The impact of institutional investors on equity markets and their liquidity

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Citation for published version (APA):
Chapter 3

Market liquidity

3.1 Introduction

Liquidity is a desired attribute of the functioning of financial markets. It measures the ease with which trades can be executed. In particular, it is concerned with the issue of whether assets can be readily sold with a minimum price impact. In this chapter we discuss three questions that concern market liquidity: What is liquidity? What are the components of liquidity costs and what determines them? How do we measure market liquidity? Answers to these questions will help us in conducting the empirical analysis of the impact of institutional investors on market liquidity in Chapters 6 and 7. Our discussion is based mostly on the market microstructure literature. Rather than a literature review, this chapter should be viewed as a review of the concepts and measures of market liquidity, in particular of shares.

Why is the market liquidity of shares important? It is one of the major determinants of a firm’s cost of capital and hence that firm’s share price. If a share (a bond, or some other asset) is illiquid, investors will require a ‘liquidity’ premium. Liquidity premium reflects the cost associated with trade uncertainty, and the compensation for bearing the risk that liquidity is unpredictable. A liquidity premium increases the required return on an illiquid share, and hence the firm’s cost of capital. Increases in liquidity reduce investors’ required rate of return and hence increase the share’s price. Amihud and Mendelson (1986) show that reductions in liquidity costs should lead to higher share prices, even without any improvement in corporate fundamentals. The cumulative effect of liquidity costs on the

1Brennan and Tamarowski (2000).

2In addition to these private costs of illiquidity, there is a social cost. Low liquidity may lead to a divergence of securities prices from their efficient or true value. As a result, the efficient allocation of capital within the economy may be hampered. The focus of this dissertation is on private costs.
security’s value is considerable because these costs are incurred each time the shares are traded. Increased share prices mean that the cost of capital for firms that issue shares decreases.³

The chapter is organized as follows. In Section 2 we define liquidity. In Section 3 we discuss the components of liquidity costs. We look at the main determinants of liquidity costs in Section 4. In Section 5 we review some of the most frequently used measures of liquidity. Section 6 draws some conclusions.

3.2 What is liquidity?

Market liquidity of an asset is usually defined as the ability to trade when needed, without incurring substantial costs or affecting the price substantially. This broad definition suggests that liquidity can have different interpretations and cannot be represented by a single variable. Liquidity has a time component (immediacy), it is related to trading costs and it has to do with the price impact. In addition, market liquidity may depend on the amount of the asset that needs to be traded.

With respect to immediacy, market liquidity can simply be viewed as a result of the demand and supply of immediacy.⁴ If an asset has to be sold immediately, the price concession (price impact) reflects its liquidity. The impact of trade orders on prices reflects the lack of liquidity and stems from adverse selection and inventory costs (as we will see later on). The ability to buy or sell a particular asset with a minimum price impact can be viewed as liquidity in a narrow sense. Liquidity can also be defined in a broader sense, as the total funds available to security markets, or even to the economy as a whole.⁵

Kyle (1985) distinguishes three components of liquidity: tightness, resiliency and depth. Tightness refers to the deviations of transaction prices from the efficient price. It shows in the bid-ask spread quoted by the market maker. Resiliency takes into account the speed of return to the efficient price after a random deviation and as such requires some estimate of the equilibrium price. The third component of liquidity is depth. A partial (and frequently) used measure of market depth refers to the volume that can be traded at the current price level. The slope of the price impact function (discussed later on) can also be used as a measure of market depth. Thickness of trading in a particular asset, or market intensity has been discussed as an additional component of liquidity in the literature. It is

³The link between liquidity and a firm’s cost of capital has recently been emphasized in the literature, but it is not the subject of our study. Amihud (2000), e.g., provides a concise overview of the literature on the impact of liquidity on stock returns. See also Eleswarapu (1997), Chalmers and Kadlec (1998), Amihud and Mendelson (2000), Brennan and Tamarowski (2000), Botosan (2000), among others.

⁴For example, Grossman and Miller (1988) model market liquidity in this way.

⁵See Stumpp and Scott (1991) for definitions of liquidity with different scopes.
positively related to the first two components, and defined by either the number of shares, or the number of transactions per unit of time.\textsuperscript{6} Thickness of trading is a result of the willingness of informed and non-informed market participants to trade, and could as such also be viewed as liquidity in the broader sense.

