FINANSINSPEKTIONEN

FI REPORT

Investigation into high frequency and algorithmic trading

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Contents

FI's conclusions from its investigation into high frequency trading in Sweden

During the autumn of 2011, Finansinspektionen (FI) conducted an investigation into high frequency and algorithmic trading on the Swedish equity market. FI gathered information about automated trading via surveys, interviews and analysis of research and ongoing work on legislation. The investigation shows that the negative effects related to high frequency and algorithmic trading are limited. It is apparent that trading has undergone a transformation, and to some extent a deterioration, but most parties believe that this is due to multiple factors and not just faster, more computerised trading techniques. However, there is considerable concern that the market will be subject to greater abuse, and FI believes that this concern must be taken very seriously.

BACKGROUND

During the fall of 2011, FI conducted an investigation into high frequency and algorithmic trading on the Swedish equity market and how Swedish participants have perceived it to have impacted trading.

The investigation consists of two parts. The first part summarises the Swedish industry's view on algorithmic and high frequency trading. The basis for this section of the report comes from two surveys conducted by FI during the autumn/winter of 2011 pertaining to companies' perception of algorithmic and high frequency trading and the risks these firms see for the functioning of the market.

The second part discusses the emergence and propagation of high frequency trading and lists current research on the subject. This section of the report was authored by an independent investigator, Niklas Johansson, on assignment from FI.

SUMMARY OF COMPANIES' VIEWS AND CURRENT RESEARCH

Risks related to high frequency and algorithmic trading are smaller than feared

According to both current research on the subject and the views of Swedish actors on the financial market, the effects of high frequency and algorithmic trading are limited. Overall, there is an indication that certain aspects of liquidity have deteriorated and that the market has become more volatile, but these changes can also be explained by multiple factors and not merely the emergence of high frequency trading. In general, Swedish actors are not overly concerned about the effects of high frequency trading. Rather, they have accepted that trading has undergone a transformation as a result of new legislation and technological developments.

But concern for market abuse is considerable

Even if the effects on trading are considered to be limited, there is still considerable concern about market abuse. The majority of companies that were surveyed expressed concern that a large portion of high frequency trading was being used to manipulate the market. There are clear apprehensions that market abuse has become more extensive and difficult to identify as a result of the sharp increase in the number of orders and trades.

Risks for financial stability are limited

Existing research also indicates that the impact of high frequency trading on financial stability is still limited. The higher degree of complexity and the technologically advanced environment can naturally create uncertainty on the market and, as a result, volatility can increase. But the business models of companies conducting high frequency trading - i.e. to not carry any financial risk in their balance sheets – means that the risk for contagion is small. There are greater risks, though, associated with other types of algorithmic trading in that poorly designed algorithms can create long-term consequences for actors on the market over a very short period of time.

WHAT CONCLUSIONS HAS FI DRAWN?

International research and the answers from Swedish companies indicate that the harmful effects from high frequency and algorithmic trading are less extensive than many feared. Many of the issues surrounding high frequency and algorithmic trading will also be addressed by the pending European Directive proposal that is part of the supervision of MiFID (Markets in Financial Instruments Directive) and MAD (Market Abuse Directive).

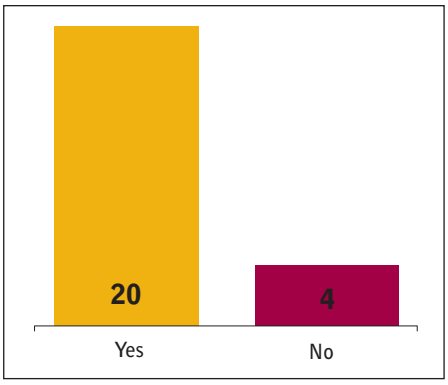
FI still takes the position, however, that the concern for increased market abuse must be taken seriously. It is important in this matter that both legislation and the actual supervision of trading keep pace with the developments on the market. Applicable legislation regarding market abuse is already in place, but opportunities to identify abuse are dependent on supervision by the market places.

FI therefore believes that the market places must focus on expanding their systems that monitor trading in real time and improving co-ordination between themselves to identify any market abuse. A joint European model for market supervision is worth striving for, but it will take time. In the meanwhile, FI believes it is important to develop solutions for the short-term that focus on the Swedish market.

