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DEFINITIONS, BENEFITS AND RISKS OF HIGH FREQUENCY TRADING

Jakub Kučera *

Introduction

Algorithmic trading (AT, algorithmic trading) [1] , and in particular the subgroup
of high-frequency trading (HFT high-frequency trading) [2] lately moves markets; both literally,
when its share of the stock markets continues to grow, and in a
figurative sense, when the trading using computers became the subject
of often passionate debate among academics, regulatory authorities and
the traders themselves.

This text seeks to answer both questions that appear regularly in discussions and those
that are often overlooked. The first part deals with the definition of HFT, which is a topic to
which the current scientific literature does not pay much attention. This can be seen as
a problem, as the correct definition of HFT greatly influences the debate on its impact on
the functioning of markets. At the same time and in the creation of a
new regulatory framework is the correct definition of essential.

Subsequently, attention is paid to the business strategies used in HFT. These are the
strategies that determine the behavior of traders in the market. The third section summarizes
the findings of fact as a big part of the market for AT / HFT accounts. The
fourth section will focus on the question of whether the arrival of a new type of trading has
increased the quality of markets. Its first subchapter deals with the liquidity of markets (their
depth and width of spreads). It is followed by an assessment of the impact of HFT on the
efficiency of markets in general. The conclusion of the text is devoted to
possible systemic risks and other pitfalls. A thorough assessment of the changes on
the markets caused by the onset of AT / HFT it should form the basis for discussion on
possible new regulation of the sector.

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* RSJ, as, Prague (jakub_kucera@volny.cz).

1 Also automated trading (*automated trading*) algo trading (*algo trading*), *the black-box
trading* or robotic trading (*robo trading*).
2 Also high-speed trading or high-speed trading.

1. Definition of high frequency trading

Most of the studies that are engaged in high-frequency trading, it is understood as a subset of algorithmic trading (eg. Gomber et al. 2011, p. 24; Brogaard, 2012, p. 5). The professional literature provides a large amount of definitions HFT, which is often focused on just one aspect of it. For example, Jarnecic and Snape emphasize that equity is used to make a profit (Jarnecic, Snape, 2012). [3] For quite common definition can be considered to have used Cvitanic and Kirilenko: "[term] HFT is typically refers to the business activity, which uses extremely fast automated programs to generate route [to the corresponding stock exchange], cancel and carry out instructions on electronic markets. High-frequency traders enter and cancel a large number of orders and execute a large number of trades… and end each trading day without a significant open position " (Cvitanic, Kirilenko, 2010, p. 2).

A German study from Goethe-Universität summarizes several different definitions and lists ten features typical of HFT, especially in relation to other, non- high frequency algorithmic operations. The criteria , however, may not be always fulfilled all.

For HFT is characteristic (Gomber et al., 2011, p. 15): [4]

and) *high number of instructions* , ie their high frequency,

b) *quick cancellation of instructions* . A study on the behavior of traders in Nordic equities [5] during August 2011 and February 2012 states that the guidelines of high frequency traders with a limit price (*limit order*) have been ordering the book an average of 3.6, or 10.6 seconds (Hagströmer, Norden, 2012, p. 47–48), [6]

C) *trading on own account,*

d) *profit from the purchase and sale of assets as an intermediary,*

E) *small or even zero open positions at the end of the trading day* . Vysokofre- kvenční market maker on the market, Chi-X ended with zero open positions in 39% of trading days for the "big" the shares and at 59 % for the "small" (Jovanovic, Menkveld, 2010, p. 24)

F)*very short holding time* [assets / risks]. A study by the Bank for International Settlements (BIS) argues for referring to market participants that HFT foreign exchange firms hold a risk of "usually less than five seconds and often less than one second", [7]

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3 Taken from Gomber et al., 2011, p. 76.
4 Quotes from the study are marked in italics.
5 Index OMXS 30.
6 Time from entering the order to the first cancellation. The exchange allows partial cancellation of the order. In February 2012, the markets were significantly calmer.
7 However, neither the team that drafted the study, it is unclear what exactly below this figure conceals, or what method to these numbers there. These are probably mere estimates (BIS, 2011, p. 4).

G) *low margins from one trade* - an HFT trader in Dutch shares, whose behavior was studied in detail by Menkveld, earned on average 0.88 euros per trade (Menkveld, 2012, p. 18), [8]

h) *the requirement for low latency* , ie the speed with which algorithms can respond to market events , [9]

and) *placing computer technology as close as possible   to   the markets (co-location*) or renting so-called proximity services (data processing as close as possible to the stock exchange). This further reduces latency ,

j) *concentration on highly liquid assets* . HFT is focused on the most liquid currency pairs like EUR   /   USD, stocks with large market capitalization, interest rate futures and futures on government bonds or stock indexes.

However, a closer look at these ten features reveals that many of them are either derived from the first criterion - high frequency instructions - or secondary.

The second character HFT - fast interference instructions - stems directly from high frequency, because if they are businessmen (especially then the makers of the market, who are dimensioned most) to achieve high- frequency trading, is it for them to frequent interference or editing instructions.

The following criterion - trading on own account - can be described as secondary, as it does not matter on whose account the company trades. [10]

The fourth characteristic - the profit from the role of mediator - is again closely related to the first. If the goal was to hold the asset for a long time, it would not make sense to carry out a large number of trades that would minimize the position. Especially when the stock exchange pays a fee for each trade.

The following sign - an almost closed position at the end of the trading day - can again be counted among the less important ones. Again, true that some HFT firms cannot meet.

For the sixth criterion, much depends on how we define the holding period of the asset. If we consider the holding period of an asset as the time that elapses between opposite operations on the market, the high frequency of trades must lead to a shorter holding period . Unless that would like to traders to build large positions on the market after small steps and then her hold. However, this assumption is not in line with the strategies used by HFT companies (see the following section).

Market logic leads to low margins from a single trade. If HFT promised high margins from a large number of trades, it would become very lucrative, attract more companies and the competition would bring yields down. The eighth and ninth characters of the HFT are related to the need to respond quickly to changes in the market. It can be argued that if we are to achieve a large frequency of instructions, ie short times between them, we must be

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8   On the one meter stock title for one day , then 1416 euros.

9   According to the BIS report , companies using HFT operate on Forex with a latency of less than one millisecond (BIS, 2011, p. 4).

10 Although we may find that this feature is an "important difference" (Hagströmer, Nordén, 2012, p. 10), there are situations where an HFT company leases its entire infrastructure to manage a certain portfolio and monitor agreed business strategies.

able to respond to market changes adequately quickly. The longer
the latency (response time), the longer the pauses between instructions.

The last characteristic -
the concentration on liquid assets - is again closely linked to the first. In order for HFT
companies to cover their investments in demanding technologies, they need to achieve
high trading volumes. In less liquid assets, the money spent on purchasing computer
equipment and developing algorithms would return much later. Furthermore, there can
not fully utilize its advantage of high frequency stores and velocity (Hagströmer,
Norden, 2012, pp. 4 and 21).

If we are to name one character typical for HFT, it is most logical to choose
a high frequency of trades. Other characteristics are either secondary or derived. Some
specific situations may be an exception, especially in *market making* . The high
frequency of trades also explains why HFT must be a subgroup of AT, because only
machines are able to generate and execute a large number of trading orders at once. The
speed with which trades are carried out is not suitable as a main feature
of HFT , because there are also very fast algorithms that do not belong to HFT . [11]

It remains an open question if we can find a clear limit on the frequency
of trades from which we can call a trader high-frequency, and whether this effort would
have any other than purely academic benefits. Another option would be to
distinguish between algorithmic execution of the order (*algorithmic execution*) and
algorithmic decision making (*algorithmic decision-making*), as is the
study of HFT from the workshop BIS. Here too , however , a problem arises . It is not
at all clear where to draw a dividing line in the field of process automation. Business
models that most experts do not consider to be such could fall under HFT . [12]

2. Strategies used in HFT

HFT is not a strategy in itself, but a tool to best execute some, mostly long-known,
business strategies. [13] According Hagströmra and Norden are actually differences
between the high-frequency traders and their strategic GIEMME "so significant as
the difference between HFT and non-HFT activity" (Hagströmer, Norden, 2012, p.
27). High-frequency trading strategies "change" only in the sense that
the human brain is replaced by an algorithm that can process and evaluate

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11 For example, "intelligence" algorithms or those for "crushing" large trading
   instructions. "Intelligence" algorithms respond to new information based on pre- programmed pat
   terns of behaviour. It seeks to process agency reports as quickly as possible and to estimate their
   impact on the markets. To do this, they use *text-mining* techniques or rely on already
   electronically pre-processed news offered by some agencies (e.g. Bloomberg, Reuters, Dow
   Jones). "Crushing"
   algorithms are used to divide a large operation into smaller instructions. The motive for using similar
   algorithms is an unfavourable market reaction for the trader. The algorithm divides and masks
   a large operation , thus minimizing the impact of trade on the market (*market impact*). For the trader,
   this reduces the risk of so-called *adverse selection* .
12 For example, the already mentioned "intelligence" algorithms.
13 This view is shared by many studies (e.g. IOSCO. 2011, p. 24; Gomber et al., 2011, p. 24).

large amount of data. The technology also allows the trader to react to market events in a fraction of a second. Neither speed itself by itself is not ,
however, in no event strategies as well as strategies of survival of the cheetah does not run fast, but to hunt antelope.

HFT can be used in a whole range of strategies. One of the best known is arbitrage, the classic form of which is to use the price differences of the same asset in different markets. Similarly, it is possible to focus on financial instruments based on the same asset, ie. financial derivatives and their underlying assets. Arbitrage targets market inefficiencies, or situations where the market does not faithfully reflect the state of other markets or reality as perceived by traders. Sophisticated kind of strategy is arbitration statistics, in which a trader trying to track down even the most subtle correlations between related assets, eg. The German share index DAX and its American counterpart, the S & P 500. [14] In the event of arbitration is "hyper-growth" crucial, because a business opportunity usually It quickly disappears - often by the activities of competing companies.