Definitions of liquidity used in empirical studies have to be more operational. Asset managers, for example, describe liquidity in terms of the free float of securities, or the size of transactions that can be processed immediately. The latter suggests that liquidity has to be viewed as a transaction-size-specific concept.\textsuperscript{7} What we refer to as liquidity throughout this chapter is the relative ease, cost and speed with which an asset can be traded.

### 3.3 Components of liquidity costs

Liquidity depends on explicit and implicit costs of buying and selling an asset. The lack of liquidity effectively augments trading costs, therefore it becomes important to find out what the components of trading costs are.\textsuperscript{8} Trading costs arise explicitly and implicitly in all organizational forms of securities’ markets. Four components of trading costs can be distinguished: bid-ask spread, market impact costs, delay and search costs, and direct transaction costs (Amihud and Mendelson (1991)). The first three components evolve more implicitly and also depend on the trading mechanism in place. They could also be viewed as the adverse selection and opportunity costs. The higher any of the cost components, the lower the liquidity of the asset. In this section we discuss these components of liquidity costs in more detail. Because the bid-ask spread is probably the most important of them, we devote more attention to it.

#### 3.3.1 Bid-ask spread and the price-impact costs

The \textit{bid-ask spread} is the difference between the highest share price on the bid (i.e. the buying) side and the lowest price on the ask (i.e. the selling) side, quoted by market makers, specialists, or any other public traders. The spread is a consequence of the asymmetry of information about the value of the share. It results from the inability of market makers to distinguish between information-driven order flow, and the order flow of non-informed traders. Because larger orders are more likely to come from informed-traders, market makers set prices as an increasing function of the order flow. This creates a positive

\textsuperscript{6}Some of the discussion in this paragraph follows Engle and Lang (1997).

\textsuperscript{7}Some markets may be liquid for small-size transactions, and very illiquid for large ones. The opposite might hold for other markets.

\textsuperscript{8}For example, Breen et al. (1999) provide empirical evidence on the costs of illiquidity.
relationship between the order flow and the price change (Kyle (1985)), also known as the price impact, or ‘Kyle’s lambda’.

Market impact costs therefore result from the influence of large sell and buy orders on the market price. The spread and the price impact reflect the asymmetrical information among traders in the sense that transactions may be induced by informed traders that possess new information that is not reflected in market prices yet.

Röell (1997) argues that there are four main sources of the bid-ask spread that each explain a different aspect of the spread: order processing costs, inventory costs, adverse selection costs and oligopoly profits. The spread arises because market makers as providers of liquidity in the dealer markets need to be compensated for the risk they undertake when they hold inventories of assets in order to be able to accommodate orders (inventory costs). Moreover, market makers need to be compensated for the losses they may have to bear when they trade against informed traders (adverse selection costs). The tougher the competition among market makers, the lower the trading costs, ceteris paribus. We look at each source of the spread in turn.

i) Order processing cost

Part of the bid-ask spread that market makers set is due to the cost of processing orders. There seem to be considerable economies of scale in processing the orders, hence one would expect per unit order processing costs to decrease in the size of orders.\(^9\)

ii) Inventory costs

The costs of carrying inventory arise as the downside of the market makers’ provision of immediacy. Market makers are those that absorb temporary imbalances in order flow in the dealer markets, and they have to be compensated for this service. One reason for that is that they need to hold inventories of the assets they trade in. When their inventory level deviates from the desired one, it causes additional costs to market makers. Moreover, price changes expose market makers to the risk of fluctuations in the value of their inventory.

\(^9\) The models of the behavior of stock prices in the dealer markets have been extensively studied in the market microstructure literature. They can generally be divided into two groups: i) inventory-management-based models, and ii) asymmetric information-based models. See Madhavan (2000) for a recent review of these models.

