SURVEY OF ONE-DIMENSIONAL LIQUIDITY MEASURES

Jelena Minović*  
Assistant research, Serbia  
jelena.minovic@gmail.com

Slavica Stevanović  
Assistant research, Serbia  
slavica.stevanovic@ien.bg.ac.rs

Grozdana Belopavlović  
Assistant, Serbia  
grozdana.belopavlovic@bba.edu.rs

ABSTRACT

In order to integrate Serbian market into EU financial market, structural change is required. Since Serbian market belong to frontier markets, it should be transformed to emerging markets in order to develop market. One of the major requirements for this to happen is to improve market liquidity and its measuring. Liquidity is not easily defined and measured. Liquidity itself is not observable and therefore, has to be proxies by different liquidity measures. This paper presents an overview of different types of one-dimensional liquidity measures. Definition of liquidity would be a market characterized by the ability to buy and sell securities with relative ease. The one-dimensional liquidity measures covered in this paper are: probability of informed trading, market capitalization, turnover, and different spread-related liquidity measures (bid-ask spread, relative spread, effective spread, Roll’s measure, realized spread, quoted spread). The advantages and disadvantages of these measures are given.

Key words: Liquidity, liquidity measures, one-dimensional measures.

1. INTRODUCTION

Liquidity is not easy to define and there is no common definition of liquidity anyway (Wyss, 2004). Liquidity is easier to recognize than to define (Crockett, 2008). Liquidity generally denotes the ability to trade large quantities quickly, at a low cost, and without moving the price. Liquidity is a market characterized by the ability to buy and sell securities with relative ease (Clark, 2008). Market liquidity refers to the ability to undertake transactions in such a way as to adjust portfolios and risk profiles without disturbing underlying prices. The dimensions of market liquidity include:

- market *depth*, or the ability to execute large transactions without influencing prices unduly;
- *tightness*, or the gap between bid and offer prices;
- *immediacy* or the speed with which transactions can be executed;
- and *resilience*, or the speed with which underlying prices are restored after a disturbance (Crockett, 2008).

Liquidity is one of the favourable characteristics required by the investors. Liquidity on stock exchange is generated by the so called market makers (Campbell et al., 1997). Speculative investors and market makers are the key players that bring market or assets liquidity (Huberman

---

1 This paper is a part of research project No. 47009 (European integrations and social and economic changes in Serbian economy on the way to the EU), financed by the Ministry of Science and Technological Development of the Republic of Serbia. This paper is a part of research project No. 179015 (Challenges and prospects of structural changes in Serbia: Strategic directions for economic development and harmonization with EU requirements), financed by the Ministry of Science and Technological Development of the Republic of Serbia.
and Halka, 2001). Indeed, liquidity is the condition for investors (regardless of the investors being individuals or institutions) to get returns from the expected changes in prices. They, however, generate demand which enables liquidity. Liquidity has several aspects and cannot be described by one indicator only.

This paper presents an overview of different types of one-dimensional liquidity measures. The one-dimensional liquidity measures covered in this paper are: probability of informed trading, market capitalization, turnover, and different spread-related liquidity measures. The advantages and disadvantages of these measures are given. The rest of the paper is organized as follows. The Section 2 presents different one-dimensional liquidity measures. The Section 3 presents their advantages and disadvantages. The Section 4 concludes.

2. THE ONE-DIMENSIONAL LIQUIDITY MEASURES

2.1. The probability of information based trading (PIN)

The probability of information based trading is measure of the degree of information asymmetry among investors about the value of individual stocks (Yan and Zhang, 2006). This measure describes the percentage of trading based on private information of all the observed trading. Higher value of this measure means a higher degree of information asymmetry, and therefore less liquidity (Li, 2008).

Orders from informed trades arrive at rate \( \eta \) (on information event days), orders by uninformed buyers arrive at rate \( \varphi_s \), and orders from uninformed sellers arrive at rate \( \varphi_b \). Informed traders buy if they have seen good news and sell if they have seen bad news. If there is no information about an event that reached rates of uninformed buyers and sellers remain unchanged (Easley et al., 2002).

The probability of information based trading is defined as:

\[
PIN = \frac{\alpha \eta}{\alpha \eta + \varphi_s + \varphi_b},
\]

where \( \alpha \eta + \varphi_s + \varphi_b \) is the arrival rate for all orders and \( \alpha \eta \) is the arrival rate for information-based orders. The ratio (eq. 1) is thus the fraction of orders that arise from informed traders or the probability that the opening trade is information based (Easley et al., 2002).

