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The impact of competition and information on intraday trading ☆

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ABSTRACT

In a dynamic model of financial market trading multiple heterogeneously informed traders choose when to place orders. Better informed traders trade immediately, worse informed delay – even though they expect the market to move against them. This behavior generates intraday patterns with decreasing spreads, decreasing probability of informed trading (PIN), and increasing volume. We predict that policies that foster market entry improve the welfare of uninformed traders and lead to increased market participation by incumbent traders. Technological advances that lead to better signal processing also encourage market participation and increase volume but at the expense of uninformed traders' welfare.

1. Introduction

Over the last two decades, equity markets have become increasingly accessible. Improvements in technology allow investors to obtain information at lower costs and to access equity markets faster. Moreover, reduced exchange and brokerage fees invite more activity. How do these changes affect trading behavior and through it, trading volume, liquidity, and price dynamics?

We develop a theoretical model to study the impact of changes in competition and information on trading behavior, trading profits, market participation, and volume. In our model, the strategic behavior of heterogeneously informed traders endogenously generates dynamic patterns in volume, bid-ask spreads, and the probability of informed trading that are consistent with commonly observed empirical intraday patterns.[1]

The theoretical model underlying our analysis is in the tradition of Glosten and Milgrom (1985). Liquidity is supplied by a competitive, uninformed, and risk neutral market maker. Traders either place orders for reasons outside the model (e.g., to rebalance their portfolio), or they have private information about the security's fundamental value. Adding to Glosten and Milgrom, we allow the informed traders to choose the timing of their trades, and we admit that the total number of traders is uncertain.

The critical component of a trader's timing decision in our model is the information "slippage cost" of delay. Introduced by Rosu (2012), the "slippage cost" refers to the gradual loss of an

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[1] The patterns differ across markets and across the analyzed time spans, but, most commonly, bid-ask spread decline and volume increases toward the end of the trading day. For instance, NYSE historically displayed U- or reverse J-shaped spreads and volume (Jain and Joh, 1988; Brock and Kleidon, 1992; McInish and Wood, 1992; Lee et al., 1993, or Brooks et al., 2003), but recent evidence (Serednyakov, 2005) suggests L-shaped spreads after decimalization; NASDAQ has L-shaped spreads and U-shaped volume (Chan et al., 1995); the TSX has U-shaped volume (McInish and Wood, 1990); the London Stock Exchange has L-shaped spreads and reverse L-shaped volume (Kleidon and Werner, 1996 or Cai et al., 2004). See also Brockman and Chung (1999) for the Hong Kong, Al-Suhaibani and Kryzanowski (2000) for the Saudi, Lee et al. (2001) for the Taiwanese, Ding and Lau (2001) for the Singaporian, and Kalev et al. (2004) for the Australian stock exchanges. Du (2011) shows that the probability of informed trading (PIN) (see Easley et al., 1996) for DJIA stocks follows the pattern of volume.

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informed trader's informational advantage over time. This cost arises in our model when an informed trader is pre-empted by other informed traders.[2] For an informed trader to delay, the bid-ask spread must thus decline over time to compensate this trader for the slippage cost. The adverse selection cost that the market maker faces (e.g., measured by the probability of informed trading) follows the pattern of the bid-ask spread and declines over the day.[3] Finally, in our model, the intraday decreases in bid-ask spreads and adverse selection costs are accompanied by an intraday increase in volume.

We next study how these measures are affected by changes in key components of the model to generate testable predictions that shed light on several market developments of the past decade. Our first set of results determines the impact of an increase in the competition among traders. Recent years saw the enactment of many policies that encourage market entry such as the improvement of market access for international investors by simplifying cross-country clearing and settlement procedures, the removal of barriers to trading through new regulations (e.g., the establishment of so-called "exempt brokers" who can offer trading services to retail investors at lower fixed costs), or the establishment of direct market access for institutional investors. Our model predicts that, as the expected number of traders rises, the cost of delay increases and more traders act early to capitalize on their information. This behavior mutes the intraday increase in volume, and it leads to a steeper intraday decline in the spread. The steeper decline in spreads generates an increase in market participation, in the sense that each trader is more likely to trade. Consequently, competition for information rents does not deter but attracts market entry and allows traders to benefit, even if they have comparatively weak information.

