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Special report

High frequency trading – credible research tells the real story

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High frequency trading: where exactly are we today?

With the increasing debate about high frequency trading (HFT) that often dominates the financial and mainstream press, one sometimes needs to simplify the information provided to remember what it is we are discussing in the first place.

For those that manage research driven portfolios that invest in the underlying earnings of a company through trading listed equities, the advancement of HFT volume has often been met with scepticism. The debate is centred upon whether HFT causes increased frictional trading costs that erode returns for fundamental investors, and more importantly, whether HFT has degraded market quality resulting in a distortion of asset allocation away from equities.

HFT have relied on microstructure shifts, regulatory arbitrage and technological innovation to generate returns. HFT's justification lies squarely on the idea that it, as a sub-industry, provides social improvement through improving market quality whilst earning significant profits.

Whilst HFT has marketed itself as a provider of liquidity through its market making techniques, market quality as measured by three central points of price discovery, volatility and executable liquidity is increasingly coming under the microscope as research reveals a more directional nature to HFT volumes than mere passive quoting.

According to TABB Group, HFT is conducted by three types of firms, 48% of the volume comes from dedicated HFT houses (proprietary in nature), 46% by investment banks and 6% by hedge funds.

Something often overlooked here is that those investment banks involved in the space have multiple roles to the play; not only do they deploy HFT themselves but, in many cases, also act as the intermediaries for the remaining 48% of the volume coming from HFT houses.

As such several banks have dedicated teams that sell their execution capabilities directly to independent HFT houses, for example, exchange access and stock-loan facilities.



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What is HFT?

Generally speaking, independent HFT houses are proprietary trading firms that hold few, if any, overnight positions. HFT are fully automated with high spends on technology and are highly latency (speed) sensitive. Cross-technique risk adjusted returns are abnormally high, with Sharpe ratios often in the order of nine or double digit. Holding periods are at the extreme short end of the curve, operating in a time frame ranging from milliseconds to a few hours. Well known names in the HFT space include Getco, Infinium and Optiver.

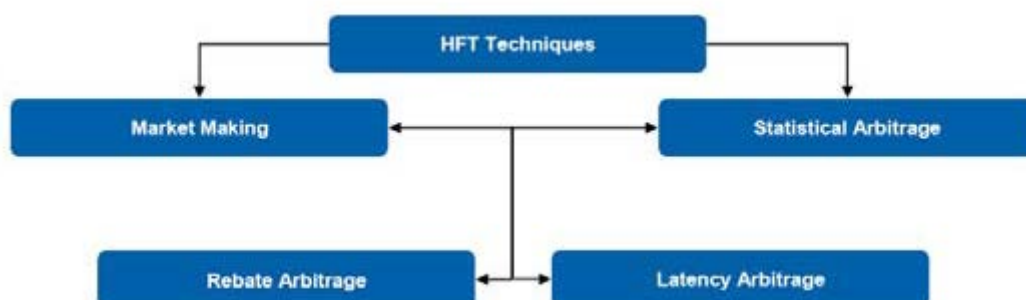


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Broadly speaking, most techniques fall under the two umbrellas of statistical arbitrage and market making (a technical description, not the role of an obligated “market maker”). Sub categories would include latency and rebate arbitrage as well as directional trading. Beneath these top lines, processes from artificial intelligence, machine learning, physics and mathematics are widely deployed in each umbrella.