2.2. Market Capitalization (MC)

Liquidity measure of some share can be size or market capitalization. Market capitalization calculates as follows:

\[
MC_j = n_j \cdot P_j,
\]

where \( n_j \) is the total number of issued shares \( j \), and \( P_j \) is the price of share \( j \). Using equation (2) we can determine the market value of a company. Market capitalization of some stock exchanges is the total value of all traded securities at the prices determined by supply and demand.\(^2\)

2.3. Turnover (TO)

Turnover is:

\[
TO_{ij} = \frac{1}{N_{ij}} \sum_{t=1}^{N_{ij}} V_{jxt}.\]

\(^2\)http://www.belex.rs/trgovanje/vesti/8237
Where $V_{yt}$ is trade volume in shares of stock $i$ on day $t$ in year $y$, and $n_{iyt}$ is number of shares outstanding of stock $i$ on that day (Amihud, 2002).

2.4. Absolute Spread ($S^{abs}$)

Glosten and Milgrom (1985) consider a market structure in which competitive market makers must quote binding bid and ask prices and investors arrive sequentially and can decide whether to buy one share at the ask ($P^a_t$), sell one share at the bid ($P^b_t$), or refrain from trading. In this case, the bid is the expected value of the fundamental given that the next trade is a sell order, and similarly for the ask, leading to the following “regret free” prices (Amihud et al., 2005):

$$P^b_t = E(f|\mathcal{I}_t, sell),$$  \hspace{1cm} (4)

$$P^a_t = E(f|\mathcal{I}_t, buy),$$  \hspace{1cm} (5)

where $f$ is the fundamental value of orders, and $\mathcal{I}_t$ is the public information. The quoted bid price (eq. 4) reflects the risk that a seller is informed of bad news, and the ask (eq. 5) reflects the risk that a buyer is informed of good news. If the market maker were sure that the counterparty is informed, she would not trade at all since as long as the informed trader wishes to sell, the price is too high. What makes the market maker willing to trade is the possibility that the counterparty is uninformed, and it may gain by selling to him at a “high”-ask-price or buying from him at a “low”-bid-price. Thus, the market maker gains from trading with uninformed traders and loses with informed ones. Since in a competitive market the market maker ends up with zero profit, the gains of the informed traders are at the expense of the uninformed trade. Clearly, the model implies a bid–ask spread (bid<ask) which is greater if the probability of trading with informed traders is larger (Amihud et al., 2005).

The absolute bid-ask spread is the difference between the lowest ask price and the highest bid price:

$$S^{abs}_t = P^a_t - P^b_t.$$  \hspace{1cm} (6)

This measure is always positive and its lower limit is the minimum tick size.

2.4.1. Relative Spread

Relative spread calculated with last trade:

$$S^{rel}_t = \frac{P^a_{t-1} - P^b_{t-1}}{P_t}.$$  \hspace{1cm} (7)

$P_t$ denotes the last paid price of the asset before time $t$. $P^a_{t-1}$ and $P^b_{t-1}$ are ask and bid prices before trade execute, respectively. $P_t$ may be at the ask price in an upward moving market, whereas it will be at the bid price in a downward moving market. On the other hand, the paid price $P_t$ has to be known before $P^a_{t-1}$ or $P^b_{t-1}$ are quoted (Wyss, 2004).

2.5. Effective Spread

The effective spread of a particular stock on the $k^{th}$ trade is defined as:

$$S^{eff}_k = 2 \cdot \ln \left( P_k \right) - \ln \left( mq_k \right).$$  \hspace{1cm} (8)

where $P_k$ is the price of the $k^{th}$ trade and $mq_k$ is the midpoint prevailing at the time of the $k^{th}$ trade. For a particular stock aggregated over a time interval $T$ (either a month or a year), the Effective Spread is the dollar-volume-weighted average of $k$ Effective Spread computed over all trades in time interval $T$ (Goyenko et al., 2008).
2.6. Roll’s model (RO)

Roll’s (1984) model is one of the measures of effective bid-ask spread, and it means that this measure is used for calculation effects of bid-ask spread on feature of stock returns time-series (Campbell et al., 1997). This estimator of liquidity indirectly includes costs of trading which are based on behaviour of prices (Lesmond, 2005). Roll proposes an estimator of implied effective spread based on measuring the negative autocorrelation produced by bounces between the bid and ask quotes. Particular to general liquidity, this estimator should be positively related to the bid–ask spread. However, the serial autocorrelation is, at times, positive, invalidating the estimate (Lesmond, 2005).