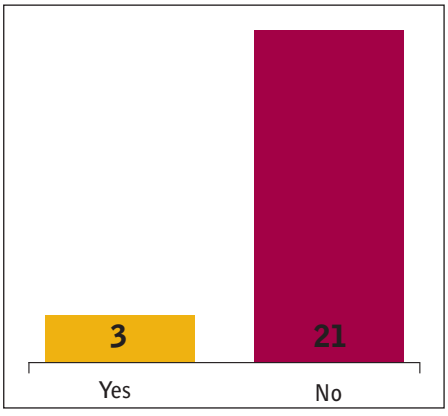
Summary of the surveys on high frequency and algorithmic trading

Finansinspektionen (FI) conducted two surveys during the autumn of 2011 in order to identify the views of actors on the Swedish market with regard to high frequency and algorithmic trading on the Swedish equity market. The two surveys were sent to 25 companies, of which 24 responded. Ten Swedish banks and investment firms that are members of NOMX and 14 large Swedish institutional investors participated in the survey.

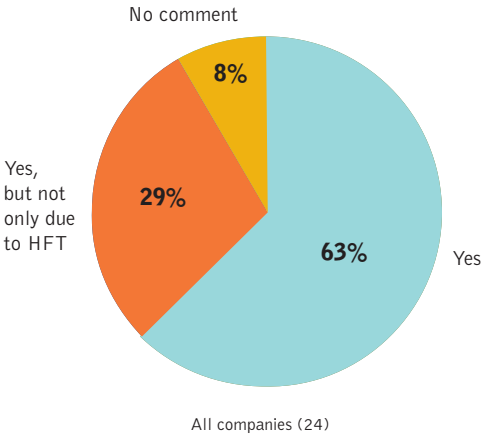
DO YOU USE ALGORITHMS?



DO YOU USE HFT?



UNFAIR TRADING STRATEGIES?



SUMMARY OF THE SURVEYS

High frequency trading (HFT) is very limited among the actors on the Swedish market. Only three of the 24 companies surveyed state that they use HFT in their operations. However, 20 companies respond that they use different types of algorithms.

A total of 22 companies believe that unfair trading practices related to algorithmic trading and HFT are present on the market. The strategies mentioned most often include:

- spoofing/layering: a strategy of placing orders that is intended to manipulate the price of an instrument, for example through a combination of buy and sell orders.
- quote stuffing: the submission of a large volume of orders to a marketplace with the intention of slowing down the trading systems of other actors or hiding one's own strategy.
- momentum ignition: initiating or enhancing a trend through the aggressive placement of orders in the hope that others will follow, which creates an opportunity to reverse a position.
- last second withdrawal: the cancellation of orders at the final second of a call procedure.

There was also reference to an increase in front running on the market, which in the absence of an existing definition has also come to be used for attempts to identify opportunities and place orders on the market ahead of others, without any knowledge about client orders. Seven companies add, however, that unfair strategies have existed on the market for a long time and are not just related to HFT.

Several of the companies believe that volatility on the market has changed but that there is no clear connection to HFT. A majority of the companies believe that liquidity has deteriorated primarily as a result of the fragmentation on the market, but also due to a smaller tick size. Several of the companies state that increasing the tick size should have a positive impact on liquidity.

A majority of the companies believe that current market supervision is insufficient and that there is a considerable need for coordinated market supervision.

The developments on the market, including more fragmented trading and poorer liquidity, have caused larger transactions to move to dark pools. The survey demonstrates that dark trading is common among

actors on the Swedish markets since it offers the possibility to place larger orders with less of a market impact.

DEFINITION OF HIGH FREQUENCY AND ALGORITHMIC TRADING

Questions regarding the definition and scope of HFT and algorithmic trading were included in both surveys and the answers are therefore reported together below.

FI used the following definitions of algorithmic trading and high frequency trading (HFT) in its surveys:

> **Algorithmic trading:** Trading where orders are generated by an electronic system based on pre-determined instructions and parameters.
>
> **HFT:** Trading that utilises advanced hardware and software to achieve the fastest possible placement and execution of orders. The purpose is to carry out trading strategies that take advantage of arbitrage or other inefficiencies existing for extremely short periods of time and conduct market making. This type of trading is also characterised by a lack of fundamental analysis and in general results in a high number of orders.