Often applied strategy is called. The creation of the market (*market making*), the trader at the market dimension on both sides, ie. Publishes prices, for which it is willing to particular financial instrument to buy and sell. Market makers are referred to as liquidity providers because their activity increases the market liquidity. On the contrary, other strategies - such as the aforementioned arbitrage - usually reduce liquidity in the market . [15] Market makers generate profit either from the difference between the purchase and sale price (the so-called spread) or from the fees they receive from stock exchanges for their activities. They are willing to pay *market makers* because their activity increases liquidity in the market. Fees also allow markets narrow spreads, i.e. reduce trading costs for other traders. [16] For market makers are typically very high frequency trading orders, because they must often adjust their quotes in order to reduce the likelihood of adverse selection (*adverse selection*). According to a study on Scandinavian stocks , market makers were responsible for the "lion's share of total high frequency trading" - 71.5% during August 2011 and 62.8% in February 2012 (Hagströmer, Nordén, 2012, p. 4).

Among other HFT strategies include *directional trading* (active trading), the trader opens on market position (sells or buys assets) with the aim to make on the future price movement. One of the techniques that can be used in this strategy is the so-called *liquidity detection* , where traders try to estimate the behaviour of other market participants. For example, they try to find out if someone has broken up a larger trade order into smaller ones. If they think they have detected such a deal, they can adjust their behaviour accordingly. [17] But by no means do these traders know in advance what others will do on the stock exchange . It is therefore not an electronic version of the *queues*

14In his book *Dark Pools* , Scott Patterson also mentions *latency arbitrage* , a trading model based on the use of small delays between exchanges and dark pools, which are trading platforms where the order book is not visible (Patterson, 2012, p. 202).

15*Liquidity providers* versus *liquidity takers* . Passive and active strategies are also often discussed. 16 An alternative to the charges, which exchanges apply makers market who will undertake dimension, is asymmetrical charging. In this model, active trades (reducing liquidity) are charged more than passive ones (increasing liquidity).

17 A similar technique is a *quote matching* , "tuning quotes".

running , in which the broker abused his position. [18] Traders with this strategy only estimate what will happen in the market, at the risk of being wrong. Nevertheless, some criticize this strategy (eg *What is Wrong With High Frequency Trading?*). Although the strategies outlined in this paragraph are often associated with HFT, they are also used by other, non- high frequency algorithmic traders.

Techniques that may be designated as predatory was "flash trading" (*flash trading*). In this case , stock exchanges offered some traders the opportunity to see the instructions of others a little earlier than other market participants, which was very similar to *front running* , which is prohibited. The reason was the efforts of stock exchanges to some extent bypass the NBBO [19] system and keep trades with them. *Flash trading* only concerned US stock and several other markets, and many stock exchanges banned it themselves after complaints. [20] This group HFT techniques include and *pinging* (loosely translated oťukávání) or *sniping* (loosely translated blasting), which are used to getting information on the state of ordering books, which in some OTC systems are not visible (ie. Dark pools), or can these techniques used to uncover hidden instructions on stock exchanges (Gomber et al., 2011, p. 29).

The last group of HFT strategies are techniques that try to influence the market. Examples are *spoofing* and its slightly more complex version of *layering* . When *spoofing, the* trader places an order on the stock exchange, the size and order of which changes the spread to another level in the order book. However, the real purpose of the event is trading on the other side of the book. The "mystifying" order itself is revoked before it is traded (Gomber et al., 2011, p. 48). *Layering* then "improves" the strategy by placing the visible quotations on one side of the order book and the hidden quotations on the other side. Visible quotations will lead to a market shift in the direction of hidden quotations, which are then traded at a better price (Linton et al., 2012, p. 25).

Stock exchanges are trying these techniques to eradicate unfair, but it is not always easy to separate the misuse of market and cancellation of listing on the basis of other circumstances. Usually, the stock exchange has to gather enough statistical evidence, as shown by the recent case of the now-defunct Swift Trade, which was fined £ 8 million by the British FSA in 2011 for *layering* . According to the stock exchange, the company was to place a total of 990 large orders in 12 stocks on the London Stock Exchange in 2008, three years earlier, 99 % of which were subsequently canceled. [21]

The BIS study points out that these "predatory" or "unfair" practices are nothing new at all . HFT only enables their "high-tech and high-speed manifestation" (BIS, 2011, p. 2). High frequency trading is not a strategy in itself and, moreover , cannot be easily defined. Any adjustments to the regulatory framework should therefore apply to the specific strategies used by exchange traders and not to HFTs as such.

18 For example, when you had the client buy a large number of shares alone he can initially have bought.
19 NBBO = National Best Bid and Offer - a system that aggregates quotations from individual exchanges
20 For example, Nasdaq OMX Group and Bats Global Markets (Kisling, Westbrook, 2009).
21 In contrast , Swift Trade canceled only two -thirds of small quotations in the same shares (Masters, 2012).

3. The share of AT / HFT on market

Calculate or only estimated share of HFT on markets is
not easy, because not always be by myself simply to separate HFT traders from other kinds AT. If exchanges keep similar statistics at all , they
are usually only able to identify who placed the order . The algorithm or
the human investor will no longer know who decided to enter
the order . Alternatively, they can declare as HFT all instructions that were sent from the collocated servers or were entered through the direct communication interface of the exchange (so-called API). For example, mentioned
"Crushing" algorithms can thus be easily included in the HFT, although they are not.

Most studies on HFT agree that its share is growing on most exchanges (stocks, futures, options, currencies, the bond market), including some non-exchange OTC markets (eg BIS, 2011; Gomber et al., 2011). For the whole of AT, most of the estimates are close to the data compiled by the consulting firm Aite Group (see Chart 1), which is based on data provided by individual trading platforms. [22] In general, the share of AT (and with it HFT) in trades is highest in the US, for which up to 70% is reported for the stock markets . In order regions followed by Europe, where about a third of equity trading accounted for AT. For the Asia-Pacific region , only about 20 % is reported .

Graph 1
The share of AT on equity markets
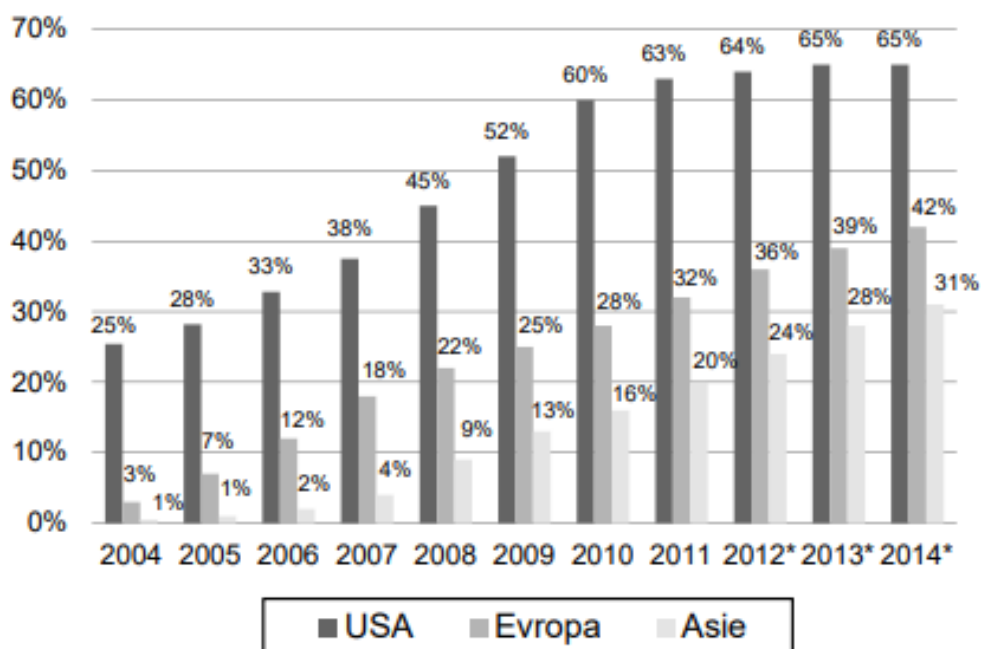
22Partly published in The fast and the furious. *The Economist* [online]. 2012, Feb 25th [cit. 2012-11-20]. www.economist.com/node/21547988.

In terms of financial instruments, AT focuses on equities and futures. It is estimated that in the US share amounts to 60-70% and 40-50% (see Chart 2). In Europe, the value is lower - shares between 20 to
5 % and futures 30 until 40 % (Gomber et al., 2011, p. 72). [23] For shares and futures following options (in the USA about 30 %) and marketed with the foreign currencies which are globally indicates a tenth portion (see graph 2). However , much higher estimates can be found for the Forex currency market , for example 40 to 60% (BIS, 2011, p. 10). AT's market share is less than 5%. The share of AT / HFT is also rising in commodities, such as futures contracts for oil, gold or gas.