Roll proved his model using the first order autocovariance for simple returns (return of stock \( i \) on day \( d \) in month \( t \)), on following way:

\[
RO_{i,t} = 2\sqrt{\text{Cov}(R_{i,d-1,t}, R_{i,d,t})}.
\]

(Lee, 2006)   \( (9) \)

However, this measure cannot be defined if the covariance term is positive. In that case, we force covariance terms to have negative values by taking absolute values with a negative sign added (Campbell et al., 1997; Lee, 2006).

2.7. Realized Spread

The realized spread of a particular stock on the \( k \)th trade is defined as

\[
S_k^i = \begin{cases} 
2 \cdot (\ln(P_k^i) - \ln(P_{k+5}^i)) & \text{when } k\text{-th trade is a buy} \\
2 \cdot (\ln(P_{k+5}^i) - \ln(P_k^i)) & \text{when } k\text{-th trade is a sell}
\end{cases}
\]

\( (10) \)

where \( P_{k+5}^i \) is the trading price five-minutes after the \( k \)th trade. The trades are signed according to Lee and Ready (1991) algorithm (Lee, Ready, 1991). For a particular stock aggregated over a time interval \( T \) (either a month or a year), the Realized Spread is the dollar-volume-weighted average of \( k \) Realized Spread computed over all trades in time interval \( T \) (Goyenko et al., 2008). Indeed, Goyenko et al., (2008) included effective spread and realized spread in high-frequency spread proxies, and Roll’s measure included in low-frequency spreads proxies.

2.8. Quoted Spread (QS)

In markets with established market makers, the existence range between the price at which the market maker wants to buy and the price at which market maker wants to sell can have non-trivial impact on the serial correlation in price changes (Campbell et al., 1997). The bid–ask spread is calculated using the average of the available quarterly quotes and incorporates at a minimum a single quarter’s quote for that quarter (Lesmond, 2003). The average bid–ask spread spanning the quarter is used for the estimate of the spread. This procedure minimizes outlier problems and averages out the recording of either quarterly highs or lows in quotes resulting from quarterly sampling. The quarterly quoted spread is defined as:

\[
QS_q = \frac{1}{2} \left[ \left( \frac{P^{u}_{q} - P^{b}_{q}}{P^{u}_{q} + P^{b}_{q}} \right) \left( \frac{P^{u}_{q-1} - P^{b}_{q-1}}{P^{u}_{q-1} + P^{b}_{q-1}} \right) \right]^{2} (\text{Lesmond, 2005}).
\]

(11)

3. ADVANTAGES AND DISADVANTAGES

Lesmond (2005) concludes that any measuring of liquidity has its advantages and disadvantages when used for estimation of liquidity among countries or within some country. In general, liquidity is not a one-dimensional variable and therefore can hardly be captured in a single one-dimensional liquidity measure. According to Amihud (2002), it is doubtful whether there is one single measure that captures all aspects of liquidity. On the other hand, the one-dimensional measures may give insight into specific questions of market liquidity which more complicated measures are unable to furnish. The probability
of information based trading (PIN) would be a useful indicator of liquidity in frontier and emerging markets due to informational asymmetries are expressed in these markets. However, the PIN measure is empirically impossible to find due to lack of information for buying and selling quota\(^3\), as well as the total number of purchases and sales for every action and every day, on the frontier markets. This liquidity measure was used by Easley et al., (2002), Yan and Zhang (2006), and Li (2008). Market capitalization and measures based on size of the company are not good indicators of liquidity in frontier and emerging capital markets. Large portion of the total capitalization on the Serbian frontier market is highly illiquid, i.e. many companies are listed on the exchange just de-jure rather than de-facto. In addition, only a small fraction of the companies is typically floated. Size of the company or its market capitalization as a potential for trading activity is not reliable, because there are certain categories of shareholders which are extremely realistic to assume that they will not find on side of sale. More accurate measure introduces the concept of the number of shares which are in free turnover, i.e. the market value of those shares - the free float market capitalization\(^4\). Turnover is the ubiquitous liquidity measure (Lesmond, 2005). The advantage of this measure is that it makes different stocks comparable. Turnover is easy to construct and has intuitive appeal (Lesmond, 2005). Turnover captures trading frequency but fails to account for the cost per trade, which varies considerably across assets. Moreover, turnover is likely to be nonlinear with respect to the bid-ask spread, leading to scaling problems with this measure. Turnover and the bid-ask spread is hypothesized to be inversely related because larger spreads should reduce the frequency of trade (Lesmond, 2005). Lesmond (2005) explained that turnover is downward biased for low liquidity markets. This downward bias is practically manifested by reduced trading volume that specifically affects turnover. General conclusion is that turnover measure is not a viable liquidity measure in frontier and emerging markets, either in assessing cross-country or within-country liquidity (Lesmond, 2005; Bekaert et al., 2007).

