

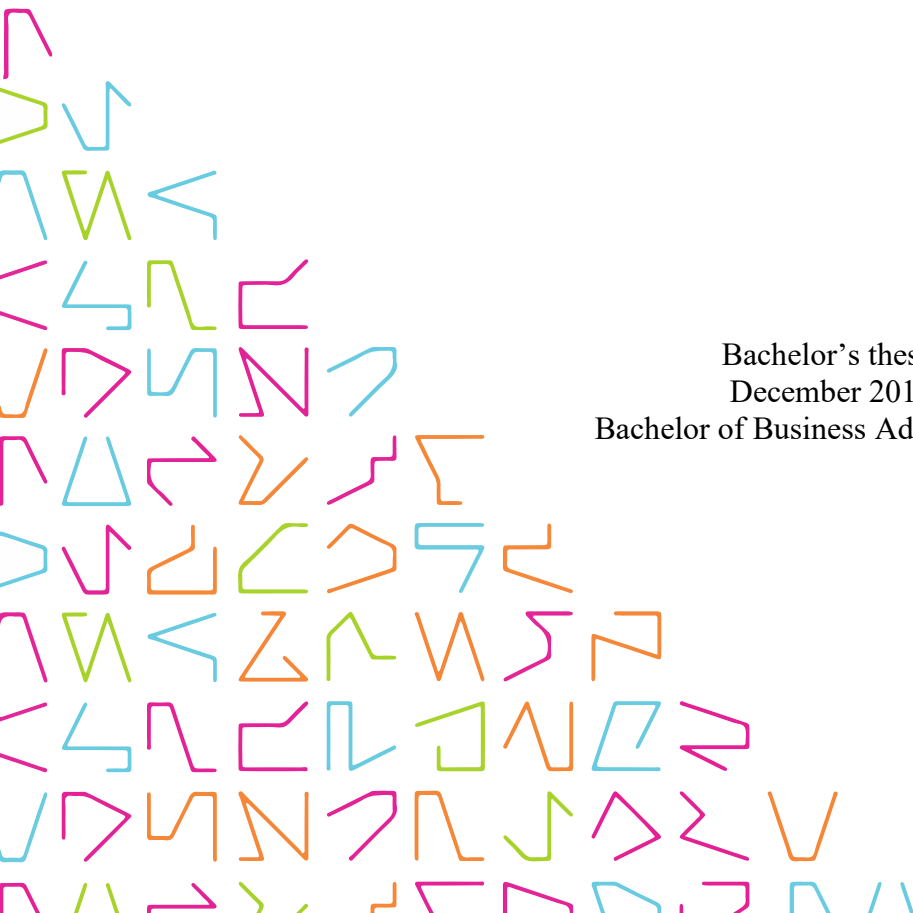


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THE POSSIBLE EFFECT OF MARKETS IN FINANCIAL INSTRUMENTS DIRECTIVE 2 ON HIGH FREQUENCY TRADING

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ABSTRACT

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This paper analyzed the possible impact of Markets in Financial Instruments Directive 2 on high frequency trading firms based on a theoretical study. In order to achieve this, the paper introduced the general concepts of high frequency trading, its potential market impact and methods applied by high frequency trading firms. Soon after, the paper examined the new regulation, focusing on the legislation concerning high frequency trading. These two parts created the foundation for the third part of the paper, which focused on the organizational changes the new regulation will require high frequency trading firms to adopt, how it affects their market access, how MiFID 2 affects the trading venue selection of these firms and how it influences the profitability of different trading strategies of these firms.

Main findings of the paper were that MiFID 2 will have a negative impact on organizational flexibility and create additional expenses for high frequency trading firms in form of additional personnel expenses, which are the result of the new organizational requirements. This will create increased income expectations for the trading desks, slow down the implementation of new strategies and make the organizational structures of these firms more reminiscent of each other.

Furthermore, MiFID 2 will drive high frequency trading activities towards Regulated Markets and Multilateral Trading Facilities, due to restricted dark trading. New multilateral trading platforms, known as Organized Trading Facilities will also attract high frequency trading activity but in a lesser extent as these venues offer less liquid financial instruments for trading.

Finally, MiFID 2 will benefit high frequency trading firms practicing in market making, as the increased tick sizes will benefit them. On the contrary, some opportunistic trading strategies are penalized due to the new order to transaction ratio and harmonized tick sizes.

Market access does not face significant revisions. Access providers are required to be non-discriminatory and offer transparent fee structures. The more even playing field will diminish the advantage that bigger high frequency trading firms have enjoyed and transparent fee structures will help the firms to plan their finances with more granularity.

Key words: high frequency trading, hft, mifid 2, financial markets, trading venue

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ABBREVIATIONS

DEA	Direct Electronic Access
DVC	Double Volume Cap
EEA	European Economic Area
ESMA	European Securities & Markets Authority
ETF	Exchange Traded Fund
EU	European Union
FBA	Frequent Batch Auction
FX	Foreign Exchange
HFT	High Frequency Trading
ISIN	International Securities Identification Number
LIS	Large in Scale
MAR	Market Abuse Regulation
MiFID 2	Markets in Financial Instruments Directive 2
MiFIR	Markets in Financial Instruments Regulation
MTF	Multilateral Trading Facility
NYSE	New York Stock Exchange
OTC	Over the Counter
OTF	Organized Trading Facility
RPW	Reference Price Waiver
RTS	Regulatory Technical Standard
SI	Systematic Internalizer
UK	United Kingdom
USD	United States Dollar

Financial terminology is underlined when used for the first time, providing a link to a glossary at the end of the paper.

1 INTRODUCTION

What is MiFID 2? For those who are not into finance, the acronym does not say much, but its effect on Europe's economy is huge and it affects almost everything in financial markets. It is the latest directive from the EU that regulates the financial markets inside the EEA, which includes EU member states, Liechtenstein, Iceland and Norway (EFTA, EEA/Relations with EU). The directive aims to provide fair and transparent financial markets for all the market participants. (Josie Cox 2018, Independent)

MiFID 2 was implemented January 3 2018 and it is almost 7'000 pages, including its addendums. Needless to say, the legislation is broad and covers most of the financial markets. It took seven years to create the sequel for the original MiFID, resulting in even more extensive regulation than the previous one. Even prior to its release, traditional financial institutions recognized the challenges its implementation would bring, spending over 2 billion USD for preparations. (Jones Hadfield & Brush 2018, Bloomberg.) As the numbers demonstrate, the legislation is crucial for the functioning of the markets.

MiFID 2 was created by the EU, more specifically by the European Parliament and the Council of European Union. While these entities are quite familiar to the public, one less known organization that has been influencing the legislation is ESMA. Its role was to draft technical standards for the directive and give technical advice. In addition, ESMA is monitoring the implementation of the legislation, providing reports and has certain product intervention powers. (ESMA, MiFID 2) Having drafted the technical standards, it had a considerable power to propose quantitative limits that are to be implemented.

Besides the directive, automated trading forms another important topic for the study and before going into the methodology and the study itself, the paper should give a brief introduction on why the new technologies are under the microscope of the EU.

Financial markets have used computers in trading for decades and the fact that trading is becoming more and more electronic is nothing new, quite the contrary, it has been a trend

since 1970s (McGowan 2011). What has been a late development however, is the wide spread trading that does not involve human interaction at all.

HFT is the embodiment of this technological advancement. Broadly speaking, HFT is fully automated trading that relies on algorithms and extreme speed. It is not a trading strategy and has been difficult to categorize. MiFID 2 solves this problem by giving a definition and quantitative limits that once fulfilled, categorize trading as HFT. These limits will be discussed in a later section of this paper. (Directive 2014/65/EU, article 4(40).)

These algorithms are able to make decisions and trade in speeds that humans cannot, which has raised public concerns. As we are talking about such speeds, it means that the ordinary investor cannot compete using trading strategies, which require taking an advantage of short-term opportunities, such as some arbitrage strategies. Also, if one of the algorithms would malfunction, it could take too long before the staff responsible for the algorithm, or markets as a whole, would be able to intervene.

This discussion has brought algorithmic trading and especially HFT to the crosshairs of regulators. However, regulators have been challenged for years with the topic because it has been difficult to gather data that would allow waterproof conclusions. Additionally, the literature, just as the financial world for that matter, has been divided whether this type of trading is beneficial for the markets. (John Longworth, 2017, Are High Frequency Traders Good or Bad For the Markets.) What is clear, is that regulators should take action to one direction or another, demonstrating that the situation is under control, preserving the trust of other market participants. Now, after the release of MiFID 2 we have the answer from Europe's largest regulating body. The new legislation shows the markets how these high speed strategies are taken to an account.

These are some of the issues that the EU had to face when drafting the new legislation. MiFID 2's aim is to provide a transparent, fair and safe market place for all the participants. How the regulation succeeds in handling automated trading is important for the functionality of the markets, but also, how the public perceives the fairness of the market

place. EU has to convince the ordinary retail investor that their interests are taken to a consideration, and that they are offered fair prices and an opportunity to succeed.

To understand the effectiveness of the regulation and its practical consequences, the study evaluates the effect of the directive from HFT firms' perspective. Also, as HFT has an important part to play in the future of financial markets, the paper uses a forward-looking approach, providing examples on how HFT could adapt to the new environment. The next chapter will introduce the four research questions the paper is studying.

1.1 Main Areas

The paper has four main areas. First, **how MiFID 2 will change HFT organizations?** Little data is available on the organizational structures prior to MiFID 2 and considering the focus the legislation has on transparency, this will change. When examining the future and nature of HFT firms, organizations themselves are important part of it. More transparent organizations can increase the public's trust, but on the other hand, the legislation might change the operational costs of HFT firms by increasing the staff requirements. These factors make the organizational requirements relevant for the study as the aim is to provide a picture of the future prospects of these firms.

Second, **what is the effect of the directive on HFT trading strategies?** As the paper will demonstrate, HFT is not a strategy and individual firms might utilize several strategies. New regulation leads to a change in the market environment and this might make certain strategies more profitable than others. In the worst case from HFT firms' perspective, MiFID 2 might make some popular strategies non-profitable and forcing the firms that have been relying on the strategies to adapt or get out of business.

