Theories of Liquidity

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Theories of Liquidity

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Abstract

We survey the theoretical literature on market liquidity. The literature traces illiquidity, i.e., the lack of liquidity, to underlying market imperfections. We consider six main imperfections: participation costs, transaction costs, asymmetric information, imperfect competition, funding constraints, and search. We address three questions in the context of each imperfection: (a) how to measure illiquidity, (b) how illiquidity relates to underlying market imperfections and other asset characteristics, and (c) how illiquidity affects expected asset returns. We nest all six imperfections within a common, unified model, and use that model to organize the literature.

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1

Introduction

Under the standard Arrow–Debreu paradigm, trading in financial markets involves no frictions and liquidity is perfect. In practice, however, frictions of varying importance are present in all markets and reduce liquidity. A large and growing theoretical literature traces illiquidity, i.e., the lack of liquidity, to underlying market imperfections such as asymmetric information, different forms of trading costs, and funding constraints. It also studies how imperfections affect expected asset returns through their influence on liquidity. This literature is complemented by a large and growing empirical literature that estimates measures of illiquidity and relates them to asset characteristics and asset returns.

In this paper, we survey the theoretical literature on market liquidity. We focus on six main imperfections studied in the literature: participation costs, transaction costs, asymmetric information, imperfect competition, funding constraints, and search. These imperfections map into six different theories of illiquidity. We address three basic questions in the context of each imperfection: (a) how to measure illiquidity, (b) how illiquidity relates to underlying market imperfections and other asset characteristics, and (c) how illiquidity affects expected asset returns.

The theoretical literature on market liquidity often employs different modeling assumptions when studying different imperfections. For example, papers on trading costs typically assume life-cycle or risk-sharing motives to trade, while papers on asymmetric information often rely on noise traders. Some papers on asymmetric information further assume risk-neutral market makers who can take unlimited positions, while papers on other imperfections typically assume risk aversion or position limits. Instead of surveying this literature in a descriptive manner, we use a common, unified model to study all six imperfections that we consider, and for each imperfection we address the three basic questions within that model. Our model generates many of the key results shown in the literature, and serves as a point of reference for surveying other results derived in different or more complicated settings. We use the same model in Vayanos and Wang (2012b), where we survey both the theoretical and the empirical literature on market liquidity. This paper focuses on the theoretical literature only, surveys it more extensively, and analyzes the model in greater depth.

Our model has three periods, $t = 0, 1, 2$. In Periods 0 and 1, risk-averse agents can trade a riskless and a risky asset that pay off in Period 2. In Period 0, agents are identical so no trade occurs. In Period 1, agents can be one of two types. Liquidity demanders receive an endowment correlated with the risky asset's payoff, and need to trade to share risk. They can trade with liquidity suppliers, who receive no endowment. Agents learn whether or not they will receive the endowment in an interim period $t = 1/2$. While we model heterogeneity through endowments, our analysis would be similar for other types of heterogeneity, e.g., different beliefs or investment opportunities. Market imperfections concern trade in Period 1. We consider six imperfections, studied extensively in the theoretical literature:

1. *Participation costs*: In the perfect-market benchmark, all agents are present in the market in all periods. Thus, a seller, for example, can have immediate access to the entire population of buyers. In practice, however, agents face costs of market participation, e.g., to monitor market movements and have ready access to a financial exchange. To model costly

participation, we assume that agents must incur a cost to trade in Period 1. Consistent with the notion that participation is an ex-ante decision, we assume that agents must decide whether or not to incur the cost in Period 1/2, i.e., after learning whether or not they will receive an endowment but before observing the price in Period 1. A related imperfection is that of entry costs, e.g., learning about an asset. The cost would then concern buying the asset in Period 0.