Graph 2
The share of AT in each financial instruments - in addition to the currency market, forex and bonds with it the markets in the US
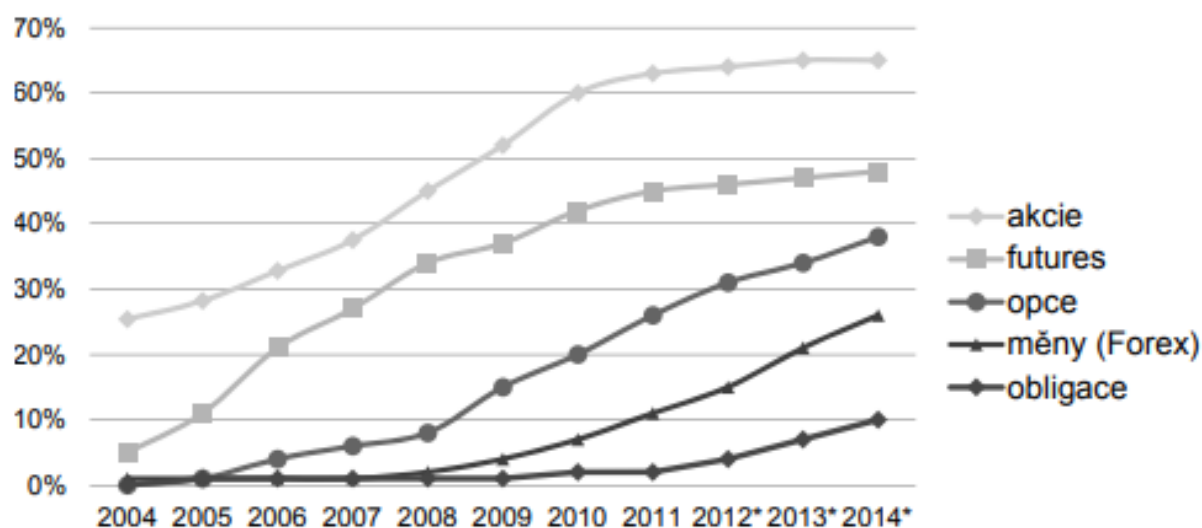
4. Benefits and risks of HFT

Discussion about the benefits of HFT will revolve mainly around the question whether it makes markets more liquid, ie whether it is easier asset in the market to buy or sell. This text also focuses on this issue . There is also a discussion about whether volatility (price movements) decreased with the advent of AT / HFT . As no more extensive studies have been published on this topic yet and the empirical data are not very conclusive, [24] this topic will be discussed only marginally. More attention will be paid to the question of whether AT / HFT has increased efficiency markets in general, including reductions in stock exchange fees and, conversely, whether systemic and other risks have not increased too much .

23Values based on estimates of European trading platforms.
24Indeed, a number of events took place in the markets that had a major impact on their volatility, such as the US mortgage and European debt crisis. This was the conclusion and the two-year study *of The Foresight Report* , published in October 2012 by a the situation on the financial markets has ordered the British Government (Stafford, 2012).

Liquidity

Although with the media, we often encounter the view that AT and especially HFT reduces "Market quality" with higher price volatility and lower liquidity, most of the literature agrees on the contrary. The team led by P. Gomber evaluated a total of eight other studies on this topic. According to only one of them, HFT can reduce the efficiency of markets. Another concluded that "HFT can have a negative impact on the quality of the market under special conditions". However, "a clear majority of studies have found evidence that HFT improves market quality" in the form of lower short-term volatility, higher liquidity, and more faithful asset prices (Gomber et al., 2011, pp. 2 and 34). The aforementioned Swedish study on Scandinavian equities also concluded that HFT reduces volatility and promotes market liquidity (Hagströmer, Nordén, 2012, p. 5).

As HFT / AT (especially then *market making*) contributes to a more liquid markets, understand if we look closely at the relations between certain market characteristics. First, it is however necessary to determine how we liquidity market measure. While its definition is relatively clear - how easy it is to sell an asset, resp. Shop - There are several ways to measure it. One possibility is offered by the extended definition itself - how easy it is to sell an asset, resp. to buy without affecting its price (CNB, 2012). [25] Liquidity can therefore be measured as the change in price (price impact) caused by identical transactions. However, in its quarterly liquidity report, CME rightly points out that measuring this indicator is not easy. It therefore offers three other options: a) spread width ; b) market depth or volume of quotations in the order book; [26] c) the time needed to find a suitable counterparty (CME, 2013, p. 1). Because the waiting time , similar to the *price impact* , is not easy to measure (but certain data can be found - see Chart 3), we will focus mainly on spreads and market depth.

25The motto "market liquidity". CNB - Glossary of Terms [online]. 2012 [cit. 2012-11-19]. www.cnb.cz/cs/obecne/ slovnik / t.html.
26Often on the edges, i.e. the best prices.

Graph 3
Speed Trading Instructions [27] on the NYSE and Nasdaq
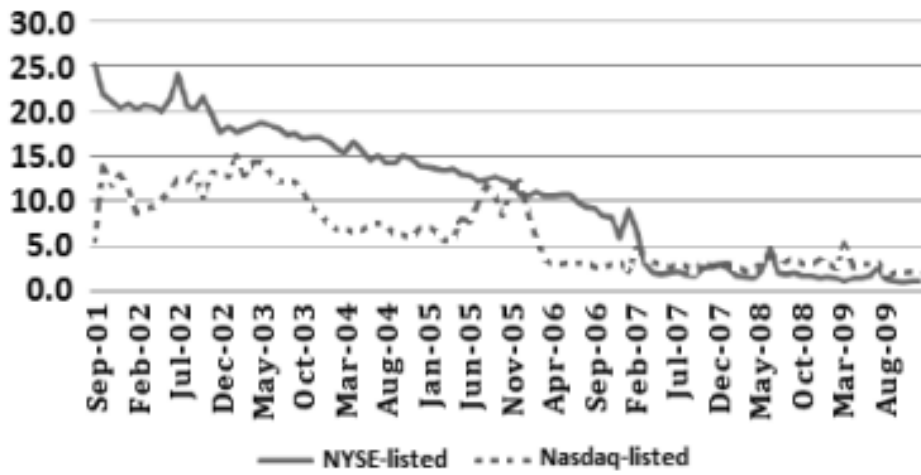

Y-axis: seconds.
Source: Public Rule 605 Reports from Thompson (Angel et al., 2010, p. 22).

Smart algorithms and powerful computer technology allow traders to react to changes on the market faster and more efficiently than before, to better assess the situation prevailing on the market and estimate , for example, with what likely will be to change the price. This is reflected in the decreasing likelihood that they start to lose money transactions - reducing the probability similarity called. Adverse selection (*adverse selection*). Adverse selection refers to a situation where one party to the trade has information to which only it has (so far) access , and uses this knowledge to the detriment of the other party . At the same time , it does not have to be an illegal activity at all - only someone knows something that others do not.

As the likelihood of adverse selection is lower, traders quote more and markets become deeper. The development of markets over the last decade has been influenced by a number of different factors, and the rise in AT has been just one of them. Yet to not resist the impression that behind the increase in capacity offered trades observed in recent years, standing in a large extent, AT / HFT (eg. Hendershott et al., 2011, p. 1; Hasbrouck, Saar, 2012, pp. 23 and 32; Menkv eld , 2011, p. 4). For example, the average volume of edge quotations (best prices) for the Euribor (green outright) futures contract, where AT / HFT is very active, rose from 228 lots in the first quarter of 2009 to 499 four years later (Chart 4). We can observe a similar development in the Eurodollar contract (Chart 5).
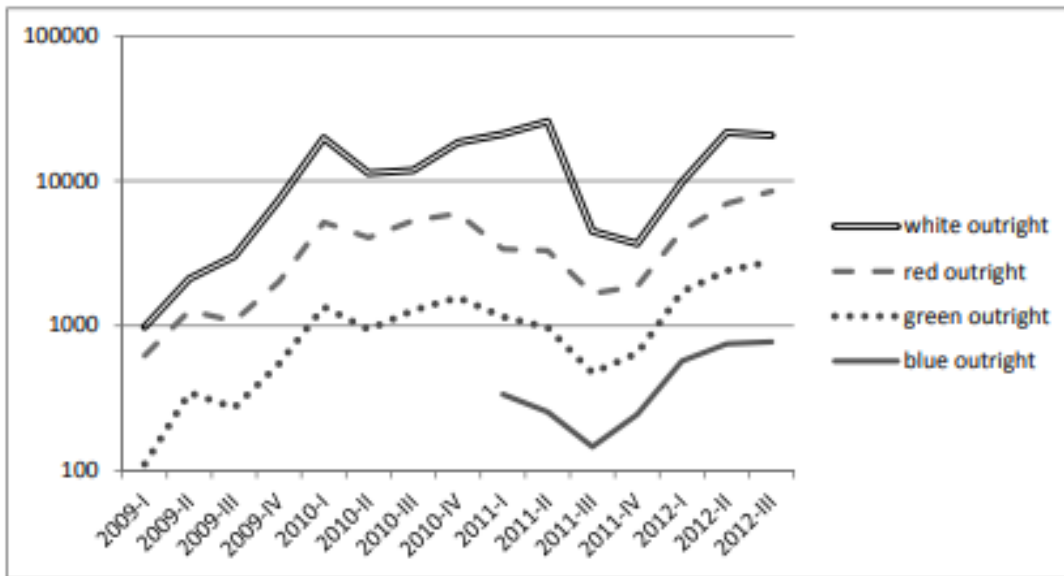
27As his report to the Stock Exchange pursuant
to rule 605. This is about *market orders* - instructions that are traded immediately, regardless of price.

Graph 4
Average number of contracts on edges - Euribor [28]
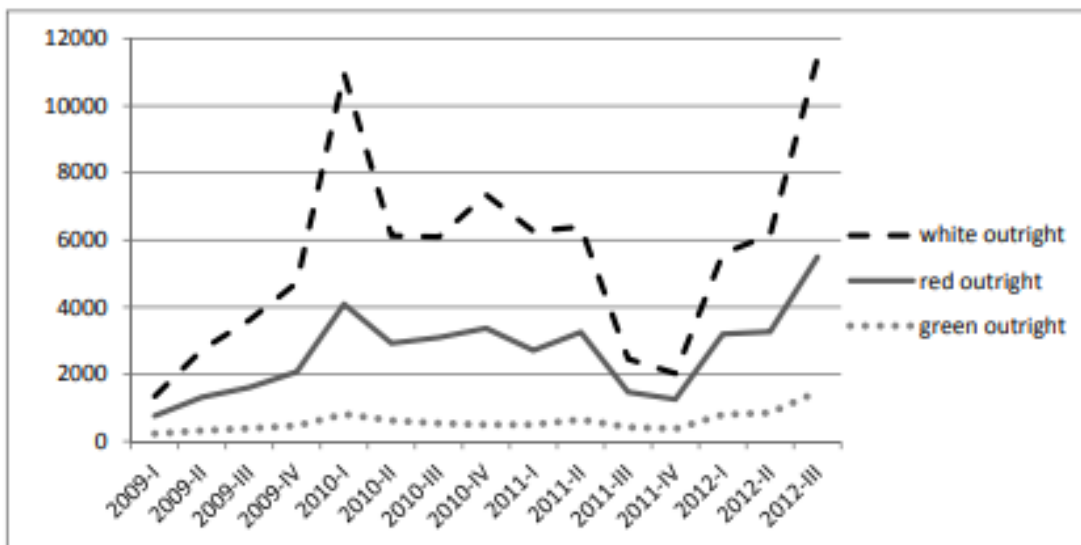
Graph 5
**Average number of contracts at the edges - Eurodollar [29] - logarithmic scale**

Source: RSJ.