Third, **will MiFID 2 drive HFT activity to certain trading venues?** Under the new financial regulation there are several potential trading platforms, many of them used by HFT firms. If the legislation drives the activity of these firms to certain venues, it might

limit the selection of financial instruments, liquidity and trading strategies at their disposal. Also, due to negative public image, some investors might want to avoid interacting with HFT firms and the new legislation might offer an opportunity to do that.

Fourth, **is MiFID 2 restricting the market access of HFT firms?** In practice this means the effect for DEA and co-location services that are crucial for HFT firms to maximize their speed. Also, HFT firms have been well-known for their secrecy, and potential transparency requirements for market access could force them to give up information that they otherwise would not. The secrecy has been a result of fierce competition and a need for protecting intellectual property. (Jeff Cox 2014, CNBC.) These services are a central part of HFT and therefore in scope of this paper.

1.2 Approach

The paper studies the possible effect of MiFID 2 on HFT firms using theoretical study. This topic has not been discussed in research literature from the HFT firm's perspective. There is a robust base of academic work focusing on HFT in general, which evaluates the effect it has on different aspects of financial markets, for example the price discovery process, volatility and liquidity. The aim of this paper is not to discuss whether these trading strategies are good for other market participants or markets as a whole, instead the focus is on what MiFID 2 means for the investment firms practicing HFT.

The paper relies on academic studies and documents provided by the EU and ESMA. This is due to the fact that highly detailed trading data, which would identify the trades executed by algorithms is not publicly available. Also, as MiFID 2 was implemented recently, the data would not necessarily reflect the long-term impact of the regulation, which takes years to display itself. Additionally, the study focuses on firms practicing proprietary trading that do not execute client orders. This will diminish the impact of certain parts of MiFID 2, such as best execution obligations, which apply only when carrying out client orders.

1.3 Structure

The paper is divided to nine sections, which introduce different parts of the subject. **Section 1** is an introduction, providing the structure of the paper, the existing literature and how this paper will complement it. The section also introduces the relevant terminology, which is provided by the EU. **Section 2** focuses on HFT, providing a brief history, current trends and biggest market players. Additional focus has been put to different strategies implemented by these investment firms. **Section 3** introduces the trading venues under MiFID 2. **Section 4** introduces MiFID 2's structure, aims and how it ties in with HFT. **Section 5** is where the paper goes through the different obligations imposed on HFT firms and answers the four research questions listed previously in the paper. **Section 6** will consider the possible applications of the findings. **Section 7** concludes the study giving a short summary of the effects and what this means for the future. **Section 8** lists all the sources which were used to complete this study. **Section 9** is an annex that includes a glossary of financial terms used in this paper.

1.4 Literature

This paper utilizes already existing literature covering the area. While there is an extensive research literature covering HFT itself, studying areas such as, whether it has a positive market impact or not, does it provide liquidity to the market, how profitable are the investment firms using HFT as their main source of income, and does it expose markets to new risks, there is no research literature focusing on the EU legislation that would examine the day-to-day challenges it imposes on HFT firms. This paper aims to fill that gap and provide insight on how HFTs are forced to adapt and how it might affect the different trading strategies implemented by them.

Maybe the most similar paper by subject has been Busch (2016), which provides a look into MiFID 2 obligations aimed at HFTs and direct electronic access providers. On the surface this seems to be the aim of this paper as well, but Busch (2016) approaches the subject from different angle. He summarizes the relevant regulation but does not discuss

the potential consequences from HFT's perspective. This paper aims to answer that question and evaluate, whether the legislation impacts other HFT strategies more than others and whether the new organizational requirements result in significant changes. Nevertheless, Busch (2016) will serve as an important source for the study, while this paper builds on the already existing base of knowledge. (Busch 2016.)

Clark and Ranjan (2012) support the study regarding the section covering the organizational requirements for HFT firms. Their paper sheds some light on the risk management structures and procedures of HFT firms prior to MiFID 2. As this paper studies the effect of MiFID 2, it is necessary to get a reference point in order to evaluate the severity of the changes associated with the new legislation. (Clark & Ranjan 2012.)

Hagströmer and Nordén (2012) is another important research paper, which studies the diversity of HFT strategies. The paper divides HFT firms to market makers and opportunistic HFTs. Hagströmer and Nordén (2012) give a clear explanation on how these strategies differ from each other and why it is relevant from a regulatory standpoint. This enables the paper to evaluate the possible effects of the legislation for both groups, as different regulatory obligations affect different aspects of trading. (Hagströmer & Nordén 2012.)

As briefly discussed in the first paragraph of this chapter, there are papers studying the market impact of HFT, such as Kirilenko, Kyle, Samadi and Tuzun (2010) and Brogaard (2010). Few covering the possible strategies regulators could implement, namely Prewitt (2012) and Korsmo (2013). Also, McGowan (2011) studies the controversy surrounding computerized trading, which this paper is going to refer to. Additionally, Chaboud, Chiquoine, Hjalmarsson and Vega (2012) covers HFT in FX markets, examining the effect of HFT on price discovery process. These papers are providing the background for the study, answering questions such as what type of arbitrage strategies HFT firms implement and which important market events might have been the result of HFT trading. (Kirilenko etc. 2010, Brogaard 2010, Prewitt 2012, Korsmo 2013, McGowan 2011, Chaboud etc. 2012.)

On the regulation side, the paper refers to Directive 2014/65/EU, known as MiFID 2, which is at the center of this study along HFT. The directive defines the regulatory obligations for HFT firms, but also acts as a basis for the paper's definitions. The paper uses MiFID 2's definitions in order to be consistent when discussing what is in scope, the aim of the regulation and what obligations are imposed. (Directive 2014/65/EU.)

But the directive is not applicable by itself, it refers to Markets in Financial Instruments Regulation (EU) No 600/2014 also known as MiFIR, which supplements the directive and is therefore in scope of this paper. There are also Regulatory Technical Standards drafted by ESMA, which give more detail on the obligations imposed by the previously mentioned legal instruments. Especially, RTS 6 and its annex will be in close examination, as it is directly aimed at HFT firms and states the organizational requirements that these firms should fill. (EU, Technical standards under directive...)

On top of the sources listed above, the paper will use ESMA's latest publications to examine market developments after the implementation of MiFID 2. Also, news articles are used to cover current developments that have not been studied in research literature.

1.5 Definitions by MiFID 2

It is fundamental for the study to use the terminology in the same manner as it is used in the regulation to stay consistent and arrive to right conclusions. Therefore, the paper will benefit from the definitions offered by MiFID 2, in order to accurately describe the scale, intentions and consequences in accordance to the legislation.

1.5.1 Regulatory Terminology

In order to discuss about the magnitude and the application MiFID 2 legislation, the paper has to clear up such concepts as directive, regulation and regulatory technical standard. According to the glossary provided by the EU, a directive is a legislative act of the EU which imposes obligations to member states, but instead of dictating how member states

should approach certain issues, it gives results that member states should be able to achieve, but they can do so in a way which is the best for their country's interests. (Glossary of useful terms linked to MiFID 2.)

What separates regulation from directive is the fact that regulation does not leave room for improvisation from member states' perspective. Therefore, these regulations should be followed and implemented to each country's markets identically, as stated in the legislation. This means that MiFIR should be implemented as it is by every Member State, while MiFID 2 states the end results each state should achieve on their own terms. (EU 2018, Regulations, Directives and other acts.)

Regulatory Technical Standards are designed to supplement the main legal instruments MiFID 2 and MiFIR. They are drafted by ESMA and bring further detail on quantitative thresholds and procedures mentioned in those legislations. (Directive 2014/65/EU, Article 1(157).)

1.5.2 Terminology for Financial Markets

DEA is an arrangement where investors buy direct access to a market from a market participant or member of the venue. This allows the investor to use the trading code of the participant to electronically trade at the market. There are two subcategories to DEA: The first one is Direct Market Access, where the investor is using the participant's infrastructure. In the second, Sponsored Access, the infrastructure of the participant is not used. (Busch 2016.)

HFT firms often use DEA as it allows them to be faster than when trading through a broker. For this reason, the new obligations binding DEA providers might have a significant impact on HFT firms.

Co-location is a term used for placing servers in close proximity to trading venue's matching engine, which is responsible for matching the buy and sell orders on the trading venue. Some venues offer these services for investment companies and sell space inside their

data centers. Co-location is relevant for HFT, as every fraction of a second counts for strategies such as latency arbitrage, which will be discussed in a later part of this paper. Placing their servers as close as possible to the matching engine, investment firms can minimize latency and gain a competitive advantage as they receive the information before the other market participants. Therefore, the paper evaluates the changes to co-location services brought by MiFID 2. (Busch 2016.)

1.5.3 High Frequency Trading Terminology

HFT, which is in the core of this paper has been defined by MiFID 2 as a group of trading strategies depending on minimizing latency by optimizing infrastructure, utilizing co-location, DEA and proximity hosting. The trading itself is executed using algorithmic trading techniques, as maximum speed is achieved by eliminating human intervention. Therefore, defining algorithmic trading is a necessity to get a grasp of HFT itself. (Directive 2014/65/EU, article 4(40).)

Algorithmic trading is defined in MiFID 2, article 4 as:

“‘algorithmic trading’ means trading in financial instruments where a computer algorithm automatically determines individual parameters of orders such as whether to initiate the order, the timing, price or quantity of the order or how to manage the order after its submission, with limited or no human intervention, and does not include any system that is only used for the purpose of routing orders to one or more trading venues or for the processing of orders involving no determination of any trading parameters or for the confirmation of orders or the post-trade processing of executed transactions” (Directive 2014/65/EU, article 4(39).)

What separates HFT from algorithmic trading is the reliance on speed mentioned in the first paragraph. For legal certainty Commission Delegated Regulation 2017/565 provides quantitative thresholds for intraday message rates, which are two messages per second on a single financial instrument or four messages per second in all traded liquid financial instruments. If the trading activity of a firm fills this criteria, it is considered as a HFT firm. At the end of each month, trading venues are obligated to provide this information

regarding the market participants of their venue for the competent authorities covering the past 12 months. (2017/565, article 17.)

However, as venues are providing the data from previous 12 months as of January 3 2018, regulators have to rely on estimates until February 2019. This means that EU has to wait before having accurate data and possibly some HFT firms are not authorized as such at the moment. (ESMA 2018, Q&A, 18.)

