High frequency trading:

The application of advanced trading technology in the European marketplace

Netherlands Authority for the Financial Markets

The AFM promotes fairness and transparency on the financial markets. We are the independent supervisor of the conduct of the savings, loans, investment and insurance markets. The AFM works to ensure prudent financial services to consumers and supervises the fair and efficient working of the financial markets. Our aim is to boost the confidence of consumers and businesses in the financial markets, both in the Netherlands and internationally. By doing this, the AFM aims to make a contribution to the prosperity and economic reputation of the Netherlands.

Inhoudsopgave

Executive summary

High frequency trading (HFT) is a method of implementing certain short-term trading strategies using advanced technology, however it is not in itself a separate trading strategy. The strategies used in HFT (market making, arbitrage) are in themselves nothing new. HFT does however make it possible to implement these strategies to the fullest extent. This means that the question for regulators regarding HFT concerns the actual *behaviour* of the market participants using HFT: as long as people are using legitimate strategies, they should be treated exactly like other market participants. If the strategies are not legitimate and involve market abuse, action needs to be taken. In itself, HFT cannot be equated with market abuse. The AFM does not see that it is part of its role to prescribe the speed or time horizon with which trades can be executed, or to prevent market participants from realising the legitimate profits that result from their investment in technology.

In these considerations, it should however be remembered at all times that HFT has further increased the dependence of the financial markets on technology. It is thus essential that the orders issued by high frequency traders and the systems that generate, process and execute these orders do not damage the integrity of the market. For this reason further safeguards need to be established for the risk management and operational systems of traders, platforms and clearing & settlement organisations.

The Markets in Financial Instruments Directive (MiFID) has created a competitive market for order execution. This has created new market making and arbitrage potential for HFT traders. The AFM attributes the recent growth of HFT in Europe to the fact that high frequency traders recognised the potential offered by the new market structure. HFT strategies that add liquidity and assist the process of price formation make a positive contribution to reducing fragmentation, and therefore in the opinion of the AFM on balance have a positive function in the market.

The further development of technology and automation of trading in financial instruments would appear to be an irreversible process. The market structure that has contributed to the growth of HFT is also here to stay. The most sensible course for policymakers and regulators therefore is to devote their efforts to further improving the existing market structure.

The evaluation of HFT and any new policy initiatives that may arise must be conducted with due care, on the basis of facts rather than emotions. The counter-productive and undesirable effects of ill-considered policy need to be kept in mind. Given the international nature of the financial markets, this process should take place at not lower than European level. Unilateral national measures are useless and therefore undesirable. While convergence of regulation is desirable, any measures to be adopted should however be tailored to the specific properties of the market structure in the various countries and regions.

Introduction

1.1.1 Basis

Technological innovations and significant changes in the macro and micro structure of the European financial markets landscape have contributed over the last few years to rapid growth in the use of high frequency trading (HFT) on European trading platforms. HFT has recently attracted a great deal of attention from a broad group of market participants (including institutional and retail investors), regulators, the media, and politicians. This is understandable. In certain (but definitely not all) respects, HFT is a new phenomenon. HFT uses advanced information technology that enables market participants to trade at speeds and volumes which until only recently would have been considered impossible. As the recent financial crisis has taught us, complex technological innovations of this kind in the financial markets require a careful analysis of the potential impact and risks (including systemic risk) which they might entail. This report makes a contribution to this analysis.

Although HFT cannot be held responsible for the development or exacerbation of the recent financial crisis, it did become part of the (sometimes furious) polemic generated by the crisis. In view of the intensity of the crisis, this was perhaps inevitable. The polarisation between supporters and opponents of HFT does not however contribute to rational discussion on the subject, especially since a policy response to HFT needs to be based on objective consideration rather than bias. It is therefore an important objective of this report to inject more clarity into the discussion of HFT. To this end, we will describe the various (both positive and possibly negative) aspects of HFT, and make a number of suggestions to improve the current situation.

1.1.2 Report objectives, by section

Section 1:

The first objective of this report is to qualify the picture which exists of HFT, and to clarify the difference between HFT and other forms of trading. Section 1 therefore describes HFT as a phenomenon and its position among other possible trading strategies. Although it is difficult to give a conclusive definition of HFT, certain characteristics distinguishing HFT from other forms of trading can be specified. The exact size of HFT's market share cannot easily be established, but it is clear that its share is significant.

Within the domain of HFT, various types of players can be identified who pursue various trading strategies. It is important to distinguish between these different types of players and trading strategies. Here too, there seems to be a clear opportunity to introduce further specification into the discussion, for policymakers as well. It is important that any changes to policy are based on a sufficiently thorough understanding of the various players and their behaviour.

The innovations introduced by HFT, as discussed, relate not so much to the trading strategies themselves as to the techniques used to implement them. Technical and operational aspects therefore play a central role in considering the phenomenon of HFT. The main issues concern methods of reducing latency (signal delay): these will be discussed, with particular attention to co-location and sponsored access.

Section 2:

A second objective of this report is to discuss the advantages and disadvantages of HFT within a clearly defined framework. In both Europe and the US, the role of HFT in the market is currently being debated. There are two opposing views. Supporters emphasise HFT's positive contribution in terms of additional liquidity, better price formation, and reduced volatility. On the other side are parties who see HFT as an obstacle to their order execution.

They focus on the negative aspects. In section two, both the advantages and disadvantages are discussed, and the trading and IT-related risks which HFT may entail are analysed.

Section 3:
Thirdly, the report will discuss the relationship of HFT to a number of forms of market manipulation. We are aware that there is confusion in this area, and that HFT and market abuse are mentioned in the same breath, as if HFT by definition implies market abuse. We emphasise that HFT does not in itself constitute market abuse, as long as the strategies which are executed using HFT are legitimate. It is true however that HFT can be used to conduct market manipulation strategies more efficiently. In section 3, we give examples of the main manipulation strategies.

Section 4:
Finally we identify a number of points which require further attention. We also make a number of proposals for measures which we believe are necessary to mitigate certain risks connected to HFT. We will also specify some measures which we believe would have less favourable or even unfavourable effects. The principle here is to support the expression of HFT's benefits for the market. This requires, among other things, a more transparent attitude from HFT parties concerning their trading practices.

1 What is HFT?

Technological innovations and significant changes in the macro and micro structure of the European markets landscape as a result of the implementation of the Markets in Financial Instruments Directive (MiFID) at the end of 2007 have contributed over the last few years to a growth in the use of high frequency trading (HFT) on European trading platforms.[1] The impact of the MiFID on the European equities market forms the primary framework of analysis for this report.[2] HFT occurs in almost all asset classes. This report accordingly focuses primarily on HFT in equities and equity derivatives. In this section, we will first describe the phenomenon of HFT. We will then discuss the scope of HFT and elaborate on a significant issue in HFT, which is the concept of latency: the length of the delay between sending and processing an order. Finally, the various strategies used in HFT will be allocated into categories.

1.1 Characteristics

HFT is a form of automated trading based on mathematical algorithms.[3] HFT is not a trading strategy in itself, but a *means* of applying certain strategies (market making and statistical arbitrage) in practice on trading platforms. These strategies concern only some of the strategies which may be deployed. In other words, HFT is certainly not the only way to operate successfully on trading platforms.

The main feature of HFT is the importance of rapid calculation and execution speeds for the trading strategy in question. As a result of the increased efficiency of the market, opportunities for arbitrage and market-making are available for ever briefer periods of time. To be able to respond to these fleeting trading opportunities, HFT market parties have optimised their response times using sophisticated systems and efficiency of infrastructure. The earnings model for HFT consists of executing transactions with very small profit margins in very large volumes. HFT is practised in most cases by proprietary traders.

Notable international HFT players include ATD, Cisco, Citadel, Getco, Madison Tyler and Tradebot. The proprietary trading desks of large (investment) banks such as Goldman Sachs, JP Morgan, Morgan Stanley, BNP Paribas and Société Générale also use HFT strategies as part of their proprietary trading. Dutch participants play a prominent role in the HFT world. All Options, Flow Traders, IMC and Optiver are significant players.

Positions as a result of HFT strategies are usually taken with the intention of being market-neutral (non-directional). They are as a rule hedged (delta neutral) and will in many cases be closed out at the end of the day (positions are rarely held overnight). The average holding period is usually of a very short duration, ranging from seconds to several minutes.[4] Many of

[1] HFT is also sometimes referred to in the Dutch media as "flitshandel" (literally, "*flash trading" in English).* This is confusing, since flash trading is entirely different to HFT. Flash trading is a trading privilege granted by certain US trading platforms to certain market participants for a fee, enabling them to look at the order book and respond a fraction earlier than other market parties. The SEC has put forward proposals to prohibit this activity. The AFM regards flash trading as an illicit trading practice which impairs the even playing field between market parties and undermines confidence in the market. Incidentally, flash trading does not occur in the EU. (see also para. 4.1.1).

[2] For this reason, we also chose in this report to include references only to the relevant European regulation, and not to the Wet op het financieel toezicht (the Financial Supervision Act, Wft), in which this regulation is implemented in the Netherlands.

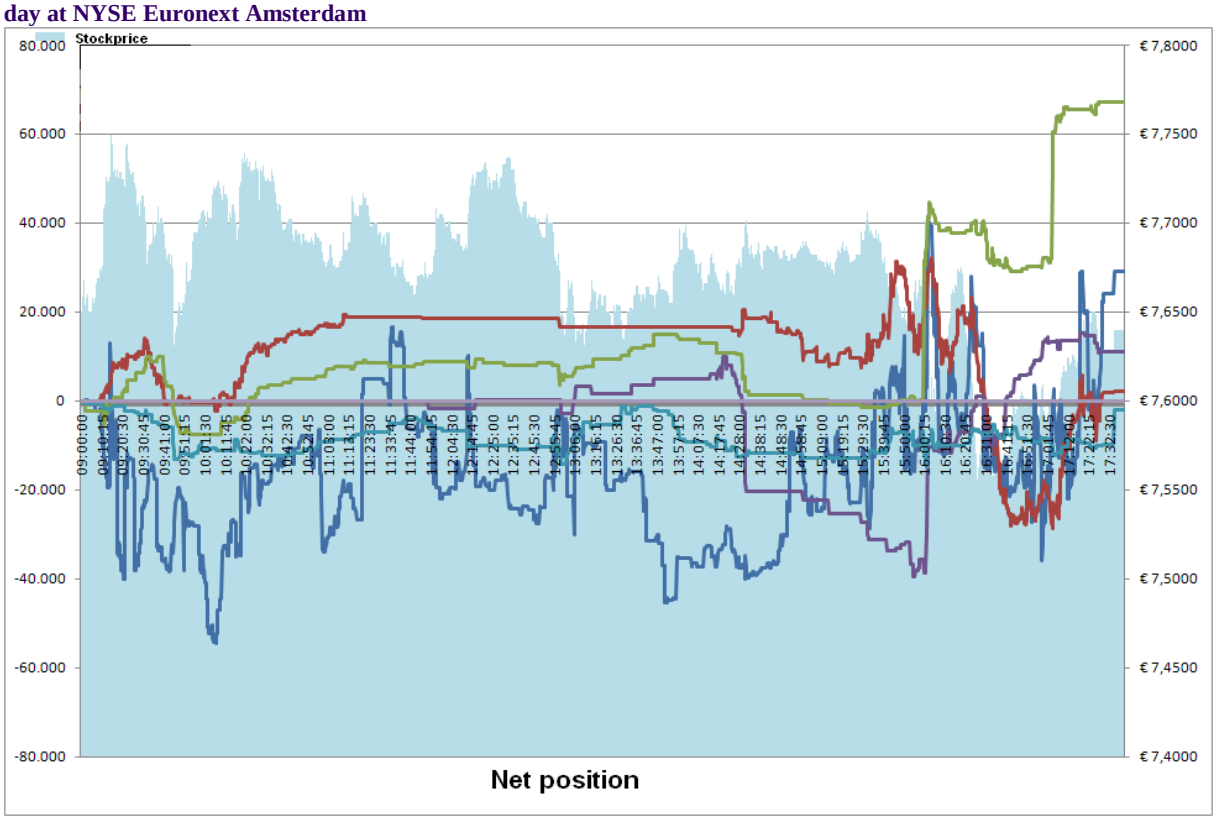
[3] An algorithm is a set of rules which, in a certain starting situation, executes a set series of operations. In the same starting situation, the same series of operations is therefore always executed.

[4] Albert Menkveld, "Middlemen in Limit Order Markets"

the orders placed are not executed (the order to transaction ratio is very high). The majority of orders are cancelled shortly after entry, as they are continually updated according to the continuously changing market conditions (in other words, newly available price information). The volumes of positions and the length of time for which positions are held are determined by the trading algorithm and may fluctuate during the day. "Bursts" of large quantities of orders, issued suddenly, are one of the main features of HFT. These bursts often alternate with periods of relative calm in which scarcely any trading occurs, in anticipation of a new trading opportunity.

Figure 1 shows how a number of players took positions over one day in a large, high volume stock, which is traded at a number of large European trading venues. The diagram shows that most players built up and closed out their positions during the day, often several times per day. Various players had both negative and positive positions on several occasions during the day. This reflects the non-directional character, the short holding period and the fluctuating nature of HFT traders' positions. It can also be clearly seen from a number of players that periods of relative calm alternate with periods of large quantities of orders. Although the players did not fully close out their positions at the end of the day, their positions are clearly within specific ranges.

Figure 1: Positions in stock that is traded at multiple venues, held by a number of HFT players on a typical trading day at NYSE Euronext Amsterdam



HFT can be regarded as a sub-category of algorithm trading, which has undergone enormous expansion since the late 1980s. Algorithm trading is the collective term for all strategies whereby orders are given according to a pre-programmed set of rules (algorithms). There is no consensus on the precise share of algorithm trading in overall trading volumes, but it is very considerable on all European trading platforms (see paragraph 1.2).[5] A professional market participant trading entirely without algorithms has now become almost unthinkable. [6]

Figure 2 shows the relationship of various forms of trading to each other. "Total trading" consists of trading on trading platforms in its entirety, which can be divided into trading initiated by humans and trading initiated by algorithms.[7] The latter category can then be divided into generic algorithm trading and specific High Frequency Trading.

It is important to stress that not all types of automated trading can be classified as HFT. In terms of trading frequency, holding period and strategy, institutional investors, brokers and hedge funds which use algorithms, either automated or not, cannot be regarded as using HFT. Unlike HFT, this form of automated trading is by definition directional and therefore *not* market neutral. This is because, in order to build or reduce an asset portfolio, a position is chosen (long or short) based on a view regarding the current or future development of the market. These positions are therefore usually not fully or partially hedged. The holding period is usually (much) longer than a few seconds or minutes, and indeed positions are usually also held overnight. The order-to-transaction ratio in generic algorithm trading is also different from that of HFT. This is because this trading does not involve market making or arbitrage strategies with a very short time horizon, and there is therefore less reason to very quickly update orders (although the order-to-transaction ratio can also be high in generic algorithm trading).

The sophistication of the algorithms and trading software used in HFT varies from one market participant to another, and is highly dependent on the knowledge and tools that are available. The largest, fastest and most professional players develop their systems (with high investment costs in people and resources) completely in-house. They utilise proprietary knowledge, which they endeavour to protect as much as possible for competitive reasons.

A less expensive solution is using "build-and-buy" software, a trading system programmed by third parties, but tailored to the requirements of the market participant concerned. This requires a lower – but still considerable – investment. From the HFT trader's point of view, the disadvantage of this approach is that the programmers they hire also work for other parties, so that the exclusivity of the trading algorithms used is not guaranteed.

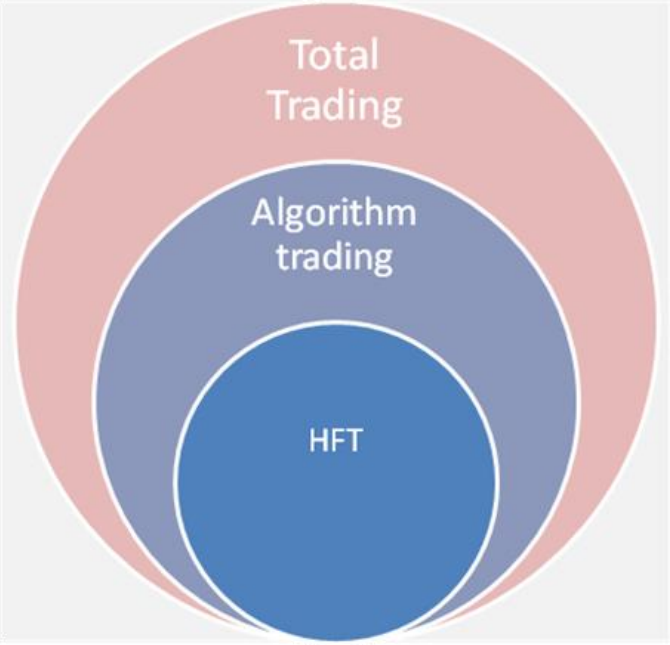
The cheapest solution finally is "out of the box" software. This is sold by companies specialising in developing ready-made trading software. In this software, the parameters can be adjusted, but the code cannot be rewritten. This means higher latency and less control over the behaviour of the trading algorithms.