Glosten and Milgrom (1985) modelled the cost of trading as the bid-ask spread. Although the bid-ask spread is the most used measure, spread is not always available for all bonds or for all time periods. This is especially true for thinly traded bonds or more mature bonds. Additionally, if data are hand-collected, quote information are gathered only on a quarterly basis, what lead to smaller precision for liquidity measure (Chen et al., 2007). Presence of bid-ask spread complicates things in several ways. Instead of one price for each, there are now three prices: bid price, ask price, and price of transaction which is not bid nor ask (although in some cases it is), neither it lies between these prices (although in the most cases lies). Since random purchases and sales go in the market, prices can bounce back and forth between bid and ask price, making spurious volatility and serial correlation in returns, yet economic value of stock is unchanged (Campbell et al., 1997). The bid-ask spread based on market microstructure data is not accessed for longer time series. Further, the bid-ask spread is good measure for cost of sales for small number of stocks, but this measure is not good measure for cost of sales for high number of stocks (Acharya and Pedersen, 2005). The quotes are rough indicators of the underlying liquidity. The bid–ask quote is by far the most demonstrable indicator of overall liquidity, but closing prices often deviate from the quotes as trades are consummated at different prices from, or even outside, the quotes. In addition, quotes are not always available in all markets and for all time periods (Lesmond, 2005). Fleming and Remolona (1999) used relative spread. Relative spread is liquidity measure which is the most studied because it is easy to calculate and because it allows comparison of a spread of different shares. Some authors have called this measure "inside spread". If the last trade occurred long before the absolute spread measured, prices for traded and the relative spread may be irrelevant to the actual market situation (Wyss, 2004). Amihud et al., (2005) inferred that relative spread is not good measure of liquidity, because it does not cover all aspects of liquidity.

The advantage of Roll’s measure is that it require only price to estimate liquidity instead of trading volume (Lesmond, 2005). Hence, Roll (1984) accepted that quoted spread can usual differ from effective spread, or spread between actual market prices of a sell order and a buy order (Campbell et al., 1997). Some of Lesmond’s findings are that cross-country differences in liquidity are best reported using the price based model as Roll’s (1984) model. However, results by Lesmond (2005), Bekaert et al. (2007) indicated that Roll’s measure is not robust estimator of liquidity when it is used within each

\(^3\) Information on buying and selling quotas for each share of these small, specific markets are not publicly available.

\(^4\) http://www.belex.rs/trgovanje/vesti/8237
individual country. The Roll (1984) measure uses the bid-ask bounce-induced negative serial autocorrelation in returns to estimate the effective spread. Roll’s measure requires a negative autocorrelation in the returns. If the serial autocovariances are positive, Lesmond (2005) force it to be negative and uses the Roll estimate as if a negative serial autocovariance is estimated (Harris, 1989). Harris (1990) explains that positive autocovariance could result from closing prices that cluster at the ask, violating Roll’s assumption of trade independence (Lesmond, 2005).

4. CONCLUSION

This paper presents an overview of different types of one-dimensional liquidity measures. In order to integrate Serbian market into EU financial market, structural change is required. Serbian market belongs to frontier markets. One of the major requirements that this market transforms to emerging and than to develop market is to improve its liquidity. Thus, it is very difficult to cover liquidity with only one variable. Liquidity can be well described as a function of a number of variables, where each variable is an approximation for incomprehensible concept of liquidity (Amihud, 2002). The one-dimensional liquidity measures covered in this paper are: probability of informed trading, market capitalization, turnover, and different spread-related liquidity measures. The one-dimensional measures may give insight into specific questions of market liquidity which more complicated measures are unable to furnish. For a global liquidity measure, certainly one of the multi-dimensional liquidity measures have to be used (Wyss, 2004). Generally, measuring of market liquidity is not a trivial problem.

REFERENCES