2 HIGH FREQUENCY TRADING

Computer powered trading has been the topic of discussion over the last decade, however it has been around for a long time. Exchanges started implementing computers into their daily activities, in hopes of gaining a competitive advantage in the markets, as soon as in the 1970's. NYSE introduced DOT (designated order turnaround) system 1976. The system supported electronic securities transactions at a trading post. (McGowan 2011.) In essence, electronic trading has not changed since, aside from increased speed and accessibility.

As discussed in the previous section, MiFID 2 defines HFT as use of algorithmic trading, which focuses on speed and minimizing latency. However, HFT is not a trading strategy in itself. Many HFT firms generate their profits using traditional trading strategies but gain an additional advantage due to the higher speed, which reduces exposure to price changes and time to react to new information.

HFTs also tend to end the trading day with a flat inventory, which means finishing with virtually no positions in financial assets. As expected, long term investing is not a part of the toolset HFT firms utilize, as they would not be able to profit from their speed advantage if assets are held over a long time span. For this reason, intraday holding periods are sometimes just fractions of a second. (Hagströmer & Nordén 2012, 2.)

2.1 Important Events

There have been numerous events during the last ten years that have brought HFT to the public's, as well as regulators', attention. Maybe the best known is the Flash Crash of 2010. The crash happened on May 6, 2010 and raised questions regarding the risks brought by HFT and the structure of financial markets. It was a short period of severe market volatility during a 30 minute timespan. US stock market indices, ETFs, stock index futures and options plummeted over 5 percent, after which they recovered even quicker. What makes this relevant regarding HFT, is that according to survey conducted

between June 23 and June 29, 2010 by Market Strategies International, over 80 percent of US retail advisors believe that HFT and the high reliance on computer systems caused the crash. Later studies, such as Kirilenko (2010) determined that the event was sum of many variables, but what matters is that HFT jumped into the public sphere, and not in a good light. (Kirilenko etc. 2010, 2.)

However, the Flash Crash of 2010 has not been the only event raising concerns about HFT. In addition, summer 2012 included few market events that were linked to HFT. First, the initial public offering of Facebook on May 18, 2012 was followed by a high volume of order cancellations in a rapid sequence that overwhelmed the computer systems of NASDAQ stock exchange. HFTs have been considered to be the reason for these cancellations, which caused problems with several trades. The second event was on August 1, as Knight Capital, a well-known HFT firm focusing on market making, bought high and sold low due to algorithm's malfunction. The firm lost 440 million USD, making the public question the integrity of stock markets. (Prewitt 2012, 133.)

Furthermore, there was a market event in the beginning of 2018 that was potentially exaggerated by HFT activity. Dow Jones Industrial average plummeted 700 points over a time span of 20 minutes, causing speculation whether the event was made more severe due to algorithmic trading. This demonstrates that HFT is still a current topic despite the decrease in the volume during the past few years. (Drew Harwell 2018, Washington Post.)

2.2 Largest HFT firms

In this chapter the paper will introduce some of the largest known HFT firms that operate in Europe. Many of the mentioned firms have their headquarters outside of Europe but as they access the European single market they are under MiFID 2 obligations.

Virtu Financial was founded 2008 and has since become one of the biggest players in HFT. While majority of the HFT firms have chosen to stay private so far, Virtu went public in 2015, and in 2017 it merged with KCG Holdings. (Virtu Financial, History.)

The firm is a direct member of major European exchanges and MTFs (Virtu Financial, About).

The firm focuses on market making and uses big data, which means collecting and archiving extensive amounts of data to produce statistical models. The firm trades equities, commodities, currencies and options in all the major markets around the globe. The firm reported to have generated a loss only during one trading day between 2010 and 2015. (Bernard Marr 2015, Forbes.)

Another considerable HFT firm is Citadel Securities, which is also a market maker. It opened an office in Dublin 2017 entering European options and ETF business. (Citadel Securities, About Citadel Securities.) Currently, it is providing market making in 35 countries, mostly in equity instruments and options (Citadel Securities, Products). In 2015 the firm had 26 billion of assets and had outperformed its peers since financial crisis of 2008 (Lawrence Delevingne 2015, CNBC)

A firm with a different approach is Hudson River Trading that emphasizes their scientific approach. Their website has a slogan: *Built by coders. Led by coders*, differentiating their mentality from their more finance-minded peers. The firm employs 190 people around the world and has offices in London. (Hudson River Trading, About.)

In addition to their different approach, the firm was responsible of five percent of overall equities trading in US in 2014. It also holds 25 percent of its trading assets overnight, which is considerably larger amount than an average HFT firm. (Bradley Hope 2014, Wall Street Journal.)

Lastly, the paper introduces Maven Securities, which was founded in 2011 in London and specializes proprietary trading, investment management and market making. Currently the firm employs over 166 people has expanded its operations to Hong Kong. It holds memberships in major European trading venues, such as Euronext Amsterdam and Euronext Paris. (Maven Securities, Home Page). Back in 2013, when the firm employed only 18 people, the firm reported annual revenues of 18.9 million British Pounds (Tim Cave, Financial News).

2.3 High Frequency Trading and Financial Markets

In this chapter the paper discusses the relevance of HFT in the current market place and the latest trends, which are either enforced or reversed by MiFID 2. The peak of HFT was around 2009 when HFTs were responsible of 60 percent of trades in the US stock markets, while numbers being lower in Europe, where markets were slower to adopt the new technology. However, there are signs that HFT activity has decreased during the past few years, representing around 50% of trades in the US. (Joshua Warner 2018, Why has HFT decreased.) Furthermore, according to Brogaard (2010), HFT involvement varies from day-to-day and per financial instrument. HFTs usually trade more large stocks, which offer the liquidity for large amount of transactions. (Brogaard 2010, 2274.)

The reason for decline has been a sum of many variables such as, lower volatility in the markets during the past years, which has decreased the opportunities to profit from price changes, higher costs, and tighter competition. Many opportunistic trading strategies such as arbitrage are profitable only for the fastest HFT, which is able to profit from the price misalignment. Increased competition means more firms are sharing the same pie, therefore decreasing the profitability of individual firms. (Joshua Warner 2018, Why has HFT decreased.)

The best profitability estimation available for this study was conducted by Brogaard (2012), who estimated the overall annual revenues of HFT firms in their sample, which settled around 5 billion USD. This sum was divided between 26 HFT firms that were observed in the study. Despite being seemingly a large profit, Brogaard (2012) also mentions that this is only a revenue estimation and does not tell anything about the costs, such as technology costs and capital employed. However, as stated in the previous paragraph, the profitability has declined over the past few years and Brogaard (2012) used sample data from 2008 and 2009. (Brogaard 2012, 2290)

2.4 High Frequency Trading Strategies

This chapter discusses different strategies implemented by HFT firms. Many of the strategies are traditional trading strategies, such as market making and arbitrage. However, individual firms can implement several of these strategies and dividing firms in different categories is complicated in practice. Nevertheless, understanding potential differences in business models helps us to examine how these firms are affected by new regulation.

2.4.1 Market Making

First, we are going to divide HFT firms into two categories, market makers and opportunistic HFTs. Market making, which according to Hagströmer and Nordén (2012) is increasing liquidity in the market place, has been around as long as the stock exchanges themselves. (Hagströmer & Nordén 2012, 26.) Traditional market maker buys and sells securities to provide liquidity to the market place. They are profiting from the bid/ask spread and additionally, as they make trading easier for all the participants. This attracts more traders to these exchanges, some exchanges additionally offer lower transaction fees for market makers. (Prewitt 2012, 135.)

HFTs are able to profit from the spread while exposing themselves to lower risk than traditional market makers, as additional speed means less exposure to price changes and more transactions. (Prewitt, 2012 135.) Market making contributes to the largest amount of trades among the HFTs. According to Hagströmer and Nordén (2012) over 80 percent of HFT limit order submissions were traced to market making at NASDAQ OMX in their study. For this reason, such measures as transaction taxes would affect mainly the market making HFTs. (Hagströmer & Nordén 2012, 1.)

HFT firms practicing market making clearly benefit the markets. They are providing liquidity and also mitigate volatility. (Hagströmer & Nordén 2012, 37.) While these HFT firms seem to be the ones all the market participants would want to have in the market, there has been some controversy regarding them as well. Mostly, the concern has been the lack of regulation regarding the liquidity provision. Traditional market makers are

part of exchanges' market making programs and are obligated to provide liquidity even in the case of stressed market conditions. This is the period when the additional liquidity is needed the most and therefore, these arrangements seem reasonable for all the participants. However, considerable amount of HFTs exercising market making did not participate in the programs prior to MiFID 2, which means they could pull out the market when they are needed the most. This has caused concerns among majority of the traders and dislike among traditional market makers who are obligated to follow these contracts. (Prewitt 2012, 135.)

2.4.2 Opportunistic High Frequency Trading

As mentioned in the previous section, most of the HFT volume falls under market making. However, these are not the firms that have been causing public controversy and concerns, as market participants see the value of effective market making. Opportunistic HFTs on the other hand, have been practicing some controversial trading strategies and many investors believe that these firms are not providing any additional value to the market place. But just as HFTs in general, opportunistic HFTs are not a homogeneous but a diverse group, which utilize different strategies. Often times a single firm uses several strategies, for example momentum trading and arbitrage. (Hagströmer & Nordén 2012, 11.) In this categorization, opportunistic HFT includes all the other strategies except market making. The paper is going to introduce some of the strategies included in this group.

Arbitrage

Arbitrage strategies focus on profiting from price differences. When there is misalignment between two or more securities, which routinely move in sync, the firm or investor exercising arbitrage buys the cheaper one and sells the more expensive one, continuing to profit from the misalignment until the price difference is erased. HFTs can exercise this strategy even when price differences are miniscule, or the timeframe is a fraction of a second. HFTs are able to profit from arbitrage opportunities such as identical assets between exchanges, between a derivative and its underlying, and between ETFs and its underlying securities. Unique arbitrage strategy for HFTs is latency arbitrage, which takes

advantage of the delay between a move of the market price and the time market makers update their quoted prices. (Prewitt 2012, 136.)