[5] For example, Hendershott and Riordan (2009) calculate for Deutsche Boerse that algorithms generate 52% of all volume and 60% of all transactions. The larger the transaction, the more often a transaction is human-generated. HFT is a subset of these percentages. The estimates for HFT however vary widely (see para. 1.2).

[6] See Hendershott, Jones, Menkveld: "Does algorithmic trading improve liquidity?"

[7] There are degrees to which algorithm trading is automated. This may range from algorithm trades directly monitored and initiated by human traders to fully automated trading.

Figure 2: HFT is a sub-category of algorithm trading



1.2 Scope of HFT

Estimates of the scope of HFT vary a great deal, but HFT represents a considerable and growing proportion of trading on all 'HFT-friendly' platforms. In general it is assumed that the growth of HFT will continue for the time being. As we mentioned earlier, there is no consensus on the precise scope of HFT. The figures given for the European market vary enormously and range between 13% and 40% to 50% of turnover (see table XX)[8]. Various reasons can be cited for this lack of clarity.

In the first place, there is still no consensus on a generally accepted definition of HFT, which makes classification difficult. HFT and generic algorithm trading, using sell-side execution algorithms for example, are regularly confused, making the estimates too high. For the purposes of this report, we are obviously interested in the specific market share of HFT alone, not including generic algorithm trading.

Trading platforms also report that, even with an established definition, they would not be able as yet to distinguish HFT from other forms of algorithmic trading. To be able to make this distinction, they would have to establish the specific market shares of the various trading strategies, something which is not yet possible. To do this all the transactions executed using a specific strategy would have to be brought into relation to each other. This would require, in addition to an accessible central location where the transaction data could be collected for all trading venues, identification of the party originating the orders so that their trading pattern could become fully visible (see further in paragraph 4.4).

In the absence of a more precise method of estimation, the market share of specialist HFT firms (proprietary traders) is used as a proxy for estimating the market share of HFT as a whole. This too provides an incomplete picture: as well as the specialist HFT firms, there are other market participants for whom HFT is a (significant) ancillary activity, such as large banks trading for their own account. In addition, there are HFT parties who utilise the services

[8] In the USA, HFT is said to have accounted for 50-70% of market trading volume in 2009. In 2005 this figure was only 30%. The same qualifications however apply as to the estimates for the European markets.

of executing brokers (sponsored access, see paragraph 1.6) and therefore do not issue orders under their own name. The HFT order flow from large banks and brokers is almost impossible to distinguish from the other non-HFT trading of these organisations for clients and for their own account. This is because all orders are delivered by the same telecommunication channels without specific identifiers.[9]

Regarding the scope of HFT's market share in the European markets, there seems to be a cautious consensus for a percentage between 30% and 40%. For the above reasons however, there is no firm empirical evidence for this. With this reservation, this percentage can however be used for the time being for conceptual purposes. In 2010, HFT accounts for a substantial portion of trading in European equities and equity derivatives, and this share will continue to increase (rapidly) in future.
The lack of clear figures for a trading method which has such a large impact on the financial markets is obviously unsatisfactory. The widespread speculation about the market share of HFT indicates that the market feels that more precise figures are needed. From a regulatory point of view as well, a better picture of the actual scope of HFT would be desirable. The current lack of clarity contributes to the aura of secrecy surrounding HFT. This does not encourage market confidence and also makes it difficult to conduct a rational discussion about the changes in the microstructure of the European market of which the growth of HFT forms a part.

Table 1: Estimates of the market share of HFT in Europe for Q1 2010. Source: responses to CESR Call for Evidence on Micro-structural Issues of the European Equity Markets (May 2010).[10]

[9] Rosenblatt Securities, An in-depth look at HFT.

[10] See: Consultation responses to Call for Evidence on Micro-structural Issues of the European Equity Markets, http://www.cesr-eu.org/index.php?page=responses&id=158.

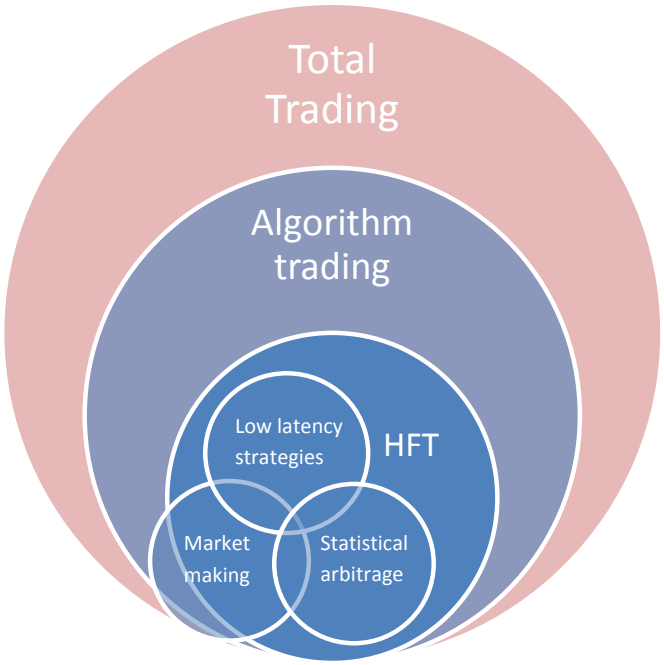
Estimated share of HFT in the European market	Market party responding	Comments from market parties responding
	Trading platforms	
-	BATS	Says it does not use a specific HFT classification
20% (equities)	Borsa Italiana (LSE)	
30% (futures)	Borsa Italiana (LSE)	
40%	Chi-X	
35-40%	Deutsche Bank	
33%	LSE	
13%	Nasdaq OMX	Share of the Nordic markets
23%	NYSE Euronext	Was 5% in Q1 2007
-	SIX Swiss	Says it does not use a specific HFT classification
21%	Turquoise (LSE)	
	HFT parties	
45%	Flow Traders	
>40%	IMC	Derived from figures stated in the market, thinks it is too high.
30-40%	Optiver	Derived from Rosenblatt Securities[11]
	Consultants	
25%	AITE Group	Expects 30% at end 2010 and 45% in 2012
30-40% (futures)	Rosenblatt Securities	
35% (equities)	Rosenblatt Securities	
	Other	
50-80%	European Banking Federation	Concerns all forms of algorithmic trading

1.3 Strategies

The trading strategies for which HFT is used are not new in themselves and were already previously in use. It is however true that the technical innovations introduced by HFT make it possible to implement these strategies to the fullest extent. This may entail certain risks which *are* to some extent new. The strategies which we are encountering in practice may broadly be divided into the following categories: market making, statistical arbitrage and low latency strategies. This last category consists of the strategies that cannot be allocated to either of the other two categories. These are described in more detail below (see also figure 3 for their inter-relationships).

[11] Justin Schack and Joe Gawronski, An In-Depth Look at High Frequency Trading (Rosenblatt Securities, 30th September 2009) 7.

Figure 3: Different HFT strategies, relative to the different forms of trade

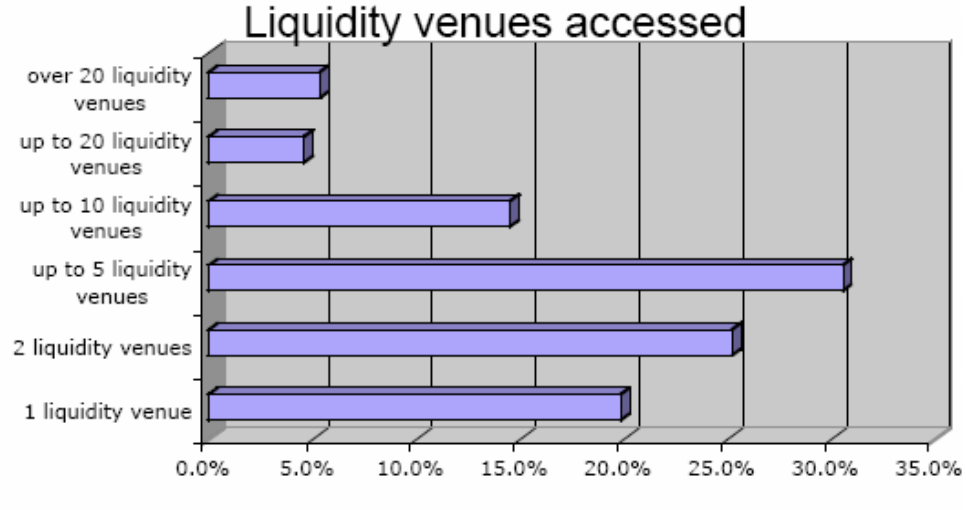


1.3.1 Market making

Market making is the provision of liquidity in listed instruments which are not liquid on the platform in question. In this sense, HFT market making is nothing new. Algorithms calculate the prices (bid or ask) at which an instrument can be offered at high speed. Specifically in the area of HFT, this involves the setting of prices on a certain platform for a stock which is quoted on another platform. The spread between the two is the premium for the market maker. It is possible to expand this to several platforms. This is known as cluster trading: simultaneously quoting prices on a number of platforms.

Since the advent of MiFID, a number of new trading platforms (MTFs) have developed an almost symbiotic relationship with HFT market makers. The market makers provide liquidity on these platforms by quoting securities which are traded on other platforms (the reference markets) on these new platforms, including a certain spread (Figure 4). The platforms are able to increase their attractiveness by reducing their rates for members and structuring them differently. Make/take fees are an example of this: a more attractive rate is paid for the passive side of a transaction, where an order is standing in the order book, than for the aggressive side of a transaction, which takes an order out of the order book as a result of the transaction.

Figure 4: Illustration of access to multiple trading venues in HFT
Source: *Automated Trader*-survey among 171 high frequency traders



Various leading HFT companies have their roots in options trading. A main feature of the options market is that it is order-driven by nature, as a result of the fact that there is relatively little standardisation in options (because of their different strike prices and expiration dates). Because of this there is no natural liquidity for options. Market makers are needed who will continually quote bid and offer prices so that a quote-driven market is created. (The market maker receives a fee for its services). The value of an option is set using mathematical models, and the sophistication of these models determines the accuracy of the calculation. So it was a natural process for these market makers to constantly invest in IT innovation, as this investment was immediately repaid in the form of more accurate pricing. Because of their expertise with sophisticated technology and complicated mathematical models, market makers had an advantageous starting position enabling them to play a leading role in HFT.

1.3.2 Statistical arbitrage

Statistical arbitrage involves identifying opportunities for arbitrage based on statistical links (for example derived from large historical datasets). If stock prices temporarily stop behaving as might be expected based on statistical assumptions, this can be used as a signal for an execution, as it is possible to make sound deductions about where the price will end up. The assumptions which are required are the important issue; some market parties see this as directional trading rather than arbitrage (an assumption is made about the direction in which the market will move). Statistical arbitrage is often seen as an advanced form of the strategy "pairs trading", in which two shares are linked to each other based on fundamental data. One example of statistical arbitrage is dispersion trading. This involves tracking variations in for example the volatility of an index and the volatility of a basket of individual stocks from that index to provide opportunities for arbitrage. (Volatility is expressed for example in the price of options).

The main market participants in statistical arbitrage are the US trading houses. The large Dutch HFT parties, which so far have mainly concentrated on electronic market making, are as yet playing a relatively modest role. It does seem however that these Dutch parties are also increasingly focusing on statistical arbitrage. The reason for this is the increased competition in the field of electronic market making, which is causing parties to search for new earning potential.

1.3.3 Low latency strategies

The most important factor for success in low latency trading is being faster than the rest of the market. This is a very broad category consisting of many types of strategies. These strategies stand or fall on having the fastest systems and the best connection to the trading venues. Some examples of low latency strategies are:

- Searching out limit orders by placing immediate or cancel orders. This means an investor will always pay the maximum price for an order, the difference goes to the HFT party.
- Analysing the way in which other market participants' algorithms for order execution work. As soon as the party has discovered how the algorithm in question works, this knowledge can be used to perform arbitrage.
- By moving the market through small gradual orders, in order to capitalise on the increased volatility through an options position taken beforehand.
- Building your own (based on relevant raw data feeds) national best bid and order quote (NBBO), in order to find out will appear in the public NBBO book as a quote milliseconds later. Smart orders can be used to drive up quotes to the desired level. (This example only applies to the market in the US, where a public NBBO book is used. In Europe the best execution obligation rests with the investment firm acting for clients).

Algorithms used in low latency strategies are also called "aggressive" algorithms. This refers to algorithms which are a step ahead of the rest of the market and/or are trying to encourage a certain movement of the market by utilising this higher speed. Systems which are set up to implement low latency strategies may make new forms of manipulation possible. They can also act as a means of more effectively implementing existing forms of market manipulation. Section 3 looks more closely at the prospects for market abuse of this type.

1.4 Latency

Because of the importance of speed, the objective of HFT is to reduce latency, the time delay between the moment when the price is discovered and market analysis is performed by the trading algorithm and the confirmed placement of an order. Between these two instants, which must therefore be as close to each other as possible, the order must be sent, accepted, executed and confirmed, or, in the event that it is not accepted, confirmed and possibly cancelled.

There are two forms of latency to be distinguished: the "round-trip latency" of the trading platform, and the "proprietary latency" of the market participant itself. "Round trip latency" concerns the time required by a platform's matching system internally to accept an order, process it, confirm it and (if possible) execute it. Round trip latency is measured from the moment when an order enters the system via the demarcation line (the trading platform's firewall), and the moment when the confirmation signal leaves the system via the firewall.
Proprietary latency concerns the latency caused by the distance of the market participant from the firewall of the matching engine, the nature of its access to the platform and the quality of the connections and speed of the algorithms and computational systems which it uses. A market participant can minimise its proprietary latency by optimising its software and hardware and access to the trading platform.

Latency depends on multiple factors:

- The sophistication and complexity of the trading algorithms
- The computing power of the IT systems used
- The capacity (bandwidth), speed and stability of the data connections ('network latency'), also dependent on the topographical *routing* of these connections and the number of *hops* (steps from one router tot the next, also 'switching delay')
- The physical distance between the server running the trading algorithm and the matching engine(s) of the platform(s) (propagation delay)
- The means of access by the trader to the trading platforms (as a member, or by sponsored or direct market access)

The benchmark speed for HFT is constantly decreasing, as a result of technological developments and the constant competition between parties. Speeds are now expressed in microseconds (i.e. 1 millionth of a second), and the expectation is that in the future this will move towards a nanosecond. The importance of latency for a market participant depends on the strategy followed (see paragraph 1.3), as long as it is within a certain range of less than around a tenth of a second. The table below gives an indication of the round trip and proprietary latencies currently stated in the market, for the purpose of illustration:

Table 2a Overview of round-trip latency of various trading systems at April 2010[12]

	Average round-trip latency (microseconds)
NASDAQ OMX INET	250
Bats Europe	270
Chi-X Europe	400
NYSE ARCA	900
LSE Tradelect	2000
TSE Arrowhead	5000

Table 2b Illustration of benchmark speeds by trading strategy (Q1 2010)

Low latency strategies	**Market making**	**Statistical arbitrage**
40 microsec.	180 microsec.	200 microsec. to 100 millisec.

Low latency enables market participants to react rapidly to changing conditions in the markets and to newly available price information, by placing or adjusting orders. This reduces their risk of exposure. This enables HFT market makers to quote keener bid and ask prices. This reduces the spread and thereby has a positive impact on liquidity. It also enables HFT users who undertake arbitrage activities to strip out price inefficiencies, which leads to more sophisticated price formation.

In view of the importance of low latency for market participants, the trading platforms are also investing heavily in making their systems faster. The investments consist of upgrades to both software and hardware. As a result of this development, trading platforms are in effect increasingly becoming providers of IT services. The new MTFs have taken the lead in adopting technology, but the incumbent exchanges have also been making large investments in new IT facilities. One example of this is NYSE-Euronext's large new data centre in

[12] http://mondovisione.com/index.cfm?section=news&action=detail&id=89825

Basildon, UK, which became operational in September 2010 and which will operate as the central data centre for all this market operator's European trading platforms.