The companies were asked how well these definitions corresponded with the companies' own definitions. A majority of the companies believe that FI's definitions are well in line with their own definitions. Several companies view HFT to be an subcategory under algorithmic trading.

Several of the major banks break down automated trading strategies one step further, for example into different categories of algorithmic trading. Several of the investment firms and banks believe that market making should not be included in the definition of HFT.

In addition to its intention of taking advantage of arbitrage and other inefficiencies, a few companies also state that HFT can include unfair trading strategies. Other additions to the definition are that HFT often refers to the execution of trades on own account and positions are usually closed at the end of the day.

SCOPE OF HIGH FREQUENCY TRADING

FI asks in the second question in both of the surveys what portion of trading in 2011 consisted of algorithmic or high frequency trading.

Seven of the ten banks and investment firms use algorithms as a trading strategy and to support the placement of orders. Five of these companies execute orders on own account and state that the use of algorithms is present in 50–60 percent of its proprietary trading. Two of these companies state that HFT represents a large portion of its proprietary trading.

Seven of the ten banks and investment firms offer their clients Direct Market Access (DMA). Several of these companies comment that the possibility of carrying out HFT via DMA is limited to less time-sensitive strategies and that DMA is in general too slow for HFT. None of the banks or investment firms currently offer their clients Sponsored Access (SA).

Among the institutional investors, 13 of the 14 surveyed companies say that they use algorithms, primarily via DMA, but that trading also

occurs via agents' algorithms. More than half of the companies state that they use algorithms to a considerable extent. The few companies that quantified their use of algorithmic trading state that it represents approximately 30–40 percent of total flows. Application of HFT and SA among fund management and insurance companies is very limited. Only one of the companies uses HFT in its operations.

OTHER QUESTIONS AND A SUMMARY OF THE RESPONSES FROM EACH OF THE SURVEYS

Survey responses from banks and investment firms

Do the marketplaces and your internal trading systems work satisfactorily at times of extreme high order volumes? Have you or your clients experienced any problems as a result of quote stuffing?

A majority of the ten companies believe that their internal trading systems work well at times of extremely high order volumes. However, five of the companies experience some delays or deadlocks internally or in the trading systems of the marketplaces at times of extremely high order volumes. A few actors identify specifically the need for investments and adjustments to its proprietary system.

It is FI's understanding that HFT systems unintentionally close transactions with themselves relatively often. Even if these types of transactions represent a small portion of the total, tolerance for them has historically been very low. To what extent (number and total value///) are such transactions closed by you as a member of stock exchanges or MTFs as a result of HFT? How are you handling this problem?

The two companies that use HFT state that unintentional transactions with itself are limited, but that these orders are cancelled in the system.

Do you believe that unfair trading strategies are present that are related to algorithmic trading or HFT? Have you observed trading patterns that potentially could be market abuse, or could be classified as market conduct misbehaviour?

Nine of the ten companies believe that unfair trading patterns related to algorithmic trading or HFT are present, primarily spoofing/layering, quote stuffing, momentum ignition and last-second withdrawal, but an increase in front running[1] is also mentioned. Three of these companies add, however, that this phenomenon has existed on the market for a long time and is not just related to HFT.

Do you believe that the current market supervision system is adequate for identifying and preventing market abuse? How large is the need for co-ordinated supervision to prevent the improper influence of prices between marketplaces?

The effects from MiFID, primarily the fragmentation of trading, requires that more resources be earmarked for market supervision. All

1 Front running is addressed in Article 1.1, third paragraph of the Market Abuse Directive (2003/6/EC). The term is not explicitly stated in the Market Abuse Act, but is regulated in FFNS 2007:16, Chapter 20, section 4. Front running entails having knowledge about a client order that will affect prices and executing transactions before the client's order is placed. For lack of a better term, front running has also come to be used for attempts to identify and stay ahead of other orders on the market without knowledge of client orders. This type of ”fronting” or ”market front running” is not illegal.

ten of the companies believe the current market supervision to be insufficient and that coordinated market supervision is required. A few companies believe there to be a conflict of interest in that the stock exchanges must supervise their clients and express the need for independent supervision. One company also mentions that the definition of what constitutes market abuse should be harmonised.

