**Japan’s High-Frequency Trading: The Product of a Unique Evolution**

**Section 1. The Merits and Deficiencies of High-Frequency Trading in Japan**

**Is High-Frequency Trading Fintech?**

High-frequency trading (HFT), which has been actively practiced in the United States since the early 2000s, began becoming more widespread in Japan around 2010. Today, after almost ten years, opinion is still divided regarding the impact of HFT on Japanese financial markets, and many aspects of its effects have yet to be fully evaluated. HFT defies straightforward judgement, due to a marked lack of clarity regarding matters such as the actual status of HFT activity, its effect on financial markets, and the possible existence of unfair trading.

Do AI-driven algorithmic trading, together with HFT as one of its subclasses, really constitute significant fields in fintech? If fintech is understood in the broadest sense as a fusion of finance and technology, then algorithmic trading and HFT are undoubtedly fintech fields. 　However, defining fintech more narrowly, as “innovations in financial fields that enhance the convenience of numerous users,” results in greater ambiguity as to whether or not HFT constitutes fintech.

Indeed, it is undeniable that many people have a negative impression of HFT, as “a way for only a few market participants to make money,” or believe that “advances in HFT technologies have not led to win-win situations that benefit more participants, but rather to zero-sum games,” or that “HFT manipulates the market and harms the interests of other investors, particularly individual investors.”

Professor Joseph E. Stiglitz of Colombia University has concluded that, while HFT firms profit from making trades faster than do other firms, this activity leads to excessive investment and wasted costs in social terms. Moreover, the involvement of HFT is suspected each time a “flash crash” occurs, where prices in equities, bonds, or forex markets fluctuate significantly over a short space of time. Consequently, HFT is often criticized as a destabilizing influence on financial markets.

**The Social Significance of HFT Should Not Be Ignored**

Nonetheless, considerable empirical analysis in Japan and throughout the world indicates that HFT enhances market functioning, including increasing the liquidity and improving the efficiency of markets. There is a far greater volume of research demonstrating HFT’s positive impact than there is any empirical analysis showing that HFT destabilizes financial markets.

　It may therefore be reasonable to suggest that HFT has broad social significance, benefitting society as a whole by enhancing market functioning. The importance of this issue should not be underestimated.

**The Movement Toward Greater Regulation of HFT around the World**

　Even if HFT clearly enhances market functioning under normal conditions, can the same be said in the case of a crisis or an emergency? If markets become turbulent for some reason, HFT may actually amplify this instability. To date however, there has not been sufficient evidence of this effect.

　In addition, it cannot be denied that HFT firms may, intentionally or otherwise, be engaged in unfair trading practices, such as market manipulation. It is also possible that trading by HFT firms may deprive other investors, particularly individual investors, of opportunities to gain profits. These issues too, still await thorough evaluation.

Throughout the world, countries have proceeded to strengthen regulation and implement systems to respond to the risks potentially associated with HFT. In Japan, for example, a registration system for HFT firms was instituted in April 2018.

　It is to be hoped that this increase in regulation does not overly constrain those HFT activities that contribute to the public good, including its enhancement of market functioning, but rather mitigates risks that may result in the potential problems described above.

The regulation of HFT requires sophisticated technology, and represents a new frontier for regulators. In fact, the level of technology used by regulators has been cited as one reason why, in Japan, very few cases of unfair trading by HFT firms have been exposed to date. In order to improve the level of technology available to regulators, more collaberation with the private sector will be needed.

**HFT May Play a Role in Shaping Business Models in Japan's Securities Industry**

　Included in this paper’s review of the latest trends in the activities of Japan’s securities companies and HFT firms (see Section XX) is an examination of the mechanism, already common in the United States, whereby a Japanese online securities broker may pass on share trading orders submitted by individual investors to an HFT firm in return for receiving a rebate (compensation) from the HFT firm. This practice has begun to be adopted by Japanese online securities brokers, leading to an increasingly strong relationship of mutual dependence between HFT firms and securities companies.

　Japan’s online securities brokers face an extremely fragile earnings base due to a persistent low interest rate environment. In the future, it is conceivable that these brokers may grow even more dependent than their United States counterparts on rebate income from HFT firms, obtained through mechanisms such as this.

Continued, strict monitoring will be necessary to ensure that these practices are not conducted in a way that significantly damages the interests of individual investors.

**Section 2. What Are Algorithmic Trading and HFT?**

**What is Algorithmic Trading?**

　HFT is one form of algorithmic trading. What then, is algorithmic trading?

Algorithmic trading can be defined as “the repeated trading of securities where the timing and volume of orders placed is determined automatically by a computer system, according to a predesignated procedure.”

　Algorithmic trading itself has been around for a long time. In many cases, it is not particularly sophisticated, consisting of nothing more than the automation of conventional trading procedures. A significant proportion of algorithmic trading is not actually high-frequency, high-speed trading. Recently however, there has been an increase in sophisticated algorithmic trading utilizing AI technologies, such as machine learning.

　The main objective of algorithmic trading is to achieve stable profits. To this end, it seeks to pursue maximum returns while controlling risk, as well as reducing costs.

　Institutional investors, proprietary firms (investment companies that invest using only proprietary funds for direct gains rather than for commissions), proprietary trading and brokerage divisions of securities companies, and even individual investors all engage in algorithmic trading. For all of these players, with the exception of the brokerage divisions of securities companies, the main objective of algorithmic trading is achieving maximum profits. For the brokerage divisions of securities companies, the main objective is to fulfill their duty of best execution; that is, their obligation to ensure that customer orders are executed under the best possible conditions.

**Types of Algorithmic Trading**

　Algorithmic trading can be classified into six types, according to its objective and procedure — trading using: (1) execution algorithms; (2) benchmark execution algorithms; (3) market making algorithms; (4) arbitrage algorithms; (5) directional algorithms; and (6) market manipulation algorithms.

