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AN ASSESSMENT OF THE SOCIAL DESIRABILITY *of high-frequency trading*

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While much has been written on the vast topic of high-frequency trading (HFT), a great deal of the evidence has been contaminated by group self-interest. Furthermore, what constitutes a 'good' or a 'bad' is not clearly discussed. This paper presents an assessment of the costs and benefits of HFT and considers the more philosophical question as to what good or bad might mean here.[1] The paper formed the basis of a presentation given at JP Morgan, Sydney on 22 March 2012.

After defining HFT, my analysis focuses on an examination of HFT across three main categories, each of which follows naturally from the existing literature. The first broad category is what HFT has done to prices. Here we can consider price efficiency, price discovery and price volatility. The next broad category is the impact of HFT on price liquidity/volume/costs. A third category is HFT profitability. Where appropriate, the discussion on each of these three issues distinguishes between different agents operating in the markets, including retail investors, asset managers, hedge funds, high-frequency traders, the public and regulators. Finally, a brief review on current academic research in this area is provided along with a discussion of the welfare issues associated with HFT.

What is HFT?

Like many things, HFT is easy to see and hard to define. We instantly get into problems as it is often confused with algorithmic trading (ALGO), which is the use of algorithms to make trading decisions. It is worth noting that in United States (US) markets, there are approximately 100,000 orders per second. As such, some form of ALGO seems necessary if we believe that traders should endeavour to analyse available information.

In defining HFT, we follow the SEC (2010) concept release on equity market structure. The SEC definition is based on five characteristics:

1. the use of extraordinarily high-speed and sophisticated computer programs for generating, routing and executing orders;

2. the use of co-location and data-feed services offered by exchanges to maximise speed;

3. very short times for establishing and liquidating positions;

4. many orders and high cancellation rates; and

5. very few overnight unhedged positions.

Some common practises associated with HFT include high-speed market making, taking advantage of stale prices, cross-exchange arbitrage, order anticipation and momentum ignition (i.e. artificial trades designed to induce correlated price behaviour in other market participants). There may be many others as well. Many of these activities could be described by the phrase du jour — 'latency arbitrage'. This refers to the ability to act more quickly than other agents in the market. As such, it can be compared to an antique dealer getting to a street market at 5 am where it is known that all the bargains will be gone by 5.10 am. Controversy enters if the market mechanism allows for unfair informational advantage. Consider a closed auction where bids are made, not knowing what other bids are extant (an example would be a double-blind Dutch auction, see Mendelsohn 1982). If the bids/asks are entered, then the book is closed, and then sorted, latency might allow you to change your bid upon

knowing others' bids. It is claimed that the practice of flash orders (whereby exchanges could show unfilled orders to preferred clients, prior to sending them off elsewhere), which was prevalent in the US in 2009 and is possibly still prevalent in Europe, is a version of this.Indeed, many of these descriptions are not quite what they seem. Market making as an example, is not binding in any way and the ability of HFT traders to get out of the market in troubled times means that this is not equivalent to traditional market marking which was there to provide two–way prices in all climates. However, the fact that traditional market makers (are claimed) not to answer their phones during periods of market turmoil, such as during the crash of 1987, suggests that market making in any form has a built-in option and legislation to remove HFT on this basis is probably misguided.

HFT costs and benefits: price efficiency

Our first area of interest is the impact of HFT on price efficiency. This can be interpreted in many ways, but a simple mechanistic version is that prices are random walks, and that corresponding returns are white noise. Such an approach has been used by Castura et al. (2010) and Linton and O'Hara (2011). By comparing results of variance ratio tests, which indicate the presence of positive/negative correlation in returns, they present strong evidence that price efficiency is a consequence of the introduction of, and increase in, HFT. Other attempts to assess the impact of HFT are based on the use of volume-weighted average price (VWAP). The idea is that you want VWAP to be high if you are selling and low if you are buying. Here the argument takes a number of twists. The essential idea is that the presence of HFT traders selling in a market with a lower VWAP than other traders is creating a trading opportunity. An opposite argument will apply to VWAP buyers. The difficulty with this measure is that there is very little theory to guide us as to what VWAP is actually capturing. It could be movements along a demand or a supply curve, for example, in which case, it is simply reflecting order size rather than trading skill. Another version of VWAP is that high VWAP for sales by HFT traders is a 'good' because it suggests that they are performing well relative to others. This latter version may reflect the benefits of HFT to HFT traders but does not give much indication of benefits elsewhere.

Yet another claim in favour of HFT is improved 'price discovery'. The term price discovery is very widely used in modern microstructure but again, it is less clearly defined. In this respect, it is worth examining a paper by Huddart et al. (2001). They use the term to mean specifically that the uncertain future price will have a smaller variance. This is in the context of normal returns and has no time dimension. More generally, we might think of it as meaning that improved price discovery means less fat-tailed distributions. A time-based notion of price discovery uses the idea that if news arrives, then the system will take a certain time until the price reflects that new information, so enhanced temporal price discovery means that this process will be quicker. HFT is likely to deliver this version of price discovery. Since the impact of HFT on price distributions will be discussed later in the section on academic research, we will say no more on price discovery.