The commercial pressure to lower the latency of trading platforms is not free of risks. Trading platforms each use their own means to increase speed. This could lead to a *race to the bottom* and induces inconsistent risk management. For example, a trading platform could outsource certain risk management measures, that slow down the platform, to a broker. An example of this is implementing a system of 'non-persistent orders'. In this case, order registration takes place de-centrally at broker level, and not at platform level. Broker receive a fee for this service. However, in case of a calamity, there will no longer be a proper order registration, which could increase counterparty risk.

The latency sensitivity of the trading strategies of HFT parties is expressed in the fact that the consequences of increases in latency over the trading day (for example for technical reasons) are immediately visible in the profit and loss (P&L) statement. Because of the importance of minimising latency throughout the entire chain mentioned above, efforts are made to optimise speed. This is associated with considerable investments in software, hardware, infrastructure and access to trading platforms.

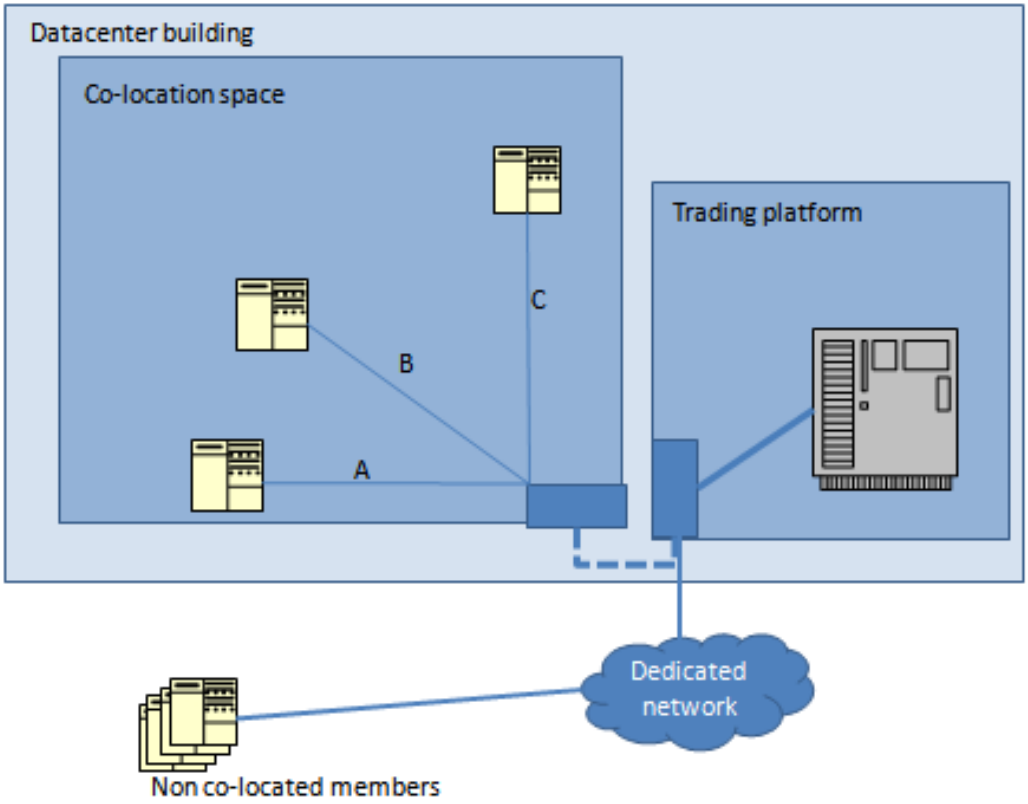
Latency is by definition relative and is only meaningful in relation to the latency of other market participants. This means that latency-sensitive market participants that cannot afford to fall behind the competition invest continuously in further minimising their latency. It must also be remembered that latency sensitivity varies enormously depending on the investment strategies and decisions involved. Market making and taking advantage of very short-lived opportunities for arbitrage are extremely latency-sensitive, but this is much less the case for directional long-term investment strategies (see also paragraph 4.6).

1.5 Co-location

One way of reducing latency is to locate the server on which the trading algorithms run as close as possible to the trading platform's matching engine. This is what happens in co-location. In co-location, a trading platform offers market participants who are members of the platform the opportunity to rent server racks in the same building as that in which the matching engine is located.[13] The member can locate the servers on which its trading applications run here. This set-up means the data has only a minimal distance to travel and reports (such as order book data, transaction data, price data and other notifications) can be sent and received with the minimum delay (see figure 5).

[13] Depending on the options offered by a trading platform or data centre (for a fee), the server racks of the different market participants are located together in the same area, or it is possible to lease separate areas, completely enclosed or not. In enclosed areas, there may also be the option for the party to arrange its own sprinkler systems and air conditioning entirely to its own requirements.

Figure 5. Diagram of co-location
Capacity and length of data connections A, B and C must be equal.



1.5.1 Characteristics of co-location

Although recent technological developments have facilitated co-location, it is not actually a new concept. Professional traders have always needed to be as close as possible to the location of price discovery. This allowed them to react rapidly to newly available information and trading opportunities and to limit their risks as far as possible.

The concept of co-location is therefore comparable with the earlier jobber system, in which the stock exchange rented space on the trading floor to members, when physical trading still occurred. As long as the MiFID conditions for a fair market are satisfied (see below), co-location is more democratic than the previous situation. The playing field for all the parties co-located on the same platform is level, which was not the case on the physical stock exchange floor between the jobbers. In principle, co-location also offers to all market parties requiring it the opportunity to be immediately present at the centre of price discovery, regardless of their actual physical location.

Co-location therefore enables market participants to maintain their offices at a location other than the location of the trading platforms on which they trade (for example in another country), without any disadvantage in terms of latency compared to participants whose offices are located in the vicinity of the platforms. This means for example that the Dutch electronic market makers that play an important role in European HFT are able to keep their offices in Amsterdam, whilst the data centres of almost all the main European platforms on which they operate are located in London or its direct vicinity.

Co-location offers the opportunity to deal in an orderly manner with the fact that the physical distance to a platform's matching engine has consequences for the latency of market parties. In the absence of co-location facilities, certain market participants might for example be able to decide to set up their own data centre immediately next to the trading platform's data centre. These participants would thus acquire an arbitrary advantage over those not able to achieve this, for whom rapid access to the platform would therefore be denied. This is one of the reasons why the suggestion which is sometimes made that co-location should be prohibited would not contribute to ensuring fair market access.

It is also important to be aware that co-location is just one way of reducing latency. The total latency for a market participant depends on many more factors than just the location where its algorithms operate, as described above. Even if there is no opportunity for co-location, or if the latency benefits created were to be restricted, significant variations in speed between market participants would always exist due to varying levels of technological competence and the resources they (are able to or wish to) invest in software and hardware.

In assessing the acceptability of the phenomenon of co-location from the point of view of fair market access, the distinction between the two forms of latency mentioned earlier (round trip and proprietary) is relevant. In a fair market environment, latency can never be minimised further than to the demarcation line of the matching engine. In other words, efforts to reduce proprietary latency as far as possible are acceptable, but round trip latency should be equal for all market participants under all circumstances. If this were not the case, it would mean that some market participants' orders would be executed earlier than those of others based on a discretionary decision from the operator of the trading platform. This would undermine the principle of a fair market and also contravene the definition of an RM or an MTF as "a multilateral system (…) bringing together buy and sell intentions of third parties (…) *within* this system and based on the *non*-discretionary rules of this system.[14] For this reason there must be no difference in speed or capacity between the connections from the server racks to the matching engine's demarcation line. This means that the connection cables between the server racks and the matching engine must all be of the same length and have the same data processing capacity (see figure XXX).

1.5.2 Multiple co-location and central proximity hosting

Latency-sensitive market parties are often co-located in several places ("multiple co-location"). For HFT users, this is because of the arbitrage or market-making strategies which they execute between various platforms. For brokers, multiple co-location is also often necessary in order to efficiently execute client orders under their best execution obligation. The use of multiple co-location means the various liquidity centres in the European markets landscape are efficiently connected to each other. Co-location thereby contributes to mitigating the fragmentation of liquidity which was the necessary consequence of the restructuring of the market under the MiFID.

An alternative to multiple co-location is "central proximity hosting", where the servers on which a market participant's trading algorithms run are located in a data centre strategically positioned between the physical locations of a number of trading platforms. These services are provided by specialist commercial parties which have connected their data centre to various trading platforms themselves by means of high-speed connections. High-speed access to these platforms is thus offered from a single location. Central proximity

[14] Art. 4(14) and 4(15) MiFID. Italics added.

hosting is significantly cheaper than co-location. It therefore offers opportunities for market participants for whom co-location is too expensive. It is also attractive to participants whose trading is primarily inter-platform. However it can be slightly slower than co-location. Whether it is a suitable alternative therefore depends on the needs of the participant concerned and its own cost-benefit consideration.
Central proximity hosting services are provided by non-financial IT companies. As non-financial companies, they are not subject to regulation. However, as central proximity hosting increases choice for market participants and lowers the threshold for market access, the AFM does not support proposals to oblige market participants to purchase connection services only from market operators or investment firms which are regulated. Market participants using central proximity hosting must however be able to demonstrate that the provider to which they have outsourced a portion of their activities offers adequate safeguards to guarantee the physical and operational integrity of their systems. These safeguards should be of the same quality as those at market operators which are subject to regulation (see paragraph 1.5.3)[15].

1.5.3 Considerations for co-location

Critics argue that minimising propagation delay by means of co-location should be regarded as an unfair trading practice. According to them, co-location gives the market participants using it an unfair technological advantage. Indeed, because of their minimum distance from the platform's matching engine, they have an advantage in terms of information over participants who are further removed from the matching engine. Critics of co-location argue for this reason that co-location is equivalent to market abuse, or that it at least facilitates it.
The AFM does not share this opinion. Offering fair access under reasonable conditions ("fair and equal access") means that market participants should be offered the same *opportunity* to invest in access to low latency facilities and the technology required for them. This is not the same as making uniform technical opportunities mandatory or guaranteeing equal *outcomes* to market participants. These outcomes are after all dependent on the knowledge, skills and resources at their disposal. Provided that transparent and non-discretionary access conditions are applied at reasonable commercial cost, minimising propagation delay through co-location can be replicated by all market parties wishing to invest in it.

The AFM therefore sees the option of co-location as an investment decision which each market participant must make for itself, depending on its latency sensitivity, skills and a consideration of the costs and benefits. The potential benefits of low latency are offset by high fixed costs.
So the use of co-location is legitimate in itself, provided that those using the service do not commit market abuse. The reulator must be able to take effective action against market participants who abuse the low latency they obtain for manipulative purposes. This makes more sophisticated and coherent international monitoring of the market essential. Like the other technological developments which are linked to HFT, co-location therefore places higher requirements on the regulatory apparatus. (see paragraphs 4.2 and 4.3).

For the above reasons, the AFM sees no reason to restrict co-location. It is however of the opinion that in the European context, additional guidelines and stringent technical standards are needed to guarantee the robustness of the operational systems and access to co-location facilities under objective, transparent and non-discretionary commercial conditions and at reasonable cost. These must be in line with the spirit of the provisions in MiFID regarding access to trading platforms and price information.[16] Such standards must be

[15] Cf art. 13(5) MiFID and art. 2(6), 13(1) and 14 MiFID Implementing Directive.
[16] Cf. art. 14(1), 14(4), 42(1) and 42(3) MiFID and art. 32(c) MiFID Implementing Directive.

formulated at not lower than European level, but in such a way that they do not detract from further technological innovation which contributes to increasing the efficient operation of the market.[17]

1.5.4 Necessary conditions for co-location

Co-location involves placing part of the technological infrastructure of market participants with a third party. This makes the participants concerned dependent on the services of co-location providers. It is therefore important that the physical integrity of the co-location centre is guaranteed under all circumstances. This means, among other things, adequate security and maintenance measures must be in place.[18]

In order to guarantee access on a non-discretionary basis, any conflict of interest must also be mitigated and discrimination against or preferential treatment of specific market participants must be prevented.[19] In view of the importance of co-location for market participants and for the efficient operation of the market, there is also an obligation for providers to ensure that sufficient server racks are always available so that any party wishing to connect to the trading platform via co-location can be served.

The dependency of market participants on unimpeded access to the trading system places a responsibility on the platform to communicate clearly about system upgrades and to perform them consistently and punctually, so that the participants can adjust their systems in anticipation of the upgrades in good time.

The information provided on the costs and speeds of co-location must be correct, clear and not misleading, so that market participants are unambiguously and transparently informed about costs and technical specifications.[20] In the AFM's view, agreement by the market on further uniform definitions and standards for the measurement and comparison of the latency and data capacity of providers of co-location services would be desirable.

One point of concern regarding the efforts to achieve increasing speeds is that the high costs involved might lead to some participants dropping out because they can no longer keep up with the race to the top. This would reduce the diversity of the market, and thereby impede the free operation of the market.

For this reason, some observers have asked whether it might not be desirable to cap the speed of co-location, so that this race to the top would be brought to an end. It is unclear however what the advantages of this might be, in view of the fact that co-location is only one way of limiting latency. As stated earlier, it is relevant to the concerns about the costs of reducing latency to realise that not all market parties are equally latency-sensitive. They therefore have different needs and investment requirements in this field. It is essential however that fees for one of the largest cost items, i.e. co-location, are based on fair, objective and transparent commercial conditions.

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[17] The AFM supports the CESR's recommendations to the European Commission with regard to establishing stringent technical standards and guidelines in relation to (matters such as) co-location and amendments to MiFID at level 1 and if necessary also level 2 for this purpose (see par. 4.1).

[18] Cf art. 13(5) MiFID and art. 2(6), 13(1) and 14 MiFID Implementing Directive.

[19] Various prominent MTFs are for example owned by investment banks or consortiums of investment banks. The possibility that they might give preferential treatment to their own clients above others, for example, must be excluded. Cf. art. 21, 22 and 23 MiFID Implementing Directive. For regulated markets, see art. 38(2) and 39(a) MiFID.

[20] Cf. art. 19(2) MiFID.

An oligopoly in the market for HFT services, if it occurred, would obviously be undesirable. Not only from the perspective of competition law, but also because of the (systemic) risk for the integrity of the market if too much market power became concentrated at a small number of market participants.

While oligopoly in the market for HFT services is not yet an issue, this is still a matter that deserves the attention of the regulators. Action by the regulator may be necessary in the case of market failure or if actual risks to the integrity and fair operation of the market are identified. Such measures are not intended however to maintain the status quo, or to protect inefficient companies from free market forces. Concerns of this nature must therefore always be carefully weighed against the need to avoid the unnecessary restriction of free market forces and the technological innovation which contributes to the efficiency of the financial markets.

The importance of co-location to latency-sensitive market parties gives trading platforms a powerful position. Under the influence of the changes to the market structure resulting from the MiFID, the incumbent exchanges' earnings models have come under pressure in recent years. It is no surprise therefore that they welcome the new income from the sale of data and rental of server racks. In view of the investment and maintenance costs which this data and the co-location opportunities entail for trading platforms and the value these services add to the trading activities of latency-sensitive market parties, it is reasonable that trading platforms expect the fees for providing these services to be in line with the market.

It should be noted here that the market participants who depend on (multiple) co-location play an important role in the efficient operation of the financial markets, in particular by combating the fragmentation of liquidity flows. It is therefore important that the costs of co-location are not unreasonably high, so that the playing field remains accessible to sufficient players. Trading platforms must not therefore misuse their market power to set monopolistic prices which prevent competition between market parties and thereby threaten market efficiency. The development of the prices of co-location services must remain an important consideration for regulators, and the outcome of such consideration will probably be closely related to achieving one of MiFID's key objectives; promoting a competitive market for trading platforms.

1.6 Sponsored Access

There are various ways for market participants to acquire access to trading platforms. The most direct and fastest way is through membership of a platform. But this involves strict requirements (and high costs). An alternative form of direct access, which is especially attractive to certain HFT parties, is sponsored access (SA).

Sponsored access consists of an adapted form of direct market access (DMA).[21] DMA enables clients of an intermediary which is a member of a trading platform to obtain direct access to the trading platform, without themselves having to become a member. These orders nevertheless pass via the member's internal systems, so that the control mechanisms there are automatically exercised on the client's orders as well. In SA the affiliated member's licence is also used, but the connection is made entirely outside the member's systems. This provides a gain in terms of speed. DMA and SA may be attractive to market participants which are latency-sensitive, but due to cost or other reasons (such as wishing to maintain anonymity and/or flexibility, or wishing to limit compliance obligations) do not need to become a member of a platform.

[21] In its "Principles for Direct Electronic Access to Markets, IOSCO discusses Automated Order Routing through Intermediary's Infrastructure, another term for the same phenomenon.