\(^10\) Order processing costs are usually modeled as a fixed amount that increases the transaction price of the asset, i.e. it increases the actual price the buyer has to pay to the market maker (as in Glosten and Harris (1988)). Roll (1984) shows that under some restrictive assumptions fixed order processing costs also imply a fixed spread. The inventory costs models, however, predict a spread that is increasing in the size of the order.
For these reasons, a risk-averse market maker adds a risk-premium to the bid and ask price. Ho and Stoll (1981, 1983) show that these two mark-ups increase in the market maker’s monopoly power, trade size, volatility of share price, risk aversion and time horizon. Moreover, the size of the mark-ups also depends on the inventory level. The mark-up on the ask price is decreasing in the inventory holdings, and the mark-up on the bid price is increasing in the inventory holdings.

iii) Adverse selection costs

When trading against informed traders, market makers face an adverse selection problem. Adverse selection in this case means that informed investors will sell a share when they know that its price is too high and they will buy when they know the price is too low (Amihud and Mendelson (2000)). Even without explicit transaction costs, the spread between bid and ask prices arises due to the information that some of the traders might be trading on. Knowing that they may incur losses on the trades with the informed traders, market makers respond by quoting higher prices for buyer-initiated transactions, and lower prices for seller-initiated ones. Kyle (1985) shows that the larger the number of non-informed, liquidity traders, the easier it is to conceal the information-based trades, and the more the informed investors trade. In a market where transactions are more likely to be initiated by informed traders, the bid-ask spread is larger, the price impact is stronger, whereas the liquidity of the market is lower.

3.3.2 Other costs of liquidity

Delay and search costs represent the opportunity costs of not having the transaction executed immediately. They depend on the type of orders given (i.e. limit-, market-, stop order etc.). Delay and search cost are incurred explicitly when traders have to delay the execution of a particular order to get a better price, or search for a new trading partner. Because the market maker’s inventory costs are ultimately determined by his search and delay costs, the latter can sometimes be replaced by the inventory cost. In that sense, the cost of search and delay encompasses the risk of unfavorable price movements due to delays.

Direct transaction costs are the explicit trading costs. They include brokerage fees, ex-
change commissions, and transaction taxes. They differ across exchanges and across countries. They are affected directly by the securities regulation that determines exchange fees, transaction taxes, brokerage commissions and the disclosure of trading information.

### 3.4 Determinants of liquidity costs

Multiple factors determine the costs of liquidity. Most of these costs are determined outside of a company’s control: by investors, brokers, dealers, exchanges and regulators. In addition to the securities regulation, the components of liquidity cost are also determined by the level of information that different types of traders possess, the level of competition among them, and by the market structure and design. In this section we discuss the impact of market architecture and competition in more detail.

#### 3.4.1 Market design

Securities markets exhibit wide heterogeneity with respect to degree of continuity of trading, reliance on market makers, order types, trading protocols and transparency (Madhavan (2000)). These dimensions to a large extent determine liquidity of the markets. With respect to the reliance on dealers, we can distinguish two types of stock markets: i) dealer or quote-driven markets; and ii) auction or order-driven markets. The auction market can be organized either as a batch or as a continuous auction. In the dealer markets, the providers of liquidity are the agents (market makers) who are willing to buy and sell a particular asset at the quoted bid and ask prices. Market orders (limit order book systems) provide for liquidity in the auction markets. Pagano (1996) shows that the lower transparency of the dealer market makes it less liquid than the auction market. Since market makers have less information about the recent trading history they have to set spreads higher than in an auction market. There is a trend towards hybrid systems (think of the London Stock Exchange, Nasdaq etc.).

By choosing an appropriate trading mechanism that enables the fast execution of trades, stock exchanges can reduce the delay costs and in this way enhance liquidity of the market. A manual (or an electronic) auction market with multiple participants who are willing to absorb incoming orders is an example of how the costs of searching for potential trades can be reduced. Another feature of the organization of trading is allowing limit orders to compete with quotes by market makers (like on Nasdaq since 1997), for example. Limit orders intensify competition which then reduces the bid-ask spreads and can provide greater market depth (Amihud and Mendelson (2000)). However, search/delay costs may be big

\[13\text{See e.g. Madhavan (2000) for an excellent survey of the literature on market structure and design.}\]
if the market is too thin. Many markets feature competition between market makers as well. We return to the issue of competition in the next subsection.