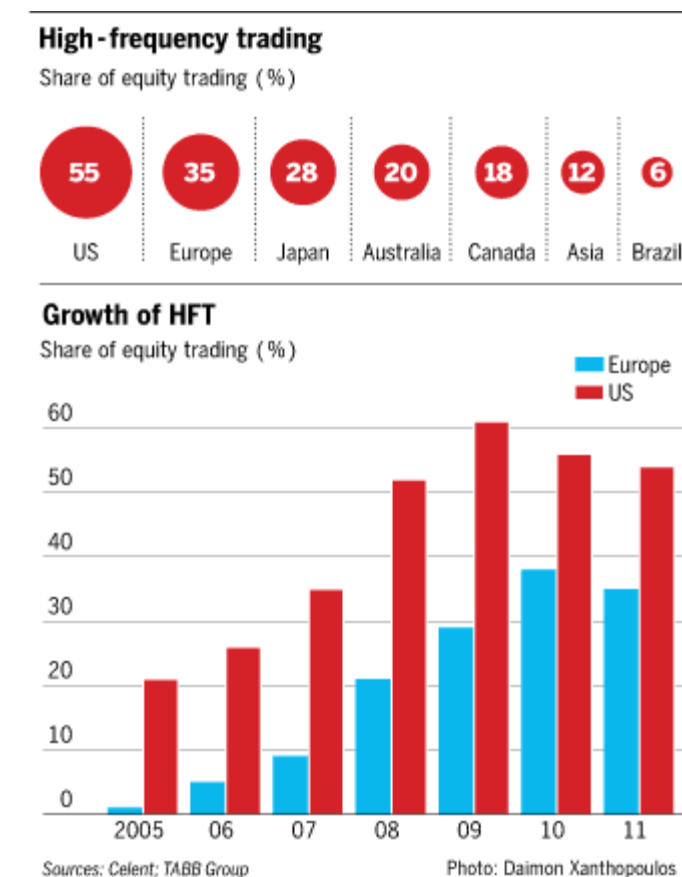
Similarly, stochastics, GARCH and a high number of algorithms adapted from voice recognition and defence technology are utilized to enable pattern recognition sequences in both linear and nonlinear conditions, an example being the Baum-Welch algorithm. Diagram 1 below highlights some relationships within the umbrellas.

Diagram 1 HFT techniques



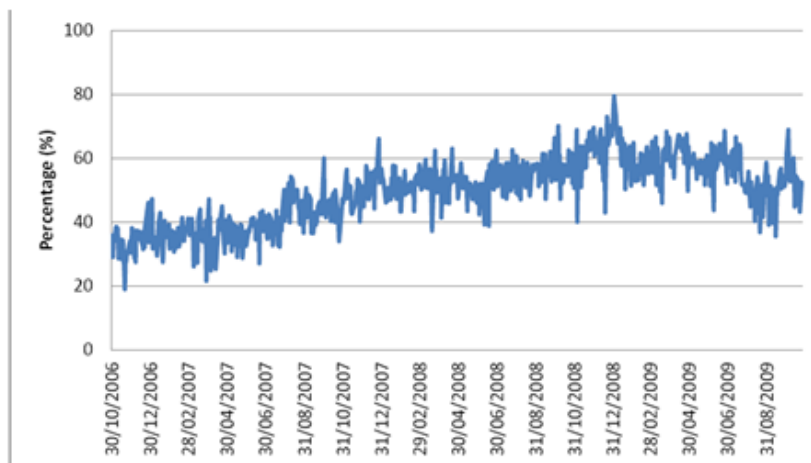
In terms of market share, HFT accounts for approximately 60% of US secondary market equity trading and an average of 35% of total pan European trading (with considerable variation between stocks and countries, with over 50% in the UK for example), see Figure 1.

Figure 1 The global spread of HFT



A recent study into HFT in the Australian market has quoted HFT participation in Australia at between 30% and 80% for the period of Oct 2006 and Oct 2009 (Figure 2). These numbers seem abnormally high with respect to levels in other more HFT friendly markets and the research conducted by TABB and Celent (2011; Figure 1).

Figure 2: Daily dollar volume proportion of HFT trades - ASX



Source: Frino, Leung and Mistry, "The New Breed of Market Participants: High Frequency Trading: Evidence from the Australian Stock Exchange"

Widely accepted global net profit numbers are in the multi billions of dollars with TABB Group noting 2008 fiscal year estimates at between US\$8 and US\$20 billion net profit for HFT in the US alone.

Should the buy side be so cynical?

At its core, the publicly listed market exists to provide equity capital to businesses, with the exchanges being the mechanism to efficiently exchange ownership of these shares. HFT is seen to derive its information from the analysis of statistical and deterministic modelling to extract an information signal from a buy-side² order and thus generate a very short term trade. Simplistically, whilst HFT might see itself as an intermediary, opponents might describe it as a form of front running³.

