The impact of latency sensitive trading on high frequency arbitrage opportunities

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ABSTRACT

This study examines the *duration*, *frequency* and *profitability* of potential high frequency arbitrage strategies between the share price index futures contract and an exchange-traded fund (ETF) written on the S&P/ASX200 constituent securities traded on the Australian Securities Exchange (ASX). We find the frequency and profitability of potential arbitrage opportunities are greater during volatile and high turnover periods—other things equal. We examine the impact of increased competition in high frequency trading (HFT) by identifying the number of 'co-location connections' utilized in the ASX's minimum latency liquidity center. We document an increase in the frequency, duration and value (albeit small) of index arbitrage profit opportunities with increased HFT connections. Our results are robust to the inclusion of transaction costs. We conclude that increased HFT activity in markets increases trade execution risk associated with arbitrage (or legging risk) which in turn increases mispricing in markets.

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1. Introduction

Classical economic theory suggests that excess returns should be competed away as participants enter the market. This is especially true for the profits from riskless arbitrage. Yet, there is conflicting evidence in the financial economic literature over whether high frequency trading (HFT) profits, in general, (Baron et al., 2012; Chordia et al., 2015) and arbitrage profits, in particular (Budish et al., 2015; Chaboud et al., 2014), decline as high frequency or other algorithmic trading increases. There are important public policy implications for market microstructure and the social value of investments by HFT firms in being faster if arbitrage profit opportunities persist (in the absence of limits to arbitrage).

Several trading strategies are used by high frequency and latency sensitive traders (O'Hara, 2015). These include: index arbitrage; spread arbitrage/market making; and correlated arbitrage among others. Irrespective of the strategy, traders suffer execution risk if orders in markets are fleeting or stale. Legging risk for arbitragers (Sofianos, 1993) may decline in markets as latency is improved with the adoption and roll-out of enhanced electronic trading platforms, but it may also increase as the number of

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market makers and arbitragers compete to try and exploit the same opportunities, and in the process impose negative externalities on markets and impede pricing efficiency (Kozhan and Tham, 2012).

In this paper we focus on one HFT strategy—index arbitrage, and examine whether the *duration*, *frequency* and *profitability* of potential arbitrage opportunities between the Australian Securities Exchange (ASX) Share Price Index (*SPI*) futures contract and the exchange traded fund (*ETF*), SPDR S&P/ASX 200 Fund (*STW*), has changed as the number of HFT firms (or intensity of HFT activity) has increased, since the ASX introduced co-location services in February 2012. In addition, we compare the estimated potential arbitrage profits to the cost of being co-located, in order to determine the value of minimum latency.

We have two principal reasons for examining ASX data. First, we are able to examine a finer time interval than past studies, with data time-stamped at the microsecond level. Second, we have information on the growth of HFT over our sample period. More specifically, we know the number of co-located cabinets reported by the ASX in its minimum latency co-location center and use this measure as a proxy for HFT competition.

Our principal findings are as follows. First, consistent with Budish et al. (2015), the *frequency* of potential arbitrage opportunities is greater during volatile periods, other things equal. Second, increased HFT in markets changes the speed of convergence between paired instruments, suggesting greater competition among HFTs in their demand and provision of liquidity. Third, contrary to Budish et al. (2015), the average daily profit, frequency and duration of arbitrage opportunity *increases*, as HFT connections increase in the market. HFTs appear to compete aggressively against each other, resulting in larger and more frequent price discrepancies albeit with economically trivial arbitrage profit opportunities. Our findings are consistent with Kozhan and Tham (2012) who demonstrate that HFTs suffer execution uncertainty from negative externalities inflicted by trading against each other.

The remainder of this article is organized as follows. Section 2 reviews the related literature. Section 3 outlines the data, arbitrage strategy, and method utilized to examine the impact of HFT on arbitrage opportunities. Section 4 reports results and robustness tests. Section 5 concludes.

2. Review of the literature

Recent surveys highlight the significant debate surrounding the effects of HFTs on markets (see Biais and Woolley (2011), Chordia et al. (2013), Jones (2013), and Goldstein et al. (2014)). O'Hara (2015) further states in light of the fundamentally different way markets are structured today, it is important to understand the strategic behavior the microsecond trading environment affords traders, especially in terms of arising price differentials. Madhavan (2012) for example finds market structure, in particular the increase in market fragmentation and venue competition, is a catalyst for extreme price movements. Equally, Menkveld (2013) finds that the likely success of a new trading venue hinges on the participation of HFTs.

Most of the research related to HFT focuses on its impact on market quality. Examining the NYSE and NASDAQ markets, Hendershott et al. (2011a,b) and Hasbrouck and Saar (2013) report that bid-ask spreads and volatility improved during times of increased HFT, while Jarnecic and Snape (2014) document that on the London Stock Exchange (LSE) HFT is associated with shorter order duration and thinner depths that increase the transience of prices. Carrion (2013) and Brogaard et al. (2014a) extend these studies by investigating the relation between HFT and information efficiency/price discovery and document that HFT is associated with improved impounding of information into markets. However, Jain and McInish (2012) find that HFT increases tail-risk in Japan, while Boehmer et al. (2014) in their global study report that HFT increases short-term volatility, leading to further negative externalities in the market, as modelled by Biais et al. (2012).

Brogaard et al. (2014b) find following infrastructure upgrades on the LSE, the associated increase in HFT activity does not affect institutional trader costs, while Van Kervel and Menkveld (2016) document that institutional transaction costs increase (decrease) when HFTs trade in the same (opposite) direction as institutional investors who execute a package of trades through order-splitting strategies on the Nasdaq OMX Sweden. Conversely, Toth et al. (2015) find order splitting does not appear to change with the rise of algorithmic trading on the LSE.

Extending beyond the issue of the introduction of HFT, Breckenfelder (2013) examines the effect of competition among HFT firms on market quality. Able to identify international entrants into the Swedish market, Breckenfelder (2013) finds HFT competition is associated with an increase in demand for liquidity, volatility and momentum trading. Similarly, examining 13 HFT firms on Canada's Alpha exchange, Brogaard and Garriott (2015), find that HFT firm entrants generally improve liquidity and price efficiency, however their marginal affect differs across stocks and their presence can be disruptive at first. Brogaard and Garriott (2015) also find asymmetric effects in terms of the profits earned by incumbent HFT firms as other HFTs leave and enter the market, leading them to conclude that not all HFT drives competitive pressure on profits.

Baron et al. (2012) examine the profitability of HFTs in the (all electronically traded) e-mini S&P 500 stock index futures market during the entire month of August 2010. Using a comprehensive data set identifying the trades of 31 HFT firms, they report all 31 HFT firms were profitable during the month. The HFT firms collectively earned $29 million during the month all while assuming very little risk—the average Sharpe ratio was 9.2. Baron et al. (2012) identify the most profitable HFT firms were not liquidity providers but rather the most aggressive liquidity takers, competing on speed, sophistication and technological innovation.

The focus on the continuing investments in speed by HFT firms as a potential explanation for why their profits remain relatively stable extends to Budish et al. (2015). Essentially, Budish et al. (2015) argue that over very short periods of time, correlation between related securities breaks down and creates purely technical arbitrage opportunities, available to whomever is fastest,