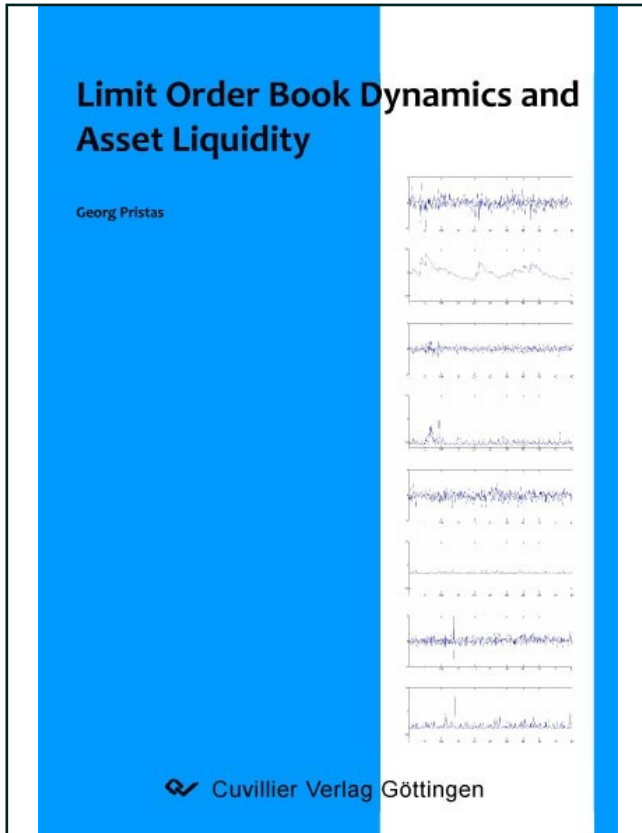




Georg Pristas (Autor)

Limit Order Book Dynamics and Asset Liquidity



<https://cuvillier.de/de/shop/publications/1381>

Copyright:

Cuvillier Verlag, Inhaberin Annette Jentsch-Cuvillier, Nonnenstieg 8, 37075 Göttingen,
Germany

Telefon: +49 (0)551 54724-0, E-Mail: info@cuvillier.de, Website: <https://cuvillier.de>

Chapter 1

Introduction

Liquidity, in the sense of market liquidity, is an essential characteristic of a well working financial market. In fact, the absence of liquidity can influence the trading process considerably. The simple situation that an investor is not able to sell any given amount of assets at a given point of time can cause a financial distress even up to its insolvency. From this point of view, market liquidity can be seen as the life elixir of financial markets.

Albeit it is easy to circumscribe or to think of intuitively, liquidity is much more difficult to define appropriately. Market liquidity, or, as related to one single asset, asset liquidity, has numerous dimensions. As mentioned above for the buyer side, timing is one of them. An additional dimension is the size of the amount of shares the investor needs to sell. The combination of just these two dimensions influences the price impact of the order in the market. But the price impact depends as well on the trading preparedness of the counterparty, the seller side. Hence, asset liquidity can be considered as a multidimensional problem.

Already a descriptive specification of a liquid asset or a liquid market reveals the complex nature of liquidity considerations. Since liquidity consists of several different dimensions it is difficult to find a definition that accounts for all these attributes. Such a definition has to be bound very general. An example can be found for instance in O'Hara (2004), where she states that a liquid market is one in which investors can trade into and out of positions quickly and without causing large price effects.

The vast majority of academic works suppose the existence of enough asset liquidity implicitly. Most models for valuation assume that the considered asset can be sold or bought immediately and for no costs, i.e. that enough asset liquidity is available. For that reason the aspect of not being able to trade is not included in valuation. However, two stories from financial history should help to highlight the importance of the topic of asset liquidity and in particular, the consequences of the lack of asset liquidity. The first one is the market crash of October 1987 and the second event mentioned here is the financial collapse of the Long Term Capital Management (LTCM) in 1998.

In financial markets history, Black Monday is the name given to Monday, October 19, 1987, when markets were suddenly flooded by sell orders overnight, sweeping away the outstanding buy orders. Because of this imbalance of orders, markets declined extraordinarily strongly and caused the greatest financial distress of modern times. Grossman and Miller (1988) discuss this event in the framework of their liquidity model and stated that in that situation "...markets had become highly illiquid and virtually incapable of supplying immediacy at low cost...". The crash started in New York and Chicago and activated a chain reaction across all financial markets around the world. It is the largest market breakdown reported in financial history. Although the event was entirely, or even primarily, not a matter of liquidity rather than of fundamentals, the large effects were assisted, if not even caused by the liquidity question.

