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Strategic execution in the presence of an uninformed arbitrageur ☆

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Abstract

We consider a trader who aims to liquidate a large position in the presence of an arbitrageur who hopes to profit from the trader's activity. The arbitrageur is uncertain about the trader's position and learns from observed price fluctuations. This is a dynamic game with asymmetric information. We present an algorithm for computing perfect Bayesian equilibrium behavior and conduct numerical experiments. Our results demonstrate that the trader's strategy differs significantly from one that would be optimal in the absence of the arbitrageur. In particular, the trader must balance the conflicting desires of minimizing price impact and minimizing information that is signaled through trading. Accounting for information signaling and the presence of strategic adversaries can greatly reduce execution costs.

JEL classification: G11

Keywords: Optimal execution; Asymmetric information; Perfect Bayesian equilibrium; Price impact; Predatory trading

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1. Introduction

When buying or selling securities, value is lost through execution costs such as exchange fees, commissions, bid–ask spreads, and price impact. The latter can be dramatic and typically dominates other sources of execution cost when trading large blocks, when the security is thinly traded, or when there is an urgent demand for liquidity. Execution algorithms aim to reduce price impact by partitioning the quantity to be traded and placing trades sequentially. Growing recognition for the importance of execution has fueled an academic literature on the topic as well as the formation of specialized groups at investment banks and other organizations to offer execution services.

Optimal execution algorithms have been developed for a number of models. In the base model of Bertsimas and Lo (1998), a stock price nominally follows a discrete-time random walk and the market impact of a trade is permanent and linear in trade size. The authors establish that expected cost is minimized by an equipartitioning policy. This policy trades equal amounts over time increments within the trading horizon. Further developments have led to optimal execution algorithms for models that incorporate price predictions (Bertsimas and Lo, 1998), bid–ask spreads and resilience (Obizhaeva and Wang, 2005; Alfonsi et al., 2007a), nonlinear price impact models (Almgren, 2003; Alfonsi et al., 2007b), and risk aversion (Subramanian and Jarrow, 2001; Almgren and Chriss, 2000; Dubil, 2002; Huberman and Stanzl, 2005; Engle and Ferstenberg, 2006; Hora, 2006; Almgren and Lorenz, 2006; Schied and Schönenborn, 2007; Lorenz, 2008).

The aforementioned results offer insight into how one should partition a block and sequence trades under various assumptions about market dynamics and objectives. The resulting algorithms, however, are unrealistic in that they exhibit predictable behavior. Such predictable behavior allows strategic adversaries, which we call arbitrageurs, to "front-run" trades and profit at the expense of increased execution cost. For example, consider liquidating a large block by an equipartitioning policy which sells an equal amount during each minute of a trading day. Trades early in the day generate abnormal price movements. The resulting "information leakage" allows an observing arbitrageur to anticipate further liquidation. If the arbitrageur sells short and closes his position at the end of the day, he profits from expected price decrease. The arbitrageur's actions amplify price impact and therefore increase execution costs. Concern about the increased cost of trading due to information leakage is not academic. Indeed, it is known that many high-frequency statistical arbitrage trading strategies developed by banks and hedge funds profit by exploiting precisely this type of signaling (Duhigg, 2009).

Several recent papers study game-theoretic models of execution in the presence of strategic arbitrageurs (Brunnermeier and Pedersen, 2005; DeMarzo and Urošević, 2006; Carlin et al., 2007; Schönenborn and Schied, 2007; Oehmke, 2010). However, these models involve games with symmetric information, in which arbitrageurs know the position to be liquidated. In more realistic scenarios, this information would be the private knowledge of the trader, and the arbitrageurs would make inferences as to the trader's position based on observed market activity.

This type of information asymmetry is central to effective execution. The fact that his position is unknown to others allows the trader to greatly reduce execution costs. But to do so requires the deliberate management of information leakage, or the signals that are transmitted via trading activity. Further, the desire to minimize information signaling may be at odds with the desire to minimize price impact. A model through which such signaling can be studied must account for uncertainty among arbitrageurs and their ability to learn