimum volume are made up of next size level and previous maximum size minus previous minimum. Iterations stop when there are no more size data for bid or ask. Below is the calculation of liquidity level for Bond A:

Bond A.

Bid Size	Bid Price	Bid Yield (%)	Ask Yield (%)	Ask Price	Ask Size
11	97.5	16.1	13.21	99.9	202
5	97.36	16.35	12.92	100.15	5000
112	97.35	16.47			

$L(t) = 0;$

- 1) $L(t) = 0 + \text{Min} [11, 202] / [16.1 - 13.21] = 11 / 2.89 = 3.8;$
- 2) Since Bid Size equal to 11 was minimal, we subtract it from Ask Size: $202 - 11 = 191$
- 3) $L(t) = 3.8 + \text{Min} [5, 191] / [16.35 - 13.21] = 3.8 + 5 / 3.14 = 5.39;$
- 4) We have used Bid Size again, therefore we subtract the size used from Ask Volume: $191 - 5 = 186.$
- 5) $L(t) = 5.39 + \text{Min} [112, 186] / [16.47 - 13.21] = 5.39 + 112 / 3.26 = 39.74;$
- 6) Further data on the bid side are missing, so iterations stop at liquidity level of 39.74.