1. Trading Using Execution Algorithms

Execution algorithms automate the splitting and timing of buy or sell orders placed by investors, choose optimal markets and make other adjustments, in order to achieve objectives such as cost reduction. Some of these algorithms are designed to conceal the execution of trades from other investors, thus mitigating market impact cost (the price change that occurs from the action of buying or selling a security). Others incorporate mechanisms to ensure compliance with market rules.

Splitting large orders into smaller ones, and placing these smaller orders gradually over time, is an effective way of reducing market impact cost. On the other hand, the longer it takes to complete the execution of an order, the greater the risk of market price movements (timing cost). Therefore, one important role of execution algorithms is to determine and implement the optimal timing that will minimize the sum of these two costs.

1. Trading Using Benchmark Execution Algorithms

　Benchmark execution algorithms aim to ensure that the results of order execution approximate a defined benchmark, and are used when executing large orders. For example, when splitting a large order into several smaller ones in order to limit market impact cost, a benchmark execution algorithm may be designed to ensure that the average price of each small order approximates a benchmark such as the market closing price.

1. Trading Using Market Making Algorithms

Just as do regular market makers, market making algorithmic traders place both buy and sell limit orders. By placing such orders simultaneously, at prices more favorable than the current market price (mid-price), and then awaiting other market participants to trade with, they aim to profit from the difference between the market price and the bid or ask price. If buy and sell orders of the same size are executed, the trader will then profit from the combined bid-ask spread.

Such trading by market makers provides market liquidity, thus contributing to the stability of markets. Investors utilizing market making algorithms must constantly adjust spreads and order sizes in accordance with the movements of markets and order books, repeatedly placing new orders, adjusting, and canceling orders.

1. Trading Using Arbitrage Algorithms

When the prices of identical securities, or other equally-valued products or instruments, differ at the same point in time, arbitrage algorithms aim to generate profits by simultaneously selling at the higher price and buying at the lower price, and then closing these positions after the prices converge. In this way, traders can make profits while limiting the price change risk (market risk). To the extent that the application of arbitrage mitigates or eliminates distortions in markets, it can be said to contribute to enhancing market efficiency.

Four processes must be completed before arbitrage trading can generate profits: the discovery of arbitrage opportunities; the opening of arbitrage positions; the total or partial resolution of price distortions; and the closing of the arbitrage positions. Because the effect of arbitrage is to eliminate price distortions, the investor that first utilizes an arbitrage opportunity can make the greatest profit. Therefore, speed is vital in the first and second arbitrage processes, the discovery of arbitrage opportunities, and the opening of arbitrage positions, respectively.

1. Trading Using Directional Algorithms

Directional algorithms are used to predict changes in market prices using market data such as prices and trading volumes, as well as news and other event data. They are also used to generate profits from trading based on these predictions. The strategy behind their use is to profit from unidirectional changes in market prices. This style of trading is generally high-risk and high-return.

1. Trading Using Market Manipulation Algorithms

Market manipulation algorithms are applied to move market prices in a favorable direction by issuing orders designed to mislead other market participants with respect to information, such as the provision of liquidity or the intention to buy or sell. Using these algorithms can enable the user to achieve considerable profits. In some cases, these algorithms can operate to reduce trading costs by attracting significant liquidity to the market. They can also delay or prevent the execution of orders by other market participants by causing the repeated cancellation of large orders,.

**Using Machine Learning in Algorithm Construction**

　Two types of methods are used to construct the algorithms used in trading strategies such as those described above: a theoretical approach and an empirical approach. Using the theoretical approach, the designer establishes certain assumptions regarding price movements and the mechanisms that determine market conditions, and constructs a model based on this. In contrast, using the empirical approach, a computer is programmed to discover patterns in historical data using AI technologies, such as machine learning, and then search for a model that matches these patterns.

The theoretical approach facilitates the validation of the assumptions made, and the correction of any problems, as the designer understands the mechanism of the algorithm. At the same time, however, the strength of the theoretical approach is dependent on the designer’s individual experience and is constrained by the fact that there is a limit to the number of theoretical causal relationships that any designer can recognize and understand. Consequently, it can be anticipated that using the empirical approach to construct models based on more extensive and diverse case data will to lead to better trading performance. Therefore, a combination of theoretical and empirical approaches is often used in algorithm construction.

**A Struggle Between AI Technologies**

Among the forms of algorithmic trading described above, competition often arises between the AI technologies in market making algorithms used by the brokerage divisions of securities companies in execution algorithms, and those used by HFT firms..

The execution algorithms used by securities companies automatically determine a series of processes for the execution of large orders received from customers, such as order splitting, order timing adjustment, and the selection of optimal markets. In doing this, execution algorithms try to prevent these large orders from being detected by other investors, and to execute them without giving rise to market price movements.

In contrast, the aim of trading by HFT firms using market making algorithms is to profit from rapidly placing, altering, and canceling both buy and sell orders. By quickly detecting the existence of large orders in the market, these algorithms try to profit by anticipating their execution.

This leads to an intense struggle between the AI technologies designed to conceal the existence of large orders, and the AI technologies designed to uncover them.

**What is HFT?**

　High-frequency trading (HFT) refers to a type of algorithmic trading where securities are bought and sold at high speed and high frequency.

Because HFT enables many trades to be executed within a short period of time, it can generate large profits even when the return on each individual trade is comparatively small. In addition, because trades are executed rapidly, HFT allows the trader to capture and capitalize on profit opportunities that may exist for only an instant.

It is common for HFT strategies to open and close positions within a brief interval. The is advantageous because holding a massive position for a long period of time exposes the trader to significant market risk.