Our second set of results addresses the impact of policies that lead to systematic improvements in private information. Such an improvement can occur, for instance, when a company adopts or a regulator imposes a new disclosure policy that fosters transparency.[4] Intuitively, a systematic shift in information quality leads to more competition among the informed traders because, on average, there are more traders with high quality information. Our model predicts that, ceteris paribus, such an improvement leads to higher market participation, higher total volume, and a muted increase in intraday volume. In contrast to the entry of new traders, an increase in competition that is driven by improvements in private information causes wider spreads.

When we study the effect of competition on the average per-trader profits, we observe that trader entry reduces the average profit per informed trader, but that private information improvements increase this profit. In our model, the informed traders' rents come at the expense of the uninformed traders. We thus conclude that policies that foster market entry benefit uninformed traders whereas technological advances that lead to better private signal processing hurt uninformed traders.

The literature has developed several theoretical explanations for persistent patterns in observable variables. Most of this literature is in the tradition of Kyle (1985) and focuses on the impact of the aggregate order flow on trading variables. Models in the tradition of Glosten and Milgrom (1985) explicitly capture the evolution of bid-ask spreads, and we study the impact of timing in this context.

Admati and Pfleiderer (1988) analyze a setting with endogenous timing and attribute periods of concentrated trading to the timing decisions of discretionary liquidity traders. Informed traders do not time their actions, as their information is viable for only one period. The period with highest activity is determined by exogenous parameters, and thus, in principle, their model admits any pattern. Foster and Viswanathan (1990) analyze a single informed trader model and show that *inter*-day variations in volume and transaction costs arise when there are releases of public information.[5] We complement their work and offer predictions on the impact of competition between differentially informed traders.

Holden and Subrahmanyam (1992) employ a multi-period auction model with two insiders who receive *identical* signals at the beginning of the game. They trade aggressively and, as the difference between time periods vanishes, all information is revealed immediately. In Foster and Viswanathan (1996) each trader's information is a noisy signal of the asset value, and the correlation structure of signals affects trading intensity, profits, and price informativeness. Back et al. (2000) analyze the continuous-time limit of Foster and Viswanathan (1996). Signals in these models are identically distributed, and the focus is on the competition among ex ante identically informed traders. Bernhardt and Miao (2004) analyze a setting in which the information of early traders becomes stale compared to those who arrive later. They study how the arrivals of these differentially informed traders generate patterns in observables. We analyze the competition between ex-ante differentially informed traders who receive their information simultaneously, and we focus on the timing of trades and the market participation decisions. We further contribute by analyzing systematic improvements in information on trader behavior.

Employing an inventory-based trading model, Brock and Kleidon (1992) show that U-shaped volume can be caused by demand shocks that traders experience during periods of market closure. The monopolistic market maker then exploits this pattern and charges U-shaped spreads. Our analysis complements this line of work by studying *competitive* liquidity provision in a setting with asymmetric information.

Overview. Section 2 outlines the model, Section 3 derives the equilibrium. Section 4 studies the effect of an increase in competition between traders on market participation. Section 5 discusses the patterns of spreads, volume, and the probability of informed trading. Section 6 analyzes several extensions such as the impact of a possible release of public information and the effect of systematic improvements in private information, and it discusses trader revenues. Section 7 discusses the results. Appendix A provides more details on the information structure. Appendix B contains the proofs. A table at the end of the text summarizes the empirical predictions.

2. The model

2.1. Overview of the market structure

We formulate a stylized model of security trading, in which traders trade single blocks of a risky asset with a competitive market maker. Our model builds on Glosten and Milgrom (1985) (hereafter, GM) but we assume that more than one trader may

[2] In Rosu (2012) traders may choose between limit and market orders; limit order submitters incur the waiting cost and earn the spread whereas market order submitters pay the spread cost.

[3] See Easley et al. (2002, 2010) and Duarte and Young (2009) for the importance of PIN for required rates of return; for recent empirical work on PIN estimation see Yan and Zhang (2012).

[4] Related are many examples of incremental or even dramatic improvements in economy wide information quality, such as the advent of new data sources or new computing tools that allow faster processing of data; examples are the advent of machine-readable news packages such as Ravenpack or the introduction of linguistic algorithms. Our model then delivers testable predictions for event studies of such changes.

[5] Other effects caused by the timing decision of a *single*informed trader have been analyzed in, for instance, Back and Baruch (2007) (order splitting), Chakraborty and Yilmaz (2004) (price manipulation), and Smith (2000) ((no-)timing in absence of bid-ask spreads).