28Interest rate futures. Average sizes of quotations at the edges, without two and a half upper and lower
   percentages of observations. Without so-called events (situations where important macroeconomic
   information is announced). Including implied quotations. Frames after 15 seconds. White outright -
   the first four expirations (every three months). Red -
   the following four expirations. Green outright - four more expirations. Observations from 8:30
   until 19:00 Central European Time (part of the trading day when about 95% of the volume
is traded). 29 Interest rate futures. Average sizes of quotations on the edges, without two and a
half upper and lower percentages
   observation. Without so-called events (situations where important
   macroeconomic information is announced). Including
   implied quotations. Frames after 15 seconds. White outright - the first four expirations (every
   three months). Red - the following four expirations. Green outright - four more expirations. Blue
   outright - also four expirations. Observations from 12:00 to 22:30 Central European Time (part of the
   trading day, when about 95 % of the volume is traded).

Similarly , there was an increase in the volume of quotations in
the US NBBO system , as shown in Chart 6. The increase was recorded mainly
by shares in the S&P 500 index , which brings together predominantly US companies with the
highest market capitalization. The difference between the increase in depth in the S &
P 500 on the side of one and all US stocks in diameter, possibly those in the index, the Russell
2000, which in turn brings together joint-stock companies with small market capitalization, on
the side of second can be explained by the increased presence of AT / HFT in more
liquid assets.

Graph 6
Median volume of visible quotations in the NBBO system
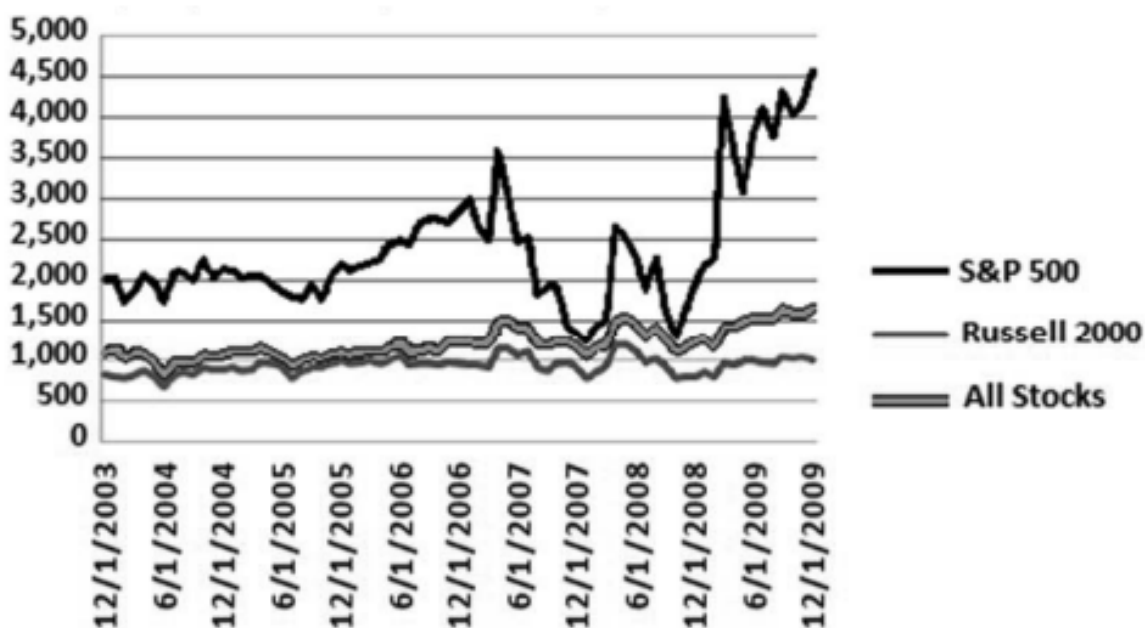

Y- axis : number of shares on both sides of
the order book. Source: Knight Capital Group (Angel, et al., 2010,
 p. 14).

The positive impact of AT / HFT on the depth of the markets is also evidenced by
data published by the Tokyo Stock Exchange on the impact of the new Arrowhead
trading system. It was launched in January 2010 and, in particular, by reducing latency,
it enabled market makers to better manage
risk. Between November 2009 and March 2010 , there
was a significant increase (between 51 % and 139 %) in the volume of quotations
(Chart 7).

Graph 7
Launch of Arrowhead - Depth [30] market between November 2009 and March 2010
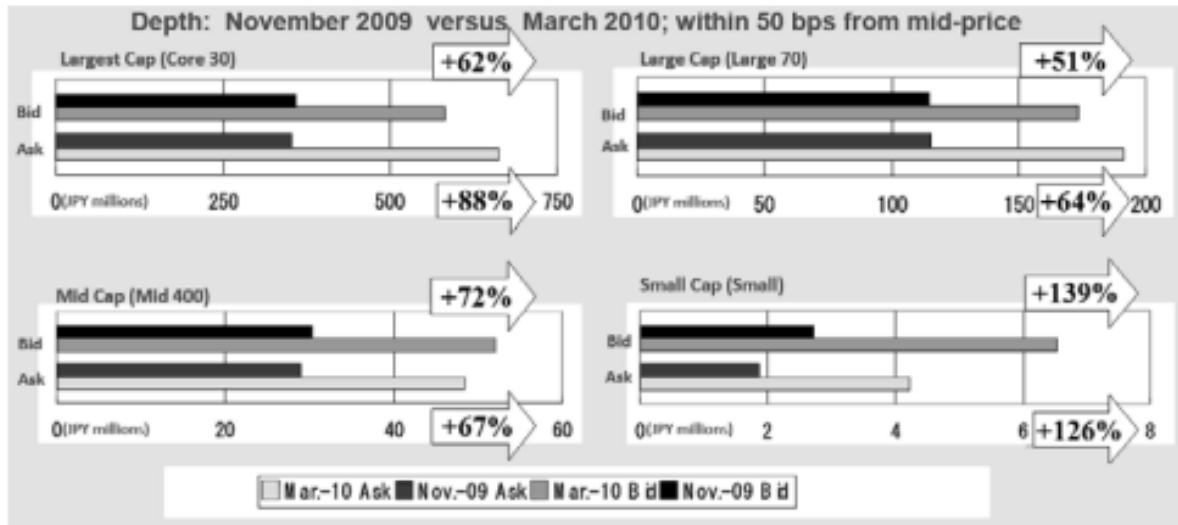
Source: Tokyo Stock Exchange (FIA, 2012, p. 16).

The discussion is sometimes about the quality of liquidity provided by HFT companies. According to the study, BIS to some participants in the market Forex complain that HFT adds liquidity only "To the top of the order book" and only for smaller trades, while having a negative impact on liquidity for larger volumes. [31] Arguments that "liquidity has deteriorated" can be encountered more frequently. Usually with but it is only the views not very or not supported (eg. Grant, 2010).

The above- mentioned graphs and data on the depth of markets compiled by the exchange CME (see Table 1), the argument for other markets confirm. Graphs published quarterly by the CME stock exchange (CME, 2013, p. 7) show that this is not only an increase in liquidity at the top of the order book, but also at other levels of liquidity .

30Depth is measured as the total value of instructions in the range of 50 basis points from the best price.
31One further unspecified business with respect to the authors of the
   study expressed in the sense that while the spreads on the currency pair EUR / JPY for businesses
   less than 5 mil. Euros narrowed by 20 % for larger businesses to expand
   - for transactions over EUR 20 million, allegedly two to four times. We can not exclude that the
   currency pair in question really has been a deterioration in the depth of the market,
   but unfortunately statement is not easy to empirically verify (the study itself to
   did not try to do so). BIS, 2011, p. 12.

Table 1
Market depth at the top of the order book (in lots)

asset	June 2009	December 2009	June 2010	December 2010	June 2011	December 2011	June 2012	December 2012	change between June 2009 and December 2012 (multiple)
Eurodollars	479	1389	2665	1295	2900	1425	14629	24005	50.1
ten - year T-Notes	274	506	690	360	965	508	789	1637	6.0
E-mini S&P 500	440	579	410	896	614	369	456	460	1.0
EuroFX	14.7	27.2	24.5	25.2	23.9	26.2	33	55.6	3.8
Japanese Yen	11.9	16.6	18.3	16.5	20.7	18.9	19.2	25.6	2.2
crude oil	8.3	7.1	7.9	11.3	6.9	7.1	9.2	8.9	1.1
corn	745	62	96	78	4836	82	1556	45.5	0.1
gold	5.7	6.6	5.9	5.4	5.8	3.8	4.6	6.3	1.1

Source: CME. [32]

Thanks to deeper markets, trades have less of an impact on the price of an asset. Brogaard states that "if the HFT traders were not part of the market, the average trade on the volume of a hundred of events would have caused the movement of prices of 0.013 USD higher than the case now. Stores in the amount of one thousand shares would have led to price moving higher by 0.056 USD " (Brogaard, 2010, p. 2). [33] The fact that the price impact of trades has decreased due to AT is positively reflected in narrower spreads and lower volatility.

The relationship between volatility and market depth is not straightforward. While low volatility generally leads to a reduction in risk and thus to an increase in the volume of quotations in the market, it is higher volatility that attracts traders to the market. Significant price movements allow traders to earn more (Brogaard, 2010, p. 64). The relationship between volatility and market
depth would thus have generally remind curve zvoncovitého shape (see Chart 8). With increasing volatility, the volume of quotations should first rise, then to some extent begin to decline. Point break it should be a situation where the movement of prices is so large that the cost for holding open positions begin to outweigh the
potential gains from them. And these costs are rising with the increasing likelihood of over-the-counter trade and therefore volatility.

