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# Very fast money: High-frequency trading on the NASDAQ ☆

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**Abstract**

This paper provides evidence regarding high-frequency trader (HFT) trading performance, trading costs, and effects on market efficiency using a sample of NASDAQ trades and quotes that directly identifies HFT participation. I find that HFTs engage in successful intra-day market timing, spreads are wider when HFTs provide liquidity and tighter when HFTs take liquidity, and prices incorporate information from order flow and market-wide returns more efficiently on days when HFT participation is high.


*JEL classification:* G1; G2

*Keywords:* High-frequency trading; Trading performance; Intraday return predictability; VWAP; Trading costs; Adverse selection; Market efficiency

## 1. Introduction

High-frequency trading has become a pervasive feature of the equity markets in a relatively short period of time. Estimates of high-frequency trading activity levels vary, but are large. Consistent with this notion, an identified group of high-frequency traders (HFTs) participates in

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68.3% of the of dollar trading volume in the sample I study in this paper. The developments in market structure (such as decimalization, REG NMS, and automated electronic limit order books) that have created the circumstances for HFTs to flourish are relatively recent. Our understanding of the impact of high-frequency trading on market quality is in its infancy, partly due to its sudden emergence and, until very recently, the lack of high-quality data. There are widely differing views among market participants, regulators, and the financial media on whether HFTs are beneficial, neutral, or detrimental. The disagreements regarding their impact on market quality partly stem from a lack of consensus on the nature of their trading practices. A common view is that HFTs have taken over the market-making function. Under this scenario, they generally benefit the market by increasing competition to provide liquidity, but there are still concerns that they lack the affirmative obligations that bound traditional market-makers and could cause disruptions by exiting the market at their discretion. HFTs are also thought to engage in high-frequency arbitrage, which may have the beneficial effect of making prices more efficient. The alternate perspective is that the liquidity they provide is unreliable, and is outweighed by disruptive practices they are alleged to employ such as order spoofing, predatory trading, herding, or overloading market infrastructure with excessive messages.

I provide evidence on these issues by examining HFT trading and market quality impacts in a sample of NASDAQ trades and quotes that identifies HFT participation. This is the same dataset used in Brogaard (2012) and Brogaard, Hendershott, and Riordan (forthcoming) [BHR (2013) hereafter], but I primarily focus on different research questions and where there is overlap, different empirical strategies are employed that yield additional insights. The first question I address is what are the sources of HFT profitability? I investigate their market timing performance. This is important because it helps characterize their strategies to give insights into their motives for trading, which likely impacts market quality, and also provides evidence on intraday return predictability. My second research question is what trading costs do HFTs face when executing their strategies? This provides additional insights into the sources of their profitability, as well as their decisions on when to supply and demand liquidity. Examining the permanent price impacts of HFT trades also tests theoretical predictions that they impose high adverse selection costs on other traders when demanding liquidity and avoid being adversely selected when providing liquidity. Finally, what impact do HFTs have on market quality? I address this question from the perspective of market efficiency. If HFTs act primarily as liquidity providers or arbitrageurs, we might expect their activity to make prices more efficient, while some of the disruptive strategies they are thought to employ could have the opposite effect.

My main findings are as follows. HFT trading performance as measured in a Volume-Weighted Average Price (VWAP) analysis reflects successful market timing, and this performance is surprisingly strong at longer horizons than might be expected. Trading costs are unconditionally very low in this sample, but spreads are wider on trades where HFTs provide liquidity and tighter on trades where HFTs take liquidity, suggesting that HFTs provide liquidity when it is scarce and consume liquidity when plentiful. I investigate theories that HFTs impose higher adverse selection costs on slower traders and face less adverse selection themselves, and find mixed results that are only significant for specific subsamples and trade types. Prices are more efficient on days when HFTs are more active in a given stock, in the sense that it takes less time for stock prices to incorporate information from order flow and market index returns. This result is driven by HFT liquidity-demanding trades.

These findings should be interpreted with caution. As discussed in more detail below, the sample does not identify the activity of all HFTs, and contains only NASDAQ continuous trading activity in the sample stocks. The sample stocks are traded in multiple venues, and are