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Optimal trading strategy and supply/demand dynamics ☆

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Abstract

In this paper, we study how the intertemporal supply/demand of a security affects trading strategy. We develop a general framework for a limit order book market to capture the dynamics of supply/demand. We show that the optimal strategy to execute an order does not depend on the static properties of supply/demand such as bid–ask spread and market depth, it depends on their dynamic properties such as resilience: the speed at which supply/demand recovers to its steady state after a trade. In general, the optimal strategy is quite complex, mixing large and small trades, and can substantially lower execution cost. Large trades remove the existing liquidity to attract new liquidity, while small trades allow the trader to further absorb any incoming liquidity flow.

JEL classification: G00; G11; G12

Keywords: Liquidity; Trading; Optimal order execution; Limit order book

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1. Introduction

The supply/demand of financial securities is in general not perfectly elastic.[2]

What trading strategy is optimal in a market with limited supply/demand or liquidity? How do different aspects of supply/demand affect the optimal strategy? How significant are cost savings from the optimal trading strategy? Traders face these questions each time when they trade. The answers to these questions are thus essential for our understanding of how market participants behave, how liquidity is provided and consumed, how it affects security prices, and more generally, how securities markets function.

We approach this problem by focusing on the optimal strategy of a trader who has to execute an order over a given time period.[3] This problem is also referred to as the optimal execution problem.[4] Previous work has provided valuable insights about how liquidity affects trading behavior of market participants (e.g., Bertsimas and Lo, 1998; Almgren and Chriss, 1999; Huberman and Stanzl, 2005). This literature tends to view supply/demand as a static object when analyzing their effect on optimal trading strategies. In particular, it describes the demand or supply of a security facing a large trade (depending on its sign) by specifying an instantaneous price impact function (i.e., a time-insensitive demand/supply schedule). Liquidity is, however, dynamic by its nature. Our contribution is to show that it is the dynamic properties of supply/demand such as its time evolution after trades, rather than its static properties, such as spread and depth, that are central to the cost of trading and the design of optimal strategy.

We propose a general framework to model the dynamics of supply/demand. We consider a limit order book market, in which the supply/demand of a security is represented by the limit orders posted on the "book" and trade occurs when buy and sell orders match. We describe the shape of the limit order book and especially how it evolves over time to capture the intertemporal nature of supply/demand that a large trader faces. We choose to focus on the limit order book market merely for convenience. Our main goal is to demonstrate the importance of supply/demand dynamics in determining the optimal trading strategy, and our main conclusions remain applicable to other market structures.

Our model explicitly incorporates three basic characteristics of liquidity documented empirically: bid–ask spread, market depth, and resilience. The first two features — bid–ask spread and market depth — capture the static aspects of liquidity. They are related to the shape of the limit order book, which determines how much the current price moves in response to a trade. Bid–ask spread and market depth therefore are key for determining the transaction cost that the trader incurs upon the execution of his trades instantaneously. The third feature — resilience — reflects the dynamic aspect of liquidity. Resilience is

[2]See, for example, Scholes (1972), Shleifer (1986), Holthausen, Leftwitch, and Mayers (1987, 1990), Kaul, Mehrotra, and Morck (2000), and more recently, Greenwood (2005) for empirical evidence on imperfect elasticity in the supply/demand of individual securities. Extensive theoretical work justifies such an inelasticity based on market frictions and asymmetric information (e.g., Kyle, 1985; Grossman and Miller, 1998; Vayanos, 1999, 2001).

[3]Ideally, we should consider both the optimal size of an order and its execution, taking into account the underlying motives to trade (e.g., return, risk, preferences, and constraints) and the costs to execute trades. The diversity in trading motives makes it difficult to tackle such a problem at a general level. Given that in practice the execution of trades is often separated from the investment decisions, we focus on the execution problem as an important and integral part of a more general problem of optimal trading behavior.

[4]The relevance of this problem for practitioners is highlighted in Chan and Lakonishok (1995, 1997), Keim and Madhavan (1995, 1997), and Obizhaeva (2008), among others.