32Taken from CME, 2013, p. 6.
33It was a detailed examination of 120 equity titles in the system NASDAQ.

Graph 8
Assumed dependence of quotation volume on volatility
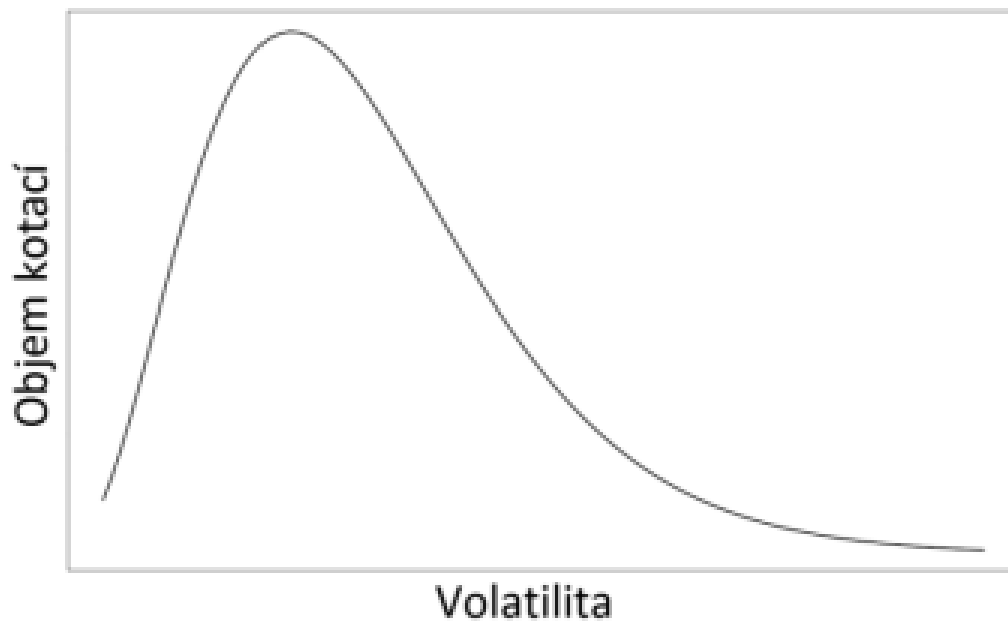
The relationship just described is a theoretical model that may not apply to
all markets. Often the particular left-hand portion of the curve varies and the volume of
quotes is also at a lower volatility high (e.g. 2011 in Figure 9). The reason is probably traders
who, with low volatility, ie lower earnings opportunities , quote larger volumes so that
the profit remains the same. A number of markets , however, the
situation described in Chart 8 recalls - for example, futures on stock EuroStoxx50 or interest
rate Euribor futures - see graphs 9 to 10.

Graph 9

Dependence of quotation volume on volatility - futures on EuroStoxx50 [34]
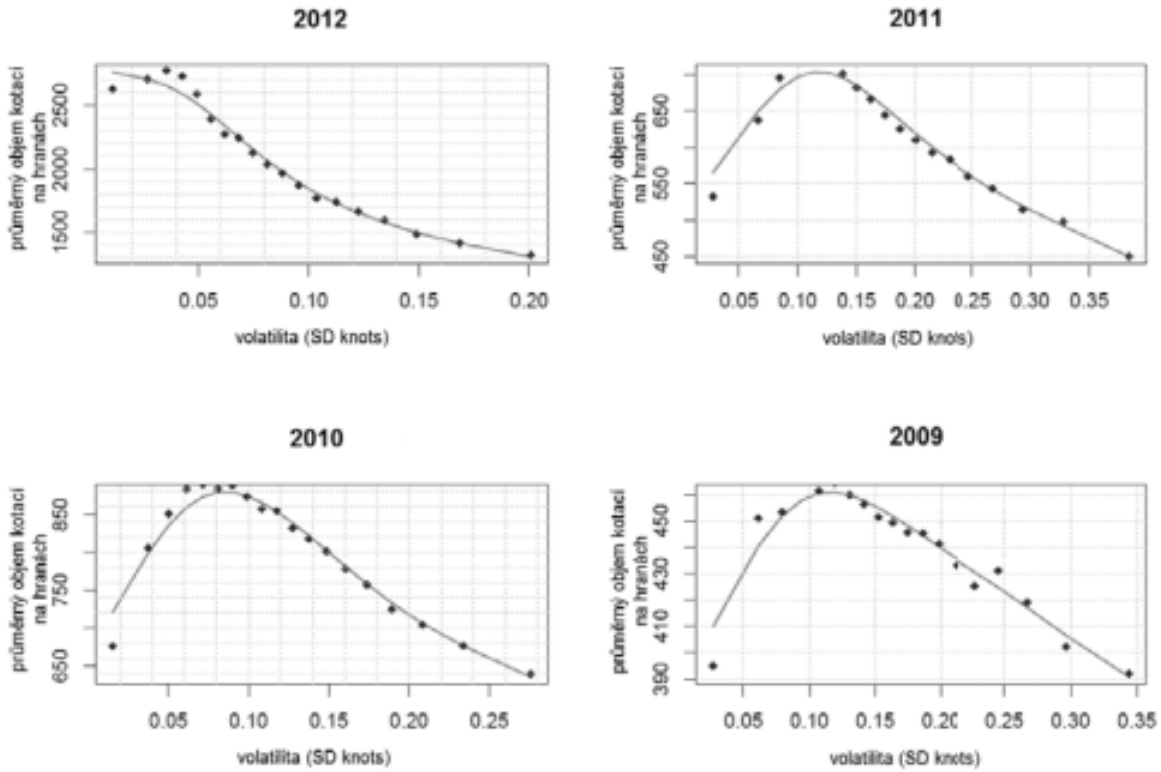

2012

2011

2010
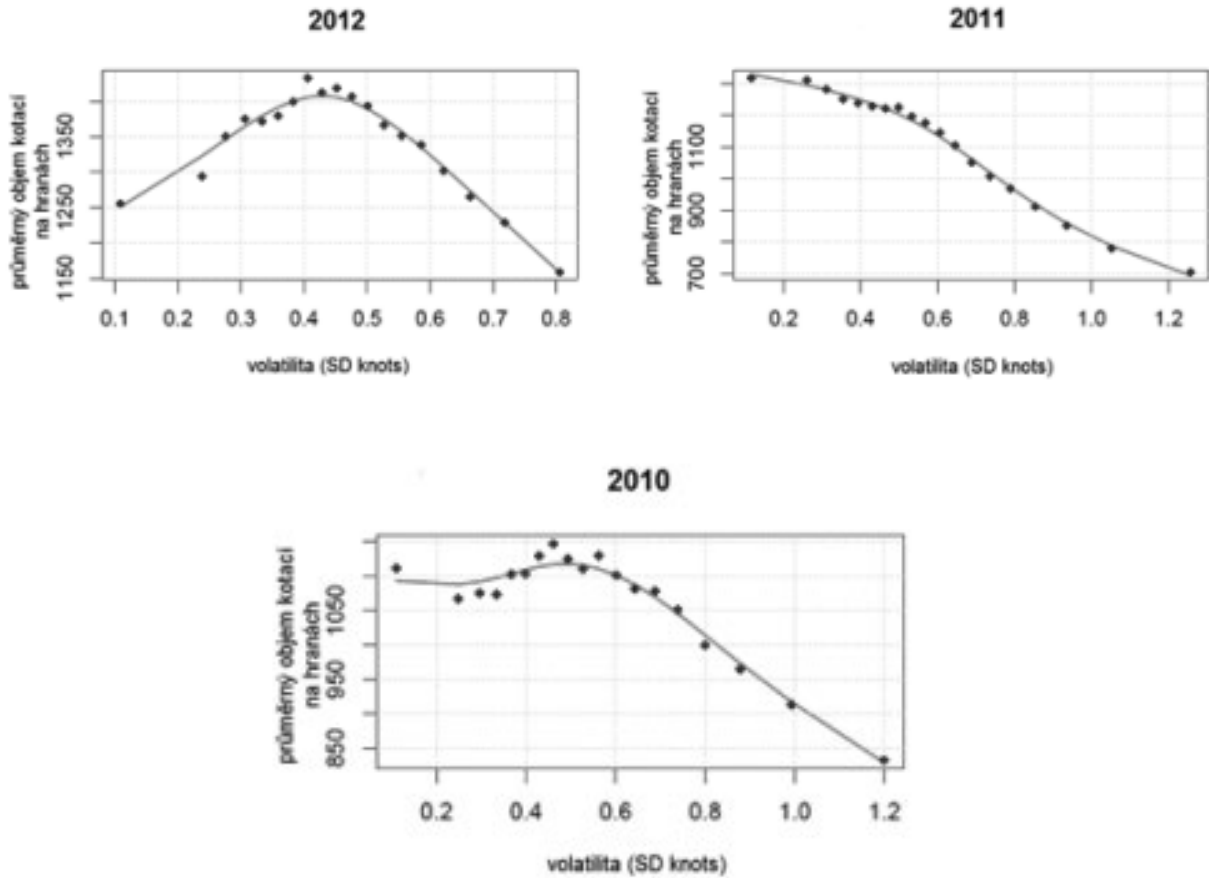
Pramen: RSJ.

34 Stock index futures. Average sizes of quotations at the edges, without two and a half upper and lower percentages of observations. Without so-called events (situations where important macroeconomic data are reported). Frames after 15 seconds. Volatility (vector of quantiles with a step of 0.05) expressed in SD knots - the weight of the measured values decreases continuously with the fact that after six minutes it has half the weight. The average volume is given in the number of contracts. In 2010, observations begin on April 7.

Graph 10

Dependence of quotation volume on volatility - futures on Euribor (green outright) [35]

35Interest rate futures. Average sizes of quotations at the edges, without two and a half upper and lower percentages of observations. Without so-called events (situations where important macroeconomic information is announced). Including implied quotations. Frames after 15 seconds. Volatility (vector of quantiles in 0.05 steps) expressed
in SD knots - the weight of the measured values decreases continuously with the fact that after six minutes it has half the weight. Observations from 8:30 to 19:00 Central European Time (part of the trading day, when about 95 % of the volume is traded). The average volume is given in the number of contracts.