Ferber, M. (2012) defines HFT as trading that satisfies at least four of the six conditions below:

* Use of colocation services (services that allow trading participants to place servers and other devices that execute trades physically close to the trading system operated by the securities exchange)
* Daily trading value is at least 50% of the portfolio
* Order execution rate is less than 25%
* Order cancellation rate is more than 20%
* More than half of positions are offset by intraday positions
* Receives rebates on more than 50% of transactions or orders

**Trading Algorithms Used in HFT**

　Of the six forms of trading algorithms examined above, three in particular tend to be used in HFT: market making algorithms, arbitrage algorithms, and directional algorithms.The most common of these are market making algorithms. High-frequency, high-speed trading is effective for market making, because of the need to constantly place, alter and cancel orders according to changes in market prices and liquidity.

　For arbitrage, the greatest profits can be generated by algorithms that are able to discover price distortions — arbitrage opportunities — and execute arbitrage trades the fastest. In this context too, the use of HFT is effective. This type of algorithmic trading — HFT — was described in *Flash Boys: A Wall Street Revolt* by Michael Lewis, published in 2014. In the United States, New York is the hub for trading individual stocks, while trading of equity index futures is centered in Chicago. A direct fiber-optic cable was laid between these two cities, with the aim of encouraging arbitrage trades between their two markets.

　Similarly, in the case of directional algorithms, the use of HFT is effective when the aim is to attain trading profits over a short period of time.

**Background to the Increase in the Use of HFT for Arbitrage in the United States**

　Regulatory reform in the United States provided the opportunity for more active use of HFT in arbitrage. The U.S. Securities and Exchange Commission (SEC), uneasy about the monopoly exercised over equities trading by the New York Stock Exchange (NYSE) and Nasdaq, promoted regulatory reform aimed at stimulating competition between securities exchanges.

As a result, from the 1990s onward, markets became increasingly fragmented, with orders executed on a greater number of exchanges or alternative trading systems (ATS), or by market makers other than exchanges.

　The more places — markets — where a stock is traded, the greater the number of possible discrepancies between indicative prices, and therefore, the greater the opportunity for arbitrage. Investors progressively introduced high-speed trading systems capable of rapidly responding to changes in order book information. At the same time, markets (securities exchanges) themselves also increased the response speed of their order execution systems in order to meet the needs of these investors.

　In Japan however, with the Tokyo Stock Exchange accounting for around 90% of the total value of trades, the use of HFT for arbitrage is relatively minimal. Rather, the use of HFT in Japan centers on market making algorithms.

**Will High-Speed Trading Approach the Speed of Light?**

　A relatively small number of emerging companies manufacture network switches that enable the processing of transactions at the equivalent of the speed of light. In 2016, *The Wall Street Journal* reported that network switches manufactured by Metamako, based in Sydney, Australia, and xCelor, based in Chicago, required just four nanoseconds (four billionths of a second) to relay information such as data sent from a securities exchange to an electronic trader.

　Consequently, for some HFT processes, trading really is approaching the speed of light. Does this mean that the competition for greater speeds in HFT is coming to an end?

　As the speed of trading almost literally approaches the speed of light, the amount of investment required to increase this speed even fractionally higher than that of competitors is growing exponentially. With the marginal cost of greater speeds becoming greater, HFT firms can be expected to stop making additional investments in speed when the marginal cost of such investments matches the marginal expected return. 　As I will discuss later, the proportion of HFT within all equity trading in the United States has actually been decreasing since its peak around 2009. Some have cited this as an indication that the investment in speed has already reached just such a critical point where the cost of investing in speed is no longer worthwhile. Nevertheless, in the United States, firms still compete to achieve speeds even fractionally faster than their competitors, and get just even a little bit closer to the speed of light. Clearly, that the critical point has not yet been reached.

**Section 3. Reviewing the Historical Development of HFT around the World and in Japan**

**HFT First Flourished in the United States**

　It was the United States where HFT first became popular. By the mid-2000s, many HFT firms were already participating in U.S. markets. The percentage of HFT in all stock trades increased rapidly through the second half of that decade, and had reached 61.0% by 2009, according to an estimate by Valerie Bogard of the Tabb Group, a U. S. research firm.

　After this peak in around 2009, however, the percentage of HFT in total market activity began to decrease. Excessive competition and declining profits were likely the reasons for this decline. In many ways, HFT is a zero-sum game, and an increase in HFT firms tends to decrease each firm’s profits. According to the Tabb Group’s estimates, in 2018, the HFT industry earned a combined revenue of 1.8 billion dollars on U. S stock markets. This represents a decrease of roughly 70% from the 5.7 billion dollars earned in 2010.

It is also possible that the sudden drop in stock prices in May 2010 — the so-called flash crash — contributed to reduced participation in HFT. Subsequently the HFT firm Eladian Partners was driven out of business in 2012, followed by Infinium Capital Management in 2014.

By 2014, the percentage of HFT as a proportion of the total value of all trades (as estimated by Bogard) had decreased to 48.5%. Since then, HFT’s share of trading value appears to have remained relatively stable. Because this proportion is close to 50%, it may be inferred that a situation exists in which each trade involves a HFT firm on one side and a non-HFT counterpart on the other. If this proportion were to exceed 50%, then the struggle between HFT firms on both sides of trades to achieve profits would lead to the elimination of some of them. A proportion of around 50% is thus regarded by some observers as the upper limit of sustainability for HFT. According to such an analysis, the proportion of over 60% seen in 2009 is gone, never to return, as such a level is unsustainable.

HFT activities in Europe were much like those in the United States, albeit with a lag of several years. The percentage of HFT as a proportion of equities trading in Europe (based on the total value of all trades) was 29% in 2009, and reached 38% in 2010 (according to The World Federation of Exchanges). Subsequently however, it trended downwards, and is estimated to have sunk to 24% by 2014 (European Securities and Markets Authority).