1.6.1 Various options for accessing a trading platform

The diagram in figure 6 below shows a number of the main forms of access to a trading platform. The traditional situation is that access is either obtained directly through membership of a trading platform, or indirectly through the agency of an intermediary. This indirect form of access is usual if direct membership of a platform, for whatever reason, is not needed. It may be that the intermediary itself has direct access to the market, or that the intermediary uses a successive intermediary to ultimately pass the orders to the platform.

Client orders can be executed at different speeds and at different prices. This depends on the intermediary's technical facilities, and also on the priorities of the trader connected to the intermediary. Intermediaries are obliged to ensure the best possible execution of client orders, within the framework of the order execution policy agreed with the client. Depending on the client's requirements, the selected intermediary chooses a suitable strategy to ensure the desired execution.[22] The intermediary therefore has a certain discretion in this case to ensure the best execution of orders according to its own view, and sends the client's orders to the trading platform's matching engine based on this view.

Non-members can now choose a direct connection to a trading platform's matching engine via DMA or SA without being dependent on their intermediary's order execution policy (the two lowest options in the diagram in figure 6). In the case of DMA or SA, the client itself is responsible for the manner in which execution occurs, as would be the case if it had direct membership of the trading platform. This is because orders in this case reach the matching engine as they are sent by the client, which has itself implemented the strategy for the correct placement of orders prior to sending the order.

The difference between DMA and SA is as follows: in DMA, the orders which are sent to a platform's matching engine are still routed first via the intermediary's infrastructure. The intermediary therefore is able to monitor and apply filters to the orders which have been sent through. If the connection is via SA however, then only the intermediary's contract with a trading platform is used without any further use being made of the intermediary's infrastructure. In order to still be able to see what the client is doing, in many cases the intermediary receives a copy of the orders which the client has sent to the trading platform (often referred to as a 'drop copy').[23] These order copies can be used by the intermediary to monitor the behaviour of the sponsored participant in near real-time and to take action if necessary (ideally before undesirable transactions have actually occurred). Post-trade data is subsequently obtained from the trading platform where the orders are executed.

It should also be noted that in practice market participants utilise combinations of various forms of access to trading locations. A trading firm may for example operate on one platform as a member of the platform, whilst it trades on another platform via SA and on another via DMA.

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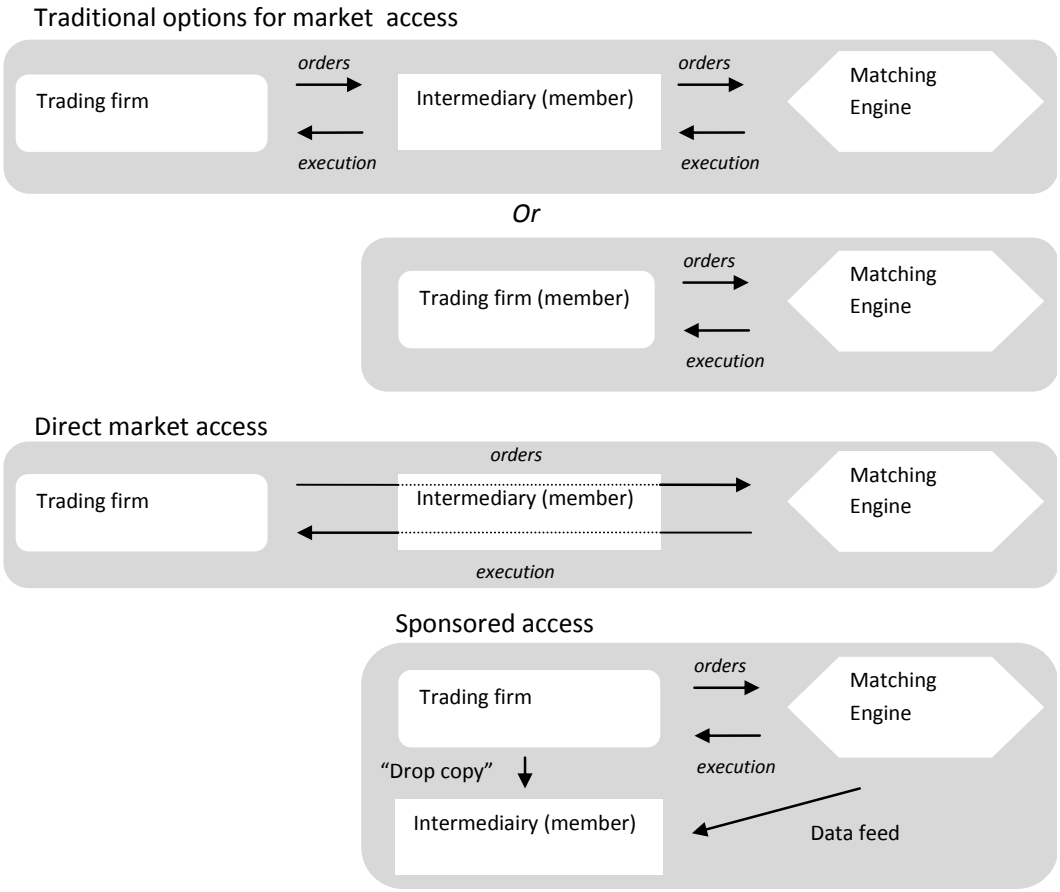
[22] In best execution for professional clients, the following factors must be taken into account: the price of the financial instruments, the cost of execution, the speed, the probability of execution and settlement, the size, the nature and all other factors relevant to the execution of the order. In the event of a specific instruction from the client regarding an order or a specific aspect of an order, an investment firm must perform the specific instruction. When an order (within the order execution policy) can be received at several places of execution, there must be an analysis of the results which may be obtained for the client in these various places of execution, with the aim of achieving the best result for the client (art. 21(1) MiFID and art. 44 MiFID Implementing Directive).

[23] Responses to the IOSCO consultation paper "Principles for Direct Electronic Access to Markets" showed that there are cases in which this type of control is entirely omitted.

Figure 6: options for access to trading platforms



1.6.2 Speed

In DMA and SA, orders are placed more rapidly than when execution is conducted through the agency of an intermediary. The speed of SA is (potentially) the highest, because in DMA all orders still pass through the intermediary's systems first (see figure 6). This means that the physical distance which the signal must cover is usually greater than in SA. In addition to physical (routing) delays, there can also be delays in the system, for example because the intermediary applies its own monitoring systems and filters to the client's order flow. Market participants usually expect orders to be sent as quickly as possible. This may act as an incentive to intermediaries to keep delays for monitoring purposes as brief as possible (thereby ensuring latency is as low as possible). [24]

In SA, the client only uses the intermediary's licence, not its infrastructure. Connecting via SA can therefore in principle be just as fast as connecting via membership. There may be a difference however in the available bandwidth of the connection to the trading platform (this may become apparent when the order flow increases in volume).

[24] See also paragraph 1.3 on latency and page X on standardised risk management.

1.6.3 Monitoring

The risks which are linked to placing orders via DMA or SA in general can be roughly divided into three categories: erroneous transactions (for example as a result of 'rogue algorithms' or 'fat fingers'), market abuse and credit risk.

- Erroneous transactions

Erroneous transactions occur despite the trader, and are the result of either human error or an incorrectly programmed trading algorithm.[25] It is therefore in the first place in the interests of the trader that the potential for this type of error is kept as low as possible. Ordinarily, traders will also have set up systems to detect this kind of error before it is sent to the trading platform. Since these systems offer no guarantee that erroneous transactions will be prevented, it is essential that additional monitoring occurs.

Trading platforms therefore monitor member parties, both prior to and during the term of a membership contract. In the case of DMA and SA this means however that the trading platform must hand over some of the above monitoring to the intermediary offering DMA or SA services because the trading platform has no (direct) contractual relationship with the intermediary's client. The responsibility for this monitoring is partially transferred to the intermediary.[26] The obligations to the platform remain with the intermediary, however the platform's options for direct monitoring as to whether the intermediary is fulfilling these obligations are reduced.

The facilities offered by SA and DMA to place sizeable volumes of orders at great speed involve the risk that if these orders are erroneous, they can also reach the order book more rapidly and in larger numbers than previously was the case. Seen from this angle, the AFM is of the opinion that adequate pre-trade monitoring, also in the case of DMA or SA, has increased greatly in importance. In the case of trading via an SA contract, the potential for pre-trade monitoring seems limited. The intermediary can of course follow closely what the client is doing via the "drop copy" which is sent and if necessary act quite quickly, but taking action prior to actual order execution is not always possible in practice.

- Market abuse

Accessing trading via DMA or SA makes it difficult to get a complete picture of the behaviour of players in the market. In many European countries, market participants that connect to a platform via a DMA or SA contract with an intermediary are able to trade under the name of the intermediary. As also explained in paragraph 4.3, the AFM is in favour of the introduction of a "client ID". This would enable supervisors to monitor the market more effectively, the use of DMA and SA would be less attractive to parties with malicious intentions and the specific risks of market abuse related to DMA and SA would be reduced.

[25] The extent to which orders are initiated by human traders or by algorithms is difficult to establish precisely (see par 1.2). For risk management of algorithms, see also para. 4.5

[26] Usually via a contract between the client, the intermediary and the trading platform.

- Credit risk

In many cases, clients trading via DMA and SA have their transactions settled by an intermediary which is affiliated as a clearing member to a central counterparty (CCP). Agreements will have been made with this intermediary in its capacity as a clearing member regarding the maximum trading and position limits which can be held, and which, when they are reached, require extra financial margins in order to be able to continue trading. Insofar as the intermediary relies on timely action from the central counterparty for its risk management, it is essential that the latter party actively monitors these positions (and where necessary requires action from the relevant clearing members) in order to be able to adequately fulfil its signalling role. This becomes more essential where clients trading under a DMA or SA contract via an intermediary/clearing member are able to build up very large positions in a fraction of a second, as is possible in the current technologically sophisticated market environment.

It is conceivable in the chain of client-intermediary-clearing member that either the client or the intermediary is already no longer able to meet its obligations before the central counterparty takes action by requiring additional collateral. As soon as an organisation is in danger of being unable to meet its obligations, a domino effect can occur which affects the creditworthiness of the party or parties further on in the chain. Considered from this point of view, the AFM sees a risk if an intermediary/clearing member relies too much on external parties (such as a central counterparty) in its risk management, certainly if the intermediary is offering services such as DMA and/or SA. At the central counterparty as well, the AFM sees risks arising from the increased speeds of trading, certainly if it becomes less clear to the central counterparty which players are connected to the intermediary. For example, when assessing the credit risk of clearing members central counterparties will have to take into account the possibility that large positions can be built up in a much shorter time period than previously was the case. This requires an adjustment to the provisions which a central counterparty makes for the risks it acquires from intermediaries, and also an adjustment to the central counterparty's internal monitoring systems to enable it to adequately deal with the trading speeds which can now be achieved.

2 Impact of HFT

Depending on who is asked, estimates concerning the nature and scope of the risks of HFT vary. Market participants which themselves use HFT emphasise the positive aspects: increased liquidity, improved price formation, lower volatility. Participants which consider HFT to be an obstacle to the execution of their orders (such as some buy-side participants), are more likely to emphasise the negative aspects. Although commercial (competitive) considerations play an important role in this discussion, this does not mean that the arguments for and against are not valid. However it is difficult to weigh them against each other. The available empirical studies of the role of HFT in creating liquidity seem to endorse the arguments of the HFT parties, albeit with the observation that the "production" of liquidity by HFT may seem to have increased, but that its "consumption" by other market participants seems to have decreased somewhat.[27]
It should be noted in connection with the available empirical evidence that some of these studies were carried out in association with HFT parties, so that the objectiveness of the findings has not been established. Further independent empirical investigation would therefore be desirable, but is not currently available to a sufficient extent.

2.1 Achievements

Supporters of HFT emphasise that HFT has a positive effect. They cite in particular the contraction of the bid-ask spread, the increase in the speed of execution, improvement in liquidity on platforms, the cushioning of volatility, reduction in trading fees, and a general increase in the efficiency of the market.

2.1.1 Bid-ask spread

Because of the speed of their systems, HFT market makers are able to rapidly adjust the bid and ask prices they offer to new market circumstances. This means they are able to remain closer to a certain reference price with their prices, without increasing their trading risk. More speed means a narrower bid-ask spread, which in turn means lower trading costs for market participants because they are able to trade on more attractive conditions. The tendency for the bid-ask spread to become narrower has been in place for some time, but HFT players' sophisticated trading systems have provided a new impetus to this development.

Market makers may enter into a commitment to set bid and ask prices (they then become liquidity providers/dedicated market makers). In exchange, these market makers are granted a lower fee and/or more bandwidth on the platform in question. The obligation to set prices prevents the market from "drying up" at moments of uncertainty and volatility. At these times there is always a market maker to quote prices, with a bid and ask price within a certain range. Discussion is currently ongoing about the absence of this commitment for trading in larger stocks. The AFM assumes an open position in this debate and hasn't committed itself to an opinion yet. She does however feel that the benefits of possibly forcing a commitment to taking certain positions should outweigh the possible drawbacks of it. Additionally, changes to the market structure, which have their impact on the role of market making in the financial markets, should be taken into account (also see 2.1.3, 2.1.4 and 2.2.1).

[27] Menkveld, Middlemen in Limit Order markets. [provisional result]

2.1.2 Liquidity

Supporters of HFT also point out that HFT market makers create liquidity in a range of instruments. They create liquidity on platforms where these instruments were not previously offered, and they also create liquidity in instruments in which by their nature there was no liquidity, as a result of the varied nature of the instruments (such as options). The bid-ask spread (described above) is often used as an indicator of liquidity. The narrower the spread, the greater the liquidity of a stock. But the bid-ask spread is not the only indicator of liquidity. Market depth (the depth of the order book) is another indicator of liquidity; the 'deeper' the market, the larger an order must be to cause a change in the price, and the greater the liquidity of the stock.[28]

Supporters argue that liquidity on trading platforms has increased as a result of HFT. The main arguments in favour of this are that HFT has created a sharp increase in the number of outstanding tradable buy and sell orders, as a result of which the market depth has increased. The spread as described above has also narrowed.

2.1.3 Speed of execution

Supporters point out that the speed at which investors are seeing their orders filled is greater than previously because of HFT. This means that there is less time for adverse price changes between placing and executing the order. In the time between placing an order (by the 'early investor') and the transaction being achieved (through a counter-order by a 'late investor'), valuable information may come to light which was not taken account of in the 'early investor's order. This means an adverse selection problem may arise: the 'late investor' can trade against the 'early investor' by waiting for new information, thus gaining a price advantage. A high execution speed means that there is less time for this adverse selection problem to occur.

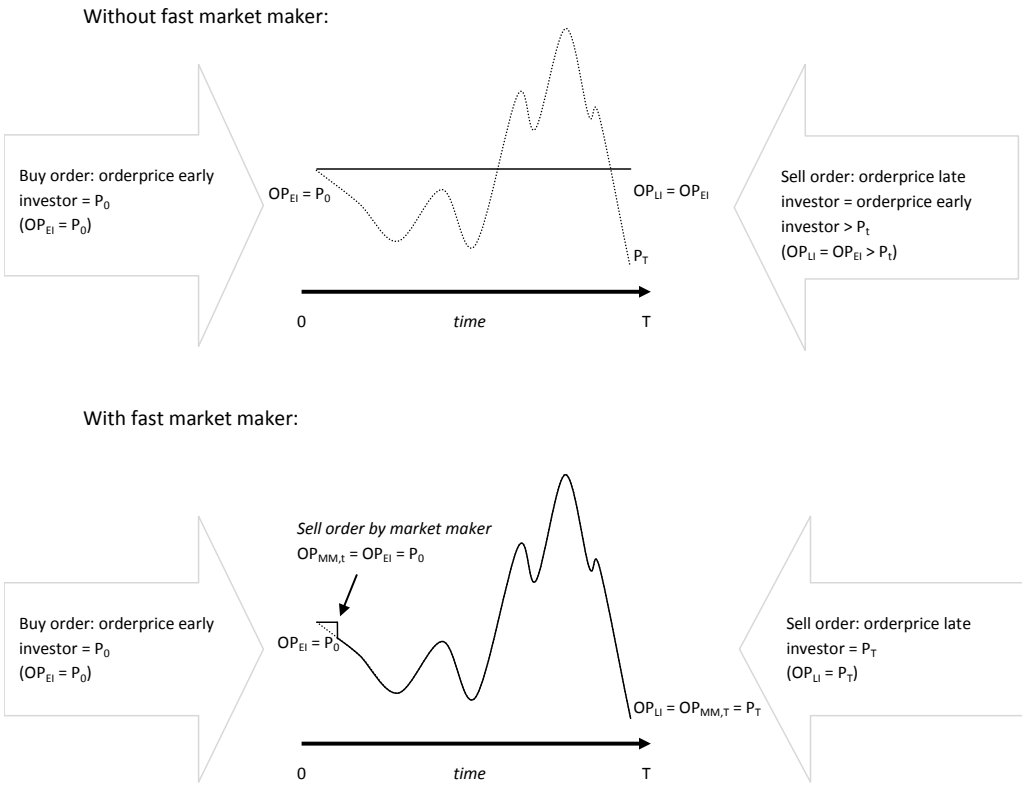
HFT parties can stand between the 'early investor' and the 'late investor', cause the early investor's order to be executed, and before the sale to the late investor, adjust the price to new information which becomes available before price formation.