The last two decades brought about substantial changes in the design of securities markets. Heterogeneity among market participants and their specific needs spurred on the rise of specialized markets that can be more efficient in matching the liquidity needs of different groups of investors. The upstairs markets for blocks of shares and separate markets for processing large and institutional trades (like SEAQ International, for example) developed. The advances in computer technology spurred the growth of electronic markets which can provide liquidity for small, retail traders and support the issues of shares. Internet trading has reduced the cost of trading and improved the provision of relevant information about companies and their shares. Internet trading presents direct competition to other traditional trading modes. While these additional market 'places' might improve liquidity and trading terms for particular types of investors, their side-product might be the fragmentation of order flow.

3.4.2 Competition and the fragmentation of order flow

Although trading augments liquidity and the theory shows that it would be optimal for each asset to be traded in one market only, it is quite common for the same asset to be simultaneously traded in multiple markets. Trading across fragmented markets provides informationally less efficient prices than consolidated trading in a single market. In addition, fragmentation of order flow may reduce the liquidity of individual markets and increases their bid-ask spreads.

One possible explanation of the fragmentation of order flow is that it increases competition among the traders that trade in the same asset. The higher the level of competition among

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14 Another market structure factor that influences the liquidity of security markets is the existence of derivatives markets. The introduction of basket securities, like indices for example, also has an impact on the liquidity of the underlying securities. Multimarket trading has complex consequences for market liquidity, some of which we mentioned when we discussed market fragmentation. More recent research on price discovery may prove very important for better understanding of these complex interactions among different markets (See Leach and Madhavan (1993), for example). This is beyond the scope of this study.

15 With symmetrical information and in the absence of transaction costs, two markets can coexist only if they are completely identical (Pagano (1989)). When two markets differ in size and in variance of the traders' endowments, the presence of transaction costs can facilitate the existence of both markets. When traders have asymmetric information and only the informed ones can choose where to trade, the informativeness of prices increases in the number of markets if traders can observe all trading prices (Chowdry and Nanda (1991)). This result is driven by the immobility of small uninformed traders and by the exogenous number of informed traders. If all traders are able to choose the location of their trade, and there are no obstacles to their mobility, which would force them to trade in a particular market, the trading will concentrate in one market due to liquidity considerations. See O'Hara (1995) for an extensive discussion of this model.
markets where the same asset is traded, the lower the spreads and trading costs (O’Hara (1995)). In other words, the magnitude of trading costs also depends on the degree of competition among market makers. The problem is how to measure competition.

Fragmentation is a function of the information that traders possess, their mobility etc. It is closely related to differences in disclosure and transparency across markets (see Chapter 3). The markets differ with respect to what information is provided (pre-trade, post-trade), how much information gets disseminated and how fast this occurs. Informed investors prefer not to trade in those markets with stricter rules on disclosure of ex-post trading information and stricter trading practices (see Madhavan (1995)). In such markets, market makers can set better prices. Liquidity traders benefit from better prices, hence they concentrate on the more transparent markets. Madhavan (1995) demonstrates that even when potential informational economies of scale are present under multiple markets, the order flow fragmentation occurs if trade disclosure is not mandatory. This happens because large traders, informed traders and market makers all benefit from fragmentation with nondisclosure. Large and informed traders can get better executions in a non-transparent, fragmented market, while market makers face less price competition. Changes in transparency are hence not likely to benefit all traders equally. Public policies aimed at the integration of fragmented markets may neutralize the drawbacks of fragmentation.

Depending on the organization of the market, market makers compete for order flow with other dealers, floor traders, specialists, other exchanges, public limit orders, proprietary trading systems etc. Fluid entry and exit are crucial. Wahal (1997) shows that the number of market makers in a particular share depends on trading intensity of the share, its volatility and on the bid-ask spread. He finds that large-scale entry is associated with substantial declines in (end-of-day) quoted spreads, even after controlling for changes in volume and volatility. The magnitude of the effect is larger for securities with few market makers.

The degree of competition among market makers is reflected in quoted bid-ask spreads. Securities dealers may quote aggressively in order to obtain order flow from other dealers and institutions, and to indicate the willingness to provide price improvements to institutional traders (Pagano (1996)). The bid-ask spread increases with imperfect competition among market makers when these trade against informed traders. As shown by Pagano (1996), market makers recognize the adverse effect of their trading on the market price, therefore they demand less of the uninformed traders’ order flow than in the competitive case. As a consequence, less trading takes place. The lower the competition among market makers, the higher the expected trading costs that have to be borne by the uninformed traders.