**HFT Firms Move to Japan from Saturated Markets Such as the United States**

　The spread of HFT in Japan occurred later than in Europe or the United States, where its share of market trading peaked in around 2010. Its initial spread in Japan was driven by the launch by the Tokyo Stock Exchange of the “arrowhead” equities trading system in 2010, featuring world-class speed, reliability, and extendibility which enabled high-speed trading. Its introduction paved the way for full-fledged HFT.

　In 2010, just as the proportion of HFT in the United States had peaked, it began spreading in earnest in Japan. It is possible that the spread of HFT in Japan was also boosted by HFT firms shifting their activities to Japan from the saturated U. S. markets, which were becoming less profitable.

　In *Analysis of High-Frequency Trading at Tokyo Stock Exchange* (Hosaka, 2014), as of 2014, HFT represented 25.9% of the equity trading (its share of trade value) in Japan. This is roughly equivalent to the level in Europe at around the same time.

However, it has been suggested that the proportion of HFT in Japan has grown since then, given the improvment of “arrowhead” in 2015, and the quantum increases in trading speed and the number of transactions processed. Current levels of HFT in Japan, although lower than those in the United States, are quite possibly higher than in Europe.

It should be noted that the percentage of HFT as a proportion of equity trading in Australia was estimated to be 27% from January to March, 2015 (Australian Securities and Investments Commission). On the other hand, the proportions of HFT in the Hong Kong and Singapore trading markets are thought to be very low (Wheatey, 2011).

Figure 1: International Comparison of the Proportion of HFT in Equity Markets

Source: Tooru, Fukuda, Japan Securities Research Institute, “Interim Report of ‘The Conference on the Impact of IT Innovation on Securities Markets.’”

Notes: (1) Comparisons are based on the total value of all trades.

(2) Measurement periods are as follows. Japan: September 2012, January and May 2013. United States: January 2008–February 2010. Canada: August–November 2011. Australia: May–July 2012. All other countries: May 2013.

**Activities of HFT Firms in the High Market Concentration of Japan**

　Compared to markets in Europe and the United States, Japanese equity markets are highly concentrated, meaning that the level of market fragmentation is low. This is probably attributable to the Tokyo Stock Exchange’s overwhelming share of equity trading.

　As can be seen in the nature of U.S. HBT trading described *Flash Boys*, the dispersion of trading over multiple different markets creates an environment that enables HFT firms to profit from arbitrage. Moreover, a large number of markets translates to a large number of opportunities for HFT firms to engage in market making. In this sense, the greater the market fragmentation in a country, the more profit opportunities it provides for HFT, and the more attractive it is for HFT firms.

　From this perspective, Japan, where equities trading is largely concentrated on the Tokyo Stock Exchange, may not necessarily be an attractive market for overseas HFT firms. The fact that, as discussed below, foreign HFT firms are nevertheless highly active in Japan, is explained perhaps to the saturation of overseas markets, leaving Japan as a place where they can still survive and profit.

**The Domination of the Japanese Market by Foreign HFT Firms**

　 Japan introduced a registration system for HFT firms in April 2018. As of October 15, 2020, 55 HFT firms (officially referred to as “those engaging in High Speed Trading”) had been registered. With the exception of one Japanese firm, the head offices of all the registrants are located in countries other than Japan, (See Table 1). The clear domination of Japan’s HFT by foreign players seems to indicate that HFT firms from the saturated United States markets have now moved to Japan seeking profit opportunities.

　It is therefore quite likely that much of the profit from HFT in Japan is flowing out of the country. This situation may place domestic investors, particularly individual investors at a disadvantage, with so much of the HFT profits flowing offshore.

　And yet, as of today, there does not appear to be much criticism of foreign domination of Japan’s HFT market in the country. Perhaps this is because there is a stronger awareness among market investors and others relevant parties of the positive contributions of HFT, such as supplying the market with liquidity. Or perhaps the paucity of criticism arises out of a lack of awareness of the very existence of HFT firms among the general population in Japan.

Eventually, however, foreign HFT firms may one day be subject to the stern scrutiny of the Japanese population. The situation is reminiscent of the time when some overseas investment funds, referred to as “vulture funds,” beat down the prices of Japanese companies, resulting in a strongly cautious stance among the Japanese population.

Figure 2 Location of the Head Offices of Registered HFT Firms in Japan

|  |  |
| --- | --- |
| Hong Kong | 14 |
| United States | 13 |
| Singapore | 12 |
| Australia | 7 |
| United Kingdom | 2 |
| Israel | 2 |
| Netherlands | 2 |
| Germany | 1 |
| Ireland | 1 |
| Japan | 1 |

Note: As of October 15, 2020

Source: Financial Services Agency

**Section 4. Evaluation of the Impact of HFT on Financial Markets**

**HFT Effectively Enhances Market Functioning**

　Both the positive and negative effects of algorithmic trading, and of HFT in particular, have been the subject of debate from a variety of perspectives. First, considering the market making algorithms used by the majority of HFT firms for trading, one of the most often cited positive effects of HFT is its role in supplying liquidity. Not only does the HFT activity of placing both buy and sell orders contribute to the supply of liquidity, but it is also instrumental in maintaining market stability.

　Second, HFT trading based on arbitrage algorithms, another of the main forms of trading algorithms used by HFT firms, eliminates price divergence by rapidly placing orders whenever an arbitrage opportunity is discovered. To the extent that HFT eliminates these price differences, or market distortions, it can be viewed as improving market efficiency, at least in part.

Therefore, given HFT’s effects of supplying capital, stabilizing markets and enhancing market efficiency, it seems clear that HFT-style algorithmic trading effectively enhances overall market functioning.