To illustrate the adverse selection problem, in figure 7 on the following page a stylised example is given of two situations: the first case occurs without a fast (HFT) market maker, and the second with. In the first situation an early investor, EI, places a sell order with an order price P_{EI} (equal to the market price P_0). Some time passes and the market price changes, but the order remains the same. A late investor, LI, who plans to place a buy order, has some room to wait until the price has changed in his favour and to place an order at P_{LI} (equal to P_{EI}), or otherwise to cancel the buy order. This ensures that the early investor to a certain extent always has to cope with counter-parties (late investors) trading against him (adverse selection).

In the second situation there is a fast market maker (for example an HFT party). The early investor places a sell order at the current market price P_0 and the market price changes slightly. A fast market maker sells to the early investor at a slight profit and almost immediately places an adjusted buy order, and continues to adjust this buy order at high-speed to the market price P_t. This means the late investor has almost no chance of waiting for the price to develop in his favour, reducing the problem of adverse selection.

[28] Critics of HFT argue that although the bid-ask spread may have narrowed, the depth of the market has shrunk, and that the liquidity of the market has become less overall.

Figure 7
Adverse selection in a buy order as a result of slow execution



2.1.4 Volatility

Increasing liquidity is often said to dampen price volatility. Supporters of HFT point out that HFT parties have managed to continue to set prices even in volatile periods (for example in the final quarter of 2008), thus ensuring liquidity and more stable price formation. The spread logically becomes wider in volatile situations, but prices nevertheless continue to be formed, so the argument goes. Concerns nevertheless exist about the ease with which HFT parties, in the absence of any formal dedicated market making (DMM) obligations, can withdraw from the market at times when it becomes too difficult for them to estimate the correct price of a share. If this occurs, this might have serious consequences for the provision of liquidity. Critics argue that a large proportion of the current liquidity is no longer linked to any obligation to continue providing prices in any situation (as already cited above), and further that the increasing dependence on algorithms in general may boost volatility, and might be a source of systemic risk (see 4.4.1).

In the discussion of the impact of HFT on volatility, it is essential to differentiate between different types of strategies. A distinction may be made for example between parties providing liquidity (by entering limit orders and quoting bid and ask prices) and parties removing liquidity (through market orders).[29] In other words, the former provide trading opportunities, the latter make use of these trading opportunities. Placing a limit order or series of limit orders will usually have an entirely different effect on volatility than placing a market order or a series of market orders.

[29] A distinction which is often made is that between passive and active trading. Placing limit orders/bid and ask prices is often equated with passive trading. The assumption is not accepted as correct by everyone however.

2.1.5 Increased market efficiency

Market making by HFT parties may also be seen as a sort of arbitrage: abnormal prices are removed from the market, resulting in better/more efficient price formation. This principle is also in keeping with the ideas in the paragraph above, on speed of execution: the more rapidly an opportunity for arbitrage is realised, the less the impact of the arbitrage will be for the counterparty. The alternative is that the participant is in an unstable situation for a longer time, with the associated opportunity costs (the participant would have been able to adjust earlier to the situation which had arisen).

2.1.6 Fees

Supporters argue that HFT has made an important contribution to lowering transaction costs for market participants. Along the same lines, it can be argued that HFT parties will ensure that costs of market access do not become unreasonable. This argument rests on the principle that HFT provides liquidity to trading platforms, so it is in the interests of the platforms to attract HFT players, for example by charging competitive transaction costs. The more liquidity a platform has, the more attractive it becomes as a trading location for market participants. In view of the competition between trading platforms which MiFID is intended to stimulate, it is essential for competitive considerations that there is sufficient liquidity for the market mechanism to function.

In competition with each other, platforms have started to offer the most advantageous conditions possible to parties which can add liquidity to their platform, such as HFT users. In addition to optimising the trading infrastructure (low latency) it is an important condition for HFT parties that the transaction costs per order are as low as possible. This is because HFT users execute large numbers of orders. In fact, transaction costs per order have fallen significantly since the introduction of MiFID. Supporters argue that the reduction in transaction costs is due to HFT for the above reasons, and that all market participants have benefited as a result. They also argue that as everyone can now trade at lower cost, brokers for example have more room to reduce their own fees to their end-clients.

2.2 Risks

The risks observed with regard to HFT can be divided into trading risks and IT-related risks. The latter are discussed elsewhere (1.5, 1.6, 4.4). The following will discuss trading risks related to HFT.

2.2.1 Trading-related risks

The expectation is that HFT will expand to an increasing number of asset classes, and that there will be a consolidation process among the market participants after which only the most professional and best capitalised companies will remain. This may lead to a large part of trading taking place between only a small number of players, with the accompanying concentration risks.

Oligopolisation of the market, wherever it should arise, is to be avoided. Competition considerations are not the only reason for this, there will also be increased systemic risk if too much market power is concentrated at a few players.

A related risk is the risk that many participants, small and large, use the same strategies. As these strategies are implemented by algorithms, chain reactions are possible whereby the strategies will reinforce each other to the extreme, in particular if there is a ‘black swan event’. When volatility in price formation on trading platforms occurs that cannot be explained, mutually reinforcing algorithms are often blamed. One example is the event which

took place on 6th May 2010 in the US, known as the 'flash crash', when the Dow Jones Index underwent an extreme fluctuation which was difficult to explain. This kind of suspicion weakens investors' confidence in the efficient operation of the market. It has incidentally not been established that HFT has been responsible for such events (see also paragraph 4.1.2).

HFT parties pride themselves on continually providing liquidity to the market, and that they continued to do so at the depth of the recent financial crisis. Nevertheless there is no certainty about the firmness of their commitment to actually continue to provide liquidity to the market under any circumstances.

HFT users play an important role in maintaining a bilateral market in the electronic order book. They may therefore be designated as quasi-market makers. The word 'quasi' is of importance here, because in most cases these parties have no official dedicated market-making obligation (liquidity providing function) to provide bid and ask prices. This means that they could always decide in a volatile market to temporarily stop making quotes. HFT users are always free to enter the market when sufficient liquidity and opportunities for profit present themselves, and to withdraw when they are absent. So there is no guarantee that HFT users will actually be present in the market under any circumstances as they themselves state. This uncertainty may be a risk, because the market has now become accustomed to their presence. If we assume that HFT constitutes 30% to 40% of trading, its absence would obviously have a great effect on the market.

The larger players in the market suggest that the greatest risks lie with parties having no obligation at all to the trading venue on which they trade (for example, through membership as a liquidity provider for certain stocks). This would be a signal that participants are not prepared to commit themselves to a certain (market making) strategy and therefore will not contribute per se to the positive effects attributed to HFT (increased liquidity, better price formation, narrower spreads).

Clearing houses monitor the exposure of parties and the associated 'haircut' (the percentage of the exposure for which capital is maintained). But the clearing houses do not have a real time picture of the participants' exposure; they monitor the positions of members at the end of the day. This raises the risk that the clearing institution may suddenly be confronted with a large exposure if it turns out that a party has taken excessive positions during the day for which insufficient capital is available. HFT may increase this risk, simply because more intraday trading occurs. It is therefore essential that the clearing parties also make appropriate adjustments to their systems and control mechanisms to meet the requirements imposed by new trading technologies like HFT.

There is a concern that HFT is increasing trading costs, for example by forcing the average order size down, by introducing smaller tick sizes, and under the influence of "maker-taker pricing", where liquidity providers (= the HFT parties) are given a small fee for each transaction, whilst parties which remove liquidity (= buy-side parties) actually have to pay a small fee (see also paragraph 1.3.1). HFT parties counter these criticisms by pointing out the liquidity they add to the market and the narrower spreads they create, which they say compensate for any negative consequences their presence has for trading costs.

A risk related to the above is that the presence of HFT is encouraging other parties to move to a trading environment not affected by HFT, for example by finding a 'dark pool' or through bilateral OTC trading. The concern here is that if this occurs to an extreme extent, the transparency of the market as a whole may decrease. For now this is not an issue. OTC trading does account for a significant share of European trading, but this was already the case

even before the introduction of MiFID, and the market share of dark pools is so far still limited.

It is also interesting that with the exception of some trading platforms, concerns about a possible increase in OTC trading originate mainly from the HFT parties, who say that they see OTC trading by definition as a threat to the transparency of the market as a whole. It should be remembered that there is a direct commercial interest in gaining access to the order flows which are currently being transacted OTC. The principle of best execution for the end-client is served however by the existence of a variety of forms of liquidity, including OTC trading.

2.2.2 IT-related risks

A risk related to IT is the quality of monitoring in sponsored access (SA). Thorough monitoring often means a loss of speed, and so there is pressure on the SA providers to make monitoring less time-intensive (and less thorough). In the US, curbs are currently being imposed on the most extreme variant of this, 'naked' (i.e. completely free) access (see also paragraph 1.6).

The commercial pressure to reduce the latency of the platforms also involves risk. Each trading platform uses different methods to increase speed. This may result in a 'race to the bottom' and does lead to inconsistency in risk management practices. For example, the platform can outsource certain risk management facilities which slow the platform down to the broker. An example of this is the introduction of a system of 'non-persistent orders'. Orders are then registered locally (as opposed to centrally) by the brokers and no longer at the platform. The brokers receive a fee for this. But in a disaster, there would no longer be any central order registration, which could increase the counterparty risk.

3 HFT and market integrity

As stated, HFT is not a strategy in itself, but a means of optimising, implementing and executing certain complex trading strategies through automation. As a means of executing certain trading strategies which are not legitimate, HFT may also be misused for market manipulation. The AFM is also paying particular attention to HFT from this perspective, albeit in the awareness that HFT in itself is a legitimate technique which does not under normal circumstances constitute market abuse.

The technological advantage which HFT users have over most other market parties raises the question as to whether they are also at the forefront in using manipulative strategies. There is no clear answer to this. It seems that HFT has not created any new manipulative trading strategies, but simply executes existing strategies at a greater speed and in greater volumes. So far, a clear causal link has rarely been demonstrated between HFT and market manipulation. In view of the complexity of demonstrating such links in the current market structure, this obviously does not mean that the possibility of manipulative use of HFT is not worthy of attention.

Some strategies implemented using HFT may (under certain circumstances) be manipulative by nature.[30] The main potentially manipulative patterns are as follows:

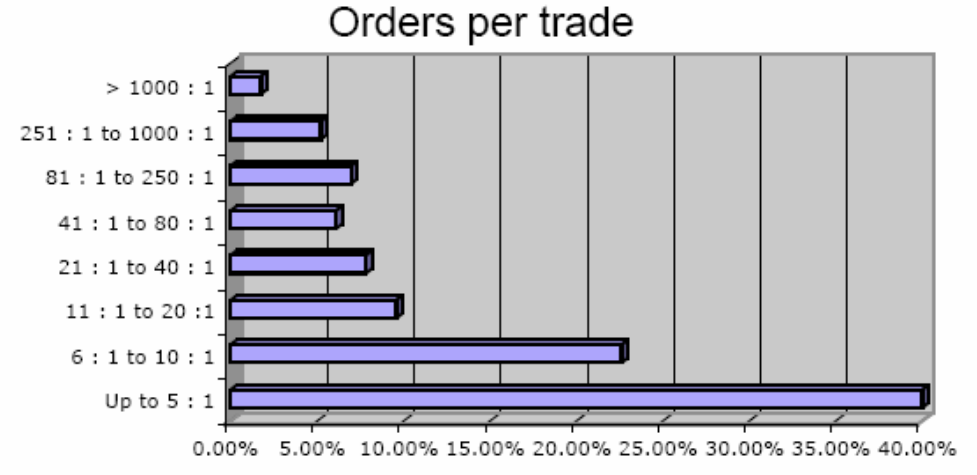
- *Spoofing*: introducing an order (for example a buy order) to the order book, which is not meant to be executed, whose size and ranking in the order book results in a change in the spread to another (in this example: higher) level.
- *Layering*: a form of spoofing in which a trader on one side of the order book (for example the buy side) inserts a large quantity of orders with *different* price limits. This is designed to create the impression of increasing pressure on one side of the order book. The actual intention of this trader however is to trade opposite transactions to the orders originally inserted (in this example: to sell). The buy orders in question are then cancelled before they are executed.
- *Blocking orders*: entering large misleading orders (which do not lead to execution) on one side of the order book in the aim of achieving a better price for a transaction on the other side of the book.
- *Abusive market making*: the trader places orders at various limits. Then he moves the spread, with an aggressive order, to new limits, where he also has a dominant position.
- *Order anticipation strategies*: a trader looks for the existence of large (for example) buyers, in the objective of buying before these orders, in order to benefit from their impact.
- *Momentum ignition strategies*: entering a series of orders/transactions (sometimes along with the spreading of rumours) with the aim of quickly stimulating a change in the price.

[30] With regard to dealing with (potentially) manipulative trading patterns initiated by algorithms, see H.B. de Vries and N. Boonstra, "Handel op basis van algoritmes: op het kruispunt van technische topprestatie en marktmanipulatie", (*Algorithm-based trading: at the intersection of technical peak performance and market manipulation*), Compliance Yearbook 2010 (Capelle aan den IJssel 2010) 15-30.

A complaint from some market participants that implies that market manipulation might be occurring concerns the fact that HFT is said to create 'ghost liquidity'. The suggestion is that HFT orders may create an unclear picture of the actual depth of the order book (and might therefore give an unclear picture of supply and demand). In certain HFT arbitrage strategies, the liquidity previously shown completely disappears as soon as the relevant orders from the arbitrage trade are executed on one of the platforms. Although this can have a disruptive effect, this method of trading cannot however automatically be labelled as manipulative.

As observed earlier, the technological edge enjoyed by HFT users allows them to respond quickly to changing market circumstances. These might consist of changes to the bid-offer price in the order book, the transactions effected and the extra volumes. More traditional market participants not using HFT do not have this edge, which may impede their execution strategy. This unclear picture may emerge as a result of large quantities of orders, most of which remain unexecuted, being entered at great speed. The order-to-transaction ratio of HFT during the trading day is easily 100:1. This may produce trading patterns which, even where legitimate strategies are used, might have a disruptive or confusing effect on other market players because they can deprive the traditional market participants of an overview of the orders that are actually tradable (sometimes called 'blur')

Figure 8: illustration of the order-to-trade ratio in HFT
Source: *Automated trader*-survey amongst 171 high frequency traders



To the extent that this situation is the result of legitimate HFT strategies, traditional participants will have to consider the costs and benefits of changing their systems so that they can once again gain the ability to hit the orders they wish.

If the strategies involved are indeed not legitimate, action by the regulator is needed. In extreme cases, where there is also malicious intent, market abuse may occur in the form of 'quote stuffing': entering and then withdrawing large quantities of orders in the aim of overloading other market participants' systems, so that they are unable to benefit from market opportunities, subsequently offering the trader in question an advantage.

In general, in all of the above examples of potentially abusive strategies, the question of whether they qualify as market manipulation is highly dependent on the *intention* of the trader (or the algorithm). In principle, all orders which are entered into the order book are definite orders, which are executed without confirmation. There can be legitimate reasons for cancelling orders (such as to adjust the orders to new market conditions, see paragraph 1.1), but entering orders without any actual intention to execute or have them executed is prohibited. If there is no such intention, this means the market party in question is giving an

incorrect or misleading signal for supply of, or demand for, the specific financial instrument. This automatically qualifies as market manipulation.[31] In paragraphs 4.2 and 4.3 we make a number of recommendations regarding the supervision of market abuse.

[31] De Vries and Boonstra (2010)

4 Points to note

It is essential that the (international) policy discussion around HFT is based on careful consideration of the facts, and not on emotions. The guiding principle in formulating any new regulatory policy concerning HFT should be to allow HFT's benefits to the market to be realised as far as possible.
This means that the risks associated with HFT must be mitigated as far as possible in the instances where they endanger the integrity of, and confidence in, the market. However, in the instances where HFT makes a positive contribution, restricting the workings of the free market and unnecessarily interfering with (technological) innovation is undesirable. Any insufficiently considered action may have unforeseen and counterproductive consequences which fail to strengthen the market and encroach on HFT's role in adding liquidity and mitigating fragmentation. The possibility that participants may be less likely to invest in IT and improvements to trading technology because of concerns about potential regulatory measures must also be avoided.

