High-Frequency-Trading

High-Frequency-Trading Technologies and Their Implications for Electronic Securities Trading

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1 Delineation and Market Relevance of High-Frequency-Trading

High-Frequency-Trading (HFT) has become quite prominent in public and academia after the May 6th, 2010 "Flash Crash" and in the context of the recent financial crisis. However, the public discussion is mostly based on generalizations instead of a well founded research-based point of view, and the terminology of electronic trading is often used indiscriminately. Literature defines HFT as a subset of Algorithmic Trading. Therefore, and to foster the understanding of these terms, we first describe Algorithmic Trading. Based on this definition we will then specify HFT.

Algorithmic Trading in the broadest sense is the generation and submission of buy and sell orders by an algorithm (Prix et al. 2007, p. 1). An algorithm in this context is defined as a set of instructions which processes market data in real-time and submits orders to a single or multiple market places without human intervention. Narrow definitions require the algorithm to have a direct market access, automated order management, and usage by professional market participants. While the non-HFT subset of Algorithmic Trading focuses on long-term increases or decreases of big trading positions in agent trading to prevent market impact (Gomber and Gsell 2006, p. 541), High-Frequency-Traders (HFTs) act as proprietary traders, i.e., trading for their own account utilizing corresponding trading strategies.

HFT is a trading technique that is characterized by short holding periods of trading positions, high trading volume, frequent order updates, and proprietary trading. HFTs take advantage of a large amount of buy and sell orders, which are executed, modified, or deleted within a short time period. These modifications and deletions are necessary because of the fast information processing on the market, which requires to place orders close to the current market price or to delete obsolete orders from the market. Exploiting profitable market situations, e.g., arbitrage possibilities (the profitable usage of price differences across different markets), is only possible for HFTs who are able to detect these market situations based on real-time market data and who are the first to submit the corresponding buy or sell orders. Hence, HFTs require a fast reaction time of the algorithm to changing market conditions, which is achieved on the basis of an extremely low technical time-delay (latency). In this competitive environment, market participants who are physically located away from the market have a significantly higher latency and therefore a competitive disadvantage. Therefore, they strive to place their trading algorithms physically as close as possible to the trading system of the exchanges (co-location). To prevent overnight risks, accumulated positions are closed at the end of the trading day. HFTs mostly trade in liquid securities as they generate money from multiple but small transactions (with a small profit each) and as they need to close positions fast and at lowest costs. HFT is primarily conducted by specialized, technologically leading trading firms and investment banks in proprietary trading.

The market share of HFT varies depending on the maturity of the respective market. Due to the lack of a uniform delineation of HFT and differing methods of quantification, the reported market shares deviate significantly. About 40 % to 70 % of total US equity trading is already HFT-based. Operators of European exchanges quantify the market share of HFT between 13 % and 40 %, HFTs quantify their market share between 30 % and >40 % (AFM 2011, p. 13).

2 Typical HFT Strategies

The media often describe HFT as a monolithic structure and therefore discuss HFT mostly in an undifferentiated way. In fact, HFTs need to be evaluated according to the respective algorithms, i.e., their trading strategies, and their impact on market quality. Many strategies used by HFTs are similar to trading strategies known for several years, even though they profit from the short latencies. Basically, these trading strategies can be classified into four categories (Gomber et al. 2011, pp. 24–25): arbitrage strategies, electronic market making strategies, liquidity-detection strategies, and trend strategies.

Arbitrage strategies are built upon price differences of at least two financial instruments which share a similar payoff structure. These strategies can be further subdivided into market neutral (e.g., pairs trading that uses current deviations from the historical price correlations of stock pairs), cross market (e.g., simultaneous purchase and sell of the same financial instrument in different markets), and cross asset strategies (e.g., purchase of an exchange traded fund and shortening the underlying stocks) (Aldridge 2010, pp. 190).

Electronic market making strategies, i.e., the simultaneous submission of buy and sell orders, are also often conducted by HFTs (ASIC 2010). These strategies can be further distinguished into spread-capturing and rebate-driven strategies. When utilizing spread-capturing strategies, HFTs continuously provide buy and sell orders at the spread (by adjusting their quotes according to the current order book situation) to realize the difference between bid and ask. Rebate-driven strategies are based on maker-taker pricing models that are mainly used in alternative trading venues (multilateral trading facilities). In this pricing regime, traders who submit liquidity to the market in the form of limit orders (maker) are granted a discount per executed order, while members removing liquidity from the market (taker) are charged a fee. Applying electronic market-making strategies therefore enables HFTs to earn the spread by providing liquidity and simultaneously realizing fee rebates in markets with respective fee structures.

Liquidity-detection strategies are strategies where HFTs try to unveil the trading motives and therefore hidden liquidity of other market participants to adjust their own trading behavior accordingly. Hidden liquidity such as high volume orders (hidden orders or iceberg orders) can be identified by submitting orders with a small volume (pinging) or by systematically analyzing the trading activity on market data tickers (sniffing the tape). A large order within the order book can for example be used as a hedge for the HTF's own trading position (quote-matching).

Trend strategies can be subdivided into short-term momentum and latency-arbitrage strategies. The first try to identify current market trends and profit from using these trends with the shortest possible time-delay (latency). By applying latency-arbitrage strategies, HFTs use an information advantage concerning the provision of pricing data from different market places – especially in US-markets.