**Empirical Research Overseas on the Effect of HFT in Enhancing Market Function**

　There is a large body of empirical evidence from outside Japan on how HFT supplies and enhances market liquidity. Figure 3 shows some representative examples of this research.

Figure 2: Empirical Research on the Supply of Liquidity by HFT

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| --- |
| ● Empirical analysis of equity markets in the United States: Zhang and Riordan (2011)  → Tendency to draw liquidity away from highly liquid stocks, and provide liquidity to less liquid stocks  ● Empirical analysis of equity markets in the United States: Brogaard et al. (2014)  → Institutional investors’ trading costs (the costs of correcting for market movements) have not increased, despite an increase in the proportion of HFT due to system renewal  ● Empirical analysis of equity markets in Canada: Brogaard et al. (2014)  → Observed reduction in HFT and shrink in the bid-ask spread after an increase in trade commissions |

Source: Prepared by the Nomura Research Institute from various materials

Empirical research from the United States and Canada indicates that HFT effectively enhances market liquidity. Supporting these findings from a different perspective is empirical analysis from the United Kingdom showing no evidence that increased HFT leads to higher trading costs for market participants by reducing market liquidity.

　Moreover, the conclusions drawn from significant empirical research conducted outside of Japan indicate that HFT has the effect of enhancing market efficiency. Figure 4 shows some representative examples of this research.

Figure 4: Empirical Research on HFT’s Enhancement of Market Efficiency

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| --- |
| ● Empirical analysis of equity markets in the United States: Zhang and Riordan (2011)  → HFT rectifies divergence from efficient price levels  ● Empirical analysis of equity markets in the United States: Benos and Sagade (2014)  → HFT actively promotes movement towards efficient price levels, and tends to anticipate orders that may cause price divergence |

Source: Prepared by the Nomura Research Institute from various materials

　The contribution of placing orders using HFT in determining efficient price levels has been confirmed through empirical analysis in the United States and United Kingdom.

**Results of Research in Japan**

　In Europe and the United States, there is a significant body of academic research on HFT’s impact on markets. Much of this research presents a positive assessment of HFT’s impact on equity markets, where it contributes to enhancing the price discovery function and increasing liquidity.

　The large amount of research in Japan, a relative newcomer to HFT, is notable for its focus on the changes in markets that occurred due to the advent of full-fledged HFT following the launch of the “arrowhead” trading system in 2010. For example, an analysis conducted by the Tokyo Stock Exchange (Hosaka) is relatively clarifies the characteristics of HFT firms by classifying orders into those placed by HFT firms and those placed by others, based on attributes of HFT as defined by Ferber of having an order execution rate of less than 25%, and an order cancellation rate of more than 20% (see Section 2). According to this study: (1) few orders were placed in after-hours trading; (2) market orders were extremely rare; and (3) many orders were limit orders, placed outside the best bid and ask prices, which therefore tended not to be filled immediately, but rather to remained in the order book, unfilled, for a long period of time. This suggests that the orders placed by HFT firms provide the market with liquidity, and contribute to market stability.

Below are the results of some representative examples of empirical research into the impact of HFT on market liquidity in Japan

Figure 5: Empirical Research on HFT’s Enhancement of Market Efficiency

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| --- |
| ● Uno & Shibata (2012)  → High-speed trading grew after the launch of “arrowhead,” and the supply of liquidity became more dynamic as a result  ● Arai (2012)  → The introduction of “arrowhead” made the supply of liquidity more dynamic for stocks subject to large price movements, and resulted in lower trading costs  ● Hosaka (2014)  → Many of the executed orders placed using HFT provided liquidity through this transaction. Many HFT limit orders are placed outside the best bid and ask prices, thus increasing the depth of the order book. Many HFT orders work to suppress price movement, softening the movement of stock prices  ● Ota (2015)  　→ Spreads shrank markedly after the introduction of “arrowhead” |

Source: Prepared by the Nomura Research Institute from various materials

**The Possibility that HFT May Destabilize Markets**

　While the preceding discussion of research about HFT throughout the world indicates that HFT effectively increases market liquidity and enhances market efficiency, there are others who argue that HFT-style algorithmic trading destabilizes financial markets. As already mentioned, t involvement of HFT is immediately suspected each time a “flash crash” occurs. Indeed, it is possible that in the event that markets become unstable for some reason, algorithms may act in unforeseen ways, resulting in an amplification of market instability. Others have pointed out the possibility that a “runaway” algorithm, whether caused by a malfunction or some other factor, might cause disruption in markets. 　In addition, it is possible that, because HFT firms place, alter and cancel orders swiftly and frequently, a few HFT firms may dominate price formation, with other investors unable to accurately grasp market conditions, thus resulting in price formation distortions. However, these effects remain in the realm of conjecture, as, in contrast to the abundance of research on the HFT’s positive effects on markets, there appears to be relatively little research on its negative effects. Nonetheless, it cannot conclusively be determined that the positive impact of HFT on markets outweighs its negative effects, as research on HFT’s negative effects may simply be more difficult to carry out due to data and technical limitations.

**Conflicting Opinions on Whether HFT Amplifies Market Disruptions**

As indicated in Section 1, even if it is now clear that HFT effectively enhances market function under normal, calm conditions, uncertainty remains regarding the value of HFT in times of crisis. Should markets become turbulent for some reason, it is possible that HFT may amplify this turbulence. However, to date, this possibility has not been supported by sufficient research.

In one example of such research regarding the relationship between HFT and the flash crash of 2010, Professor Kirilenko of MIT writes that when the flash crash occurred and price movements become accelerated, automated programmatic trading by HFT firms immediately withdrew the best bid and ask orders, which amplified price movements. He concludes that, when markets are under stress, biases in HFT order flows become more pronounced, leading to further price movements. The conclusion: HFT amplifies market disruptions.