It was mentioned that HFT reduces the likelihood that traders will start to lose money . This is reflected not only in the deepening of markets, but also in narrower spreads. It leads to them constant competition between the various participants in the market about it, who will offer the best price and the shops themselves "downloads". This is reflected in lower purchase prices and higher sales, or narrower spreads. The already mentioned Brogaard writes that HFT traders quoted at the best prices almost in the middle of the time (45 %), during which he watched the shares on the NASDAQ market (Brogaard, 2010, p. 64). Thanks to innovation , the limits to which traders can afford to go in the competitive struggle are constantly shifting. As in the case of market depth, we can also observe a positive development of spreads in recent years, ie their narrowing - see Chart 11.

Graph 11
Median spread size for shares in the S&P 500 index (in USD cents)
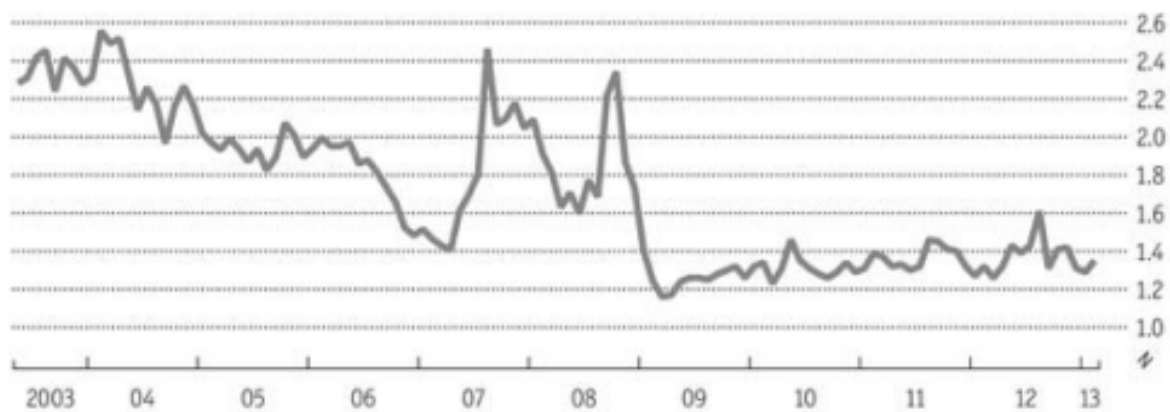
Source: Knight Capital Group. [36]

Similarly and Exchange CME recorded over the last three years a decline in spreads. In the most liquid assets - such as futures on EUR / USD or a Eurodollar contract - spreads fell to the width of one tick, ie. to the smallest possible. The narrowing again took place mainly in the most liquid assets (see Table 2). On the markets, where the proportion of AT / HFT less, may not even be improved hardly at all - for example, futures on gold and crude oil (here plays a role too high volatility). This suggests that AT in particular was behind the improvement in spreads . To this conclusion arrived and other studies (eg. Hendershott et al., 2011 p. 1; Hasbrouck, Saar, 2012, p. 23; Menkveld, 2011, p. 4).

36Taken from The fast and the furious. *The Economist* [online]. 2013, May 11th [cit. 2013-06-18]. www. economist.com/news/special-report/21577187-trading-equities-barely-profitable-these-days-many-banks-are- carrying.

Table 2
Width spreads on the stock exchange CME (in USD)

asset	number of lots	June 09	June 10	June 11	June 12	December 12	the size of one tick	spread in December 12 as a multiple *of ticks* *
Eurodollars	500	15.91	12.98	12.59	12.6	12.5	12.5	1.0
ten - year T-Notes	500	29.98	15.75	15.64	15.64	15.93	15,625	1.0
E-mini S&P 500	500	16.37	17.37	13.07	15.66	15.85	12.5	1.3
EuroFX	25	25.88	15.17	15.96	13.48	13.12	12.5	1.0
Japanese Yen	25	31.64	24.14	20.13	20.56	15.45	12.5	1.2
crude oil	25	28.06	19.87	33.76	26.36	26.07	10	2.6
corn	25	20.26	24.09	36.77	14.71	12.76	12.5	1.0
gold	25	42.93	41.33	36.84	52.07	32.41	10	3.2
* rounded								

Source: CME, 2013, p. 7.

The positive effect of increased competition between markets and the onset of AT / HFT, which is connects interesting document in its study of 2011 already mentioned Menkveld. The graphs presented by him show how the share of HFT in Dutch equities increased with the advent of the new Chi-X trading platform (Chart 12). At the same time we can observe the reduction of spreads in the Dutch equities in comparison with stocks Belgian, which is traded in the system Chi-X and not act on them no HFT trader (Chart 13) (Menkveld, 2011 p. 12). Overall, spreads have fallen by as much as 50 % (Menkveld, 2012, p. 2).

Graph 12
Share of Chi-X and HFT trader in Dutch shares

Source: Menkveld, 2011, p. 12.

Graph 13

Unlike the width of the spreads between Dutch and Belgian shares in % (axis y)
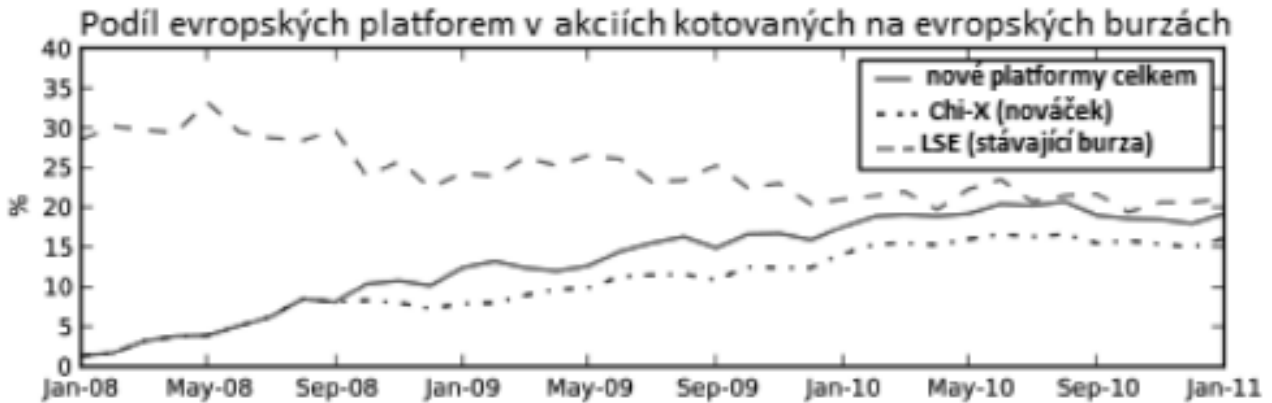

Source: Menkveld, 2011, p. 12.

Conclusions of other studies and the above theoretical model supported by empirical observations suggest it, that AT / HFT and in particular the strategy *market making* to facilitate trading on the stock exchange. In ordering the book of the increased volume of quotations , and there has been a reduction in the cost of trade in the form of narrower spreads. This opinion held by even their own stock exchanges, for example, New York NYSE (NYSE, 2010, p. 7).
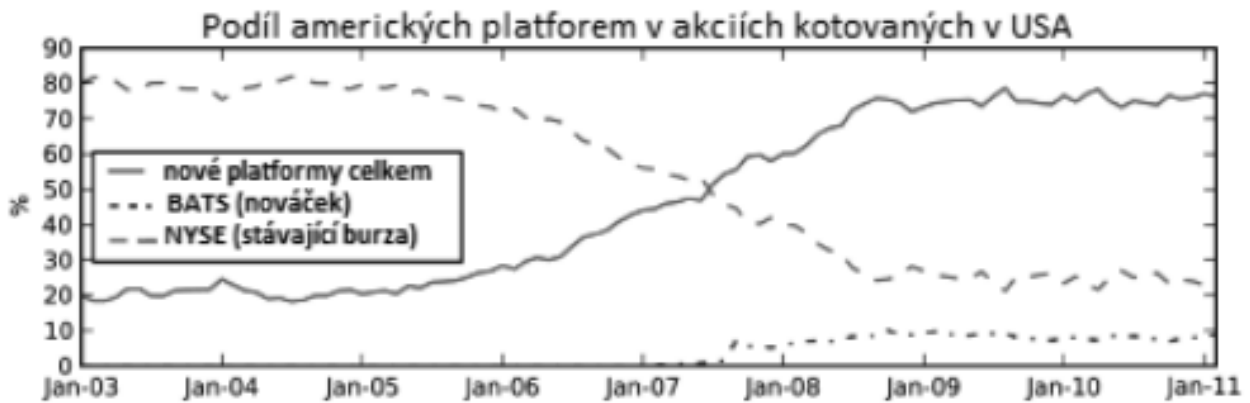
Market efficiency and stock market fees

Menkveld shows how the transition to e-commerce, with which AT / HFT is inextricably linked, has helped to create alternative trading platforms alongside traditional exchanges (eg Chi-X in Europe or BATS in the US). Prior to the advent of AT / HFT , several major stock exchanges had a de facto monopoly. [37] E- commerce has significantly changed this situation (see Graph 14).

Graph 14

The share of trading platforms in the volume of trades in Europe and the USA

Podíl evropských platforem v akciích kotovaných na evropských burzách

Legend:
— nové platformy celkem
··· Chi-X (nováček)
– – LSE (stávající burza)

37 In Europe, mainly the London Stock Exchange, Deutsche Börse and Euronext.

Podíl amerických platforem v akciích kotovaných v USA

Legend:
— nové platformy celkem
··· BATS (nováček)
– – NYSE (stávající burza)

Source: Barclays Capital Equity Research, FESE (Menkveld, 2011, p. 10).

Sharpening the competitive struggle between business systems is reflected in narrower spreads (see above), improved infrastructure and the declining exchange fees (Friederich, Payne, 2011, p. 13). In 2000, when all trades were still conducted through traditional brokers, the average fee for institutional investors in Europe was 25-40 basis points. Eleven years later, when around two-thirds of institutional investors' trades are executed electronically (*no touch*), fees for electronic intermediation range between one and three basis points. Also and fees for the "classic" mediation (*high touch*) is reduced to 10 up to 15 points (see Table 3).