An example of arbitrage strategies is from the research paper conducted by Chaboud (2012), where algorithmic traders are practicing triangular arbitrage between the three studied currency-pairs, USD-Yen, USD-Euro and Euro-Yen. Euro-Yen is the least liquid of the studied currency-pairs, meaning it is often times trailing in price the other two. This gives an opportunity to HFTs to see the price development of both Euro and Yen against the USD, and when there is a discrepancy between the valuations, execute trades on the Euro-Yen currency-pair to close the price gap and gain profit. (Chaboud etc. 2012, 3.)

Liquidity Detection

Liquidity detection strategies revolve around large hidden limit orders, which cause movements in price. For example, a large institutional trader is selling a large amount of shares in parts over time, because selling all of them at once would drive the price of the asset down, hurting the profits. HFTs use algorithms to recognize patterns, which would imply for such a seller. Then, HFTs are aiming to profit from the price movement caused by this large trade. (Prewitt 2012, 135.)

Momentum Trading

Momentum trading is where HFTs use algorithms to foresee short-term price movements, then trading directionally with the movement until it ceases. Additionally, it might include statistical strategies such as mean aversion, and event trading where HFTs react to central bank policies. High speed allows HFTs to react first to the new information, giving them an advantage when trying to profit from events or short price movements. (Prewitt 2012, 135.)

3 TRADING VENUES

HFTs tend to operate in the most liquid markets and trade the most liquid assets. This is due to the fact that most of the HFT strategies need quick access to the seller and a buyer in order to profit from the short term price changes. This is common for both, the market makers and the opportunistic HFT firms. For this reason, HFT firms are not taking part in OTC trading, which is done one-on-one basis by definition.

Examining different trading venues is relevant, as the regulation might drive HFT activity to certain venues, if the regulation changes the market landscape in a way that allows HFTs to gain higher profits in one venue against the other.

3.1 Regulated Markets

Regulated markets are officially recognized trading platforms, including some of the best know market places such as the London Stock Exchange and the Deutsche Börse. Regulated market operators in not allowed to exercise discretion, thus all the trading decisions are done by the counterparties. A wide range of instruments are traded in regulated markets, including equities, debt instruments and different derivatives. Due to the reasons above, these platforms offer an extensive liquidity pool and are used by HFTs regularly. (Regulated Market, emissions-EUETS.com, 2018.)

MiFID 2 does not fundamentally change how the regulated markets function. Trading executed on these platforms is under the same transparency requirements as on the other venues and MiFID 2 does not impose new limitations for trading specifically on regulated markets.

3.2 Multilateral Trading Facilities

Multilateral Trading Facility is an alternative trading venue introduced in the first MiFID in 2007. These are regulated venues operated by an investment firm or a market operator that compete with traditional exchanges such as the London Stock Exchange and the Deutsche Börse. The main difference between regulated markets, is that MTFs do not have the official recognition and can be operated by an investment firm. Additionally, they are legally centered on the country, while some regulated markets are reaching over the borders to create a larger global economy. (Leal 2014, 4.)

Some of the biggest European MTFs are Chi-X, Turquoise and BATS, which are operating in UK. These venues have been able to capture a formidable market share due to technical advantages that provide faster trade execution and lower fees. All of the previously mentioned MTFs also operate with maker/taker pricing scheme. This is where orders taking liquidity are charged and liquidity providing trades are rewarded with a liquidity rebate. This is especially beneficial for market making HFTs who are operating on these venues. (Riordan, Storkenmaier & Wagener 2011, 6.)

MTFs are highly attractive for HFTs as they offer trading in the most liquid asset classes such as, equities, options and futures. Some of the biggest FX trading platforms are also registered as MTFs, such as Thomson Reuters' FXall. (Thomson Reuters, Products.)

MTFs got a similar treatment from the EU as regulated markets. The Union seemed to be satisfied with the functioning of MTFs and does not impose new obligations that would change the purpose of these platforms.

3.3 Organized Trading Facilities

MiFID 2 created a new trading platform called Organized Trading Facility, which is similar to MTF in several ways. Key difference is the fact that the entity operating OTF is allowed to exercise discretion, which means the operator is making the trading decisions instead of the counterparties. (Emissions-EUETS.com, Organised Trading Facility, 2018)

For this reason, OTF operators are under the investor protection obligations imposed by MiFID 2. (Financierworldwide.com, OTFS: How they differ from MTFs, 2015) Additionally, OTFs are not permitted to trade equities, which are often times a part of HFT firms' strategies. In general, as OTFs are better suited for less liquid products such as instruments previously traded OTC, the HFT would generally prefer operating in MTF platforms. However, different futures and FX instruments might attract some HFT activity to the venues. (Euromoney.com.)

3.4 Dark Pools

Dark pools are trading venues without a public order book, which mean the traders are in the dark without information about the identity or intentions of the counterparty. These details are publicized after the trade has been executed. The advantage of this information delay is when large institutional traders are trading large quantities, as the lack of information minimizes the price impact of large trade. This allows institutional traders to sell large blocks of assets without creating a downward pressure in prices, which would lower profits. Also, as dark pools do not pay exchange fees, the traders are able to enjoy lower transaction costs. (Investopedia, An Introduction to Dark Pools.)

However, dark pools have caused controversy, as their use might mean that the prices at the exchanges do not reflect the real price due to the trailing information flow. Additionally, dark pool participants are also in the dark, which might lead to worse prices for them as well. (Investopedia, An Introduction to Dark Pools.)

Also, the recent data that shows the declining trade sizes in the dark pools has caused discussion, as their original purpose was to allow large trades with minimal price impact and that does not seem to be the case anymore. (Investopedia, If You Buy Stocks Online, You Are Involved in HFTs.)

However, MiFID 2 has put considerable effort on regulating these trading platforms. Its best execution obligations limit the amount of client orders directed to dark pools, as the broker is required to provide a rationale why dark pool would offer the best price. Also,

under MiFID 2 most of the dark pools are now MTFs, which operate under Reference Price Waivers. RPW allows the venue to trade in the dark, but it obligates the venue to set prices in the middle of the spread of the reference venue. However, MiFID 2 imposes a double volume cap per liquid instrument traded under RPW, which are 4% on one venue and 8% across all venues. If the instrument exceeds this limit, it will be banned from RPW trading for 6 months. (Zhu & Comerton-Forde 2018, Oxford Law.)

Additionally, MiFID 2 keeps the Large in Scale waiver, which means that once the trade exceeds a certain instrument specific amount, it will not be counted into volume cap, allowing large block trades still happen in the dark. This has caused creation of venues, which are focused on large trades and keep their trades in the dark using LIS waiver, such as Turquoise Plato Block Discovery, CBOE LIS and Euronext Block. (Zhu & Comerton-Forde 2018, Oxford Law.)

3.5 Frequent Batch Auctions

Frequent Batch Auctions are a new trading system for equities. While not a trading venue per se, the paper sees their development important for HFTs, and due to the different trading mechanism examines the topic in this chapter.

These systems were created to protect investors from the speed competition, which is why their functioning and popularity affect the HFT businesses considerably (Budish, Cramton & Shim 2015, 4). What is crucial to understand is that the trading done via FBAs is not subject to DVCs or pre-trade transparency requirements and is therefore considered dark. This has caused public concerns as one of the main aims of MiFID 2 was to provide more transparent markets and it seems that FBAs allow dark trading without DVC restrictions. (ESMA 2018, Call for Evidence)

Neither MiFID 2 nor MiFIR provides an official definition for the platforms. To fill this gap, Commission Delegated Regulation 2017/587 gives a definition “‘a system that matches orders on the basis of a periodic auction and a trading algorithm operated without human intervention’.” (2017/587, annex, table 1) The main premise of FBA is that orders

are matched in short auctions, which last only fractions of a second, leaving time for slower participants to react and reducing the speed advantage of HFTs. These auctions are triggered by market participants and occur multiple times per trading day. (ESMA 2018, Call for Evidence, 11.)

Due to public worries ESMA has published a Call for Evidence and is considering whether additional regulation should be imposed for these venues. Therefore, it is difficult to forecast how these platforms will develop in the future. (ESMA 2018, Call for Evidence, 3)

4 MIFID 2

Directive 2014/65/EU of the European Parliament and of the Council was implemented on January 3 2018 in EEA-countries. The directive known as MiFID 2 focuses on markets in financial instruments, aiming to provide harmonization to the European single market. The directive replaces the Directive 93/22/EEC. (Directive 2014/65/EU, article 1(3).)

The European Parliament saw the need for new regulation as the financial crisis exposed weaknesses in financial markets. The aims are to increase transparency, address new unregulated areas, provide better protection for the investors and reinforce confidence in the markets. HFT was one the areas that were unregulated in past or were not adequately regulated together with OTC trading, which is also now in scope of the regulation. (Directive 2014/65/EU, article 1(4).)

There are also additional legislations provided by EU, which determine how the European internal market functions and what business activities are allowed such as Market Abuse Regulation. The paper will refer to these regulations only when they are of relevance. However, for now it is important to understand their existence and that MiFID 2 does not cover everything.

The paper will give a brief introduction on the structure of the new directive but as MiFID 2 overhauls the new single market, the topic is too expansive to cover as a whole in this paper. Europe's main regulating body raises 5 key points regarding the directive in their summary, which are:

Moving Financial Instruments to Regulated Venues

In order to ensure a consistency across the single market, the directive aims to close loopholes that have been apparent in the structure of financial markets. The directive has taken two measures to achieve this: First, the legislation establishes a new trading platform OTF, which was covered earlier in this paper. It will capture trading that has previously taken place in unregulated markets. Instead of replacing any existing market places, it will compliment already existing trading platforms. Second, the legislation will bring

some of the already existing trading activities into the scope of regulation, such as previously mentioned OTC trading. (Summary of MiFID 2, Key Points 1)

Market Transparency

The new transparency requirements will affect the reporting around the trades of financial instruments, namely before and after the trade has taken place. The requirements are instrument specific and include information regarding the pricing of the instrument and transaction fees. (Summary of MiFID 2, Key Points 2)

Restricting Commodities Speculation

The directive sets system limits on commodity derivatives in order to minimize the effect of speculation on basic products, which has happened in the past. EU gives agricultural products as an example. Moreover, the legislation gives the power of restricting commodity derivative position to the national authorities. (Summary of MiFID 2, Key Points 3)

Updating Laws According to New Technologies

The directive is taking to an account the technological development that has taken place since the drafting of the first MiFID, and is placing a lot of its efforts on regulating these new trading methods under the new regulation. The legislation requires an establishment of controls regarding HFT and other new forms of trading that take place electronically at a high speed. The rules are to mitigate risks that might cause disorderly market conditions. (Summary of MiFID 2, Key Points 4)

Improving Investor Protection

The directive compels the investment firms ensure that they are providing services to clients to act in best interest of these clients. They should provide services and products that are best suited for these clients, and protect the assets of these clients. Investment firms should also provide adequate information for these clients regarding the services and products sold to them. Additionally, investment firms should minimize the conflicts of interest by optimizing their reward systems for their staff in a way that does not encourage selling of a financial instrument over a more suitable one. (Summary of MiFID 2, Key Points 5)

As we can see the legislation is broad and considers different aspects of financial market activity. However, it clearly states that one the main areas of improvement in the regulation regarding the new technologies, affirming that HFT should be put under tighter regulatory scrutiny.