This above represents one view, and opinions about the potential harm caused by HTFs remain widely divided. Professor Hendershott of University of California, Berkeley, writing that no meaningful evidence exists that the algorithms used in HFT vary their volume of trading according to changes in volatility, argues that algorithmic trading works to to suppress rather than to heighten volatility.

**The Issue of Fairness in Trading and Unfair Trading**

　Others claim that HFT, because of its ability to capture trading opportunities that might exist for only a moment, which is difficult for average investors, creates what could be considered unfairness among investors For example, even if average investors make decisions and submit orders based on the current market order book, by the time these orders reach the exchange, the order book will often have changed due to high-speed trading by HFT firms.

　In addition, it is often pointed out that some HFT consists of market manipulation and other unfair trading practices. As stated, HFT entails the frequent placing, altering, and canceling of large orders, and some have argued that these orders include some practices that are banned as market manipulation, such as “layering,” where traders place large orders that they never intend to execute, then cancel them when they are close to being filled. Indeed, there have been a few cases in Japan, where trading has been conducted with the intent to manipulate markets, and HFT firms have been exposed as the perpetrators.

**Section 5. HFT Regulation as a Preventative Measure**

**HFT Regulation and System Response in the United States**

　The trading strategies used by HFT firms are black box strategies; as the source of firms’ revenue, they are deliberately made difficult to discover. In response to a growing perception that HFT may lead to market disruption, and the concern that some HFT firms may be involved in unfair trading such as market manipulation, despite there being no conclusive evidence of such, there is increasing public pressure to implement measures to prevent problems arising from HFT. These measures consist of the introduction of various rules by self-regulating bodies, and of regulation by authorities.

　In Europe, regulators began by providing a clear definition of HFT for the purposes of the regulation. By contrast, no such clear definition of HFT exists in the United States. Even the definitions provided by the Commodity Futures Trading Commission (CFTC) and Securities and Exchange Commission (SEC) in 2010 are very general. Consequently, no regulation directly targeting HFT has been introduced in the United States. Still, the United States is notable for its progressive application of regulations targeting some forms of HFT-style trading.

　For example, the United States bans naked trading, the practice of granting traders direct access to securities exchanges, unfiltered by brokers’ order placement systems, and without any intervening system to check customer orders. (Where such a system exists, it is referred to as sponsored access.) This ban on naked access substantially reduces excessive competition between securities companies to acquire HFT customers.

　The use of stub quotes, which are limit orders that are deliberately set far lower or higher than the prevailing market price, is also banned in the United States. They are used by market makers seeking to meet their price quoting obligations any intention of having their orders executed.

**HFT Regulation in Europe**

As discussed in Section 2, HFT is clearly defined in the EU, through Markets in Financial Instruments Directive II (MiFID II ), a new, comprehensive regulative framework for financial and capital markets.

　Under this directive, all algorithmic trading firms, including HFT firms, have an obligation to report the details of their trading to the regulatory bodies. Additionally, securities exchanges are required to ascertain whether or not each order originates from an algorithmic trading firm.

　Prior registration is also required for algorithmic trading firms that implement market making strategies, and they must meet certain standards for supplying the market with liquidity.

**HFT Regulation in Japan**

　In Japan, government and cabinet office ordinances containing HFT regulation came into force in April 2018, pursuant to amendments to the Financial Instruments and Exchange Act. HFT firms (“those engaging in High Speed Trading”) are now required to register and provide prior notification of their trading strategies, and registration will be rejected if there are any shortcomings in the firm’s equipment or systems. As already noted, 55 HFT firms were registered as of October 2020.

　A definition of HFT firms has been established in Japan, although it is not as clear as the definition established in Europe. Japan defines HFT as trading “where methods are implemented to transmit orders, etc. in a shorter time than usual, and mechanisms are established to prevent competition with other orders.”

　In addition, HFT firms have an obligation to prepare and preserve trading records. The supervisory authority can demand and inspects reports, and issue business improvement orders.

　Regulation was not introduced in Japan with the intention of eliminate HFT firms on the basis of any inherent impropriety on their part. Rather, Japanese regulation aims to enable regulators and securities exchanges to obtain an accurate understanding of the actual status of HFT firms, which would be unclear otherwise, and to promote the establishment of an environment for enhancing their supervision.

The registration system was introduced because it was judged, with reasonable grounds, to be necessary for authorities to grasp the real situation regarding HFT. Many HFT firms are unlisted and disclose little information publicly. This makes it difficult for authorities to gain an understanding of their actual status and activities. Without the registration system, it would be necessary for the Tokyo Stock Exchange and other private sector companies to monitor the situation autonomously. This would entail significant cost, and some aspects could be difficult to implement. By introducing a registration system, Japan has clearly indicated its position, with the national administration responsible and paying for the system, and taking measures when any unfairness is exposed.

There were some initial concerns that the introduction of a registration system would inhibit HFT activities, but at present, there is no evidence to support these concerns.

**Few Cases of HFT Unfair Trading Have Been Exposed in Japan**

　At present however, very few cases of unfair trading related to HFT have been exposed in Japan. Three reasons can be suggested for this.

First, markets in Japan are not as fragmented as those in the United States. As a result, there is relatively little market distortion, and far less HFT in Japan than in the United States or Europe. In addition, it is probable that limitations on information obtainable exclusively by HFT firms succeed in suppressing unfair trading. In addition, even if unfair trading by HFT firms is discovered, some aspects of exposing such trading may be difficult due to the limitations placed on regulatory controls in Japan. Finally, it is possible that regulators have not been able to trace unfair trading by HFT firms due to inadequate technology.

　Of these reasons, the last seems the most likely to have affected HFT regulation in the past. Indeed, it seems that it was technically difficult for regulators to detect unfair trading by HFT firms due to the extremely short time frames involved.