HFT costs and benefits: price liquidity, volume and costs

We now consider liquidity. Again, it is often argued that HFT traders bring liquidity to the market. Indeed, it is a source of income for them as exchanges provide compensation for liquidity providers. Liquidity is somewhat difficult to define, but it can be viewed as something like the number of resting orders that allow for trades near the current price. Some traders state that this definition falls short in terms of what one can really trade. This definition is synonymous with depth and could be thought of as timeless. A very similar concept is resilience, which indicates the price sensitivity due to an increase in supply or demand and thus is closely related to inverse price elasticity.

A number of papers make the claim that HFT increases depth and this seems to hold most of the time, especially in normal times. The point that is contested is what happens when the market is shocked. The HFT risk systems are usually faster than their counterparties and can therefore cease trading when market risk is high. Thus, in abnormal times, HFT may lead to a reduction in liquidity. This argument is examined in BIS (2011).

We digress slightly to talk about HFT risk management systems. These seem to be shrouded in mystery and I am not aware of a theoretical approach analogous to conventional risk management models. Such an approach would presumably define risk in terms of the particular features of HFT, in addition to the conventional metrics of tracking error and value-at-risk (VAR). This seems an excellent topic for research.

Another claim in favour of HFT is the reduction in transaction costs that result from it. Again, research suggests that bid–ask spreads are unambiguously reduced. This is seen by many market practitioners

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as being an unambiguous 'good'. However, it was not always so. Keynes (1936), in chapter 12 of his general theory, states fairly clearly that the British stock market was better than the American stock market because the transaction costs there were higher. This resulted in more investment for income (long-term) rather than investment for capital gains/speculation (short-term).

It is always dangerous to presume what a long-dead economist might have liked, but it seems reasonable to think that he might not have liked HFT. It is also worth noting in this context that the alleged 'deterioration' of financial markets from places of investment to places of speculation has been noted by others, e.g. Haldane (2010). He noted that the mean holding period for investors in US stocks has fallen from 10 years in the 1940s, to seven months by 2007, with broadly similar numbers in the United Kingdom (UK). Recent research with HFT data present has produced mean holding periods of about 22 seconds. However, it may well be that bid–ask spreads would have fallen anyway as the whole trading structure has become more competitive.

Profitability of HFT

The third area I will consider is the profitability of the HFT industry. It is hard to get any accurate measure of this, but some published figures for HFT activity on US liquidity rebates suggest an annual income of $3 billion. Estimates of the profitability of US equity HFT seem to be of the order of $12 billion per annum, although Brogaard (2010) claims the amount to be about $3 billion per annum. Tabb Consulting Group publishes commercial reports (which I have not been able to obtain) that advance annual net profit figures on US HFT of circa $10 billion per annum. It is very hard to compare these figures as they involve a great deal of guesstimation as to whom or what is HFT. Scaling the former number up to gross profits might give us $24 billion. If we believe that US equity HFT represents one-tenth of the global HFT industry, we may end up with an annual gross profit of perhaps $300 billion worldwide.

Academic research on HFT

Academic research on HFT tends to take two paths. The first is empirical work based on the exhaustive analysis of tick data such as orders or trades. A frequently quoted author on this issue is Brogaard (2010, 2012) who has examined the US market. To briefly summarise, Brogaard finds that:

- HFT follows a price reversal strategy based on order imbalance;
- HFT makes up 74 per cent of trades;
- HFT does not seem to systematically front-run non-HFTs;
- HFT adds a lot to price discovery;
- HFT trading levels don't change much with market volatility;
- HFT produces best bid–asks but not much depth; and
- HFT may actually reduce volatility.

There is very limited theoretical work on HFT. The most notable, in my view, is the paper by Cvitanic and Kirilenko (2010). They show that price distributions have thinner tails after the introduction of machines. This would indicate that HFT reduces extreme tail risk in the market. The theoretical tools used are Poisson distributions of order arrival, very much in the spirit of Mendelsohn (1982). While the Cvitanic and Kirilenko (2010) paper is outstanding, the conclusions follow from the assumptions. In particular, they assume that the HFT trader in the model picks off all the high and low orders and this has the intuitive implication that it truncates the distributions of prices; thus it is not surprising that tail risk is reduced. It may well be possible to reverse the result by assuming different rules for HFT trading.

The view that tails would be thinner after the introduction of HFT is consistent with improved price discovery. Taken together with the improvements in price efficiency, we seem to have a conclusion that HFT will lead to a well-behaved market with innovations in prices being Gaussian or something very similar. This does not seem to be the view held by Sornette and Von der Becke (2011). They unequivocally assert that HFT leads to higher turbulence in prices. This is a reference essentially to unstable dynamics. The authors' backgrounds are much more econo-physical (one at least is an eminent vulcanologist). They claim that the processes involved don't differ dramatically from our understanding of financial bubbles. Rather, they are the same but they happen more quickly. They also argue that we need to look at agent-based models to assess the welfare gains or losses. They conjecture that the gains, if any, are likely to be minimal.