5 IMPACT OF MIFID 2 ON HFT

This chapter will dive deeper into new obligations that bind HFT firms and their effects. The aim is to provide insight on how these firms have to change their operational models and trading strategies to comply with MiFID 2. Since HFT is not a trading strategy, but instead a group of strategies, which are executed in high speeds. Most of the direct obligations regarding HFT firms are organizational or give additional reporting requirements. The focus of the section will be on the research questions stated in the beginning of the paper.

5.1 How MiFID 2 will change HFT Organizations?

MiFID 2 imposes an extensive list of obligations for HFT organizations. The whole RTS 6 is dedicated to organizational. However, the paper's main premise is to study the effects of the regulation, and in order to understand the practical effect of these organizational obligations, the study has to recognize the starting point of the HFT firms, as it might be that the firms already operated in a manner that fulfills the obligations. This would mean that the regulation does not have any significant effect on the daily operations of these firms.

For this purpose, the paper relies on Clark and Ranjan (2012), which studies the risk controls of HFT firms based on interviews. Despite focusing on the firms based in the United States, Clark and Ranjan (2012) will support the aim of this paper as many of the HFT firms are operating globally and North American and European business organizations are structured in a similar manner in most cases. This chapter will provide perspective on how these firms used to operate few years before the implementation of MiFID 2 and what possible changes they have to implement.

5.1.1 General Organizational Requirements

The first article states general organizational requirements that give a template to other risk controls and procedures. It requires HFT firms to have a formalized governance arrangement that will take to an account the firm's business model's nature and complexity. The arrangement should establish definite lines of accountability and these should have a regard to the development, implementation and updating of trading algorithms. Additionally, the firms should have efficient communication lines that allow instructions to be executed in a timely manner. Lastly, the firms are required to separate their trading and supporting functions that allows risk and compliance teams to act accordingly in case of unauthorized trading activity. (ESMA, RTS 6, 2016, 7.)

Clark and Ranjan (2012) showed that HFT firms already had formalized risk management structures, although the structures varied between the participants of the study. Some firms had a flat reporting structure and others had a single risk manager for the whole business, while few centralized their risk management team to one office. All of the methods above are allowed under MiFID 2, as it does not state whether the risk management structures should be vertical or not. What it states is that the lines of accountability should be clear, risk function should be separated and possess an adequate authority. The firms in Clark and Ranjan (2012) study fill this criteria, and as long as the structure is well documented and considers the nature of the firm's business model, changes are not required. (Clark and Ranjan 2012, 5.)

In the article 2, RTS 6 defines the role of compliance function. ESMA necessitates investment firms to ensure that the compliance staff has a continuous contact with the experts of the firms who understand the functionality of the algorithms. The compliance staff should also poses a general understanding of how their firm's systems and algorithms work that allows them to recognize trading activities that could breach existing regulation. Additionally, the compliance staff should have a direct access to 'kill functionality' or a person who has access to that functionality, in order to halt the trading in case of malfunction or unauthorized trading. It is also allowed to outsource the compliance function but in that case the investment firm should guarantee the privacy of data and assure that the external compliance function can be audited. (ESMA, RTS 6 2016, 7.)

Clark and Ranjan (2012) have only one mention of compliance team in their study, so it is unclear whether the firms which participated in the study had compliance teams or not. This is because, the interviews studied risks closely related to trading activities that are usually covered by business risk team. Nevertheless, according to MiFID 2 all the HFT firms should have a compliance function, causing potential organizational changes and additional hiring for firms that previously did not have one. (Clark and Ranjan 2012, 5)

RTS 6 also has requirements regarding the staff of HFT firms, which aim to ensure the sufficient amount of competent staff. There should be an adequate number of staff members that understand the algorithms, systems, trading strategies and legal obligations of the firm. The firms are obligated to specify those skills and guarantee that the staff will acquire them through training or have them at the moment of recruitment. These skills should be kept up-to-date and reviewed periodically. ESMA offers additional specifications for the training of risk and compliance staff. These require that the training should ensure the understanding of the algorithmic trading and strategies executed by the firm, and it should ensure the skills to act accordingly in case of automatic alerts, which are produced by the systems responsible for real-time monitoring and pre-trade limits. Furthermore, the compliance staff should also poses authority to question the actions of the trading staff. (ESMA, RTS 6, 2016, 8.)

The previously mentioned compliance team in Clark and Ranjan (2012) required the traders to demonstrate their knowledge regarding the risks and markets. However, only one out of nine firms that participated in the study had a compliance team for that. The rest are obligated according to MiFID 2 to establish such a function and specify the staff's skill requirements. The interviews in Clark and Ranjan (2012) did not discuss the training, but the fact that only one out of nine firms tested the staff's knowledge implies that the majority of the HFT did not have a formalized and robust training program. Implementation of such a program is required under MiFID 2 and many of these firms have to plan, create and document their training policy. This should not affect the long term profitability of HFT firms by itself, despite the additional work that is required for the establishment of the program. (Clark and Ranjan 2012, 5.)

5.1.2 Resilience of the Trading Systems

Returning to RTS 6, one of the main focuses of the document are the systems and algorithms themselves. The regulation wants to ensure that the investment firms have adequate readiness to act in case of malfunction and processes that will minimize the probability of such malfunctions. Article 5 lays down the general methodology, requiring firms to have a clear and consistent approach for testing and developing their strategies, systems and algorithms. Senior management should also designate a person that will authorize actions regarding algorithms that are capable of order execution. And, these changes should be recorded in a manner that implies who did and/or approved the change, what was done and when. (ESMA, RTS 6, 2016, 9.)

To satisfy the obligations, the approach should regard the performance, design, record-keeping and any approvals needed for the system, strategy or an algorithm. Additionally the firms are required to apply the same consistent approach to the allocation of responsibilities and resources. (ESMA, RTS 6, 2016, 9.)

Furthermore, HFT firm's methodology should guarantee that the algorithms will not act in an unintended ways, will comply with the regulation and trading venue's rules, and will work as intended under adverse market conditions. (ESMA, RTS 6, 2016, 9.)

According to Clark and Ranjan (2012), HFT firms had a considerable differences when asked about the development of algorithms and trading strategies. Few firms that participated in the study launched their new strategies in minutes. Needless to say, after the implementation of MiFID 2, such a quick implementation of new trading algorithms and strategies is not feasible. However, Clark and Ranjan (2012) states that these firms were a minority in the study and that most firms had formalized processes for algorithm and strategy development. For the group of investment firms that launched their strategies without any formalized process, this might mean hiring additional staff for stress testing and risk functions. (Clark and Ranjan 2012, 4.)

To guarantee a frictionless implementation of new trading algorithms and strategies, MiFID 2 imposes conformance testing requirements for HFT firms. Testing should be performed with the systems of the trading venue where the firm is exercising its business activities and the systems of DEA provider. This will help to ensure the functioning of the algorithms when connected to the systems of the DEA provider and the trading venue. These test should be repeated every time there is a change to the trading venue's or DEA provider's systems, and additionally if the investment firm makes changes to its systems. In more practical terms, the algorithms should interact accordingly with the matching logic of the trading venue and process trading venue's data flows as intended. (ESMA, RTS 6, 2016, 10.)

This testing should take place in an environment dedicated to this purpose and that is disconnected from the trading platforms. This environment can be provided by the trading venue, DEA provider or the investment firm itself, as long as it fulfills the requirements laid down in RTS 6. (ESMA, RTS 6, 2016, 10.)

Clark and Ranjan (2012) findings are that HFT firms typically had such a simulated trading environment available, which was provided either by a trading venue or built-in house. Also, it is a reasonable to assume that the test environments provided by trading venues would notify about any potential errors that might occur when the algorithm is connected to the actual system of the trading venue. However, there is no mention whether the firms who had their own test environment were provided the tools to test the compatibility of their systems and algorithms with the trading venues systems. Also, the study does not mention that the firms were running tests with the systems of DEA provider. (Clark and Ranjan 2012, 4.)

This means that in the current European market environment, these firms would have to either expand their already existing compatibility testing or start from scratch and create ways to ensure the proper functionality with both, trading venue's and DEA's systems.

5.1.3 Trade Limits

After such testing, the investment firm is obligated to set limits on the algorithms before using them on a trading venue. These limits include, the number of financial instruments, price, number of orders, value, positions, and number of venues. (ESMA, RTS 6, 2016, 11.)

According to Clark and Ranjan (2012) HFT firms had limits regarding their algorithms, but they were not applied equally. In some cases, firms set less limits for certain trading strategies in hopes of reducing latency. This will not be allowed under MiFID 2 as the regulation has pre-set requirements that will not exempt individual algorithms or strategies. However, this will not result in a loss of competitive advantage, as all HFT firms trading in European markets have to fill these requirements. (Clark and Ranjan 2012, 6–7.)

Clark and Ranjan (2012) also brought clearance to these individual limits and how many of the firms in question had set those limits for their algorithms. All of the investment firms in the study had a limit for maximum order size and a position limit per trading day. One of the firms also adjusted its limits to average daily volume and on portfolio risk. Credit limits were set by all except one firm, but these credit limits were established with varied criteria, one setting limits only for new traders. (Clark and Ranjan 2012, 7.)

Moreover, around half of the firms in the study of Clark and Ranjan (2012) had pre-trade limits for price range, while most limited the number orders per specified time. Majority also had a profit and loss limit for orders or strategies. (Clark and Ranjan 2012, 7.)