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16When comparing a fragmented with a consolidated market under nondisclosure, Madhavan (1995) also finds that fragmentation leads to higher price volatility because less information is reflected in prices. Moreover, prices are inefficient in the sense that market makers are willing to undercut quotes that equal the conditional expected value of the asset.
3.4. Determinants of liquidity costs

3.4.3 Other determinants of liquidity costs

There are several other factors that determine the market liquidity of a share. We briefly consider some of them below.

First, since liquidity is mainly a function of informational asymmetries, any mechanism that reduces information asymmetry among investors can increase liquidity. Disclosure of information is one such mechanism. More extensive disclosure is typically associated with higher levels of a share’s liquidity (Botosan (2000)). Welker (1995), for example, finds a negative relationship between the quality of a firm’s disclosure and the bid-ask spread, after controlling for other factors that affect the spread. Financial analysts serve as important additional disseminators of information to the capital market. Their reports reduce information asymmetry among investors with respect to the future earnings of listed firms. Evidence shows that analysts can improve market liquidity of shares. Brennan and Tamarowski (2000) report a strong positive relationship between the number of analysts following a firm and the liquidity of its shares.

Second, advances in information technology and the dramatic rise of the Internet in particular are factors that can enhance market liquidity further. The use of the Internet has substantially reduced the cost of trading by reducing brokerage commissions, enabling investors to execute their own trades and providing direct access to information about companies at low cost.

Third, public policies and rules on exchange fees, transaction taxes, brokerage commissions and on the disclosure of trading information may have a substantial influence on trading costs and hence on market liquidity. The regulation of information disclosure which we discussed in the previous chapter is also important. There is some empirical evidence that shows that better disclosure increases the liquidity of the market (see, e.g., Brennan and Tamarowski (2000), and Botosan (2000)).

Fourth, the type of the asset and the choice of its marketplace can affect their liquidity from the start. Firms can optimize the liquidity of their shares in various ways. First of all, the design of securities matters (see Boot et al. (1999)). More information-sensitive securities will probably be more illiquid than less information-sensitive securities. Firms can further enhance the liquidity of their shares by selling them through a public offering, getting listed on a national exchange, choosing more standardized instruments, employing investment bankers and disclose additional information that can reduce informational asymmetries among traders, perhaps even by paying for analysts directly (Amihud and Mendelson (1986)). Market liquidity may also be improved by consolidating the order flow of a share on a single market.

The determinants of market liquidity we have discussed so far typically affect the liquidity of individual, not multiple shares. In general, we can distinguish between the time-series
and the cross-sectional determinants of market liquidity. Time-series properties of different liquidity measures across shares have only recently been studied in more detail (see Chordia et al. (2000b)). Intertemporal studies of liquidity suggest that there are some 'common factors' that simultaneously determine the liquidity (and returns) of multiple assets (Chordia et al. (2000a)). Common determinants of liquidity manifest themselves in correlated measures of liquidity over time. Dynamic trading strategies, tax and calendar effects and momentum trading are only some of the factors that could lead to correlated liquidity (Hasbrouck and Seppi (2000)). Because the lack of liquidity usually shows in higher trading costs, which depend on the market structure, trading costs and market structure are two likely candidates for the common factors that can simultaneously affect the liquidity of multiple shares.

3.5 How can we assess liquidity?

Liquidity subsumes a number of concepts that cannot be jointly captured by a single measure. Empirical measures are only proxies for the different aspects of liquidity (Amihud (2000)). None of them is likely to fully capture the notion of market liquidity. The choice of the measure is typically guided by the availability of required data and the purpose of the study.

According to their scope, we can divide liquidity measures into two groups: i) measures of liquidity of individual assets; and ii) measures of overall market liquidity. Market liquidity is a property of an individual asset, but we can assess the liquidity of the overall market from the liquidity of individual assets.

In this section we review some frequently used empirical and theoretical liquidity measures in each of the two categories. We define liquidity measures with respect to shares, and to the stock market as a whole. We only describe different measures here. Their theoretical underpinnings are discussed in the next section.