Welfare issues and HFT

The question of welfare is a very important one and seems to be unstudied in any of the existing research. I shall repeat a few well-known facts on welfare analysis, familiar to economics 101 students. The notion of a Pareto optimum is one where any improvement in the welfare of one person will lead to a loss of welfare (utility) for another one. Furthermore, even if the introduction of HFT leads to a Pareto improvement, in that everyone benefits from lower transaction costs, it may be the case that 99 per cent of the gains accrue to the traders, while 1 per cent accrues to the investors whose positions are being constantly front-run, thereby offsetting the gains from lower costs.

Echoing the remarks of Sornette and Van der Becke (2011), it seems that one way you could address welfare issues is by computing an agent-based model with and without HFT. Such an approach has been used by Leland (1992) to assess the equilibrium benefits of insider trading. There is no incentive for the private sector to carry out such a calculation; this needs to be done by central banks/regulators/academics.

A number of recent unpublished papers look at social welfare issues, see Hoffmann (2011) and Cartea and Penalva (2012). However, they are concerned with deriving analytics and use highly stylised models. While these papers make useful contributions, their goals are of a more theoretical nature and do not include sufficient detail or complexity to guide policy.

It is almost mandatory in a paper of this kind to talk about the Flash Crash (6 May 2010). Since this has been well analysed elsewhere.[2] I shall desist except to note that it seems that HFT did not start it but may well have exacerbated it. This conclusion is worthy of a comment as it may well be what we will see in the future. Large portfolio movements resulting from problems in Europe, or whatever, may initiate periods of turbulence which may well be more turbulent or longer-lived as a result of HFT. However, we don't really know this as there is not an accumulation of evidence as yet, nor are there clear counterfactuals to compare with.

In many cases, the policy responses to HFT are rather predictable. Those academics from certain business schools, whose belief in the efficiency and primacy of markets can reach extreme levels, tend to believe that regulators should take no actions at all. If the regulators were to act, they claim, then all HFT would go overseas to the huge loss (in terms of foregone taxes) to the regulating country. This policy recommendation raises a number of questions, not the least being what tax base is at risk, which leads to the profitability of the HFT industry, a topic I shall deal with later.

It is claimed that the Europeans, especially the French, want to introduce a transactions tax on HFT. This is again problematic as it would require a very precise definition of HFT to avoid keeping corporate lawyers busy for many years. Again, one would have to be sure that there is a clear differentiation between HFT and ALGO trading. However, the notion that a transactions tax on limit orders that cancel in less than some fraction of a second does seem at least worth serious discussion.

Regulators, especially those in Europe, have launched a number of initiatives about treating customers fairly.[3] These, in the main, are concerned with how managers treat their clients, but presumably should apply to exchanges as well. If this is so, the notion of co-location does seem to suggest a preferred client status and certainly goes against the idea of a market being a fair place for all to buy and sell. At the level of political economy, notions of exchanges being places where wage earners can diversify their income risk through share ownership, which was very much a feature of Thatcherian political economy, seems vulnerable to preferred client structures.

Multilateral trading facilities (MTFs) have evolved in Europe as a way of trading that allowed exchanges, in effect, to propagate. They were a consequence of legislation (MIFID) and it is not clear whether their growth is in reaction to HFT or is encouraging the spread of HFT. They exist both within investment banks (Nomura) and outside, such as Chi-X Europe. But HFT firms are also key clients or stakeholders of these organisations and the market fragmentation MTF's have caused has led to more exploitable HFT opportunities through multiple listing and timing issues. It may well be that in some circumstances they provide better trading environments for institutional block trades relative to the traditional exchanges whose revenue dependence on HFT has been growing over the decade. They currently account for about half of total volume traded.

Conclusion

The available evidence suggests that HFT is of benefit to the traders themselves, the exchanges who support it and the providers of products whose use is intrinsic to the HFT process. It may be of benefit to fund managers although this is not clear-cut. Likewise, the same can be said for retail/private investors. It is clearly not beneficial to regulators as it complicates regulatory control, and the notion of market activity being a combined 'tape' of all market activity on all assets ordered by time may become unmanageable as a regulatory tool. HFT is, however, part of an evolving process which cannot be ignored and will not go away.

I will finish by noting that the costs and benefits of HFT discussed in the previous paragraphs involve so many loose assumptions that it is very difficult to say very much for or against HFT that is evidence based. However, the original idea of Sornette and Van der Becke (2011) seems to be the best one. We need to build artificial markets to get some sense of what the introduction of new trading methods is likely to do to the welfare of all agents. I'm fully aware that practitioners will be very dismissive of what we might learn from simulation/experimental analysis since they seem to be obsessed with back-testing. I believe that that position is incorrect. Notwithstanding the limitations of having to be definite about the true generation of prices, I would remind them that simulation/experimental analysis provides them with an infinity of parallel and/or alternative histories while back-testing involves only one. ■

Notes

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2. 'Findings Regarding the Market Events of May 6, 2010', *Report of the Staffs of the CFTC and SEC to the Joint Advisory Committee on Emerging Regulatory Issues, U.S. Commodity Futures Trading Commission* (30 September, 2010).
3. For example, see www.fsa.gov.uk/pages/doing/regulated/tcf/

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