The AFM's view is that the growth and impact of HFT should be evaluated in the context of the changes in the market structure created by MiFID. MiFID's objective was to boost the efficiency and competitive position of the European financial markets and to promote an integrated financial services market. In order to achieve these objectives, MiFID has increased the options open to investors, for example by creating a competitive market for order execution. As a result, the number of trading venues has increased sharply, as has the competition between them.

For HFT parties, this new situation has created new opportunities for market making and arbitrage, not least because transaction costs have become much lower. So the AFM sees the fact that HFT users have seized the legitimate opportunities offered to them by the new market structure as a significant factor behind the recent growth in HFT within Europe.

The AFM and the other European securities regulators which together form CESR are of the view that the changes to the structure of the market occasioned by MiFID have, on balance, been positive. The European Commission will be amending the MiFID in the near future, but the fundamental features of the current market structure, such as promoting and facilitating competition and freedom of choice, will remain. Along with other members of the CESR, the AFM supports this approach.

It may therefore be assumed that the current market structure will not disappear for the time being, and that HFT will continue to form part of it. The related further encroachment of technology and automation of financial instruments trading also seems to be an irreversible process. It is therefore not realistic to advocate an attempt at turning back the clock. It is better to focus efforts instead on further improving the existing market structure and making it more robust.

However, within these considerations, it is very important to recognise that HFT has greatly increased dependency on complex technology. The AFM does not see itself playing a role, as such, in the regulation of technology, in the sense of prescribing the speed or the frequency at which trading can be conducted, or preventing market parties from obtaining legitimate profits generated by investing in technology.
The investment horizon that a market participant selects is, after all, one of the most fundamental choices he has to make. We are of the view that he must have the opportunity to select this horizon in a manner which fits his needs and skills, regardless of whether his investment horizon is measured in years or seconds.

Where sophisticated technology is used, including (as in HFT, and for that matter, in other forms of trading as well) trading strategies initiated by algorithms, it is of extreme importance however that the trading orders and the systems which generate, process and execute them do not damage the integrity of the market. Potential market manipulation via HFT must be effectively combated, and the operational and risk management systems of traders, brokers, trading platforms and clearing and settlement parties must be sufficiently robust to accommodate the effects of HFT. Operational problems at one market participant must not lead to a system crash.

The fact that in general the AFM currently sees no reason for restrictive action with regard to the activities of HFT parties does not mean that significant improvements are not possible and desirable. For this reason the AFM is making a strong case, in an international context, for additional requirements to be set (for example, by establishing binding technical standards) for operational and risk management systems throughout the entire trading chain. The points the AFM wishes to raise concern the following:

4.1 International coordination

In view of the interconnectedness of the international financial markets, the AFM does not support unilateral national measures with regard to high frequency trading. New measures will only be effective if implemented at not lower than European level. Since US and European (and to a lesser extent, Asian) HFT parties operate in each other's markets, the initiatives around HFT need to be harmonised as far as possible at global level as well. While as much regulatory convergence as possible is desirable, the differences between the structure of the markets in the various regions and countries must be taken into account.

4.1.1 Contribution AFM to the formation of international regulatory policy

The AFM contributes actively – both within the Committee of European Securities Regulators (CESR) and within the International Organisation of Securities Commissioners (IOSCO) – to the formulation of internationally harmonised policy on HFT. Within CESR, the AFM participates in all the work which focuses on HFT and aspects of HFT. A significant proportion of this work stems from a call for evidence issued by CESR in spring 2010 in preparation for its recommendations to the European Commission as part of the MiFID Review - Equity Markets.[32] In July 2010, CESR advised the European Commission to make amendments to MiFID at level 1 (and if necessary at level 2 as well) to enable the European Security Markets Authority (ESMA, which will become operational from 1st January 2011 as the successor to CESR) to set binding technical standards and guidelines regarding sponsored access, co-location, fee structures of trading platforms and tick sizes. CESR also advocates that additional work should be done regarding proprietary traders who are not market makers, and who fall under the exemption regulation in article 2(1)(d) MiFID (see also paragraph 4.3.2). CESR takes the view however that there is currently no reason for regulators to place restrictions on HFT and related activities, although further investigation of the impact and risks is necessary.[33] The AFM supports this approach, which forms part of the CESR Action Plan on Micro-Structural Issues, and is actively contributing to its further development.

HFT is also a current focus within IOSCO. The objective is to obtain an overview of the impact of HFT on the global financial markets, and to analyse the benefits and risks. This

[32] Call for Evidence on Micro-structural Issues of the European Equity Markets, CESR/10-142 (1st April 2010), http://www.cesr-u.org/index.php?page=consultation_details&id=158.

[33] CESR Technical advice to the European Commission in the Context of the MiFID Review – Equity Markets, CESR/10-802 (29th July 2010) 41-43 http://www.cesr.eu/popup2.php?id=7003.

process will make use of current initiatives by IOSCO members, including the AFM, and hearings will be organised with stakeholders. IOSCO will also tackle the desirability of formulating guidance and high-level principles on how the global financial regulators deal with HFT.

4.1.2 Development of US legislation and regulation

A number of measures[34] intended to address risks and abuses identified in the current market structure and that will affect the opportunities for HFT players were announced in the US in the first half of 2010. A proposal prohibiting flash orders dates from as early as September last year, and has already led to the removal of opportunities for issuing flash orders on most platforms.[35]

The Securities and Exchange Commission (SEC) also decided at the beginning of November 2010 to prohibit 'naked access'.[36] Naked access is a type of sponsored access in which the sponsoring member performs little or no monitoring of its clients' trading traffic. The prohibition includes the imposition of an obligation on all broker-dealers (in the US the only market participants that can obtain direct access to the market via membership) to set up adequate risk management and monitoring systems. The measure is designed to prevent participants using sponsored access from endangering their own financial position or that of other participants without this being noticed, with all the potential consequences this might have for the integrity of trading in the capital markets and the stability of the financial system. 'Naked access' is not permitted in the EU, but sponsored access and direct market access are possible, as explained in paragraph 1.6.

In April 2010, the SEC also published a proposal to oblige certain large traders to provide more information on their transactions in order to enable subsequent examination of their behaviour at specific times.[37] There was a further announcement in June 2010 that a system would be set up for consolidated data for stocks traded in the national market system (NMS). This system will be maintained by all participating NMS platforms, and is intended to facilitate the investigation of manipulation and unusual market activity (for example the events around 6th May 2010) by providing access to consolidated data concerning all orders entered at these exchanges. The US regulators already have options available to them in this respect, but the level of detail of the information is not yet sufficient, and the information is too fragmented.

The above US measures are aimed at improving the transparency of the market, improving market participants' risk management, securing a level playing field for market participants, and safeguarding financial stability. These themes are also touched upon in this report within

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[34] For proposed and accepted measures see: http://www.sec.gov/rules/proposed.shtml and http://www.sec.gov/rules/final.shtml. The following rules are relevant: Risk Management Controls for Brokers or Dealers with Market Access, Proposed Amendments to Rule 610 of Regulation NMS, Large Trader Reporting System, Consolidated Audit Trail, Elimination of Flash Order Exception from Rule 602 of Regulation NMS

[35] In June 2010 the proposal was presented again to draw particular attention to flash orders in the options market. There is a concern that prohibiting flash orders in this market will lead to a large increase in trading costs for market parties. To resolve this problem, it is also proposed that a maximum should be set for the costs of access that platforms may charge for options trading, a measure which is already in force for the equities markets.

[36] http://www.sec.gov/news/press/2010/2010-210.htm

[37] An organisation is ' large' in this sense if it has turnover exceeding USD 20m in equity trading in the national market system (NMS) on a single day, or has traded more than 20 million shares, or has turnover in excess of USD 200m in one month. Any such organisation must notify the SEC accordingly and is then allocated a unique identifier. The identifier is passed on to the broker-dealer(s) to which the organisation is affiliated. The broker-dealers are then obliged to record the transaction data of the large traders and to make the data available to the SEC on request. They are also obliged to signal if parties that qualify as large traders trade without an identifier.

the topics of international coordination, market abuse, identification of market participants, co-location, sponsored access and risk management.

The direction which the European Commission will take in these areas is not known at the time of writing this report. The Commission has announced that its plans in the context of the revision of MiFID (and to some extent with regard to HFT) will not lag behind the measures taken in the US.[38] although it has also stated that it will select its own approach geared to the European situation as the legislation and structure of the European market is organised differently. This approach is welcomed by the AFM.

4.1.3 Analysis of events of 6th May 2010

The large fluctuation in the prices of various equities and derivative products which occurred on 6th May 2010 in the US (also known as the 'flash crash') placed HFT (and algorithm trading in general) high on the policymakers' and regulators' agenda. In the US the SEC and the Commodity Futures Trading Commission (CFTC) prepared a joint report describing in detail the facts of the occurrences on that particular day. They also outlined the lessons which could be learned from this event, and the measures required to mitigate such occurrences.[39]

There follows below a brief summary of the SEC and CFTC's findings, which concentrate first of all on trading in a certain type of futures contract, the "E-Mini S&P 500 futures" (E-Mini), traded only on the Chicago Mercantile Exchange. They subsequently address the exchange traded funds, also related to the above-mentioned futures, on the same exchange, and in particular the S&P 500 SPDR exchange traded fund (SPY).

At 14.32 (local time) a large fundamental trader [40] launched a sell programme, entirely executed by a sell algorithm, to sell a large number of futures contracts in order to hedge an existing equity position. A large sell programme of this type had only been executed twice in the previous year, and on those occasions had been spread out over a much longer time period. One of these sell programmes had been executed by the same trader, who on that occasion took more than 5 hours to complete the programme. But on 6th May the programme was completed in 20 minutes.

Immediately after the sell programme had started, a number of HFT parties and intermediaries built up a net long position in the futures over a short time. Since these parties do not naturally take long-term directional positions, they closed out the most of the net long position in a few minutes. This was accompanied by very large trading volume in the futures.[41] The sequence of events which followed was set in motion by a crucial characteristic of the sell algorithm used by the fundamental trader, which was that the algorithm only took account of trading volume and price and time parameters. The volumes traded by the HFT parties caused the sell algorithm to assume that there was sufficient liquidity to absorb more sell orders, and this increased the speed at which it entered the orders in the market.

This downward spiral caused the market for the E-Mini futures to completely collapse. Parties involved in arbitrage between different markets caused the SPY market to also be affected by the sharp price falls on the related E-Mini market. It was not until trading on the Chicago Mercantile Exchange was halted by a circuit breaker for 5 seconds at 14.45 that the pressure from sell orders decreased and buy orders once more increased. Prices stabilised 13

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[38] http://ec.europa.eu/commission_2010-2014/barnier/headlines/speeches/2010/09/20100920_en.htm

[39] "Findings Regarding the Market Events of May 6, 2010", http://www.sec.gov/news/studies/2010/marketevents-report.pdf

[40] Defined by the SEC as a trader who trades in order to build up a net long or short position with the aim of acquiring long-term exposure to a market, or hedging an already existing exposure to a related market.

[41] The SEC talks about a 'hot potato' effect here: automated systems kept on trying to sell the same stocks to each other

minutes after the sell programme started, whereupon both the E-Mini and the SPY market began to recover.

In the meantime however, the equities market reacted to the hefty falls in prices on both the E-Mini and the SPY markets. It seems that many automated trading systems were then suspended, in order to give traders the opportunity to assess the situation. The combined fluctuations on both the futures and the ETF market, and the successive fluctuations of other related markets, had apparently caused panic trading by various market participants. A number of market makers decided to widen their bid-ask spread, or to completely stop quoting prices. The ensuing lack of liquidity resulted in poor price formation for a large number of stocks. In excess of 20,000 transactions were concluded between 14.40 and 15.00, in more than 300 different instruments, which diverged more than 60% from the price quoted at 14:40.

These large price fluctuations were in many cases being caused by the fact that so called 'stub quotes' were being hit. Stub quotes are extremely wide quotes that are placed in the orderbook by designated market makers to fulfil their obligation to always maintain a two sided market in the orderbook, under any circumstances. These stub quotes deviate widely from real market prices and are therefore irrational. Due to the sudden absence of liquidity in many stocks, these irrational quotes were suddenly being hit by orders. This caused great losses for brokers and investors. The consequent reversal of part of the transactions that were reached in this way led to many issues and much uncertainty for investors. In a reaction to these events, the SEC and FINRA announced new rules regarding the use of stub quotes. These entail that stub quotes can deviate no more than 8% from the price in NBBO for participants of the new circuit breaker program, and no more than 30% for other cases.

4.1.4 Lessons for the future

The events of 6th May 2010 provide the AFM with a basis for a number of conclusions. The flash crash occurred on a trading day which was already volatile, as a result of concerns about the global economy and the Greek debt crisis. These background factors were exceptional, but there is no reason to suppose that similar market conditions will not present themselves again in future. To be able to control systemic risk in our modern market system, we will have to look at all market participants using automated trading systems, not just HFT parties. The AFM considers the implementation of efficient, standardised risk management rules for automated trading systems to be an option in this respect.

It is also essential that market data is accessible, timely and robust at all times, and that it provides a full picture of the situation in the financial markets. Traders must be in a position to rapidly take stock of the situation, to enable them to adjust their strategies in an intelligent manner. Regulators must be able to investigate rapidly if there are doubts regarding the integrity of the trading of certain market participants, or if the causes of exceptional events are unclear.

Finally, we must accept that tackling risk management on an individual basis will never offer a full solution to the problems in the current financial system. A system-wide approach is required, using measures which take into account the interconnected nature of the financial markets.

4.2 Market abuse

The regulators must carefully consider which, if any, new measures must be taken to combat undesirable HFT behaviour. The basic principle for the AFM here is that the *nature* of the strategy used defines whether it is legitimate or manipulative, and whether there is reason for supervisory intervention. Action must be taken against harmful strategies, but legitimate strategies are permissible, regardless of the technical tools used to implement them. In this regard, high-frequency traders should not be treated differently to other market participants.

In other words: supervision should focus on combating *behaviour* which is undesirable, with each potential instance of market manipulation being assessed on a case by case basis. Stigmatising a generic group of market participants is not desirable.[42]

The ultimate responsibility for preventing market abuse obviously lies with the HFT parties themselves. They should clearly understand which strategies are manipulative and which are not. The regulators can certainly play a facilitating role here by providing guidance and practical examples of undesirable or illegal trading strategies.

In order to prevent and combat market abuse, effective monitoring of the market is essential, and the asymmetry in terms of technology and information between the regulator and the market must be limited as far as possible. The technological innovations introduced by HFT present regulators with the challenge of analysing new and complex trading patterns. These extend across platforms established in a range of jurisdictions. Large quantities of transactions are involved, with even larger quantities of orders underlying them. In order to analyse them, advanced monitoring and surveillance tools are required. The regulators must be in a position to analyse algorithms themselves and to classify their characteristics. To this end they must engage staff (quantitative researchers) who have specific knowledge of algorithms and HFT algorithms and who are able to develop the necessary regulatory tools themselves. In view of the multi-platform and multi-instrument strategies implemented by market parties, international regulators will also have to be able to mutually exchange information more intensively and more effectively. It is of great importance that the exchange of transaction data between the various national supervisors in Europe is further improved, so that cross-border trading patterns become more visible and the above monitoring and surveillance tools can be efficiently utilised. [43]

4.3 Identification of market participants

4.3.1 Identification of market participants

In order to be able to protect the market's integrity and to take effective action against market abuse, regulators have to be able to form a complete picture of the market. This means that regulators must be able to see by whom and for whom a specific transaction is executed. The reporting of transactions to the regulator is therefore an important cornerstone of supervision.[44] The problem for the AFM is that the lack of a client ID means that it is currently unable to identify the market participants responsible for undesirable behaviour. This applies not only to parties operating in the HFT segment, but to all types of market participants.

A client ID is a field in the transaction report which shows the originator of a transaction. This is compulsory in most European countries. The benefit of the client ID is that the regulator can take more targeted and efficient action against market abuse and possible infringements of market integrity. Individual trading patterns then become more

[42] For an overview of the structure of the AFM's supervision of market abuse, see the report "Five years' supervision of market abuse. A European regime in development."
http://www.afm.nl/layouts/afm/default.aspx~/media/files/rapport/2010/vijf-jaar-toezicht-op-marktmisbruik.ashx

[43] For further information about how the AFM collects and uses transaction data in its supervision, see paragraph 3.5 of the report "Five years' supervision of market abuse. A European regime in development."
http://www.afm.nl/layouts/afm/default.aspx~/media/files/rapport/2010/vijf-jaar-toezicht-op-marktmisbruik.ashx

[44] Under art. 25(3) MiFID, investment firms must report transactions in all instruments admitted to trading to a regulated market in the EU to the relevant authority, regardless of whether the transactions in these instruments are conducted on a regulated market or not. Parties other than investment firms are not obliged to report transactions. Transactions in instruments other than those admitted to a regulated market do not have to be reported.

traceable, and unusual trading patterns can be more easily traced back to the person or party responsible.