HFT and Institutional friction exists primarily because the HFT industry would struggle to commercially function in its present state without large institutional orders generating statistical signals. Faster access to exchanges (co-location) and the accusation of market manipulation techniques utilised to identify and trade ahead of larger institutional orders is believed by many to have resulted in a two tiered market.

A co-located server with a subscription to the ASX message platform ITCH⁴, when compared to a slower data feed from a vendor such as Reuters will create a latency arbitrage opportunity and allow for faster deployment and cancellation of quotes. Rapidly flashing and often unexecuted quotes (only 10% of quotes in the US market actually get traded against) are used to isolate statistical signals from informed traders resulting in increased frictional costs and the erosion of portfolio returns. Exchanges have also been accused of attaching indicators to trade messages that can reveal the direction and size of larger orders over their lifespan. Custom order types can also be offered to HFT clients by new execution venues. Crucially these order types are only specific to the requesting client who in many cases may also be an owner of the venue, further re-enforcing the notion of a two tiered market.

The Quantitative Services Group (QSG) 2009 study on execution strategies showed more executions per order (e.g. in a VWAP algorithm) increases the chance of leaving a statistical footprint that can be exploited by tape reading algorithms and results in the propagation of predatory strategies. In a sample set of 95,000 orders and US\$30bn in value, the potential savings generated by simply reducing the number of executions in an order, therefore masking the statistical footprint, equated to US\$35m.

² The "buy side" is a broad term that covers most investing institutions e.g. investment managers, insurance funds, some hedge funds and some quant funds. HFT does not fall under the "buy side" umbrella.

³ "Frontrunning" as a legal term is trading ahead of clients. HFT have few if any clients (dark pools aside). This raises questions of the legislative lag time versus the reality of the market.

⁴ Despite research on ASX data claiming to be able to identify the username of the market participant, the ASX denies that this is possible and no unique client identifiers are available on trade messages.

The conflict is enhanced when brokers, the traditional intermediary between the buy side and the exchange, are concurrently selling execution products to fund managers, whilst sponsoring HFT access to the exchange, or inviting them access to broker owned pools of liquidity to boost volumes. The inclination of a broker to route orders to Electronic Liquidity Providers (ELP; normally HFT market makers) rather than exchanges is frequently highlighted by the multiple ELP programs that exist attached to broker owned dark pools. It should also be noted that although many brokers may state that “there is no HFT in the pool”, some proprietary trading and internal HFT arms are outside the pool but stay as the next hop “inside the wall” of the firm before eventually being sent down to the exchange. External ELP’s are often executing outside of the pool and therefore technically not present “in the pool” either.

Recently external pressure on brokers has forced changes to counting methods where trades executed “in the pool” were double counted where as those executed with ELP’s were single counted enabling the broker to state significantly higher volume activity.

It remains to be seen if all brokers are suitably transparent in their relationships between their proprietary owned dark pool and the ELP’s. This cynicism can be extended to the exchanges and fibre network providers who may offer faster data feeds and often, increased levels of information to those willing to pay for it. An exchange responsible for facilitating the efficient exchange of shares through the secondary market should not be able to distort this function for its own profit objective.

Trading rebates under the maker taker pricing model and an economic benefit gained from artificially generated market shares, distort what should be an efficient exchange between buyers and sellers of a security at the best price. An exchange can make significant revenues, running into millions of dollars from routing to an ELP rather than to a rival exchange.

Whilst evidence shows that Smart Order Routing (SOR) techniques tend to amplify the use of HFT as intermediaries and suspicions remain regarding pattern detection and the increase in frictional costs, it is necessary to investigate these accusations to discover if the buy side view is justified in its cynicism. Objective evidence, not subjective opinion is the proper way to discuss the impact of HFT on market microstructure.

Evidential background

Across the three core areas of Price discovery, Volatility and Executable Liquidity, there has remained a paucity of rounded academic work. Such was the depravity that a doctoral candidate’s work was widely used as a benchmark study by investment banks, HFT and in some cases regulators; however, this piece has since been shown to hold material flaws and holds little credibility today.

Some papers were commissioned by exchanges who gain commercially from HFT business (e.g. Gomer/Deutsche Boerse); credibility was weak as was, more importantly, in many cases, the total underlying methodology. As time progressed more universities and researchers, un-conflicted with association, were able to conduct research into the area and the position began to shift.