The second event was the crisis of the hedge fund Long-Term Capital Management (LTCM) in 1998. The company had developed complex mathematical models and trading strategies to take advantages of different market arbitrage situations. Starting with fixed income arbitrage deals of different government bonds of U.S., Japanese and European markets, they moved into several riskier market environments. To enhance the high returns additionally, the fund had been extremely leveraged with borrowed capital. Consequently the fund grew so much that it had become the primary supplier in several markets. Hence, to find a counterparty to trade immediately large positions had been a hard task. As the Russian crisis started and Russian government bonds defaulted, LTCM had been forced to sell positions. Not least by virtue of few market liquidity LTCM collapsed.¹

¹For further readings see for instance Dunbar (2001) or MacKenzie (2003).

These two crises have shown an important aspect of liquidity - the risk of suddenly losing it. However, there is another more subtle aspect of liquidity. It is the day by day costs of transactions that have a significant impact on market prices and that are influenced by the level of liquidity. And of course the impact of dynamically changing liquidity levels. The better understanding of these changes and of course their influence on liquidity risk will be in the center of interest of this thesis.

The two liquidity risk stories of the previous section are a good example of the many faces of liquidity or its absence - illiquidity. Among the named symptoms of these liquidity crises were:

- The inability to find trading partners at market prices
- The inability to execute orders immediately
- High price impacts of trades
- High differences between offered buying and selling prices

These costs also occur in financial markets in the absence of a liquidity crisis but are influenced by the level of market respective asset liquidity.

1.1 Review of Related Literature

The term liquidity is multifaceted and can be used in several financial contexts. On the one hand in corporate finance or in accounting matters the concept of liquidity can be used to describe the ability to fulfill payment obligations at any time. This view is more cash or company based rather than market related. On the other hand an asset is considered liquid if it can be traded quickly, in large quantities and with little impact on the market price². In literature this kind of concept is called asset liquidity or, if refers to the market as a whole, market liquidity.

Asset or market liquidity, or henceforth simply liquidity, is an elusive concept. Because neither is directly nor explicitly identifiable as a risk factor, there exist

²See for similar definitions Keynes (1936), Black (1971), Glosten and Harris (1988) or Harris (1990a) among others.

a lot of different interpretations and definitions of it. Even though the existence of liquidity was already mentioned by Keynes (1936), Black (1971) tried to make a first descriptive characterization. Black (1971) established three dimensions to capture liquidity in accordance with today's understanding. He introduced the amount of stocks that can be traded at a given price (depth), the ability to trade across assets without affecting the price (breadth) and the dynamic of how quickly the price returns to its pre-traded price level (resiliency).

From another point of view that trading causes transacting costs, Demsetz (1968) already argued that the difference between the buy order price, so-called bid price, and the sell order price, referred to as ask price, reflects transaction costs. Hence, this difference between the bid price and the ask price, conventionally called the bid-ask spread, may be a proxy candidate for measuring liquidity.

Commenced with these main considerations, a vast amount of researchers started to investigate the aspects of liquidity. West and Tinic (1971), Amihud and Mendelson (1980), S. Phillips and Smith (1980), Amihud and Mendelson (1982), Ho and Stoll (1981), Ho and Stoll (1983) or Copeland and Galai (1983) for example, explored different aspects of transaction costs connected to the bid-ask spread. They conclude that the bid-ask spread may be an appropriate measure for liquidity. Garbade (1982) and Stoll (1985) shows that a negative link between the bid-ask spread and trading volume, number of shares, number of market makers and stock price continuity exists. Analysis of transaction costs in the context of a fixed investment horizon has been made by A. Chen, Kim, and Kon (1975), Levy (1978) or Milne and Smith (1980), among others.

Kyle (1985), Glosten and Milgrom (1985), Easley and O'Hara (1987) and Admati and Pfleiderer (1988) for instance started to theoretically describe the impact of liquidity on stock returns. Beside theoretical works empirical investigations such as Amihud and Mendelson (1986), Constantinides (1986), Grossman and Miller (1988), Heaton and Lucas (1996), Vayanos (1998), M. Huang (2003), O'Hara (2003), O'Hara (2004) or Eisfeldt (2004) followed and emphasized this proposition. Huberman and Halka (2001) analyzed the systematic nature of stock market liquidity. Holmström and Tirole (2001) developed a model where a security's expected return is related to its covariance of aggregate liquidity. Based on the impact of liquidity on stock returns the predictability of stock returns is another direction of sizable amount of investigations. Comparing