The AFM is only currently able to identify the originator of a transaction if it was a *member* of the stock exchange. If a market participant is not a member (as for example applies to HFT players who access trading platforms via sponsored access, and therefore not under their own name), the data currently available does not show who ultimately originated the transaction.[45] The AFM is only able to find out the name of the party originating the order via (time consuming and complex) requests for information to the members under whose names a certain transaction was executed.[46] The relationship between transactions in various stocks or instruments and by different clients remains unclear: individual clients with manipulative strategies or insider trading in various instruments go unnoticed, and the partnerships between various market participants are not visible in members' transactions either.

The client ID is as yet only an option in MiFID (although only a third of European countries, including the Netherlands, have not made the provision of this information mandatory).[47] The client ID only has to be reported when *executing* an order. In view of the great value of the client ID for supervision purposes, in its recent MiFID recommendations to the European Commission CESR proposed expanding these requirements and making them generally mandatory.[48] This would involve showing the party for which the transaction is executed, when orders are *issued* as well as when they are executed. The AFM is in favour of making the client ID mandatory, and expanding the obligation. The Ministry of Finance has now also indicated that it considers the introduction of the client ID to be desirable in the Netherlands as well.

In view of the complexity of HFT trading patterns, the question arises as to whether a client ID, in itself, offers sufficient insight into potential undesirable trading by market participants. An oft-heard concern in the discussion on algorithm trading in general is that rogue algorithms might seriously impact on the integrity of the market. The "flash crash" of 6th May 2010 was an example of this (see paragraph 4.1.2).

In the current situation, it is very difficult to actually establish whether a specific algorithm is responsible for such a disruption. Assigning a unique identification code to each individual algorithm used for trading purposes could be an additional option.

This 'Algo ID' would make it possible to trace orders specifically back to the algorithm which initiated the order. This would facilitate the investigation of market disruptions, and enable regulators to request the specific algorithm responsible from the market participant in question for further analysis in the event of suspicious or disruptive trading patterns. (Algorithms which were adjusted or reprogrammed during their life span would then have to be coded in a manner which made their relationship with the related algorithms clear). To protect the trading strategy of the market participant in question, the Algo ID would have to be visible only to the authorised regulator and not to other market participants. The possibilities for the technical implementation of an Algo ID need to be investigated further.

[45] In the Netherlands a client ID is compulsory for options transactions on Euronext Liffe in any case under the trading platform's trading procedures.

[46] Requesting information currently requires around a quarter of the manpower involved in investigating market abuse at the AFM and extends the average length of an investigation by around nine weeks.

[47] Art. 13(4) MiFID Implementing Regulation

[48] CESR Technical Advice to the European Commission in the Context of the MiFID Review – Transaction Reporting CESR/10-808 (29 July 2010), http://www.cesr.eu/data/document/10_796.pdf

4.3.2 Exemption scheme for proprietary traders

Under article 2(1)(d) of MiFID, investment firms trading for their own account fall under the licence obligation and the supervision of AFM only if they operate as market makers on the cash markets. The AFM does not directly supervise other forms of proprietary trading. When MiFID was being developed and implemented, the reason for this was that regulated markets and MTFs should already be setting requirements for expertise, reliability, business management and financial resources when admitting investment firms of this type. In the view of the legislator, this made further supervision of the activities of these traders superfluous. [49]

The environment in which proprietary traders falling under article 2(1)(d) act is very competitive, and because of the increased significance of automated trading, this environment has undergone aggressive development in recent years. As SA and DMA mean that direct membership is no longer required to obtain rapid access to trading platforms, the above considerations by the legislator are no longer fully up-to-date (see also para. 1.6).

The intermediary providing access via SA or DMA does have a comparable obligation to verify its client's expertise, reliability, business management and financial resources, but it also has a strong commercial incentive to provide these services to clients. This creates the risk of these proprietary traders obtaining access to SA or DMA even though certain of their business processes are insufficiently controlled.

The increased speed of trading, in addition to the increase in range created by the new direct access opportunities, mean that the potential impact of these traders on the integrity of the market as a whole has enormously expanded. The developments on the financial markets since this MiFID provision came into effect in 2004 therefore raise the question as to whether this approach is still adequate in the current market environment. There seems to be reason to reconsider this exemption regulation, and the AFM would support a review in this respect (see also para. 4.1.1).

4.4 Risk management

When stock exchange trading was still the work of human beings, they often made errors, but they were human after all. The automation of trading has contributed to reducing the number of "fat finger errors". However, human intelligence excels at *intuitively* recognising patterns varying from the norm, and is better at this by nature than automated systems, which attempt to establish such variations on the basis of statistical calculations. When automated trading began, trading algorithms were still closely monitored by human traders so that action could be taken as soon as an algorithm began to behave in an unanticipated and undesirable manner. These days, such human control is in many cases entirely lacking. The SEC investigation into the events of 6th May revealed that the trading algorithm which set events in motion was able to continue for 20 minutes unimpeded, sending orders which caused heavy losses and seriously disrupted the market's operation. Human monitoring leading to direct action would have prevented much damage in this instance.

It is not unthinkable however that such a scenario might unwind not in 20 minutes, but in a few seconds. In this event, the use of human, real-time monitoring would no longer be effective. The fact that the speeds in such cases have become too high for human intervention is no reason to refrain from exercising such control. Indeed, it makes it even more essential that this "human" control is translated into an automated counterpart, which combines the

[49] Explanatory memorandum, Amendment to the Financial Supervisory Act implementing the markets for financial instruments directive (Dutch Lower House, 2006–2007 session, 31 086, no 3).

speeds of automated trading with the human capacity to intuitively detect variations from the norm. We can imagine that, using insights gained from research into artificial intelligence, software could be developed which would apply these human control characteristics to all automated trading systems.

In the paragraphs below, we propose consideration of the measures required before an automated system might be brought into operation, and the measures which would exercise control once the system was operational.

As stated above, HFT should be regarded as the implementation of trading strategies that already exist by more technically sophisticated means. The role of the physical market trader has for the most part been taken over by programmed algorithms. In view of the great influence these algorithms have on the implementation of the strategies concerned, it is essential that they function correctly. It is therefore also essential from a regulatory point of view that they satisfy stringent suitability requirements, like those which would be imposed on human traders.

All of the parties involved have an interest in market participants equipping their algorithms with comprehensive risk management characteristics. This certainly also applies to the traders themselves, for whom meticulous risk management is a pre-condition to avoid potentially disastrous losses.

The robustness of an algorithm determines to a significant extent the probability of dysfunction. The simpler and more linear the model, the lower the risk of catastrophic failures. A robust algorithm will also remain stable even in extreme and unlikely scenarios. The effectiveness of a robust algorithm lessens only gradually, so it can be adjusted in time or discontinued. An unstable (fragile) algorithm can, on the other hand, break down without warning, which can lead to significant losses and disruption of the market.

In order to establish the robustness of an algorithm, we must understand *what* the algorithm does and *why* it does it (explicability). To this end, market participants must sufficiently test the algorithms and the trading strategies which they plan to implement, so that the functioning of an algorithm can be evaluated in a wide variety of (possibly extreme) situations. This should involve three types of test: back-testing, stress testing and off-line real-time testing.

In back-testing, the behaviour of the model is evaluated using historical datasets. These should preferably go as far back as possible, so that the test includes the greatest possible number of situations and correlations. (It should be remembered that some older data are not usable because of the greater market inefficiencies that existed at the time. In other words, some older datasets do not adequately reflect the way today's market operates). In stress-testing, the model is exposed to simulations of extreme situations which have a low probability of occurring, but which would have serious consequences ('black swan events'). In off-line real-time testing, the model is run in a closed test environment which works in exactly the same way as the system used by the intended trading platform. Simulation opportunities of this kind should be provided as standard by trading platforms to market participants.

When the algorithms are finally taken into operation ('online') their *performance* should be evaluated as part of the risk management process on an ongoing basis. This should establish whether any dysfunction of the algorithm is caused by market circumstances (in which case not much can be done about it) or whether the algorithm is itself defective. If the algorithm no longer works properly, there is a risk of not only very large losses but also of disruption to the market.

The responsibility of properly performing these tests lies with the relevant trading market participant. For practical reasons and for reasons of principle, the testing of algorithms and models by regulators is not desirable. In the first place this is not feasible in practical terms. HFT parties use numerous different algorithms that are adjusted or replaced on a regular basis. Regulators do not have the time or the resources to continuously evaluate these algorithms. The potential for moral hazard involved in prior testing by the regulator is moreover a serious matter of principle, as this could lead to the regulator being held responsible for the unexpected malfunction of an "approved" algorithm. We could then be faced with the undesirable situation in which the market participant that developed the algorithm and, under normal circumstances, enjoys the financial profit would not also have to bear the financial and other consequences of the algorithm's failure to function. The ultimate responsibility for the correct functioning of the algorithm must in other words always rest with the market participant that developed it.[50]

One footnote to the above is that an undesirable situation may arise if market parties feel compelled to fit their trading strategies into a uniform pattern imposed by the supervisor. For example, if compliance considerations lead to a preference for "out of the box" algorithms, this might cause the diversity of the algorithms used in the market to decrease. This entails a potential systemic risk, in that the potential for the disfunction of an individual user's algorithm is reduced, but a greater risk is also incurred, namely that the standardised algorithms of several users disfunction *simultaneously*, if something nevertheless goes wrong. The conclusion which must be drawn from this observation is that risk management must be designed to control the results of the algorithm's trading as far as possible, but must not result in trading being homogenised.

The operational risk management of trading platforms must also be of high quality. The data processing capacity of all the operational systems and data connections of a trading platform must be sufficiently robust to safeguard continuous access and operation under any circumstances. The data processing capacity of the operational systems must always be more than adequate, in order to enable these systems to process all orders, even in extreme situations.[51] This means there must be regular stress testing, taking into account extreme scenarios.

The responsibility of trading platforms to ensure sufficient data processing capacity does not alter the responsibility of market participants (whether they are members or users of sponsored access arrangements) to ensure that they do not put too much strain on the systems of the platform, for example as a consequence of a rogue algorithm and/or failing risk management, or as a consequence of irresponsible abusive strategies.

There is a risk that both platforms and HFT programmers will as far as possible limit the risk management tools contained in the code for the sake of commercially-driven latency considerations. After all, the shorter the code, the faster it is. There is thus an incentive to pare

[50] In the situation outlined here, it is assumed that the HFT parties using the algorithms developed them in-house (proprietary algorithms). There are also (smaller) market parties which make use of "out-of-the-box" software provided by specialist developers. In this instance the ultimate responsibility referred to here from the regulatory angle rests with the end user which actually implements the algorithms contained in the software for the purpose of trading. Cf art. 13(5) MiFID and art.13(1) and 14 MiFID Implementing Directive.

[51] The platforms' responsibility to provide sufficient data processing capacity does not affect the market participants' (both members and those making use of sponsored access) equal responsibility to ensure that they do not unnecessarily overload the platform in question's systems, for example as a result of the dysfunction of a trading algorithm and/or inadequate risk management.

away all code which does not directly concern the trading properties. Because of the potential for competitive advantage, this may be an invitation to a 'race to the bottom'. A possible regulatory measure might be to set standardised requirements for the risk management properties of trading codes and platforms, in order to prevent their minimisation or even entire removal. (The further technology advances, incidentally, the more options there are for validation which can be built into algorithms without any effects for latency).[52]

As everyone is subject to the same obligation in this case, there is a level playing field with regard to the delay this entails. The installation of an adequate risk management code will then no longer provide a competitive disadvantage, while at the same time greater controllability will be achieved. The risk management should have a minimum standard level that is also embedded in the systems. This would involve checking risk parameters for order validation and preclearance from the exchange. However, as stated in paragraph 4.4, the introduction of systemic risk as a consequence of high levels of homogeneity in algorithms has to be avoided.

However, in view of the great importance of using robust algorithms and models, market participants must be able to demonstrate that their business processes and policies are designed to ensure they have taken sufficient steps to guarantee as far as possible the robustness of their algorithms. The supervision of this process might take the form of a mandatory external audit of the risk management capabilities of both the operational systems and the algorithms themselves. The regulator would not in this case test algorithms directly, but would verify that market participants have organised their business process so as to ensure the required level of risk management is in place.

In the view of the AFM, the approach outlined above – supervision of the test process and design of the risk management policy, combined with the option of making a retrospective request to examine specific malicious algorithms - provides an equal balance between the need to protect the market as far as possible against algorithms which fail to function properly and the need for market participants to establish their business processes according to their own judgement.

4.5 Awareness of market parties

Participants in trading all have the same objective: making profitable investments. But there are great differences between the various market players. These differences might concern their investment horizon, openness to risk and trading strategy, but also their skills and market knowledge, whilst the financial, technical and other opportunities available to them to deploy their knowledge and skill also vary enormously.

There will always be opposing interests between buyers and sellers and between large and small parties in a market. Actively organising the market according to the interests of just one specific group of market parties is therefore undesirable, no matter which market parties are involved. The intention is to create a fair and equal market which offers trading and financing options to all different types of market parties.

[52] Cf. Bob Giffords, "What Just Happened?", Automated Trader (Q3 2010) 69.

Legislation and regulation and the structuring of supervision are intended to make the playing field on developed financial markets between the various market parties as level, fair and transparent as possible. Measures of this kind are able to reduce the principal-agent problems and asymmetries in information inherent in a complex market, but they will never be able to remove them completely. So it is essential that all market participants are sufficiently aware of the playing field upon which they operate, and of the other players on the playing field.

If the way the markets operate is more difficult to fathom, more parties will have trouble in forming a realistic picture of their environment. In the view of the AFM, therefore, there is a responsibility for market parties which contribute to making the market more complex - such as for example HFT players – to clearly explain to other market parties what their activities are, so that their presence does not undermine confidence in the fair and smooth operation of the market. This may also avert the (unjust) impression of some market parties that the market is structured against their interests.

To this end constructive dialogue between the different types of market parties is required, in this case between the buy-side and the HFT community, but retail investors also have a place in this. In order to be able to conduct this debate, it is important to recognise that the impact of the current market structure and of HFT on different market participants is not the same for all of the market parties. This impact is described in more detail below and, finally, we make some recommendations to the HFT community concerning clear communication about their activities.

4.5.1 Retail investors

The small-scale, long term investor

A small-scale, long term investor who executes transactions from time to time is less sensitive to a high speed of order execution, the amount of transaction costs and the possibilities for concealing his orders from other market participants than a large institutional investor that frequently has to rebalance its portfolios with large orders, where best execution is important.

The small- scale day trader

A small-scale day trader who conducts tens to hundreds of transactions per day and makes his profit from daily price movements, is more sensitive to rapid order execution and the size of transaction costs. This trader has to be aware that he may be trading against parties who are more up-to-date on market developments than he is, and who are also able to react more quickly to developments because they have faster systems and a faster connection to the trading platforms' matching engines.

4.5.2 The buy and sell-side (institutional investors and brokers)

Large institutional investors (such as asset managers and pension funds) have a long-term investment horizon, but they often conduct large buy and sell orders to rebalance their portfolios. In most cases these orders are actually executed by a broker. Institutional investors will, more than before, be aware of the technical facilities available to counterparties, and will have to ensure that their systems (and those of brokers) are adequately equipped to ensure their orders are executed on the best possible conditions.[53]

[53] The way in which brokers registered in the Netherlands fulfil the best execution obligation is monitored by AFM via ongoing supervision. The focus here is on the quality of information provision to clients concerning the order execution policy, and on the quality of the annual evaluation of order execution policy by the investment firm in question.

In the time before the current market structure came into effect, institutional investors were able to trade very large orders without great difficulty manually ('on the touch') in the primary market (for example Euronext Amsterdam). This is no longer possible now. As a result of the competition between trading platforms introduced by MiFID, liquidity is spread across various trading venues. The benefit of this competition is that transaction costs and spreads have been reduced, and that trading venues are motivated to take the (infrastructural) requirements of their clients more into account. However a side effect of the fragmentation of liquidity is that smaller orders have a larger impact on price formation than previously was the case, which means that the tradable size has fallen. The average order size for such large institutional parties for example was previously around 8000 to 9000 shares, whilst it is now more likely to be around 300.[54]

Large orders can only be executed these days (insofar as they are not placed OTC) if they are broken up into a large number of sub-orders. It is not unusual for example for an order for 100,000 shares to take place across seven different platforms via around 10,000 sub-orders. To process such a large number of orders, a trading algorithm is needed. The disadvantage of many (less sophisticated) algorithms is that they work according to a fixed pattern, which is volume or time-related, however. The algorithms of sophisticated HFT parties are able to recognise these patterns and trade on them.[55]

This development has led to criticism from some buy-side parties, who argue that they are being disadvantaged or unfairly restricted in their execution opportunities by HFT. Other buy and sell-side parties say however that it is more the case that HFT is forcing them to utilise more sophisticated trading algorithms themselves and to make larger investments in IT. These parties state however that their overall trading costs (for example for executing large orders based on the volume-weighted average price, VWAP) have increased since the introduction of MiFID, as a result of the continuous IT investments which are required and the need to break orders up. Although they deplore the higher cost, they say they recognise that this is the result of the market structure created by the MiFID. This has presented a new opportunity to HF traders, and they cannot be blamed for taking it.