3 Impact of HFT on Market Quality

Market quality plays a crucial role for investors, issuers, and financial intermediaries alike. The research discipline which analyzes market quality and the process of price discovery during the exchange of financial instruments is market microstructure theory (Madhaven 2000). In this discipline, market quality is often measured based on metrics such as liquidity, volatility (standard deviation of prices), explicit (trading fees), and implicit (spread) transaction costs. A high level of liquidity, in form of many buy and sell orders, is desirable as it allows market participants to trade even large volumes instantly. A low level of volatility is preferable as volatility is a measure for the price uncertainty of a financial instrument. In the following subsection, current scientific studies are presented which deal with the impact of HFT on these central parameters of market quality.

In a theoretical model, Cvitanic and Kirilenko (2010) show that HFTs cause an increase in trading frequency that is accompanied by a simultaneous decrease in volatility. A model based approach is presented by Jovanovic and Menkveld (2011) who pose the question whether informed HFTs contribute to market quality. They observe positive effects in the presence of HFTs due to their capability of quick order updates, and thus the acceleration of information diffusion in the case of news. As they empirically observe narrowing spreads, they conclude that HFTs increase market quality. Other empirical research papers also conclude that HFTs have a positive impact on market quality. Brogaard (2010) analyzes orders and trades in 120 US stocks and confirms that HFTs contribute to an improvement of price discovery and reduced spreads. In addition, the author observes only a slight change in trading activity of HFTs in times of rising volatility. Hasbrouck and Saar (2011) investigate the impact of HFT on market quality based on different sample intervals of NASDAQ-order book data during 2007 and 2008. Their results confirm that the spread narrows and the order book depth (liquidity) improves.

In contrast to the studies mentioned above, which analyze periods of normal trading activity, the event study of Kirilenko et al. (2011) investigates the "Flash Crash" in the US on May 6th, 2010. In line with the results of the Security Exchange Commission (SEC 2010), the authors confirm that HFTs did not trigger the crash. They argue that the position of HTFs in the future contract which caused the "Flash Crash" was not big enough to have substantial impact. In fact, HFTs initially acted as buyers of the large volume caused by a big order ($4.1 billion). However, as the price started to fall sharply, HFTs were forced to sell their contracts and by doing so, they caused a further increase of volatility. The authors emphasize the importance of technological innovations in the development of markets, though mentioning that respective security mechanisms like circuit breakers have to be set up as well.

Summarizing recent academic research, a tendency towards the positive aspects of HFT in today's financial markets can be observed, in particular an increase in liquidity that causes a decrease in transaction costs and thus an improvement of market quality. Concerning the impact on volatility, the available results are mixed, which is largely due to the fact that different studies were conducted in different time periods and used different data sets.

4 Current Developments in the HFT Environment

Since the recent financial crisis and the US "Flash Crash", a discussion on whether and how to regulate HFT has emerged. Current regulatory efforts include the guidelines of the European Securities and Markets Authority (ESMA), the draft bill of the German Government on the regulation of HFT in 2012, the revision of the Markets in Financial Instruments Directive (MiFID II), and the frequently discussed transaction tax. Among these measures, MiFID II and the transaction tax definitively will have the largest impact on financial markets and HFT in particular.

The MiFID II draft (European Commission 2011) is currently discussed between the EU Commission, the EU Parliament and the EU Council and will probably have to be applied from 2015. The draft states that HFTs are required to have robust trading and risk management systems, are obliged to provide information about the used algorithms to the competent authorities on an annual basis, and have to permanently supply liquidity to the market. Especially the latter requirement is seen very critically, as

HFTs would be required to build up risk positions, which contradicts their business model of achieving small margins by executing many transactions without building up relevant positions. The requirement of permanent supply of liquidity would cause a withdrawal of HFTs from the market, which would lead to a deterioration of market quality. Further measures in MiFID II are planned for the trading venues to limit the risk of HFT by means of reliable market design: the provision of sufficient trading system capacity during peak load periods, reviewing the systems for erroneous orders, the possibility to slow down the order flow, as well as adequate and coordinated circuit breakers among the markets in periods of high volatility. The introduction of a transaction tax and thus an increase in trading costs is also regarded as problematic. Past experiences with the introduction of such a tax have not resulted in the expected effect of reducing volatility, but rather increased volatility (Baltagi et al. 2006; Umlauf 1993). Moreover it can be assumed that after the introduction of this tax, market quality, and liquidity will deteriorate due to the loss of profitability and the resulting decrease in the number of transactions. A detailed and critical discussion of the pros and cons of HFT for market quality, as well as a discussion of the proposed regulatory measures from different points of view can be found in BISE-Discussion 2/2012 (Lattemann et al. 2012).

New technologies and paradigms make it necessary that the actors in the securities trading industry adapt continuously and accept large investments in order to remain competitive. Currently, the focus is on minimizing latency by using co-location and the optimization of the IT components. For a London based trader who wants to trade, e.g., on the Frankfurt Stock Exchange, co-location can reduce the time-delay for market and order data between Frankfurt and London by 7.06 milliseconds (assuming the speed of light in a fiber optic cable of about 180,000 km/s). The lower the latency in the usage of an electronic market place, the higher the reliability of the execution by an algorithm is, as minimal latency increases the likelihood that the market situation, on which the algorithm's decision is based, still exists at the time of order arrival at the back end of the market.

In the future, trading computers could be situated at remote locations like the middle of the Atlantic (Wissner-Gross and Freer 2010). This would even further minimize latency of the information exchange between different globally distributed trading venues. Current efforts focus on enhancing the speed of networks and computer technologies. Pioneers in this field are specialized network card providers, who offer interfaces with integrated software-logic or data transfer through microwaves, and thus enable a further reduction in latency. It can be expected that these development-intensive innovations will lead to a positive spillover into other technology-intensive industries.

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