While the previously mentioned HFT firms had an extensive amount of pre-trade order limits, according to Clark and Ranjan (2012) there was considerable differences in how the firms approached the issue. The directive brought a diverse set of limits that have to be applied and it is safe to say that almost all of the HFT firms have to restrict their trading further than previously. Nevertheless, as we are talking about limits that are set in the

software, the changes should not cause considerable expenses. Furthermore, these requirements should not result in major changes for trading strategies, because MiFID 2 offers flexibility on how these limits are set as long as the firm offers a rigid rationale.

5.1.4 Self-assessment & Change Logs

After adapting to requirements above, HFT firm's obligations are far from finished. The firms should do annual self-assessment and validation, documenting and reporting the results in a clear manner. The self-assessment requirements cover all the systems, strategies and algorithms used for algorithmic trading. On top of reviewing the procedures that have a direct impact on trading, the firms should also evaluate the supporting processes, such as governance, approval and accountability framework. The firms are obligated to include business continuity arrangement into the review as well, providing a well-rounded report that evaluates whether the firm still has a robust processes in place to fill its obligations. (ESMA, RTS 6, 2016, 11.)

This report should be produced by the risk management function with support from the staff possessing the technical know-how. The results should be reported to the compliance team and approved by the senior management, resulting in an action to fix any shortcomings that the report might expose. (ESMA, RTS 6, 2016, 11.)

This annual self-assessment should include stress testing of the systems. The functioning of the previously established procedures and controls is included in the stress testing requirements, providing a full picture on how the firm manages in case of unexpected market conditions. However, these tests should not affect the trading environment and cause additional risk during the opening hours. The test includes two parts: First running the highest number of messages sent and received by the firms from the past 6 months, multiplied by two. The second part includes the same procedure except with the trading volume. (ESMA, RTS 6, 2016, 12.)

In the study Clark and Ranjan (2012), the firms did not run stress testing for their systems or review their governance framework on a regular basis themselves. However, often

times clearing member was conducting audits that would question the resilience of the risk control framework. (Clark & Ranjan 2012, 12.) Clearing members act as a central counterparty, which ensure that trading contracts will be settled, reducing counterparty credit risk for market participants. Clearing has been important after the last financial crisis that exposed how interconnected firms are with each other. (LME 2018, The Role of Clearing Houses...)

Furthermore, credit limits were set every time a new clearing relationship was formed. There is some inconsistency on how firms reported in the study, as two out of nine participants said that periodic audits were not common. In addition to audits conducted by the clearing party, most firms reviewed their risk limits on a daily basis. Some conducting more formal and extensive reviews either monthly or quarterly. Moreover, one of the firms reviewed the change log of the systems and trading algorithms periodically. (Clark & Ranjan 2012, 12.)

Clearly, these reviews did not fill the MiFID 2 obligations and firms have to implement more robust and consistent self-assessments. However, as the firms already have risk functions and separate trading environments, the change is not going to result in considerable staff increases or in noticeable organizational changes. Most firms will manage by formalizing their review processes, including the stress tests obligated by the directive and also reviewing processes that are not directly linked to trading.

Going back to RTS 6, it also describes how the HFT firms should manage the material changes done to the trading systems. These changes should be evaluated by a person assigned by the management and this review should be done in accordance to the scale of the change. There also should be in place effective communication lines, which can be utilized to spread the information to all the personnel it might concern. (ESMA, RTS 6, 2016, 12.)

HFT firms were maintaining change logs in the past according to Clark and Ranjan (2012) and these logs were reviewed in case of a problem. However, as mentioned previously, only one of the firms were periodically reviewing these logs. Nevertheless, the firms were

already storing their change logs to a durable medium, meaning that only minor adjustments are required to comply with MiFID 2, for example reviewing these files more regularly and making them available for trading venues and DEA providers. (Clark and Ranjan 2012, 5.)

5.1.5 Kill Functionality & Monitoring

In order to ensure the resilience of the HFT firms the RTS 6 introduces a kill functionality that, despite its grand name, means the ability to cancel any individual order or all of the orders from the investment firm in question. This cancellation should be instant and applicable to all the trading venues where the HFT firm is doing business. Additionally, the firm should possess the ability to track the source of the trades, meaning the algorithm, trading desk or trader that was responsible for the execution. (ESMA, RTS 6, 2016, 12.)

This kill functionality was widely used in 2012 when Clark and Ranjan (2012) conducted their research, as all the HFT firms in the study had such a procedure in place. But as with many other risk arrangements, there were differences in how the firms decided to set up the kill functionality. In all likelihood, adjusting to new regulatory standards does not represent significant challenges in this area, as this only requires software adjustments. (Clark & Ranjan 2012, 9.)

As an additional measure to ensure the resilience, the investment firms are required to have an automated surveillance system that is able to recognize in real-time any trades that might breach Market Abuse Regulation No 596/2014. The system should be able to create alerts and reports, covering the full range of investment activities applied by the firm. The firm should act accordingly to these messages generated by the system and investigate and escalate any potential breaches. The firm should also be able to change the system accordingly to its own strategy and possible regulatory changes. (ESMA, RTS 6, 2016, 13.)

As MAR was not out when Clark and Ranjan (2012) was conducted. There is no clear point of comparison for these requirements. However, the firms in the study had automated systems, which were able to monitor pre-trade limits, meaning that the HFT firms are in all likelihood able to comply with the regulation without substantial expenses. Also, all the firms had arrangements in place of potential errors caused by the algorithms. (Clark & Ranjan 2012.)

In case of these potential errors, RTS 6 also requires formal business continuity arrangements from the HFT firms. These arrangements cover the possible unexpected events that might disrupt the trading activities of the firm. And, these arrangements should be applicable with all the trading venues the firm is connected to. The HFT firms are required to develop a framework that considers a range of adverse scenarios regarding the systems, staff, data and external parties. The investment firms should train their staff to such scenarios and establish a back-up site, which enables trading. Additional arrangements, which enable the management of open positions in case of disconnection, are also needed. (ESMA, RTS 6, 2016, 14.)

According to Clark and Ranjan (2012), HFT faced several challenges regarding the business continuity arrangements in the past. Most of these challenges were due to cooperation with the trading venues and how all the venues did not offer the same services. All the firms in the study were using trading venue's "cancel on disconnect" offering when it was available. The implementation of MiFID 2 should resolve most of these problems, as venues are under new obligations and cooperation between the venues and HFT firms is increased. (Clark and Ranjan 2012, 9.)

5.1.6 Trade & IT Security

In addition to kill functionality, automated surveillance system and business continuity arrangement, HFTs are obligated to implement several pre-trade controls, which are already covered by HFT firms according to Clark and Ranjan (2012), as previously mentioned. But in addition to instrument specific limits such as, maximum value and volume limits, RTS 6 necessitates HFT firms to set limits for messages rates. This will ensure that

the DEA provider, trading venue and their systems are able to handle the message volume without an overload.

Furthermore, MiFID 2 requires HFT firms to consider scenarios where there are orders that the firm would like execute, which have been blocked by these pre-trade controls, HFT firm must have predetermined trade specific procedures that allow it to do so. (ESMA, RTS 6, 2016, 15.) This arrangement was not directly mentioned in Clark and Ranjan (2012), but it is reasonable to assume that HFT firms are able to manually override their pre-trade limits. The real question is, how many staff members had the authority to do so and was there a formal procedure for it. But as with numerous other obligations, this will not cause problems for HFT firms once they have documented the process.

In addition to other pre-trade controls, ESMA obligates HFT firms to apply repeated automated execution throttles. These limit the repeated executions done utilizing the same trading strategy. The aim of execution throttles is to prevent algorithms for example selling the same security uncontrollably. Once this limit has been breached, the algorithm should be disabled until the responsible employee manually turns it back on. (ESMA, RTS 6, 2016, 15.)

Data on possible usage of repeated automated throttles prior to MiFID 2 was not available, but as it is a hard block set up in the software, it should not cause additional costs or implementation challenges for HFT firms. However, it might have an effect on trading strategies, which for example, repeatedly execute small transactions in order to profit from an arbitrage opportunities. This will however depend on the limit itself.

Besides pre-trade controls, ESMA sets out obligation for real-time monitoring that should be followed by the algorithmic trading firms. The investment firm is required to monitor all its activities in real-time and designate a staff member who is responsible for the trading or risk management function to undertake the task. Furthermore, this employee should be clearly identified and reachable for the relevant external parties. These monitoring systems should assist staff by alerts and messages providing information regarding the functioning of the trading algorithms. (ESMA, RTS 6, 2016, 16.)

In the comparison study, the interviewed HFT firms had risk platforms that operated in near real time and all the firms had a clearly defined risk team. Therefore, the monitoring requirements were already practically fulfilled and this part of the regulation does not have business altering consequences. (Clark & Ranjan 2012, 6.)

Organizational requirements include specifications for IT security and access limitations, including an IT strategy that complies with the business and risk strategy of the HFT firm, effective IT security management and IT organizational requirements. The strategy should have clear objectives and consider the nature of the business. In addition to serving the business, the IT systems should be secure and tested against cyber-attacks annually. Moreover, the firms should restrict the access to security systems and monitor the usage of such rights, ensuring traceability of the activity. In case of security breaches, the investment firms are obligated to report to the competent authorities. (ESMA, RTS 6, 2016, 17.)

The data on the IT security systems of HFTs firms was not available, but it is reasonable to assume that these firms possessed the necessary technical expertise for secure systems. And if not, attracting such talent to cutting-edge industry like HFT should not cause problems. Like with several other requirements, formalizing the process, running annual tests and monitoring will cause additional work and expenses but to manageable degree, unless extensive hiring is required to fulfill these obligations.

5.1.7 Summary of Organizational Requirements

The list of organizational requirements is extensive to say at least, but it does not include any individual obligations that would be detrimental for HFT firms. What will have a considerable impact however, is complying with every part of the regulation. The expenses will add up, impacting profitability and structure of these firms.

MiFID 2 requires a similar organizational structure from HFTs as from the traditional financial institutions, which are large corporations employing thousands of people. While

not necessary enforcing such a scale increase, it is justifiable to assume that these organizational requirements will have a larger impact on small firms, which will have to hire more employees. This will inevitably result HFT organizations, which are more reminiscent of each other and less flexible.