Adequate IT investments may significantly mitigate the possible effects of HFT encountered by the buy-side parties. But these effects can never be entirely removed, as they are inherent in the different roles of these two types of trader in the market. There is a fundamental difference between orders placed by institutional investors and orders placed by HF traders. Institutional order flow is by definition directional, whilst the HFT flow is

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[54] MiFID also provides exemption options from the obligation to provide pre-trade price transparency specifically because of the price impact of large orders. As part of its recent technical recommendations to the European Commission for the purpose of the MiFID review, CESR recently advised that large-in-scale (LIS) waivers should be re-calibrated (and then calibrated on an ongoing basis), taking into account the decrease in the average order size. The reason for this recommendation was partly to meet the needs of buy-side market participants. The same applies to the other pre-trade transparency waivers incorporated in MiFID (reference price waiver, negotiated price waiver, and order management facility waiver). See: CESR Technical Advice to the European Commission in the Context of the MiFID Review - Equity Markets (CESR/10-802).

[55] Two strategies are primarily involved:
Smart order routers send orders in a certain sequence to different platforms. As soon as an HFT party sees what this sequence is, it can adjust its trading strategy correspondingly;
Liquidity fading: Their low latency data feeds mean HFT parties are able to use information from one platform to adjust quotes on other platforms. If a directional trade from an institutional party is detected on one platform (which might have an impact on price), the price on another platform can be immediately adjusted to the optimum, before the order from the institutional party has reached the other platforms.

generally non-directional. Institutional orders will therefore always have a certain price impact on the market, which provides trading opportunities to HFT users. The buy-side party is fulfilling the role of liquidity taker, and the HFT party fulfils the role of liquidity maker. The benefit of the existence of HFT users, namely that they create liquidity, will always therefore be balanced by a potential disadvantage, namely that the execution of a large order has an impact on price.

The assessment of these advantages and disadvantages is a matter for the buy-side party in question, with the assistance of its broker. To properly make this assessment, institutional investors must be aware of the characteristics of the order flow of the trading venues where they execute their orders or have them executed. Depending on the circumstances, they may need to interact with a specific type of counterparty: i) bilateral OTC or by utilising a broker crossing system, ii) a mixture of different types of market participants, or iii) specifically with liquidity streams in which HFT users are over-represented (as on certain MTFs). As part of the best execution obligation, there is also a responsibility here for the executing broker to alert its institutional clients to the characteristics of the order flow on the various trading venues, and its possible advantages and disadvantages.

The institutional investor must also be aware of the technical (latency) facilities and restrictions of the trading systems of its broker, and their consequences for its desired execution strategy. Many (large) trading houses these days have sophisticated computer systems which make it possible to adjust bid and ask prices to changing market conditions at high speed, and to quote prices simultaneously on several platforms. However, not all brokers have invested in IT upgrades of this kind to the same extent, and it is therefore up to the institutional investor to make certain that the services of its broker sufficiently meet its requirements.

Some buy-side parties appear to have the impression that the current market structure puts them at a disadvantage. Clearly, this was not the intention of the policymakers who created the current structure. It is true that compared to some other market participants the buy-side was (and is) relatively under-represented in the policymaking consultations regarding the design of the European market structure. Institutional investors themselves state that due to their low degree of organisation, they have not managed to adequately give their side of the story.[56] Their point of view has therefore received less attention than that of other market participants.

Obviously it is for market participants themselves to decide the extent to which they wish to participate in policy consultations. In general however, one can say that the regulators need to obtain the widest possible response from the market. From this perspective, more active participation by the buy-side players in policy consultations (for instance, concerning HFT) would therefore be desirable.

The consequences of this under-representation of the buy side in the policy debate are now beginning to become apparent in the form of a more or less clearly articulated feeling of dissatisfaction with the current market structure. One argument made by some institutional investors is that the market is now structured too much in the interests of retail investors. In practive however it is the professional players like the HF traders rather than retail investors that are most benefited by the current structure of the market.

[56] Some buy-side players have sought affiliation with the better-organised sell-side. The interests of the buy and the sell-side players are parallel in this case: the higher trading costs complained of by the buy-side could lead to lower trading volumes for the sell-side, which of course would not be welcome.

According to this reasoning, the interests of the end consumers would be best served by a market structured mainly according to the interests of institutional investors. Indeed, institutional investors trade in much larger volumes on behalf of the same retail investors and for many more private clients (such as pensioners). The objection to this argument is that actively structuring the market to suit the interests of any particular group of participants is undesirable, whoever they are. The objective is to create a fair and balanced market that offers trading opportunities for all the various kinds of market participants.

4.5.3 High-frequency traders

HFT has recently been the subject of much attention among a broad group of market participants (including institutional and retail investors), regulators, the media, and politicians. The common feature has been that people want to better understand what HFT traders do, and what the effect of their trading is on the financial markets. In a properly functioning market, there should be confidence that the market operates in a fair and orderly fashion. Encouraging this is certainly not the task of the regulator alone; it is a responsibility of all market participants who depend on proper market operation in order to be able to conduct their business.

As relative newcomers to the market, who moreover use advanced and complicated trading technologies, the AFM considers that high frequency traders have a special responsibility to explain their behaviour to their environment and demonstrate that they make a positive contribution to the market as a whole. This does not mean that people are expected to share their proprietary trading strategies with the market, but it does mean that they should explain their objectives and methodologies in the market in sufficient detail.

Since the background of much high frequency trading is proprietary trading, and therefore no clients are involved, until now these traders have felt little need to actively communicate with regard to their activities. However the recent developments in the financial markets demand a more proactive approach.

First of all, the share of HFT trading in Europe has grown rapidly since the implementation of MiFID, and these traders now have an important role in the market. They also now interact with an increasing variety of counterparties. In view of this new position they now hold, it should be no surprise that other market participants want to be informed and reassured regarding the activities and trading objectives of high frequency traders.

Second, as a result of the recent financial crisis sensitivity to complex innovations in the financial markets has increased. Although HFT cannot be held responsible for causing or exacerbating the crisis, high frequency traders must also take account of the changed social context in which they operate, which demands greater openness.

Third, there are concerns regarding the potential systemic risks arising from the increased use of technology and automation in trading. These concerns were reinforced by the events in the United States on 6 May 2010 (see par. 4.1.3). As argued in this report, the increased dependence on advanced technology requires proper requirements regarding the robustness of operational and risk management systems throughout the trading chain. Nonetheless, regardless of the nature of these requirements it is desirable that high frequency traders themselves also demonstrate to others how they manage the risks associated with their activities so that they will not damage the integrity of the market.

Various high frequency traders have realised that partly for the reasons stated above, active openness is a sensible policy and that it is a good idea to take a constructive approach to the outside world. This is a positive development that in the opinion of the AFM should be emulated, especially by those high frequency traders that fall under the exemption rules in the MiFID.

Such openness is in the interests of all market participants, not least the high frequency traders themselves. A transparent stance enables regulators and policymakers to form their opinion of HFT on the basis objective considerations rather than perceptions.

The AFM takes the view that any new regulatory policy should be proportionate to the actually identified risks. This means that additional safeguards should be introduced where necessary, but that one should be wary of placing unnecessary restrictions on activities that make a positive contribution to the quality of the market. For the AFM the actual behaviour of market participants is the determining factor, regardless of the investment horizon of those carrying out particular trading activities or the technology that is used.

The AFM strives to encourage a robust and efficient market system that functions as a source of investment and finance for the real economy and thereby makes a positive contribution to the economic development of society. A variety of market participants is needed for this, each of which in their own way make a positive contribution to the good operation of the market. In the opinion of the AFM, high frequency trading strategies on balance play a positive role by helping to add liquidity to the market, assisting the process of price formation and mitigating the fragmentation of the market. In order to be able to continue to fulfil this role in future, high frequency traders must however live up to the responsibility that is associated with their increasing importance in the international financial markets.

5 Conclusion

The AFM sees high frequency trading as a method of implementing certain short-term trading strategies using advanced technology, not as a separate trading strategy in itself. The strategies used in HFT (market making, arbitrage) are in themselves nothing new. HFT does

however make it possible to implement these strategies to the fullest extent. This means that the question for regulators regarding HFT concerns the actual *behaviour* of the market participants using HFT: as long as people are using legitimate strategies, they should be treated exactly like other market participants. If the strategies are not legitimate and involve market abuse, action needs to be taken. In itself, HFT cannot be equated with market abuse. The AFM does not see that it is part of its role to prescribe the speed or time horizon with which trades can be executed, or to prevent market participants from realising the legitimate profits that result from their investment in technology.

In these considerations, it should however be remembered at all times that HFT has further increased the dependence of the financial markets on technology. It is thus essential that the orders issued by high frequency traders and the systems that generate, process and execute these orders do not damage the integrity of the market. For this reason further safeguards need to be established for the risk management and operational systems of traders, platforms and clearing & settlement organisations.

HFT has been boosted by the new market structure as a result of the MiFID. Like other European regulators and the European Commission, the AFM's opinion of MiFID is generally positive. Logically speaking therefore, the growth of HFT facilitated by MiFID should be considered to be legitimate. The further development of technology and automation of trading in financial instruments would appear to be an irreversible process. The market structure that has contributed to the growth of HFT is also here to stay. The most sensible course for policymakers and regulators therefore is to devote their efforts to further improving the existing market structure.

The AFM has put forward a number of measures, potential solutions and items of attention in this report. These are summarised below:

Information regarding HFT

The lack of clear figures regarding a trading method which has such a large impact on the financial markets is unsatisfactory. The widespread speculation about the market share of HFT indicates that a need is felt in the market for more precise figures. From a regulatory point of view as well, a better picture of the actual size of HFT would be desirable. This would contribute to market confidence and a rational discussion about the changes in the microstructure of the European market, of which the growth of HFT forms a part.

The AFM considers it essential that market data is accessible, timely and robust at all times, and that a full picture of the current situation in the financial markets is available. Traders must be in a position to rapidly take stock of the situation, to enable them to adjust their strategies in an intelligent manner. Regulators must be able to conduct investigations rapidly if there are doubts about the integrity of the trading of certain market parties, or if the causes of exceptional events are unclear. In this context, the AFM is in favour of making the client ID obligation mandatory, and expanding this obligation. The Ministry of Finance has also now indicated that it supports the introduction of the client ID requirement in the Netherlands.

Impact of HFT

The fragmentation of the European securities markets has contributed to the growth of HFT. Using HFT, trading strategies can be implemented that provide liquidity on various trading platforms and that contribute to more efficient price formation for financial instruments. In general, the internationalisation of the financial markets has led to increased complexity. HFT strategies that add liquidity and assist the process of price formation make a positive contribution to reducing fragmentation, and therefore in the opinion of the AFM on balance have a positive function in the market.

It should be noted that the available empirical evidence is based on relatively little research and furthermore has been obtained partly in cooperation with high frequency traders. Additional independent empirical research would therefore be desirable, but is not currently sufficiently available.

Access to trading platforms

The AFM does not support the idea of obliging market participants to only take connection services from market operators or investment firms that are subject to supervision. Market participants that for example make use of central proximity hosting must however be able to demonstrate that the provider to which they have outsourced part of their operations offers adequate safeguards to guarantee the physical and operational integrity of the systems of the market participant concerned. These safeguards must be of the same quality as those provided by operators of a regulated market or MTF that are under supervision.

For the reasons stated in paragraph 1.5, the AFM sees no reason to limit the possibilities for co-location. The AFM does however take the view that additional guidelines and binding technical standards as well as access to co-location facilities subject to objective, transparent and non-discretionary conditions and at reasonable commercial cost would be desirable in a European context. The regulator must be able to take effective action against market participants who misuse the low latency they obtain for manipulative purposes. Intervention by the regulator may also be necessary in cases of market failure or where it is established that the integrity and fair operation of the market is at risk.

The AFM also sees a number of risks in relation to the use of direct market access (DMA) and sponsored access (SA). In view of the fact that the risk management of individual traders does not provide any guarantee that erroneous transactions will be prevented, it is important that additional checks are made. The AFM is of the opinion that the importance of adequate pre-trade monitoring, also in the case of DMA or SA, has increased significantly. Access to trading using DMA or SA makes it more difficult to obtain a full picture of the behaviour of players in the market. As previously stated, and also explained in section 4.3, the AFM is in favour of the introduction of a client ID. Lastly, the AFM sees a risk in the situation where an intermediary/clearing member or a central counterparty places too much trust in external parties in its risk management, especially if DMA and/or SA services are used and it is not clear which players are actually connected to the intermediary.

Risk management

In order to be able to manage the systemic risk in our modern market system, we have to look at all the market participants using automated trading systems, not only HFT parties. The AFM considers the implementation of efficient, standardised risk-management rules for automated trading systems to be an option in this respect.

The commercial pressure for instance to reduce the latency of platforms involves risk. Each trading platform uses different measures to increase speed. This can lead to a race to the bottom and inconsistency in risk management practice. A differentiated approach to risk management at individual trading platforms can never provide a satisfactory solution to the problems in the current financial system. A system-wide approach is needed, with measures that take account of the interrelated nature of the capital markets.

The increased speed of trading, in addition to the increase in range created by the new direct access opportunities, mean that the potential impact of these traders on the integrity of the market as a whole has enormously expanded. The developments in the financial markets since this MiFID provision came into effect in 2004 therefore raise the question as to whether this approach is still adequate in the current market environment. There would appear to be grounds for reconsidering this exemption regulation for proprietary traders.

Market abuse

The strategies used in HFT are in themselves nothing new. As long as people pursue legitimate strategies, the AFM sees no grounds for treating high frequency traders any differently from other market participants. If however the strategies are designed to abuse the market, the AFM will act against them. In itself, HFT cannot be equated with market abuse.
In general, for all possible trading strategies, the question of whether the strategy qualifies as market abuse depends greatly on the intentions of the trader (the algorithm).

Regulators must be able to analyse algorithms themselves and qualify their properties. Quantitative researchers will have to be hired who possess specific knowledge of (HFT) algorithms and are able to develop the necessary regulatory tools independently.

In view of the multi-platform and multi-instrument strategies used by market participants, international regulators will also have to exchange information more intensively and effectively. The most pressing need is for further improvement in the exchange of transaction data (including client IDs) between the various national regulators in Europe, so that cross-border trading patterns are made more visible and monitoring and surveillance tools can be deployed effectively.

Concentration risks

It is expected that HFT will be used in more asset classes, and also that there will be a consolidation among market participants so that only the most professional and best-capitalised businesses remain. This could lead to a large part of the trading taking place at a small number of players, with the concentration risks that this would involve.

Items of attention for new policy and supervision

Since the legislation and structure of the European market is different from its American counterpart, one must be careful that US measures are not directly copied in the European market. The European Commission has indicated that an approach designed for the European situation will be chosen. This is welcomed by the AFM.

Where HFT makes a positive contribution, it is moreover not desirable that the free market is limited and (technological) innovation is unnecessarily hindered. Intervention that is not sufficiently thought through could lead to unforeseen and counterproductive effects that do not contribute to strengthening the market and may have a negative impact on the liquidity-providing and fragmentation-reducing functions of HFT. We should also avoid a situation in which participants are discouraged from investing in IT and better trading techniques due to fears of potential intervention by the regulator.

To conclude: Given the international nature of the financial markets, any measures to be taken should be at not lower than European level. Unilateral national measures are useless and therefore undesirable. In an international context as well, the AFM strongly supports the setting of additional requirements (for instance, the establishment of binding technical standards) for the operational and risk management systems throughout the trading chain. CESR, of which the AFM is a member, takes the view that there are no grounds for the limitation of HFT and related activities by the regulators for the time being. Further research into the effects and risks of HFT is needed. The AFM supports this approach and is actively contributing to its further elaboration. In the context of other CESR activities, for example in relation to the supervision of market abuse and the availability of market information, and also in the IOSCO context, the AFM is contributing to the practical development of the recommendations and potential solutions outlined in this report.

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