2. *Transaction costs*: In addition to costs of market participation, agents typically pay costs when executing transactions. Transaction costs drive a wedge between the buying and selling price of an asset. They come in many types, e.g., brokerage commissions, exchange fees, transaction taxes, bid-ask spreads, and price impact. Some types of transaction costs, such as price impact, can be viewed as a consequence of other market imperfections, while other types, such as transaction taxes, can be viewed as more primitive. We assume that transaction costs concern trade in Period 1. The difference with participation costs is that the decision whether or not to incur the transaction costs is contingent on the price in Period 1.
3. *Asymmetric information*: In the perfect-market benchmark, all agents have the same information about the payoff of the risky asset. In practice, however, agents can have different information because they have access to different sources of information or have different abilities to process information from the same source. To model asymmetric information, we assume that some agents observe in Period 1 a private signal about the asset payoff. We assume that these agents are the liquidity demanders. This assumption is without loss of generality in our model. It allows us to determine how the supply of liquidity is influenced by the concern of liquidity suppliers about trading against better-informed agents.
4. *Imperfect competition*: In the perfect-market benchmark, agents are competitive and have no effect on prices. In many markets, however, some agents are large relative to others

in the sense that they can influence prices, either because of their size or because of their information advantage. We model imperfect competition by assuming that some agents can exert market power in Period 1. We mainly focus on the case where liquidity demanders behave as a single monopolist, and consider, more briefly, monopolistic behavior by liquidity suppliers. We consider both the cases where liquidity demanders have no private information on asset payoffs, and so information is symmetric, and where they observe a private signal.

5. *Funding constraints*: Agents' portfolios often involve leverage, i.e., borrow cash to establish a long position in a risky asset, or borrow a risky asset to sell it short. In the perfect-market benchmark, agents can borrow freely provided that they have enough resources to repay the loan. But as the Corporate Finance literature emphasizes, various frictions can limit agents' ability to borrow and fund their positions. We derive a funding constraint by assuming that agents cannot pledge some of their future income. Because our focus is on how the funding constraint influences the supply of liquidity, we impose it on liquidity suppliers only, i.e., assume that only they are unable to pledge their income.
6. *Search*: In the perfect-market benchmark, the market is organized as a centralized exchange. Many markets, however, have a more decentralized form of organization. For example, in over-the-counter markets, investors negotiate prices bilaterally with dealers. Locating suitable counterparties in these markets can take time and involve search. To model decentralized markets, we assume that agents do not meet in a centralized exchange in Period 1, but instead must search for counterparties. When a liquidity demander meets a supplier, they bargain bilaterally over the terms of trade.

We determine how each imperfection affects measures of illiquidity in Period 1. We consider two such measures. The first is lambda, defined

as the regression coefficient of the return between Periods 0 and 1 on liquidity demanders' signed volume in Period 1. This measure characterizes the price impact of volume, which has a transitory and a permanent component. The second is price reversal, defined as minus the autocovariance of returns. This measure characterizes the importance of the transitory component in price, which in our model is entirely driven by volume. Lambda and price reversal have been derived in theoretical models focusing on specific market imperfections, and have been widely used in empirical work ever since.

In addition to the effect of imperfections on illiquidity in Period 1, we determine their effect on the ex-ante expected return as of Period 0, i.e., how does the expected return that agents require to buy the risky asset in Period 0 depend on the imperfections that they anticipate to face in Period 1. Many of the effects of imperfections that we derive within our model have been derived in the literature, albeit in a less systematic and unified manner. We highlight the links with the literature, and use more generally our model to organize and survey it. Many models in the literature can be viewed as enrichments of our model in terms of, e.g., information structure, agent characteristics, and dynamics.

Deriving the effects of the imperfections in a systematic manner within a unified model delivers new insights. We show, for example, that most imperfections raise lambda, but fewer raise price reversal. Thus, lambda is a more accurate measure of the imperfections. Intuitively, lambda measures the price impact per unit trade, while price reversal concerns the impact of the entire trade. Market imperfections generally raise the price impact per unit trade, but because they also reduce trade size, the price impact of the entire trade can decrease. We show additionally that imperfections do not always raise expected returns. The literature has shown this result for some imperfections; we examine its validity across all imperfections and identify those under which it is more likely to hold.

Our survey does not cover some important issues, either because they represent open questions on which research so far has been limited, or because covering them would detract from our main focus. Nevertheless, it is important to recognize these issues, both to put

our survey in perspective and to outline promising areas for future research.