This will result on a structure, which differs from traditional financial institutions in one crucial way. As their trading is done by algorithms and HFTs and they usually do not serve clients, the firms have a lower number of employees in the front-office. With these MiFID 2 requirements, HFTs will become structurally really back-office heavy, meaning a large number of risk, compliance and IT staff per trader. This will create additional pressure to increase profits as operational costs are increasing.

5.2 What Is The Effect of the Directive On HFT Trading Strategies?

In this chapter the paper focuses on the second research question of the study. Just as in the section introducing different trading strategies, also this chapter will be divided into two parts: Market making and opportunistic trading strategies.

Market Making

As stated previously in this paper, the preceding research has found that market making strategies are responsible for the majority of HFT activity. Moreover, these studies have discovered that market making strategies are providing liquidity to the market place and mitigate volatility. Possibly for this reason, market making is also the least debated trading strategy exercised by HFT firms.

EU has acted in accordance to these findings in RTS 8, which is dedicated to market making schemes, and does not impose any obligations that would limit HFT market makers more than traditional ones. The regulation merely brings HFT firms exercising market making under the same obligations as traditional market makers, evening out the competition. This means, market making HFT firms are obligated to provide liquidity during stressed market conditions and predetermined proportion of trading hours per trading day. (ESMA, RTS 8, 2016, 2.)

The aims of RTS 8 are to guarantee predictability of liquidity and the presence of market makers in stressed market conditions. The RTS 8 obligates market makers to have a market making agreement with the trading venue, to be active for minimum of 50% of the opening hours, excluding closing and opening auctions, maintain records, and enable the surveillance of the firms' market making activity. However, the regulation take to an account market makers' perspective as well, requiring trading venues to provide incentives, which also consider the increased risk during stressed market conditions. Additionally, RTS 8 lists exceptional circumstances where market making is not required due to unreasonable risk, such as inability to hedge a position and extreme volatility. (ESMA, RTS 8, 2016, articles 1–3.)

The obligations stated in RTS 8 should not restrict HFT market makers' ability to create profit during normal market conditions, but might lead to increased risk in stressed conditions, due to obligation to trade actively. On the other hand, being under a formalized market making agreement will increase public's trust in these firms and depending on the agreement with the venue, the incentives might offset part of the increased risk exposure.

Opportunistic Trading Strategies

MiFID 2 does not go after specific opportunistic trading strategies used by opportunistic HFTs, as MAR was already implemented prior to MiFID 2 to restrict HFTs using such strategies as front running. MAR defines the trading strategies that are forbidden due to being considered manipulative or abusive for the markets. But as MAR is not in scope of this paper, the study is not going to discuss those restrictions, but instead focuses on new obligations imposed by MiFID 2 for the allowed trading strategies under European market law.

Such a measure is the new ratio introduced in RTS 9, which sets limits on the ratio between unexecuted orders and transactions. Trading venues are required to calculate this ratio for their venue's members. The ratio is calculated in both, volume and in number terms, exceeding either maximum ratio at the end of the trading day is counted as exceeding the allowed limit. The aim of the ratio is to mitigate volatility that might be caused by excessive number of order cancellations. (ESMA, RTS 9, 2016, 6.)

The ratio is aimed specifically at HFTs and affects almost exclusively opportunistic HFTs, as market makers usually do not cancel orders in large quantities. Opportunistic HFTs have been using order cancellations to detect liquidity, this method is also called pinging. The aim is to send numerous orders to the market place in order to detect large institutional sellers. This method is from now on allowed only in the limits of the ratio, leading inevitably to decrease in its use.

However, there are several strategies such as arbitrage that do not use order cancellations and are therefore unaffected by this limit.

5.3 Will MiFID 2 Drive HFT Activity to Certain Venues?

Here the focus is on the third research question of the study, expanding on the introduction of the trading venues under MiFID 2. The directive does not change the functioning of regulated market or MTFs, but offers changes regarding other trading venues. Namely, the introduction of OTFs, stricter dark pool regulation and introduction of FBAs.

The introduction of OTF platforms changes the market landscape in Europe but it does not have a major significance for HFT, as these venues were created to attract more illiquid financial instruments to the public market place, such as parts of OTC trading. Most HFT strategies do not involve these instruments and therefore OTCs will not attract sizeable parts of HFT trading from other platforms.

However, the story is quite different regarding dark pools, which were put under extensive regulatory scrutiny under the new legislation. MiFID 2 forces dark pool activity to go back to basics, which means focusing on large trades. Reasons for this are DVCs and MiFID 2 investor protection, that prevents brokers from directing client orders to dark pools without demonstrating why the dark pool was best place to execute the transaction. Less transaction volume leads to less profit opportunities for HFTs.

Also, Dark Pools that operated under RPW do not have a bid-ask spread by default as the prices are set mid-spread based on a reference venue. This will drive away market makers, who are usually the ones setting the spread and profiting from it while offering more liquidity for other market participants.

On 9th of November 2018 ESMA also published a Call for Evidence, which gives insights on latest trading developments regarding dark pools and FBAs. The first time DVCs were reached and ESMA blocked the trading of under these waivers, was in March 2018. 618 ISINs combined had reached the limit and blocked. This led to decrease in dark pool trading. In January 2018 dark pool trading that was not under LIS waivers had a volume of 69.57 billion Euros, which decreased to 25.57 billion Euros in August due to suspensions. However, there was a considerable recovery in September after the ban of these 618 ISINs expired and the volume increased to 39.68 billion Euros. (ESMA 2018, Call for Evidence, 6.)

The suspension of 618 ISINs demonstrated that the 4% and 8% limits set to trading under waivers that count for DVCs are low enough to restrict trading and force market participants to find alternative ways to trade these instruments. HFTs are well known for their high trading volumes, leaving them more vulnerable for these restrictions. HFTs that focused on dark pool trading in the past have to find alternative ways to create profit, as suspensions might have a considerable effect on the instruments they are trading. It is reasonable to assume that at least additional diversification for these trading strategies are needed. The combined effect of decreasing dark pool trading activity and strict DVCs should drive HFT activity out of the dark.

In the same report, ESMA discusses about the increase of trading via FBAs. FBA trading seems to have a negative correlation with dark pool trading. This is due to the fact that the trading in the previously mentioned instruments under DVC suspension moved to FBAs for the period of the suspension. After these suspensions expired, the trading of these ISINs in question moved back to dark pools. ESMA also concludes that these indicates that investors are still preferring dark pools over FBAs to execute their trades. But even outside the suspended ISINs, FBA trading has been increasing from 6.78 billion

Euros in January 2018 to 22.28 billion Euros in September. (ESMA 2018, Call for Evidence, 7.)

Because FBAs are minimizing the effect of speed and therefore less profitable for HFTs, their development is relevant for HFT trading. Without further regulation the increase in use of these platforms has created a less favorable market environment for HFTs.

In conclusion, MiFID 2's impact is felt at HFTs firms when deciding in which venues to focus on. The regulation drives HFT firms out from dark venues to regulated markets and MTFs that do not trade under RPW or use FBA.

5.4 Is MiFID 2 Restricting the Market Access of HFT Firms?

The chapter will examine the fourth and the last research question, dividing into two parts DEA and co-location.

DEA

The directive goes after DEA, which is often times used by HFT firms to get the access to the markets. This regulation is mostly aimed at the access providers and its aim is to provide transparency on how the access is used, preventing abusive trading strategies to go unnoticed. However, these additional transparency requirements might force HFT firms to hand over specific information regarding their algorithms and other details essential to their business model. The information also includes in which trading venues these HFT firms are operating in. (ESMA, RTS 6, 2016.)

Co-location Services

MiFID 2 also has dedicated RTS for regulating co-location services, which are widely used by HFT firms. RTS 10 ensures transparent fee structures for these services and make them available for all the investors who want to use them. The regulation applies to co-location services provided by all three multilateral trading platforms under MiFID 2, namely regulated markets, MTFs and OTFs. (ESMA, RTS 10, 2016, 3.)

The regulation does not have a considerable effect on HFT, as most of the HFTs were already using the service and normal investors are not able to compete in speed even with the access to DEA. This is because of the computing power difference and the speed optimization of HFT systems. However, the regulation creates a more equal playing field for HFTs, removing the potential advantage that larger HFTs might have enjoyed. Furthermore, transparent fees might benefit HFTs due to more predictable expenses and increased price competition between the providers.

5.5 The Effect of Tick Size Regime

During the course of the study the importance of the new tick sizes has displayed itself. Thus, the paper provides a closer look into the new regime. Tick size means the smallest change between two price levels. Now, ESMA has defined the minimum tick sizes in RTS 11, which came into force along with MiFID 2 in January 2018.

Prior to MiFID 2, there was no pre-set tick size for trading venues, which drove the tick sizes to minimum. The trading venues participated in this race because the smaller tick sizes allowed smaller spreads and thus better prices. However, minimal tick sizes did not offer meaningful price advantage and lead to more frequent price updates, meaning more data to be processed. Now, MiFID 2 requires regulated markets, MTFs and Systematic Internalizers to use pre-defined tick ladder. This ladder applies when trading below the Standard Market Size, allowing large trades to be priced with more granularity. (Matthew's Market Views 2018) In the scope of the new tick size regime are shares, certain ETFs and depositary receipts, leaving others instruments out of scope. (ESMA, RTS 11, 2016, 3.)

Hagströmer and Nordén (2012) state that HFTs are more exposed to changes in tick sizes and predicts that increase would profit market makers and have a negative impact on opportunistic trading. Therefore, the new standard tick sizes are in the interest of market making HFTs, leading them to increase their activity in the market place, and opportunistic HFTs act the contrary. Additionally, Hagströmer and Nordén (2012) expect less cancellations per trade, in case of increased tick sizes. (Hagströmer & Nordén 2012, 38.)

Harmonized tick size regime might limit arbitrage opportunities for opportunistic HFTs, as the prices are moving more in sync. However, most common arbitrage strategies are profiting from misalignments previously mentioned in this paper, such as cross-exchange price differences and misalignments between a derivative and its underlying. Therefore, the introduction of standard tick sizes should not have a considerable effect on the business models of these HFTs.

It is unclear, how much the EU was considering HFTs when deciding to harmonize tick sizes, but the end result is more favorable to market makers, leaving less profit opportunities for opportunistic HFTs.