3.5.1 Individual shares

Precise measures of liquidity of an individual share require high-frequency, transaction data. When transaction data is unavailable, measures of liquidity based on less frequent

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17 Huberman and Halka (1999) find similar evidence for stock portfolios. They estimate time-series models for liquidity of market-capitalization-weighted portfolios and find correlations between residuals across portfolios, which they interpret as 'commonality' in liquidity.

18 See Madhavan (2000) for a brief overview of the studies of commonality in liquidity and returns.
3.5. How can we assess liquidity?

Data have to be used. For this reason, we further divide liquidity measures into (A) order-based measures, and (B) other measures.

A. Order-based liquidity measures

Bid-ask spreads are probably the most frequently used liquidity measures. They have long been used for comparing the cost of trading between markets and over time. The lower the spread, the more liquid the market is considered to be. Different variations of the bid-ask spread have been suggested. We list those that are most commonly used in Table 3.1. The spread reflects the price impact of the standard-size trades (Amihud (2000)). Because many transactions are not carried out at the (quoted) spreads, it has become common to measure liquidity by lambda. An intermediate measure in this respect would be the effective spread, which does take into account the transaction price.

Lambda measures the marginal impact of a trade on the price of a share, and corresponds to the slope of the regression line that relates the price change to the trade size. If there is no informational asymmetry among traders, lambda should be zero. We include three measures of price-impact in Table 3.1: the liquidity ratio of Grossman and Miller (1988), and two versions of lambdas. The measure that we call 'Price impact 2' is the lambda we have just described, corrected for the fact that the number of shares traded will depend on the price per share.\textsuperscript{19} For this reason, we divide lambda by the price of a share. This ‘currency’ lambda then measures the price impact per unit of currency.

One of the disadvantages of the spreads as liquidity measures is that they do not capture the provision of immediacy.\textsuperscript{20} The recognized limitations of spread-based liquidity measures lead to the introduction of measures that depart from spreads. The probability of information-based trading by Easley et al. (1999) is one of the most recent measures. It reflects the adverse selection cost that results from asymmetrical information between traders and the risk that share prices deviate from their full-information value. Another recently developed liquidity measure is the amount of one-sided volume accumulated during a price-based duration, or VNET. A price duration is a sequence of all transactions between a significant price movement (Engle and Lange (1997)). VNET is a direct measure of market depth and conveys the amount of excess demand that can be traded without making the quotes move beyond a specified threshold. This duration-based measure em-

\textsuperscript{19}See Brennan and Subrahmanyam (1996) and Brennan and Tamarowski (2000) for the discussion of the ‘dollar lambda’.

\textsuperscript{20}Grossman and Miller (1988), for example, model liquidity along its immediacy dimension. In their model, liquidity arises because in every period risk-averse market makers are willing to absorb excess demand in exchange for a favorable change in price between the periods. Their model suggests that the larger the demand for immediacy and the lower the cost to market makers of maintaining a continuous presence, the higher the proportion of transactions between ultimate traders that market makers process, and thus the better the liquidity.
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Chapter 3. Market liquidity

Table 3.1: Liquidity measures calculated from transaction data. \( P \) denotes price, \( Q \) is the guaranteed quantity available for trades at the quotes, \( q \) is total quantity traded, \( V \) is traded value and \( T \) denotes the holding period. Subscripts \( A \) and \( B \) stand for ask and bid, respectively. \( t \) indicates transaction at time \( t \), and \( M \) the bid-ask midpoint. Upper bars denote averages.

<table>
<thead>
<tr>
<th>Liquidity measure</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quoted bid-ask spread</td>
<td>( P_A - P_B )</td>
</tr>
<tr>
<td>Proportional quoted spread</td>
<td>( (P_A - P_B)/P_M )</td>
</tr>
<tr>
<td>Market depth</td>
<td>( \frac{1}{2}(Q_A + Q_B) )</td>
</tr>
<tr>
<td>Effective spread</td>
<td>( 2</td>
</tr>
<tr>
<td>Proportional effective spread</td>
<td>( 2</td>
</tr>
<tr>
<td>Amortized effective spread</td>
<td>( 2</td>
</tr>
<tr>
<td>Liquidity ratio(^a)</td>
<td>( V/(\Delta P) )</td>
</tr>
<tr>
<td>Price impact 1</td>
<td>( \lambda )</td>
</tr>
<tr>
<td>Price impact 2</td>
<td>( \lambda / P )</td>
</tr>
</tbody>
</table>

\(^a\)Grossman and Miller (1988).

phasizes a different aspect of liquidity, but it does not necessarily provide more information than spreads.