Are private and/or institutional clients trading less than before?

Six of the the ten surveyed companies comment on HFT's impact on the scope of trading. Of these companies, five of them believe that trading activity among their clients has decreased, but that this can be the result of a number of factors, such as the uncertainty in the global market.

Do you view it to be problematic that some investors are moving their transactions to other venues, such as dark pools, or changing their trading behaviour in other ways? Are you experiencing any problems with algorithmic trading or HFT, and do you view there to be a need for measures related to these phenomena?

Five of the surveyed companies believe that changes on the market, such as fragmentation, decreased tick size, removal of trading lots and technological advances, can have contributed to both the perception of liquidity as being more volatile and the emergence of HFT.

Two of the companies believe that HFT contributes to decreased liquidity and comment that any development in which the placement of orders no longer occur on the stock market represents a risk for poorer liquidity and that that the stock exchange will lose its role as a marketplace.

Six of the ten surveyed companies comment on the existence of dark pools. Dark pools fill a need for investors by executing large orders without any impact on the market. The companies comment that transparency deteriorates when trading in dark pools increases.

Two of the companies believe that all actors, including HFT actors, should be regulated. Trading where it is possible for all of the actors to trade at the same connection speed is brought up by several companies. The need for regulation regarding a ”resting period”, i.e. the minimum amount of time an order must be in the order system, is also mentioned.

Survey responses from institutional investors

Fourteen institutional investors answered nine questions. The first two questions were identical in both surveys. The other questions were different and the responses are therefore presented separately.

How have the following costs to execute transactions changed over the past few years?

- *Variable transaction costs, such as commission*
- *Fixed costs, such as investments in infrastructure and software*
- *Indirect transaction costs, such as average price for a large volume*

All of the 14 surveyed companies believe that the variable transaction costs decreased, primarily due to increased DMA usage.

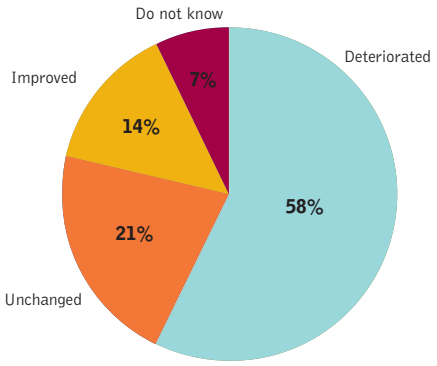
Eight of the companies believe that fixed costs for investments in infrastructure and software have increased in the past few years. The remaining companies believe that fixed costs remained unchanged.

Five of the surveyed companies believe that the indirect transaction costs

have increased, while three of the companies believe that these costs have decreased. One company states that the indirect costs remained unchanged. Five of the companies did not answer.

Do you perceive that liquidity on the market has changed as a result of HFT? Does it take more or less time than before to execute larger orders? Have you changed your investment strategies as a result of the change in liquidity (if one exists)? Do you believe that the fragmentation on the market can create an illusion of liquidity?

HAS LIQUIDITY CHANGED?



Institutional investors (14)

Fragmentation of the market: The implementation of MiFID in 2007 terminated the monopoly held by stock exchanges. The possibility of trading shares on other marketplaces gave rise to more fragmented trading.

Illusion of liquidity: An illusion of liquidity can arise when the actual volume on the open marketplaces is less than what is visible. The consolidated order book changes during execution in such a manner that the desired volume is no longer available. One reason for this can be that the volumes on each marketplace are dependent on one another, for example due to arbitrage.

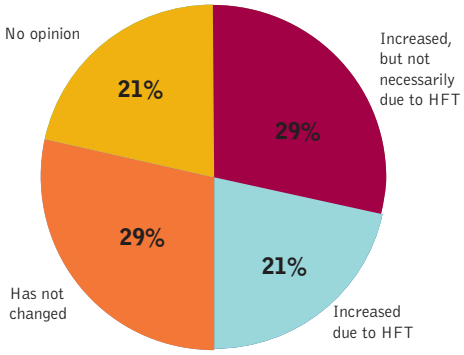
Eight of the fourteen surveyed companies believe that liquidity has deteriorated. Several of these companies believe that this deterioration may have been caused by factors other than HFT, such as cautious financial markets, decreased tick size and counterparties' decreased willingness to set prices, although the fragmentation of the market is primarily mentioned as problematic. Eight of the fourteen companies believe that the fragmented trading has contributed to the deterioration in liquidity.