What resulted was a rapid expansion in education across all facets of the investment and academic arena where tribal “pro” and “anti” HFT groups are now beginning to focus on empirical evidence and logic rather than emotion and “turf protection”. As standards in research continue to improve, simple default commentary such as HFT are “liquidity providers”, HFT “dampens volatility” and HFT “decreases bid-ask spreads” have suffered something of a credibility anorexia despite their continued use by some.

Price discovery

Price discovery is properly achieved through the interaction of buyers and sellers in a market place free of incentives to trade other than the legitimate investment in an underlying company, irrespective of the time period. Proponents of HFT have long claimed that price discovery is improved where HFT is increased, however it should be noted that HFT “market makers” learn passively from observed order flow, by often strategically setting quotes to induce the revelation of information therefore creating price distortions.

A recent effort to reduce the growth of block dark pools by regulators has been met with scepticism by the buy side. If electronic information leakage is maximised through lit market participation, the predisposition of some academics towards dark pool wide pre-trade transparency, heralds a net benefit for HFT firms that profit from large volumes of trading on the lit market by extracting sequences of low “opportunity cost” information signals. Fong, Madhavan and Swan (2002) show the “upstairs market” provides lower market impact costs for block trades than if the trades were worked through the lit market. Little evidence exists that questions the resulting quality of the downstairs (lit) market

through the apparent liquidity reduction; hence a pareto optimal outcome is achieved. Further to this study Frino, Mollica and Walter (2002) found that a significant positive price reaction and continuation is reported following block purchases whilst a negative price reaction and subsequent price fall occurred for sales. These combined results show post-trade transparent block trades improve price discovery whilst also reducing market impact for both participants more than otherwise would have resulted in price distortions through the trading period.

It is rarely doubted that HFT tighten the spread at the first quote on the book, however, questions remain to HFT's impact on market depth; frequently the number of shares at the top of the book are, despite being the best price, the smallest in quantity. 200 shares marginally price improved over a 5000 share order second in line opens the question of HFT's impact on "absorption" and thus price discovery.

An institutional investor, who ordinarily has order duration⁷ of longer than the average holding period of a HFT position, does not benefit from any of this liquidity provided at the top of the book. The 200 shares traded at the improved price can at worst; result in the release of information that will significantly worsen the execution price of the entire order. At best, the market maker will cover the initial position instantaneously where possible to minimise inventory risk, eroding whatever price improvement was gained.

Professor Zhang's seminal study finds that in fact, over the longer term (quarterly periods), "HFT hinders price discovery"; this finding represented the first trend shift away from other studies which confirmed a positive impact on price discovery, for example, Hendershott and Riordan in 2009⁸. To further elaborate, there is a general view that increased trading activity leads to improved bid-ask spreads, and thus, improved price discovery. However, this view tends to overlook the impact of noise trading on the market and it was back as early as 1993 that Campbell, Grossman and Wang conducted studies into this area, finding that noise traders lead prices away from fundamentals, agitating prices into temporary swings and reversals which would distort the discovery of a genuine price. The relationship with over and undershooting the price was preconfirmed by Schwartz and Francioni 2004 who noted "price discovery is inaccurate when new equilibrium values are not instantaneously achieved".

These underpins have transcended to a world today where market volumes are dominated by non fundamental based-HFT strategies that derive perceived value of the traded stock through correlations and pattern detection, resulting in a stock price that over (under) shoots its fundamental valuation.

The self-defined HFT technique of market making, deployment of flickering quotes spread across multiple venues, as well as more passive aggressive forms of noise trading, has led to concepts such as "artificial liquidity" and "disappearing liquidity" entering the lexicon of methods to describe HFT and thus raised questions over HFT's positive role in effecting price discovery.

Volatility

Proponents of HFT have long argued that HFT's liquidity provision into the market has the impact of dampening volatility. Some point to the fact that HFT end the day flat and so cannot impact volatility. However, this ignores the intraday.