Table 3
Average fees for institutional investors in Europe

	2000		2005		2011	
instruction execution method	% of trades	charge*	% of trades	charge*	% of trades	charge*
"classic" (*high touch* - phone , etc.)	100	25-40	70	15-20	30-40	10-15
"new" (*no touch* - direct access to the DMA exchange)			30	7-8	60-70	1-3
* in basis points (hundredths of a percent)						

Source: IMC estimates (FIA, 2012, p. 10).

In addition to new trading platforms, new clearing houses have appeared thanks to the electronicization of markets . Only "fee war" between the newly arrived Dutch EMCF a traditional provider of clearing services LCH.Clearnet reduced fees for clearing within one year, half (Menkveld, 2011, p. 13).

Last but not least, AT / HFT leads to greater interconnection of markets and thus to their higher efficiency. Thanks to AT, related markets are more predictable and synchronized. When the market appears even the slightest inaccuracy because some asset does not respond adequately to changes in other assets, ignites a battle of algorithms on it, who this opportunity to use the best and fastest. That, however, does not lead to higher volatility, more rozkývaným markets, but only to ensure that the changes are transmitted more quickly. HFT also unites geographically different markets with the same asset. Even investors who do not use proč combed ' algorithms dripping " more markets in an effort to find you the best price, as with other markets indirectly linked activities algorithmic traders. In principle, it thus gains the benefits of a large market without having to leave its home market (Menkveld, 2011, p. 14). HFT traders who constantly comparing related markets and seeks to offer the best price, is also a significant extent contribute to the process of finding prices. According to Brogaard, even to a greater extent than non-high frequency traders (Brogaard, 2010, p. 2).

System risks and other pitfalls of AT / HFT

The advent of AT / HFT has brought many changes, the impact of which is not easy to assess. The "new pike in the pond" has undoubtedly caused the size of the average transaction to decrease - see Chart 15.

Graph 15
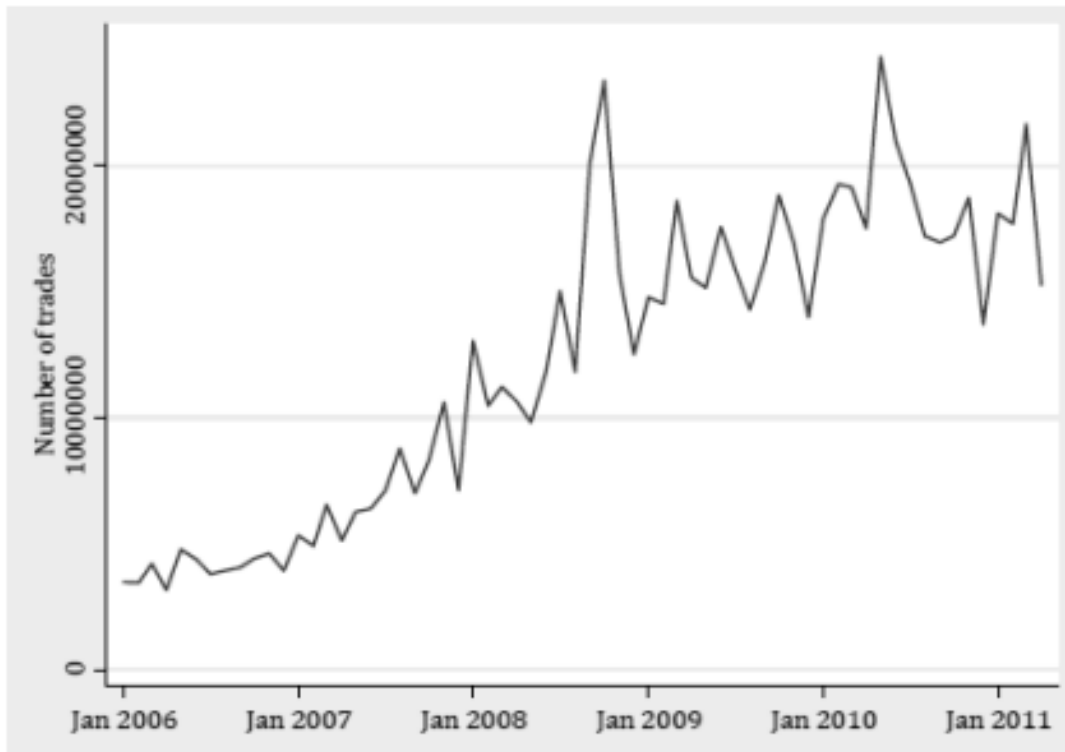**Average trade size on LSE and Euronext (in GBP)**
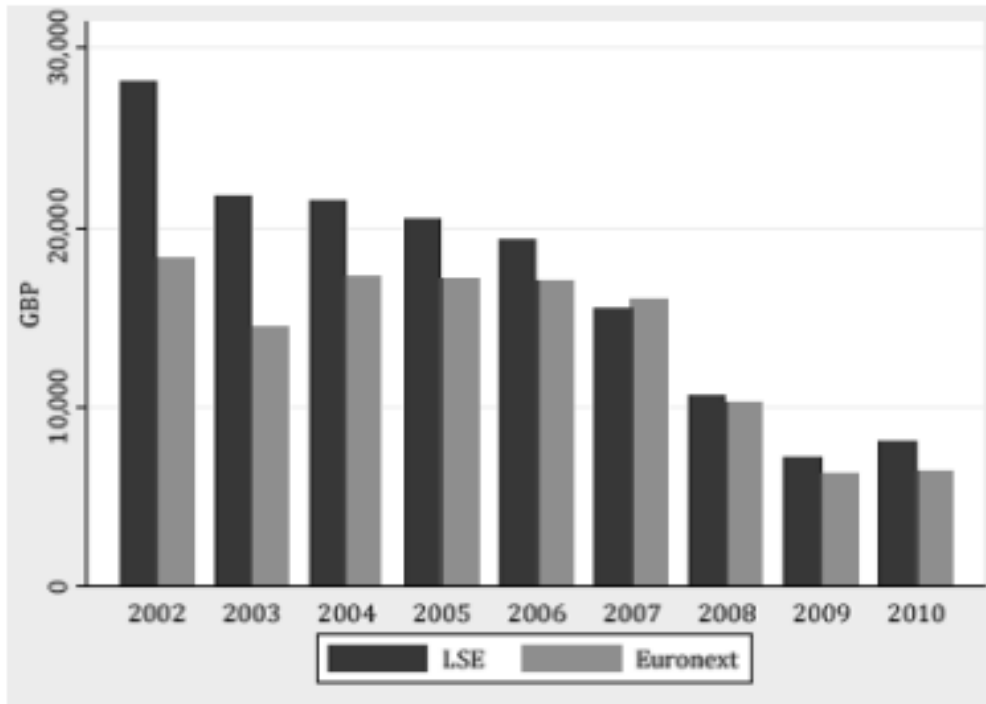
Source: Friederich, Payne, 2011, p. 18.

At the same time , the number of trades is
increasing (Chart 16) and instructions (quotations) are placed on the stock
exchange more often (eg Angel et al., 2010, p. 21).

Graph 16
Number of trades in all order books, shares in the FTSE 100 index

Source: Friederich, Payne, 2011, p. 16.

AT These phenomena are difficult to assess if they have a beneficial or negative effect on the quality of markets . For example, the growing number of trades may not be *per se* anything wrong. If market makers fulfills its role
of mediator, which increases the efficiency of markets, inevitably it leads to
a higher number of transactions. What bothers HFT's opponents more is
the increasing speed with which quotations are canceled again. There are more and more canceled quotations per trade (see Chart 17).

Graph 17
Ratio of canceled and traded orders (NASDAQ ITCH)
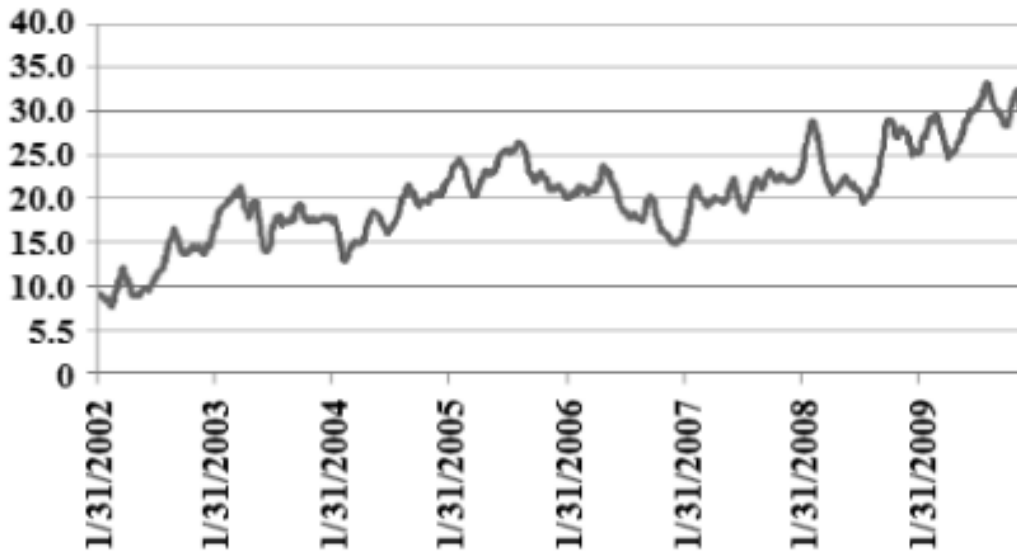
Critics point out that a large amount of quotations has not intended to traded, but just to confuse other players on the market. Indeed , there are cases where the rapid entry and cancellation of quotations serves unfair trading practices (see above). On the other hand, just the possibility to quickly react to changes on the market is not as algorithmic traders, especially market makers, reduces the likelihood of loss-trades. Without this option, they would have to quote less or would have to cover wider spreads. Another concern is that frequent entering and deleting instructions will overwhelm the stock exchange system. To prevent this, exchanges have introduced caps to cancel quotations. [38]

Most opponents of the AT point to systemic risk that a new form of commerce has brought. The most common example where HFT traders had cause chaos in the market, the situation of May 6, 2010. During the so-called. Flash Crash has started to fall steeplyAmerican stock exchanges and consequently even more markets. The Dow Jones Indust rial Average lost about a thousand points in a matter of minutes. Even before that, however, the index fell by 300 points, because the market was uncertain about the situation in Greece, where the first anti-government protests began in connection with the debt crisis. So the markets could hardly be described as calm.