Yet another measure of liquidity used by researchers and the investment industry, also advocated by Irvine et al. (2000), is the per dollar cost of a round trip, CRT. CRT aggregates the status of the limit order book at any moment in the time for a specific transaction size, and measures the ex ante committed liquidity immediately available in the market.

Just like the measures listed in Table 3.1, these recent liquidity measures all require quote or transaction data. If one needs to estimate liquidity of the market, or of assets, for which intra-day data is not available, then other measures need to be used. We review some of them next.

B. Other liquidity measures

For almost all stock markets outside the US and the UK, transaction data is not readily available. For this reason, variations on the above measures need to be employed. With daily, weekly, monthly or annual data at hand, one can choose between the measures that we list in Table 3.2. First, we list the measures that neither resemble the bid-ask spread, nor reflect any price impact of trades. Empirical evidence shows that these simple measures of trading activity and size are correlated with liquidity as defined at the end of Section
3.5. How can we assess liquidity?

Table 3.2: Liquidity measures calculated from non-transaction data. Time subscripts are omitted because we can calculate these measures for any desired time period: day, week, month, year. $R$ denotes return on the stock in the period. Upper bars indicate averages over time period, and subscripts $B$ and $A$ stand for the best bid and the best ask in the period, respectively.

<table>
<thead>
<tr>
<th>Liquidity measure</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traded value</td>
<td>$V$</td>
</tr>
<tr>
<td>Average traded value</td>
<td>$\overline{V}$</td>
</tr>
<tr>
<td>Average traded volume</td>
<td>$\overline{Q}$</td>
</tr>
<tr>
<td>Turnover ratio (% of outstanding shares traded)</td>
<td>$\overline{Q}$%</td>
</tr>
<tr>
<td>Market capitalization</td>
<td>$C$</td>
</tr>
<tr>
<td>Ratio of traded value to market capitalization</td>
<td>$V/C$</td>
</tr>
<tr>
<td>Illiquidity ratio 1a</td>
<td>$</td>
</tr>
<tr>
<td>Illiquidity ratio 2</td>
<td>$</td>
</tr>
<tr>
<td>Illiquidity ratio 3</td>
<td>$(P_{MAX} - P_{MIN})/V$</td>
</tr>
<tr>
<td>Illiquidity ratio 4</td>
<td>$(P_A - P_B)/V$</td>
</tr>
<tr>
<td>Proportional daily (or weekly) bid-ask spread</td>
<td>$(P_A - P_B)/P$</td>
</tr>
</tbody>
</table>

$^a$ Amihud (2000).

In the second part of Table 3.2 we add some variants of the measure of illiquidity that was suggested by Amihud (2000). Amihud’s (2000) ‘illiquidity ratio’ gives the absolute percentage price change per dollar of daily trading volume, or the daily price impact of order flow. It is defined as the average ratio of the daily absolute return to the daily (dollar) trading volume. One of its main advantages is that it only requires data that is provided by the stock exchanges around the world as a standard. Typically, this ratio is calculated as an average daily ratio over some period. The ratio basically represents the price elasticity of demand and supply. When the ratio is increasing with constant or decreasing turnover, the market is illiquid. When the ratio is constant, or decreasing with constant or increasing turnover, the market is liquid. This suggests that a variance of the illiquidity ratio over time might be a better signal of illiquidity than the absolute value of the ratio.

The other three illiquidity ratios either have return expressed in non-percentage terms (Illiquidity ratio 2), or use some kind of price spread (Illiquidity ratios 3 and 4). The last measure in Table 3.2 is the proportional bid-ask spread, calculated from daily data.

The common property of the measures listed here is that they do not reflect the immediacy, i.e. the time that is needed for supply to find the demand. As such, they may only be considered as proxies for liquidity measures in cases where statistical data on buy and sell...
orders is not available.