two equal stocks, which only differ in liquidity aspects, the more liquid one has lower returns but higher prices. Amihud and Mendelson (1986), Brennan and Subrahmanyam (1996) or Brennan, Chordia, and Subrahmanyam (1998) showed that measures of increased liquidity are associated with lower future returns, which seems to evidence this proposition. Among others, Pastor and Stambaugh (2003) find that aggregate liquidity is a priced risk factor in that sense. Amihud (2002) and C. Jones (2002) are even of the opinion that liquidity movements can be used to forecast aggregate returns. Moreover Baker and Stein (2004) stated that time variation in liquidity, on aggregate market or on single asset level, might deliver appropriate estimations of changes in returns and can be used to reveal insider trading.

Research has been extended to other markets than stock markets. The relationship between liquidity and option pricing have been investigated by Longstaff (1995) or Cetin, Jarrow, Protter, and Warachka (2003), for instance. Liquidity in treasury markets have been analyzed by M. J. Fleming (2003) or Strebulaev (n.d.) among others. A variety of different countries have been taken into account. It attracted attention that the kind of market-organization and market-structure, as well as trading rules and regulations, are summarized in market microstructure matters to measure liquidity. O'Hara (1995), Muranaga and Shimizu (1997) or Madhavan (2000) contributed works in that area.

Based on the knowledge of liquidity so far, some different measures have been tested in different markets. Different authors showed that the market microstructure affects liquidity measures. In the majority of cases two reasons for that are cogitable. First, liquidity measures cannot be easily compared with each other. And second, the efficiency of market microstructure can also be measured using liquidity measures. *Ceteris paribus* measuring lower transaction costs indicates a more efficient market microstructure.

1.2 Research Question

Economic theory assumes the existence of liquidity in financial markets. Asset liquidity is an essential component for a well working financial market because in the absence of liquidity no trading is possible. Since this liquidity restriction is so elementary it affects not only trading but also several other disciplines of

economic theory such as asset pricing or risk management. To measure liquidity accurately is therefore fundamental for the assumptions of a vast amount of economic concepts and financial models. It delivers the basics of the existence of all these models. The two stories at the beginning of this chapter highlight the effect of a sudden liquidity shock.

Lately, caused through these and other different events, researches into market and asset liquidity matters have grown. A huge amount of different measurement approaches have been developed. Different new figures and alternative concepts have been proposed. But all these concepts and figures consider the time proceeding dynamical behavior only implicitly.

In this thesis the main concern is to deal with the dynamical behavior of asset liquidity as time proceeds. Moreover we define the measure of the dynamical changes as the measure of asset liquidity and show that this measure reflects asset liquidity most accurately. From this point of view several questions demand to be answered. In particular these are:

- Is there a possibility to reflect the limit order book and its movements?
- Are there characteristic structures in this movements?
- Is it possible to capture the time series of these movements with a dynamical model?
- Is the measure of these dynamical changes an appropriate measure for asset liquidity?

These goals will be attained with both a sound mathematical background and on an economic fundament. The detailed structure of this thesis will now be described in the next paragraph.

1.3 Structure

The thesis is structured as follows. The first section is separated into two parts. In the first part of the section, market microstructure and some elements of it will be introduced. It will be shown how market liquidity depends on the structure and on the environment of financial markets. In connection with market

microstructure the concept of the limit order book will be introduced and explained in more detail. The second part of this section gives an overview about liquidity concepts in general. A definition of liquidity is given, liquidity dimensions are provided and several basic liquidity measures are introduced. The next section gives a short overview about specific econometric models which are used in later sections. The subsequent section introduces our new concept of an asset liquidity measure. In this section the basic ideas behind the concept are derived. We show the additional information which can be captured by the model and introduces the measurement approach in more detail. In particular, the new measurement approaches will be considered under an economic point of view. The next section is the main part of the thesis. It presents the empirical application of the model and delivers the results. The chapter starts with the reconstruction of the limit order book and shows evidence of characteristic structures in the dynamic of the limit order book. The limit order book will be examined under several points of view while these results build the fundament of the new measurement concept. Subsequently, an extensive econometric analysis follows and finally, the new concept of measuring asset liquidity based on the dynamic of the limit order book will be applied. A liquidity ranking based on this new measurement approach is presented. The chapter closes with the presentation of the liquidity premium computed on the liquidity ranking from the previous section. The last chapter summarizes the findings and gives some concluding remarks and an outlook for additional researches.