6 APPLICATIONS FOR THE FINDINGS

The paper has found several restrictions HFT firms are facing in the European markets after the release of MiFID 2. The findings indicate declining profits for HFT industry in its current form, requiring firms to adapt in order to remain in the business. Especially the firms practicing opportunistic trading strategies that rely on order cancellations or trade often in dark pools have to consider the sustainability of their business.

As the paper is looking at the new market directive from HFT firms' perspective, it is in the interest of the study to identify the new opportunities that MiFID 2 revealed. The chapter will evaluate further the effect of the legislation on public perception, new trading opportunities and technologies.

MiFID 2 regulates strictly HFT activity and firms participating in it. It provides transparency in the form of regulated market access and ensures that the firms have adequate risk frameworks. As it also drives the firms towards market making and away from dark trading, it could be expected that over the next years, industry's public image will improve. This would allow HFT firms to recruit more talented people, receive more public funding and be more pro-active in the public sphere. First HFT firms to take advantage of this opportunity will gain an edge over the competition when hiring for new talent. Also, the hedge funds that are practicing HFT are able to build a stronger brand, attracting more investors. Thus, HFT firms should consider these new profit opportunities if they see a benefit in them for their firm.

For HFT market makers, OTFs offer a new trading venue. These multilateral trading platforms offer a new opportunity for liquidity creation, despite their less liquid instrument selection in comparison to Regulated Markets and MTFs. OTFs are able to trade futures and options, which are considerable markets and despite market operator acting as a middle-man, due to discretion and best execution requirements, trading does not necessary slow down. This is because the exercise of discretion does not require human intervention. Trading venues can fulfil these obligations using automated systems, speeding up the process considerably. (ESMA, 2018, Q&A, 43–49.) As the study stated before, the

expectation is to see most of the HFT activity in Regulated Markets and MTFs but the firms should not neglect the potential of OTFs.

Furthermore, as HFT firms are driven away from the dark venues, the same volume caps and restrictions also apply to other market participants. This will lead to more market activity in Regulated Markets, MTFs and OTFs, which will provide more liquidity and opportunities to HFT firms. The firms that embrace this change will get a head start when preparing their algorithms. Also, they are able to reduce their costs as algorithms and systems do not have to be tested and controlled in numerous trading environments.

Being a high-end technology industry, HFT firms are always looking for ways to profit from latest technological developments. MiFID 2 does not name any specific technologies that would be prohibited, leaving room for development as long as risks are sufficiently managed. Two latest trends in HFT have been machine learning and non-traditional data points. Machine learning has changed almost every industry, allowing non-linear relationships to be found by computers. This is a natural fit for HFT, in which firms process extensive amounts of data every day. Non-traditional data points on the other hand use weather forecasts, social media and alike to explain market developments. These two have substantial potential when combined. Most of the HFTs are probably already aware of these developments but as MiFID 2 restricts traditional strategies, it will force firms to focus more to create new ways of making business. The firms that will be winners in this arms race, are the future leaders of the industry. (Bill Mannel 2017, Multiple Technology Trends Disrupting...)

7 CONCLUSION

The paper examined the effect of the latest European market regulation on HFT, using the existing literature and the legislation provided by the EU to conduct a theoretical study. The paper focused on three main areas, namely the effect of the regulation on organizational structure, trading venue selection and trading strategy selection of HFTs.

MiFID 2 imposes strict organizational requirements on HFTs that result in additional expenses and structural changes. The paper used the existing research literature to determine how HFTs were organized prior to MiFID 2. The findings show that HFTs are required to create a formal framework around most of their processes and documented action plans, both of which these firms previously lacked. Majority of HFTs are also forced to hire additional staff for their compliance and risk functions, resulting in higher operating costs and lowering profitability. Due to the nature of business, the firms will be structurally back-office heavy, as compared to traditional financial institutions. HFTs have a similar need for risk, compliance and IT staff but less need for staff with client and market access. This is because algorithms are responsible for the trading and are capable of trading large volumes without the need of several traders.

MiFID 2 also benefits some trading strategies used by HTFs over others. Market making strategies will benefit from increased tick sizes, but these firms will be brought under market making agreements. Opportunistic strategies, such as arbitrage strategies, will suffer from harmonized and increased tick sizes, while the order to transaction ratio introduced by MiFID 2 will hit firms practicing strategies which use order cancellations. Additionally, MiFID 2 has led to the introduction of venues focusing on LIS trading, decreasing opportunities for HFTs to profit from price movements that these large trades cause.

The new market environment will be a lot more supportive for market makers than other HTFs, reducing the profitability of opportunistic HTF strategies, which have also been suffering from increased competition and low volatility during the past few years.

MiFID 2 changes the trading venue landscape by limiting dark trading and bringing parts of OTC trading to OTFs. The changes to dark pools, such as double volume caps, redirected focus on large trades and reduced client order executions on dark venues, will drive HFT trading towards regulated markets and MTFs. Nevertheless, OTFs offer a new opportunity for these firms, which however, is more limited than the one offered by Regulated Markets and MTFs, due to less liquid instrument selection.

Market access does not face significant revisions. Access providers are required to be non-discriminatory and offer transparent fee structures. The more even playing field will diminish the advantage that bigger high frequency trading firms have potentially enjoyed and transparent fee structures will help the firms to plan their finances with more granularity.

MiFID 2 will result in an improved public perception towards HFT industry, allowing firms to attract more talent, funding and create a stronger brands. On the other hand, the arms race in the technology side will intensify as the directive allows firms to apply new technologies into their trading as long as risk measures are adequate. Need for the new technical breakthroughs has increased due to decreased profit over the last years and additional restrictions towards traditional HFT trading techniques.

Overall, MiFID 2 is creating new challenges for the industry that has been in decline over the past years. Forcing these firms to adapt and build new business models that are better suited for the current market environment.

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ANNEX

Annex 1. Glossary of Financial Terms

Asset	A source of economic value that is owned by a natural person or entity (Investopedia, Asset).
Best Execution	The firms are obligated to provide best execution for their clients under MiFID 2. PWC's report summarizes best execution as: "Achieving the best possible result for customers when executing their orders via execution venues or OTC" (PWC, 2017, Best Execution).
Bid-Ask Spread / Spread	A reflection of supply and demand, where Bid represents the highest price a market participant is willing to pay for the asset and Ask represents the lowest selling price. The spread is smaller in liquid markets and when trading liquid assets. (Investopedia, Bid-Ask Spread.)
Commodity	A basic good often used to produce other goods or services, for example oil and coffee. Must meet certain standards to be traded on an exchange. (Investopedia, Commodity.)
Debt Instrument	Allows the issuing party to raise funds in exchange to repayment in accordance to a contract. Most common debt instruments are bonds, mortgages and notes. (Investopedia, Debt Instrument.)

Derivative	Derives its value from underlying security or securities. Usually linked to stocks, currencies, commodities, market indices or interest rates. (Investopedia, Derivatives.)
Equities	Ownership stake at the firm's equity (assets minus liabilities) also known as stock or share (Investopedia, Equity).
ESMA	European Securities and Markets Authority is responsible of European Union's financial system and investor protection and it operates independently from the Union (ESMA, Who we are).
ETF	Is a security tracking a basket of assets, for example stock index or bonds. They can be traded on trading venues. (Investopedia, ETF.)
Clearing Member	Also known as Central Clearing Party that is mitigating counterparty default risk in derivatives trading by acting as a middle-man and requiring collateral. They will make sure both parties are able to fulfill their obligations at expiry. (Moneyandbanking.com, 2014, CCPs part 1.)
Financial Instrument	Tradeable assets (Investopedia, Financial Instrument).
Future	Financial contract that obligates seller to sell an asset or buyer to buy an asset at a price and time specified in a contract. Some can be settled with cash, while others require physical delivery of the assets, for example oil. (Investopedia, Futures.)

FX	Foreign Exchange refers to the currency market, where currencies are exchanged for each other (Investopedia, Foreign Exchange).
Quoted Price	Represents the latest bid and ask prices that market participants were able to agree on (Investopedia, Quoted Price).
Hedge Fund	An alternative investment vehicle that pools funding from investors in order to generate high returns, using derivatives and leverage. Available only for qualified investors as they are less regulated than other investment vehicles. (Investopedia, Hedge Funds.)
Holding Period	The period between buying an asset and selling it.
Institutional Trader	Large nonbank organization or person that trades large volumes and is therefore receiving preferential treatment (Investopedia, Institutional Trader).
ISIN	12-character international identification number that is individual to every securities issue (Investopedia, ISIN).
Latency	Describes a delay, which occurs when transmitting or processing data (TechTerms, 2017).
Liquidity	Represents how quickly an asset or security can be bought or sold without an effect on the price. Highly liquid assets can be bought or sold quickly, while opposite being true to illiquid assets. (Investopedia, Liquidity.)

Limit Order	Order placed by an investor with a brokerage. The brokerage will execute the order when price is at agreed price or better. Also, the number of assets traded is agreed upon pre-trade. (Investopedia, Limit Order.)
Matching Engine	Responsible for the matching of buyers and sellers on a trading venue. Might use different algorithms and order types to achieve this result. (Connamara, 2017, Matching Engines and Exchanges.)
Mean Aversion	Theory that states the prices will return to their long-term average eventually (Investopedia, Mean Aversion).
Message	Order, quote or cancellation (Directive 2014/65/EU, article 1(61)).
Option	A contract that gives its holder an option to buy or sell the underlying at specified price at a certain date (Financial Times, Lexicon).
Order Book	Is exchange's list of buy and sell orders for a certain security or instrument. The list is organized by price level and informs about the volume of the trade and investor behind the order. (Investopedia, Order Book.)
Over The Counter	A security not traded on a trading venue (Investopedia, OTC).
Price Discovery	The whole process of setting the spot price. It includes looking numerous tangible and intangible factors when pricing assets. (Investopedia, Price Discovery.)

Proprietary Trading	Bank or a firm is trading for its own gain and not for client's (Investopedia, Proprietary Trading).
Security	Financial instrument that represents ownership position, creditor relationship or rights to an ownership by option. (Investopedia, Security).
Underlying	In Derivatives, refers to the financial instrument that have to be delivered at maturity if the contract is exercised. (Investopedia, Underlying).
Volatility	A measure of risk, which describes the rate and severity of price fluctuations over a period of time (Economic Times, Definition of Volatility).