The recent findings of Frino, Lepone and Mistry⁹ state volatility and HFT are in fact uncorrelated; these results have been widely publicized over the last few months. However, beyond the headlines and upon further investigation of the actual data, there appears to be a discrediting difficulty of the authors to correctly differentiate between HFT and buy-side algorithmic trading through brokers, as a result the output seems, at best, skewed.

Estimates of HFT volume on the ASX are currently around 20% (Tabb, Celent, 2011). The Frino *et al.* evidence stated that HFT penetration on the ASX grew from 35% in 2006 to a high of 80% in 2008, despite this being during a period of time where the market structure was largely unsupportive of the majority of HFT techniques¹⁰, as such these numbers are met with considerable suspicion. To further complicate issues, the data used in the paper was sourced by Reuters, provided by SIRCA¹¹ and unfortunately time stamped to the nearest 1/100th of a second. HFT trades in milliseconds i.e. 1/1000th of a second so it is simplistically fair to hypothesise that HFT trades and quotes are in fact being inaccurately tracked by up to a factor of 10. In reality, the majority of HFT is now trading in microsecond (1 millionth of a second) time frames making data tracking even more important.

Perhaps perversely if the volumes included in this analysis are predominately buy side in nature, it may actually prove that the benefit attributed to HFT could mostly be attributed to traditional buy-side algorithmic trading and not HFT as it is understood by the researchers.

⁹ Frino, Lepone and Mistry, *The new breed of Market Participants: High frequency trading: Evidence from the Australian Stock Exchange*, Discipline of Finance, University of Sydney. (preliminary paper, 2011)

¹⁰ For example, considering HFT is both latency and multi venue sensitive; the ASX did not introduce Co-location until Q4 2008 and competition has yet to go live; the high HFT participation rate that underpins the research becomes questionable.

¹¹ SIRCA – Securities Industry Research Centre Asia-Pacific.

Given that stock correlation is positively correlated to volatility; Andrew Haldane, Head of Financial Stability at the Bank of England, in his July 2011 study found that “intraday volatility has risen most in those markets open to HFT”. Haldane also noted that “HFT algorithms tend to amplify cross stock correlation in the face of a rise in volatility”, in effect, stating that in volatile times HFT accentuate volatility given the positive correlation between the two variables. Separately Biais and Wooley found that “(HFT) algorithmic trading could create the scope for systematic risk”, potentially opening the debate to whether or not HFT techniques¹² have the ability to shudder the market before moving it into agitated conditions and potentially contagious scenarios. This concept of HFT adding a volatility layer, over and above the pre-existing fundamental volatility, is increasingly embedded in the body of credible research.

Protter and Jarrow, 2011 tackled the relationship between the spread and volatility head on by creating a model with perfect liquidity and a zero bid/ask spread. The authors found that under these conditions HFT “increases market volatility”. This finding re-enforced Zhang’s earlier work which uncovered that “HFT is positively correlated with stock price volatility”; crucially Zhang controlled for fundamental volatility and other exogenous factors; the author expanded by discussing HFT institutional order detection mechanisms¹³ and refers to them as “a practice that pushes the stock price up (down) if institutional investors have large buy (sell) orders, thereby increasing stock price volatility”.

Over recent years, the increase in trading volumes are largely attributed to HFT, with that generally being seen as a positive outcome by many in the market, particularly investment banks and execution venues. However, in line with more recent studies into HFT, Dichev, Huang and Zhou, 2011 have reported that “there is a reliable and economically substantial positive relation between volume of trading and stock volatility”, the authors conclude that “trading-induced volatility accounts for about a quarter of total observed stock volatility” and that high volume stock trading “injects an economically substantial layer of volatility above and beyond that based on fundamentals”.

The recent study on ASX data by Frino et. al suggests that HFT tends to trade when price volatility is low but does not suggest that HFT is in fact responsible for suppressing volatility. We look forward to the research conducted by the CMCRC on other markets that should clarify the CMCRC’s position on HFT and volatility.

Liquidity and volume

A final point to note is about the differences between liquidity and volume. Most have said they are one and the same, and in the more traditional sense of understanding they often are. However, in the more contemporary understanding they are not. As the SEC and CFTC noted in their joint report into the Flash Crash of May 6 2010, “high trading volume is not necessarily a reliable indicator of market liquidity”. This relates to the concept now referred to as “disappearing liquidity”, where there is a marked imbalance between executable liquidity and net executed volume.