A first issue concerns the horizon of liquidity effects. The market microstructure literature focuses on liquidity effects that manifest themselves over short horizons, from minutes or hours to days or weeks. At the same time, recent work on the limits of arbitrage finds that flows can affect returns even at the longer horizons used in asset-pricing analysis, e.g., months, quarters or years. We view both horizons as relevant for the purposes of our survey — provided that the price movements under consideration are temporary departures from fundamental value caused by flows. Our model can accommodate both horizons simply by changing the length of a "period." At the same time, that length is exogenous in our model and should be derived endogenously. That would require a more detailed description of market imperfections and agents' trading needs, as well as an extension of the model along the inter-temporal dimension. Such an extension would also allow for a more complete analysis of the joint dynamics of liquidity and asset returns.

A second issue concerns the interactions between market imperfections. Most of the theoretical literature considers one imperfection at a time and does not allow for interactions. Our model also does not cover interactions, except between imperfect competition and asymmetric information. Other interactions, such as between funding constraints and asymmetric information, are interesting and have received some attention in the literature.

A related but more fundamental issue concerns the underlying economic causes of the imperfections and the ways in which imperfections are linked. Following much of the literature, we treat each imperfection as primitive. Yet, some imperfections could be the consequence of other more fundamental ones. For example, some types of transaction costs, such as price impact, can be viewed as a consequence of other imperfections, such as participation costs or asymmetric information. Moreover, if participation costs are costs to monitor market information, then costly participation could be linked to asymmetric information. Asymmetric information could also underlie the contracting frictions that give rise to funding constraints. Endogenizing some

market imperfections from more fundamental frictions could further streamline, clarify and deepen the study of market liquidity. In particular, various forms of informational problems could be the underlying economic cause for various forms of imperfections.

An additional imperfection implicit in our model is that agents cannot contract ex-ante on whether they are liquidity demanders or suppliers ex-post. If they could write contracts conditional on their future trading needs, then there would be no trade ex-post and the other imperfections would not matter. Understanding the origin of this additional imperfection, and of trade more generally, is important.

A fourth issue concerns the design of the market. While we consider ways in which markets deviate from the Walrasian ideal, we do not study market design in depth. The market microstructure literature studies various dimensions of market design and shows that they can affect market performance. Such dimensions include whether liquidity is supplied by dedicated market makers or an open limit-order book, whether limit orders are visible to all traders, whether transactions are disclosed to all traders after they are executed, etc. While we survey some of that work, we conduct our analysis at a more aggregate level with less market detail, so that we can derive some key effects within a tractable unified model. The downside is that our model is not well suited for very short horizons of seconds or minutes. Our model is also not well suited for addressing the benefits of different market designs.

Related to market design is the broader institutional context. A large fraction of trading activity in financial markets is generated by specialized financial institutions, and these institutions can be important suppliers or demanders of liquidity. Following much of the literature, we model instead liquidity suppliers and demanders as individuals, thus ignoring contracting frictions and other institutional complexities. (We only consider such frictions briefly in the context of funding constraints.) The liquidity shock in our model could result from institutional frictions, but only in reduced form. The importance of financial institutions in affecting asset prices is emphasized in a rapidly growing literature on the limits of arbitrage.

Finally, we do not perform any analysis of welfare or policy (even though our model could be used for that purpose as well). For example,

we do not examine how imperfections affect the welfare of different agents and what policy actions could mitigate these effects. We survey, however, some papers that consider welfare and policy issues.

Our survey is related to both market microstructure and asset pricing. We emphasize fundamental market imperfections covered in the market microstructure literature, but abstract away from the level of market detail often adopted in that literature. At the same time, we study how market imperfections affect expected asset returns — an asset-pricing exercise. Surveys with greater focus on market microstructure include the book by O'Hara (1995) for the theory, the article by Hasbrouck (2007) for the empirics, and the articles by Madhavan (2000), Biais et al. (2005), and Parlour and Seppi (2008) for both theory and empirics. Amihud et al. (2005) survey theoretical and empirical work on market liquidity and asset-pricing effects. They mainly focus on transaction costs and not on other market imperfections. We consider instead six imperfections including transaction costs, both in this survey which focuses on the theory and in Vayanos and Wang (2012b) which also surveys empirical work. Gromb and Vayanos (2010) survey the theoretical literature on the limits of arbitrage.

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