Award blame for the sudden drop HFT traders is misleading, even though up to 80% of US retail investment advisors have thought that after slump could (Kirilenko et al. 2011, p. 2). All indications are that the slump caused by poorly executed algorithm Kansas investment company Waddell & Reed (Gordon, Wagner, 2 010), which on the market with futures on stock index S & P 500 [39] began selling large quantities of contracts without regard to their cost. Study *The Flash Crash: The Impact*

38 *Order-to-trade ratio* or *order-to-execution ratio* .
39 E-mini S&P 500 stock index futures market.

of High Frequency Trading on an Electronic Market , which examines in detail the structure of trades on this market on a given day, clearly states that it was not in the power of HFT traders to cause or prevent bankruptcy. According to the study, the *flash crash* caused by the sale of 75,000 contracts (worth 4.1 billion US dollars), while the total open position of HFT traders together exceeded before the crash only rarely 3 000 contracts (Kirilenko et al. 2011, p. 5).

Contrary to popular opinion (egg Salmon, 2012) that HFT traders *changed* their behaviour significantly during the *flash crash* and left the market to a large extent, the work of four American scientists claims the opposite. Initially, they bought contacts from long-term investors. After a few minutes, they began to contract to sell, so in some word meaning "exacerbated the tendency of falling prices." The so-called hot potato effect occurred, with HFT traders starting to sell contracts to each other very quickly until falling prices attracted long-term investors who entered the market and bought contracts (Kirilenko et al., 2011, p. 31). Graph 18 shows a similar entry of non-algorithmic traders in the EUR / USD forex market. After about half an hour, the situation calmed down and the markets returned to about the same level as before the *flash crack* .

Graph 18
Number of instructions entered algorithmically and manually during May 6 , 2010, EUR / USD market
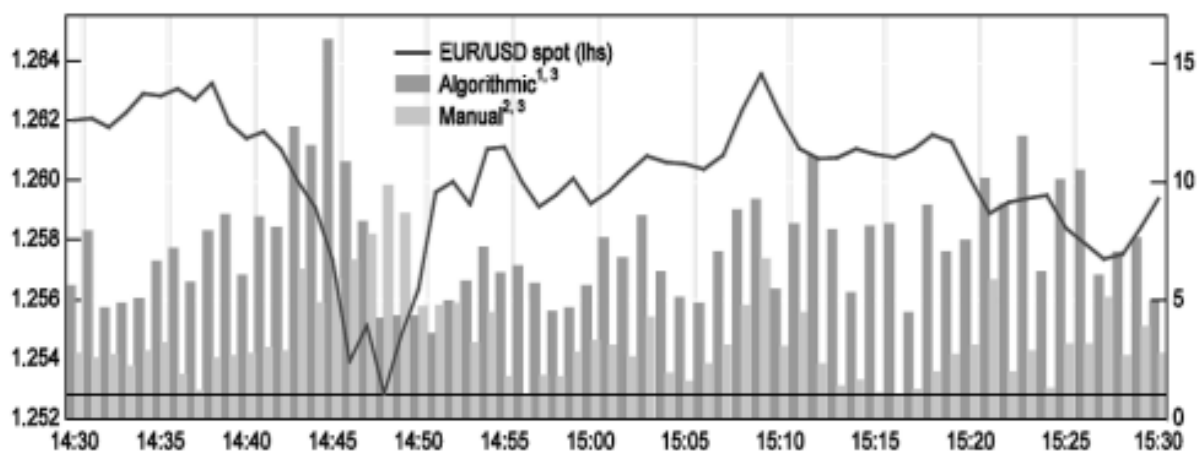
- 1 - počet pokynů umístěných algoritmickými obchodníky 6. května vydělený počtem pokynů jimi v průměru umístěných ve stejnou dobu během 25 předchozích obchodních dnů
- 2 – stejný údaj pro ne-počítačové obchodníky (*manual traders*)
- 3 – poměr vyšší než jedna (pravá osa y) znamená vyšší než průměrnou aktivitu

Source: EBS (BIS, 2011, p. 16).

As a result of the *flash crash* , measures have been taken in the US to prevent a recurrence of a similar situation . On the one hand , *stub quotes* have been banned , ie instructions that are deliberately placed on the stock exchange so far from the real price that they are almost never traded. If the price of an asset deviates too much, it may unexpectedly traded and the   situation is the worse. To this was according to some experts come just three years ago (Gomber et al. 2011, p. 46). Furthermore, US authorities have introduced safety fuses (*circuit breakers*) that interrupt trading will begin when the price changed too quickly. This will give "human" traders the opportunity to find out what caused the change.

Furthermore, the modified rules for situations where the exchange retroactively cancels the underlying business, because there was a "false trading" (*Erroneous trade*). Uncertainty about these rules often discouraged traders from trading in volatile markets, although their intervention may have calmed the markets.

For the fact that at some point the market is shallower than it used to be, you can find even more reasons. Compared to a "human" market makerům the algorithms avoid opening too large positions because of their closure lasts longer, which can increase costs. Another reason for "erratic" Liquidity is that the algorithms can be downloaded from the market if the development does not resemble anything that you "know", ie if the development does not correspond to any known situation before. In addition, the traditional floor trading on the stock exchange often named ofici- álního market maker, whose duty was to "defy the wind," especially in times of reduced liquidity. HFT traders and even algoritmičtí makers market a duty to do (Menkveld, 2011, p. 14). Brogaard in his work from the year 2012 draws attention to the possibility that the sudden disappearance of liquidity can in turn cause nevysokofrekvenční traders, who in times of increased volatility leaving the market. The motive has to be the fear of adverse selection by HFT traders continue to trade and in these situations may well use their speed advantage (Brogaard et al., 2012, p. 27).

AT may lead to the fact that the algorithms "fail panic" and become gregarious buy or sell. This danger but it is not anything new. Even earlier, when only people decided on business , herd behavior took place. After all, it can be argued that AT is in a way a safer combination, because the trading of the algorithm is always supervised by staff. Combination of computer-man by then the system could be robust.

Short bubble or Crash is not for the economy certainly no benefit, but are not bubbles term, what is able to shake the world economy. The mortgage crisis in America was not based on algorithms, but on human decisions. However, there are studies napoví- mar gin, the AT, including its HFT variants harm the interests of long-term investors. This is true even for the most watched market that the US shares (Hasbrouck, Saar, 2012, p. 34).

With regard to *flash crashes* and other market "confusions" that have been *hampered* by poorly programmed or executed algorithms, it is also worth noting that the biggest cost is often borne by the person who caused the problem. Most recently, the American company Knight Capital, which suffered $ 440 million in 45 minutes in August 2012 due to a faulty algorithm (Rundle, 2012). At the same time , they have existed similarly since the emergence of electronic markets

"Human" issues - for example, so-called. Fat-finger-
error, which is a businessman "umáčkl". There is also a known case where
a drunk trader placed so
many instructions on the ICE market in June 2009 that at one point, he should
have been responsible for up to 69 % of the traded volume (Treanor, 2010).

Conclusion

High
frequency trading cannot be defined simply and clearly . The best criterion by which we
can judge whether a given trader is high frequency is the frequency of his instructions sent to
the stock exchange. However, it is not at all clear where the line between HFT and other types
of algorithmic trading should lie. Moreover, such an effort will have
no other than purely academic benefit. An alternative would be to declare trading models as
HFT, where algorithms decide on the entire life cycle of the stock
exchange order (*algorithmic execution*). Even in this case , however, it would be a very roug
h tool. For regulatory purposes, it seems much better to focus on the individual strategies that
algorithmic traders follow in the markets.

From empirical research suggests that HFT traders will often focus on
a passive strategy of creating markets (*market making*). And it is precisely this strategy
that contributes most to the positive effect of HFT on market liquidity , especially in the form
of narrower spreads and deeper markets. AT and HFT also enabled the emergence
of new trading platforms, which was reflected in better infrastructure and lower stock
exchange fees. At the same time, AT / HFT connects fragmented markets and thus increases
their efficiency.

AT / HFT has undoubtedly caused a number of changes in the markets, the impact of
which is not yet easy to assess. Some of them, such as *flash crashes* , are clearly negative, but
the question remains how far they affect market efficiency. Nor do the same or at
least comparable problems seem to exist before the advent of e- traders.

Undoubtedly, further academic research will be needed to definitively
determine whether the positives outweigh the negatives. [40] Most studies examining AT / HFT
conclude that algorithmic trading, including its high-frequency variant, does not harm
markets, but rather benefits markets. In particular, *market making* , as one of the main
strategies of many HFT traders, is most likely to increase the quality of markets .

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DEFINITION, BENEFITS AND RISKS OF HIGH-FREQUENCY TRADING

Abstract: The paper deals with high-frequency algorithmic trading (HFT), which has recently come to dominate some fi nancial markets, eg the US equity markets. The author fi rst attempts to establish a clear de fi nition of high-
frequency trading. With the most impor- tant characteristics having been analyzed, it is concluded that such a de fi nition would not bring more clarity into the debate over HFT. Strategies pursued by traders should
be given consideration instead. On this account, the text proceeds with the examination of the most common strategies. Afterwards, the question is raised whether the rise of high- frequency algorithmic traders has resulted in more ef fi cient fi nancial markets. Based on robust evidence from academic research, Important market participants and exchanges, HFT indeed Seems to Improve market quality by narrowing spreads and Providing addi- tional liquidity - the market-
making strategy is Mainly Responsible for the latter. Issues such as possible system risks (fl ash crashes, herd behavior) are also discussed.