With the introduction of a registration system however, regulators’ grasp and assessment of unfair trading is becoming increasingly more effective. Moreover, private sector initiatives are also helping enhance monitoring functions through the application of machine learning to vast quantities of market data using AI technologies, and these are becoming more adept at discovering suspicious activity.

Stronger relationships between the private sector and regulators, including the broad supply of information to regulators by private sector companies, should contribute to suppressing unfair trading.

　According to the Financial Services Agency, “in contrast with Europe and the United States, the amount of trading in Japan that unfairly exploits market fragmentation, etc. is limited. Even so, there have been cases of market manipulation using algorithmic trading, or working on algorithms, where corrective action has been required.” It goes on to describe cases where monetary penalties have been imposed in cases involving market manipulation activities where the offenders placed trading orders that they never intended to execute.

**Section 6. HFT and the Securities Sector in Japan Today**

**Japanese Securities Companies Delayed the Introduction of Practices from the United States**

Finally, I would like to focus on two recent trends in the activities of HFT firms in Japan. In both, HFT firms are thought to benefit in some way by obtaining information on stock orders placed by investors. These cases have once again ignited the smoldering debate on whether, after all, HFT benefits or damages the interests of other investors.

The mechanism behind both these HFT activities was imported from the United States. In this sense, Japan, a relative newcomer to HFT, is following in the footsteps of the U.S. model.

The first trend concerns smart order routing (SOR), a common practice in the securities business in the United States. Securities companies have an obligation to execute orders received from their customers at the best terms possible, based on publicly available information on bid/ask quotes and trades, after considering factors such as price, cost, speed, and the possibility of order execution. This is referred to as their duty of best execution.

SOR is an automated system aimed at helping securities companies fulfill this duty of best execution by applying an algorithm to instantaneously select the market offering the best price.

**Smart Order Routing (SOR) and Order Book Information**

According to a report published in *The Nikkei* in November 2019 (“Japan’s *Flash Boys*” 1 and 2), an online securities broker working under the umbrella of one of Japan’s financial groups, after receiving orders from their customers (many of whom are individual investors) placed these orders on the optimal market, selected using SOR between the Tokyo Stock Exchange and the financial group’s own proprietary trading system (PTS). It should be noted that in Japan, the obligation to trade stocks only through exchanges was abolished in 1998, and the ban on PTS operation was lifted as a result.

After receiving a customer order, the online securities broker in question sent it first to the PTS, and then to the Tokyo Stock Exchange, if this was judged to be the optimal market. Even if the order eventually ended up on the Tokyo Stock Exchange, it would be exposed for a certain period of time on the PTS order book. This time was around 0.1–0.3 seconds. It may seem only an instant, but for HFT firms, the interval of 0.1–0.3 seconds is an extremely long time.

It seems that HFT firms were able to obtain information on these customer orders, and then swiftly place orders on the Tokyo Stock Exchange in anticipation of these orders arriving. When this happened, the HFT firm that anticipated the order may have been able to profit from the trade, and the individual investor whose order was anticipated may have been forced to trade at a less favorable price as a result. According to *The Nikkei,* this scheme was newly introduced in October 2019.

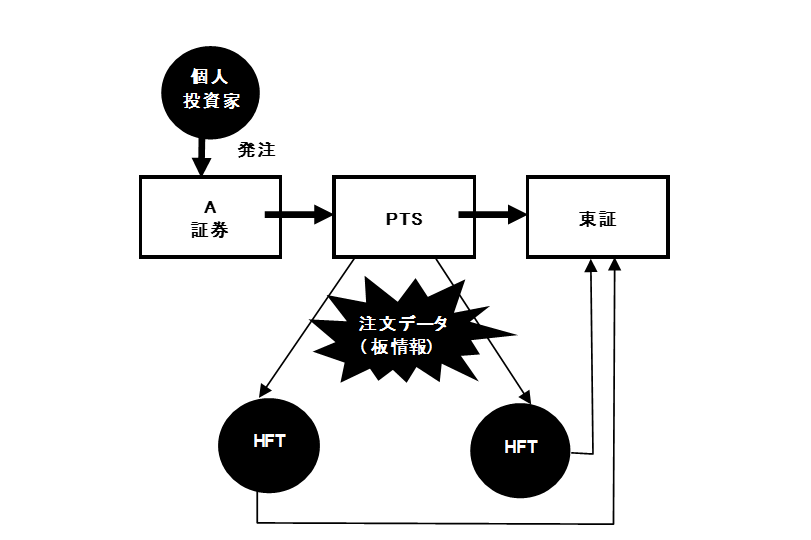
**The Emergence of Japan’s *Flash Boys*?**

The scheme described above closely resembles that described in Michael Lewis’ *Flash Boys* where an HFT firm obtained information on orders placed by other investors from the order book, and profited by instantly placing, altering, and canceling orders accordingly. Their strategy was analogous to cheating at rock-paper-scissors, waiting to see their opponent’s move, then playing their hand an instant later. The scheme described above is sometimes referred to as Japan’s *Flash Boys*.

The aim of temporarily exposure of customer orders on a PTS is sometimes explained as an attempt to stimulate counter orders, thus enhancing trading activity and improving execution rates. The Japanese financial group concerned revised its SOR execution method in November 2019, perhaps in view of criticism from some quarters, to prevent information on customer orders being temporarily visible from the outside.

However, it has been pointed out that even after this revision, in the case of customer orders that are sent by SOR to the PTS, but cannot be executed there and are thus transferred to the Tokyo Stock Exchange, there is still room for HFT firms to anticipate and profit from the arrival of these unexecuted orders.

(Figure 6) Are HFT Firms Anticipating Orders by Individual Investors?