### 3.5.2 Stock market as a whole

Although liquidity typically refers to an individual asset, it is quite easy to illustrate the liquidity of a market as a whole once we have information on the liquidity of individual assets. Measures like market capitalization, trading volume etc. can be calculated for single shares and for the overall market. In order to get the respective market magnitudes, one only needs to total up all traded shares.

The number of traders may also give an indication of how liquid the market is. The number of non-informed traders (also called liquidity, or noise traders) often appears as a measure of market liquidity in market microstructure models. The larger their number, the more liquid the market. Market liquidity can increase with scale, but not necessarily so. In other words, scale does not directly affect all empirical measures of liquidity.

The measures of liquidity we listed so far could be characterized as market-microstructure measures. Apart from the market microstructure literature, some broad liquidity measures have also been developed within the ‘macroeconomics’ literature. We now consider two of them.

### 3.5.3 Additional measures of liquidity

Liquidity is a concept that is frequently applied to the economy as a whole as well. In this respect, measures of aggregate money available for spending in the economy as a whole have typically been applied. Let us mention three examples of such macro liquidity measures: i) the annual growth rate of nominal money supply aggregate M2, less the annual growth rate of personal income; ii) the annual growth rate of real M2, less the annual growth rate of industrial production; and iii) the annual growth rate of real M3 less the annual growth rate of industrial production (Stump and Scott (1991)). When positive, each of these measures shows that money is growing at a faster rate than economic activity. In the developed financial markets much of this excess liquidity flows to the stock markets. It is interesting to see whether this excess money in the economy has any impact on the overall stock market prices. The three measures of ‘macro’ liquidity above have commonly been employed in studies of the impact of excess liquidity on the overall share prices.

If instead of the total excess liquidity within the economy we only take into account the part of it that comes from one type of financial institutions, we can perform a similar analysis of the price impact. For example, the net money flows to mutual funds could serve as a partial liquidity indicator, and we can employ this to study the impact of this
extra liquidity on stock market prices.\textsuperscript{21} The impact of flow-driven trades by mutual funds on stock prices can then serve as a measure of market liquidity. In its nature, this measure is similar to the theoretical measure of market liquidity of Gennotte and Leland (1990), who describe liquidity in terms of the impact of changes in supply of securities on their market prices. They measure liquidity as the inverse of the price elasticity of market supply, where elasticity is calculated as the ratio of the percentage change in market supply to the percentage change in the equilibrium price, or $-(\frac{\partial S}{S}/\frac{\partial P}{P})$. A higher price elasticity (a lower price impact) is interpreted as a more liquid market.

These measures of liquidity complete our overview. The list is not exhaustive. We limited our selection to those measures that we apply in the empirical analysis in the second part of this dissertation.

3.6 Concluding remarks

In this chapter we have defined market liquidity, described the most frequently used empirical measures of liquidity, and discussed the components of liquidity costs and their determinants. We have defined market liquidity in terms of immediacy, price impact of trades, and the costs of trading. Empirical measures typically take into account the last two. We categorized the measures of liquidity either as liquidity measures of individual assets or measures of overall market liquidity. Because many theoretically plausible measures require high-frequency data that is not readily available, more crude measures of liquidity need to be calculated at both levels. We have reviewed some of them in this chapter.

Furthermore, we analyzed the most important components of the costs of liquidity: the bid-ask spread, delay and search costs and the direct transaction costs. Information asymmetries among traders seem to be the most important source of liquidity costs. Among the institutional factors that additionally determine the liquidity of shares, we mentioned the organization of the market and the competition among traders and across markets.

Finally, the increasing presence of institutional investors has become important for the liquidity of capital markets around the world. Institutional investors may even be crucial for the sustainability of some capital markets. However, if shares become concentrated in the hands of a few large institutional investors, the proportion of shares that remain available for trading may drop. For this reason, the ownership structure of firms is important for market liquidity of shares. We return to the issue of market liquidity and ownership structure in Chapter 5, where we analyze various aspects of the relationship between institutional investors and capital market liquidity. We illustrate the importance of institutional investors and their influence on capital markets next.

\textsuperscript{21}For the studies of the aggregate impact of mutual funds on the stock market see, for example, Edelen and Warner (1999) or Mosebach and Najand (1999).