IOSCO (the International Organisation of Securities Commissions) took this a step further in their recent HFT consultation document, noting that liquidity could be defined as the ability to “trade in large size quickly, at low cost and when market participants want”. HFT firms are frequently attempting to redefine themselves as “*liquidity providers*” and yet, HFT do not facilitate the ability to trade in large size quickly, have been shown to increase the total costs of trading and due to HFT’s small quote size and disappearing liquidity, struggle to assist the institutional investor in allowing them to trade when they want. Larry Tabb, CEO of TABB Group exemplified this latter point when talking over recent volatility in a British broadsheet by quoting that “HFT is indirectly to blame by *removing* vast swathes of liquidity from the market”; some buy side dealers are now referring to HFT as “*artificial* liquidity providers” to emphasize the point.

Conclusion

As the level of understanding of HFT techniques has improved there has been a recent shift from subjective opinion on HFT towards objective evidence based research; increasingly correlated with research output quality. Unfortunately, some of the more publicised research is still heavily biased by for example, inaccurate data sets or a desire for commercial gain.

The buy side is improving its execution capability as the understanding of how HFT returns are generated and its impact on market quality grows. Early generation broker provided algorithms, the staple diet of many buy-side traders today, may eventually be replaced with execution algorithms customised to match the strategy of each fund manager whilst Smart Order Routers will be constantly examined to reduce the probability of adverse selection.

¹² Largely due to extensive noise trading thus irrespective of passive or aggressive techniques.

¹³ These sit in both passive and aggressive techniques.

VWAP and other schedule based strategies that are shown to release footprints and increase transaction costs may decline in their usage and the VWAP benchmark should decline in relevance. Sales traders can resume their vital role of “Natural to Natural” (Institution to Institution) block trading as it becomes the primary strategy in the minimisation of market impact.

HFT is a growing and ever changing part of the trading landscape and has every right to participate in financial markets as long as regulation evolves to allow fair and equal access to markets for all participants and the provision of a stable and efficient market place. According to the Manoj Narang, CEO of HFT firm Tradeworx, the majority of HFT is regulatory arbitrage that has allowed HFT to step in and exploit created inefficiencies¹⁴. These gaps should be reviewed.

Through the potentially flawed assumption that market wide pre-trade transparency brings benefits to all there is a considerable demand to re-assess the equation between the benefit of block trading in the dark and the need to bring those trades on exchange and run the risks of interacting with HFT. Outside of equities if CDS products are to soon move from bilateral arrangements to lit exchange traded products, what would be the consequences of a speculative HFT induced flash crash in a teetering sovereign CDS on the world economy?

Many had forecast that exchange competition would improve market quality, however who is actually benefiting from this competition? For example, under MiFID in Europe the end investor was supposed to benefit, and yet the buy side consistently state that they do not see any change in costs and so as a result neither does the retail investor; in many cases when accurately tracking HFT, costs may have in fact gone up. Certainly some banks have received healthy financial sums for the sale of principal positions in selected alternative execution venues. Whilst new venues have been and are being created and folded, technology has certainly improved.

The algorithms used by the buy side have evolved however HFT has entered the fold and raised many questions amongst algorithm providing brokers; however most concerning of all is the impact of HFT on the end investor and on market wide stability. Some brokers can assist the end investor to reduce costs in an HFT world, however market stability is a shared responsibility and also falls on to the execution venues. With some major venues lacking volatility halts such as circuit breakers and many venues suffering multiple shut downs in recent weeks, can exchanges maintain orderly markets? Can regulators track the complexities of the impacts of HFT on the market? Are market abuse and market manipulation rules written for human traders or for learning machines?

The broad level of understanding regarding the new shape of market microstructure has increased and even the most basic analysis has moved on from the simplified arguments that volume and tight spreads must auto improve market quality. As research has become relatively un-conflicted, valid, accurate and credible, the debate has recommenced with empirical evidence as its main driver. Regulation of markets should be guided by empirical evidence and not the lobbying power of both sides of the debate; as such, much is at stake.

¹⁴ Comments made at the Sungard NYC day in June, 2011

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