Two companies name HFT as a reason behind the deterioration in liquidity while one company believes that liquidity probably would have been even worse without HFT. Two companies believe that liquidity has improved and three companies believe that liquidity has not been affected. A few also express that the question is hard to interpret and that they also see the fragmented market as a problem.

Of the eleven companies that answered the questions about if it takes more or less time to execute a large order, six companies answered that it now takes more time. The other five companies perceive that there has not been a change in how long it takes to execute a large order.

Of the nine companies that answered the question about whether the company's investment strategy has changed as a result of any changes in liquidity, seven companies answered that they have not made any changes.

HAS VOLATILITY CHANGED?



Institutional investors (14)

Research indicates that HFT decreases volatility during normal trading, but can enhance price fluctuations in more extreme market conditions. Do you perceive that volatility on the market has changed as a result of HFT? If yes, do you view this to be a problem?

Four companies believe that increased volatility on the market cannot be attributed exclusively to HFT or that the link to HFT is not clear. Two of these companies specifically comment that increased volatility can be attributed to HFT in combination with other global factors, such as increased uncertainty on the financial markets. Four companies believe that volatility has not changed as a result of HFT.

Three of the companies believe that HFT has increased volatility in cases of extreme price fluctuation. One of these companies highlights the possibility that HFT enhances price fluctuations since HFT actors to a greater extent than traditional market makers, exit the market during extreme conditions.

Do you believe that unfair trading strategies are present that are related to algorithmic trading or HFT?

Thirteen companies believe that unfair trading patterns related to algorithmic trading or HFT are present, The most commonly mentioned strategy is front running. Four of the companies add that this phenomenon has existed on the market for a long time and is not only related to HFT. One company also comments that front running is now being carried out by different actors than before. Two companies mention other trading strategies.

Three companies respond that algorithms are not unfair in and of themselves, but rather certain HFT strategies can be questioned, since they deviate from what the companies consider to be traditional investment, and make trading more expensive for other actors.

Do you execute transactions in dark pools? Do you view it to be problematic that some investors are moving their transactions to other venues, such as dark pools, or changing their trading behaviour in other ways?

Eleven of the surveyed companies answered that they use dark pools. The main reason is that they want to avoid market impact.

One company states that it prefers to use crossing networks with other asset management instead of dark pools since these venues exclude HFT actors. Two companies do not use dark pools.

Seven companies do not see any problems in general with the shift of trading to dark pools. Several of these companies identify the need for better analysis to ensure the best price when using dark pools as well as the importance that dark pools are not open for HFT actors. Five companies believe it to be problematic when transparency of trading decreases. One actor comments specifically that transactions should be disclosed immediately.

Has HFT affected confidence in the market?

Thirteen of the fourteen surveyed companies believe that confidence in the market has been negatively affected. However, most of the companies comment that this is primarily due to the debate being held in the media rather than HFT itself. Two companies believe that the confidence of professional actors in the market has not changed and that it is only the confidence of the general public that has fallen.

A few companies believe, though, the confidence in the market has decreased due to some actors receiving an advantage via improved technological conditions. Factors such as the speed with which orders are placed have increased in importance. One company also commented that HFT makes trading more expensive for other actors on the market.

OPINIONS RAISED BY THE COMPANIES

In an open question in the surveys, the companies have lifted the following opinions:

Consequences of trading moving to dark pools

The companies in the survey that use dark pools have had positive experiences, despite the relatively low liquidity they have found there as well, and that the reporting of executed transactions is insufficient.

Two large companies, however, say that even if trading on dark pools is positive for the involved actors, it is negative for the market as a whole, and in particular the Swedish market. The shifting of trading to dark pools decreases the visible liquidity and weakens the market's price discovery mechanism. It also decreases the transparency along all of the stages of trading.