Source: Prepared by the Nomura Research Institute from information published in *The Nikkei*

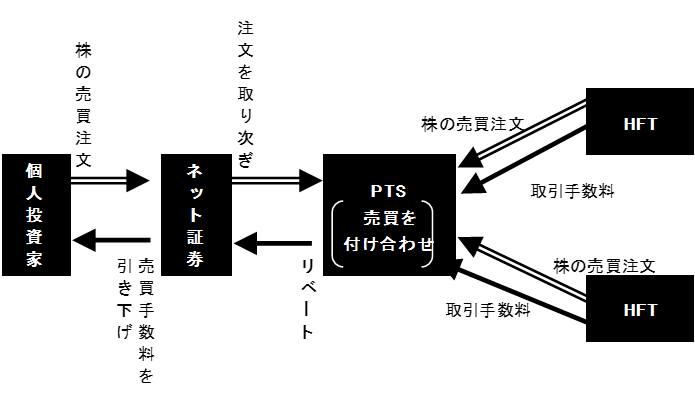
**The Movement to Introduce PFOF in Japan**

The other trend that I would like to focus on is the spread to Japan of PFOF, a practice common among securities companies in the United States. PFOF is an acronym of payment for order flow. It refers to a scheme whereby a securities company passes customer orders (transaction rights) on to market makers such as HFT firms, and receives a rebate (compensation) in return.

The setting for this scheme is, of course, the security company’s PTS. HFT firms pay commission to the PTS, and the PTS pays rebates to the online securities broker. In other words, rebates flow indirectly from HFT firms to the online securities broker, via the PTS.

It is thought that HFT firms are willing to pay rebates for information on orders issued by individual investors, because this allows them to enhance the precision of their proprietary algorithmic trading by analyzing this big data using AI, and utilizing it for purposes, such as predicting the trading trends of individual investors in Japan.

Figure 7: Spread in the Receipt of Rebates from HFT Firms



Source: Prepared by the Nomura Research Institute from information published in *The Nikkei*

**Information on Orders by Individual Investors is Valuable for HFT Firms**

　It may seem that, unlike orders by large investors, which can cause significant movements in the market, the small-scale orders placed by individual investors provide HFT firms with few profit opportunities. However, the accumulation of many these small-scale orders by individual investors can have a substantial impact on the market.

　Moreover, large orders by institutional investors are sent to the market after being split into small portions by securities companies, to prevent them affecting market prices, or even to prevent them from being detected by other market players. By analyzing orders by individual investors, HFT firms may well be able to enhance the precision with which they can differentiate between small-scale orders and large orders that have been split into several portions. If the presence of a large-scale order is detected, then they will be able to anticipate the arrival of later portions of the split order on the market, thus achieving significant profits.

　It is conjectured that for these reasons, information on orders placed by individual investors is valuable for HFT firms, and they are thus willing to pay fees to obtain it.

**Against the Backdrop of Commission-Free Trading**

　In this way, the movement by Japanese online securities brokers to introduce the U.S.-style practice of PFOF doubtless represents an effort to secure new sources of revenue. In recent years, there has been clear trend towards lower trade commissions (transaction fees) for share trading around the world. Japan is no exception.

　Securities companies require other sources of income to supplement the reduction in revenue from lower commissions. Generally speaking, these consist of sources such as interest revenue from money lent to customers for margin trading, and stock loan fees changed for lending customers’ shares to third party investors wishing to a take a short position in that stock.

In Japan, however, with its extremely low interest rates, interest revenue from margin trading and stock loan fees from lending shares have both sunk to very low levels. It was in this context that Japan’s online securities brokers began to seek to secure a new source of revenue through the introduction of PFOF. In addition, it is also possible be shiftingto more resemble that of U.S. 　Robinhood, an online (app-based) securities broker in the United States that offers almost entirely commission-free trading, passes almost all the orders that it receives from customers to HFT firms. It is estimated that, as of early 2018, it derived more than 40% of its revenue from rebates from HFT firms.

**Are the Interests of Individual Investors Being Protected?**

　Under PFOF systems, securities companies provide HFT firms with big data on orders, most of which have been submitted by individual investors, and receives rebates in return. These rebates are used by securities companies to fund the provision of commission-free trading platforms to individual investors.

This scheme closely resembles the business models used by digital platformers, which provide users with free online services funded by external income from targeted advertising, etc. utilizing personal data acquired through these online services.

　In this way, individual investors are effectively providing their order data to HFT firms in return for lower, or zero, trade commissions. It is possible however, that through this exchange, individual investors are being driven into a more disadvantageous trading environment by HFT firms. From this perspective, it is still not entirely clear whether, in fact, individual investors are receiving equivalent value in return. Further verification of this point is necessary in the future.

　Japan’s securities companies, operating under a persistent low interest rate regime, have a weaker earnings base than their U.S. counterparts. For online securities brokers in particular, the importance of rebates from HFT firms may eventually be even more important that in the United States. If this arrangement becomes institutionalized,, then HFT firms active in Japan would play an even more important role than those in the United States or elsewhere in supporting business models in the securities industry. Securities companies and HFT firms would be mutually dependent, bound together by a shared fate.

**Research on HFT is Still in Its Infancy**

　As demonstrated above, despite a relatively clear consensus on the contribution made by HFT firms to enhancing market function, the jury is still out on issues such as whether it amplifies market disruptions, and whether it damages the interests of other investors, including individual investors. This uncertainty is no doubt due partly to a lack of clarity regarding the actual nature of HFT, conducted at speeds and frequencies that defy human comprehension. For both regulators and academics, research into HFT is still in its infancy.

As this research progresses however, and the merits and deficiencies of HFT become clearer, perhaps this will serve as an opportunity for HFT to evolve into a presence that contributes to further market development and new business models for the securities industry, of the kind described in the last section. In this context, I look forward to the further development of HFT research.

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