Several companies mention that brokers try to make even smaller transactions in dark pools, or even have returned to telephone trading, partly to avoid HFT. There is concern among several companies that the stock exchange risks losing its role as a supplier of risk capital and as a marketplace.

A common viewpoint is that increased regulation of trading on dark pools is required.

Microstructure of the market

The market parameter that most of the actors commented on is tick size. Two investment firms and four management companies believe that increased tick size would have a positive impact, particularly on liquidity. Other effects that were raised include that a broader price interval would result in an explosive increase in the number of orders and that price updates would decrease, which in turn would decrease the requirements on system performance and facilitate the identification of market abuse. Another advantage is said to be that liquidity would be regained from dark pools.

Viewpoints regarding different types of volatility protection, also known as circuit breakers, are unanimous - it is important that the rules for circuit breakers are the same on all marketplaces. If the rules are not the same, they will not fulfil their function, and it will be possible to abuse the fact that different markets apply different rules, for example by consciously triggering a trading halt.

Opinions were also raised regarding trading lots and trading speed limits. Four companies believe that there should be a minimum amount of time for how long an order must be available on the market. Three companies would like to see a return to trading lots, or that it should be more expensive to trade smaller lots.

Competition-neutral trading

Both investment firms and institutional clients have raised the issue about trading being conducted on equal terms. A few actors state that even if it is not classified as insider trading to trade first on public information///, in practice it will be the same if the same actors always succeed./// They would like to see improved transparency about which technological and information advantages can be bought on a stock exchange, primarily with regard to connection speed, access to market data and order book information. The same price model should apply to all members and barriers to entry should be reasonably low to ensure competition on equal terms.

Glossary

Circuit breakers Automatic trading halts when the price of a share moves too far away from a reference price.

Crossing networks or broker crossing systems Order matching systems that can be described as internal electronic matching systems that are used by an investment firm and executes client orders in relation to other client orders.

Dark pools Order books without visible volume, where large orders are placed in order to limit the impact on price. Can be organised by both MTFs/regulated markets and broker crossing systems.

Direct market access (DMA) Client trading that occurs via direct access to the stock exchange's order books via an exchange member. An order only passes through the exchange member's risk control system before it is forwarded to the market place.

Fragmented market When securities trading occurs on many different market places. After the introduction of the MiFID EU Directive in 2007, it became easier to compete for trading, which led to a number of new trading venues.

Front running Entails having knowledge about a client order that will affect the price and executing transactions before the client's order is placed. For lack of a better term, front running has also come to be used for attempts to identify and stay ahead of other orders on the market without knowledge of client orders. This type of ”fronting” or ”market front running” is not illegal.

Last second withdrawal A procedure (normally conducted as part of an auction on a stock exchange) that entails placing an order for which there is no underlying intent to trade and removing the order just before it is closed.

Latency The time it takes to place an order in the order book.

Market making To continuously provide buy and sell orders for a certain trading volume in a financial instrument. In its traditional meaning, this term also includes a commitment to a trading venue or company to execute the transaction.

MiFID Markets in Financial Instruments Directive. EU Directive intended to strengthen investor protection and increase competition on the financial markets.

Momentum strategies Trading strategies based on buying shares that are going up and selling shares that are going down.

Multilateral Trading Facility (MTF) Alternative trading venues for the trading of securities admitted for trading on regulated market. Operated by an investment firm or a stock exchange, for example Chi-X and Burgundy. MTF can also be trading venues for smaller companies' shares that are not admitted for trading on a regulated market, for example First North, Aktietorget and Nordic MTF.

Quote stuffing The submission of a large volume of orders to a marketplace with the intention of slowing down the trading systems of other actors or hiding one's own strategy.

Risk prices Departments for proprietary trading are usually able to set prices for clients and brokers for larger volumes than what are visible in the order book, which also means that they take on greater risk.

Sponsored access (SA) Client trading that occurs via direct access to the

stock exchange's order books via an exchange member. An order does not pass through the exchange member's risk control system.

Spread The difference between the best bid and ask price for a financial instrument.

Tick size The smallest possible change in price for a financial instrument.

Volatility Price fluctuations for a financial instrument, normally measured as standard deviation based on closing prices.

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