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High Frequency Trading and Fairness

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A mio nonno,
che mi ha mostrato i veri valori della vita

A mia madre,
che mi ha insegnato a farmi forza
stando sempre al mio fianco anche da lontano

A mio padre,
che ha lavorato per aiutarmi a costruire un futuro

Alla mia famiglia e ai miei amici,
che mi hanno sostenuta, sempre e incondizionatamente

Summary

Introduction

This paper is going to discuss the role of High Frequency Trading (HTF) in financial market and whether it helps the economy or if it is obstructing other agents in the market. HFT is a subset of the algorithmic trading ('AT') distinguished by the speed at which it processes and determines plays in the market. This is due to the sophisticated technology components that are reducing the latency, the time occurring between when the order is placed and when it is executed. HFT is not just algorithms that help execute orders, but brains that think on their own, making decisions in milliseconds backed by machine learning based on proprietary strategies programmed by a firm. Characterizing the HFT strategies could give an insight into the motives for trading, which could impact market quality, also providing evidence on intraday return predictability. The regulatory and real effects on the market, taking into consideration the so-called Flash-Crash, particularly the one that occurred on May 6, 2010, will be discussed further in this paper. Ultimately, after the analysis of pros and cons are evaluated, this paper will conclude with the implications surrounding HFT and fairness in the market – which is the main focus of this paper. Human beings are supposed to know what it is right and what it is wrong but trying to put a border between the two of them is not definitively clear with regards to HFT. Using this assumption, an empirical study will be conducted to see if the assumption holds true and whether fairness in the market is adversely affected by HFT.

Chap 1   Role of HFT on the market

1.1   High Frequancy Trading

1.1.1   What is HFT?

This research paper wants to focus on the study of algorithms trading, focusing specifically on high frequency trading (henceforth HFT[1]). As the market has radically changed during the last three decades, starting with the introduction of the computer in trading, equity and future markets have been highly automated and High Frequency Trading has become the main responsible for the trading volume.

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In this chapter HFT strategies will be discuss, most of which are already known in the market. Many of them act as market-makers, the major difference is the lower costs and that is why they have replaced human market-makers. The other main strategy is conducting cross-market arbitrage (Jones, 2013). Then the pros and cons HFT is producing in the marketplace will be analyzed. However, let us start from the beginning, focussing on its introduction and development.

First, we should imagine how the picture of the stock market has changed. Once it was a large room with monitors that were showing bids and offers to physical people that were deciding to buy or sell securities. Since computers took the place of those people in the crowded stock exchange rooms, we have a different idea of it; everyone from everywhere can place an order and see it immediately carried out. That is what has happened in the last few decades, where technology transformed

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[1] referred also as High Frequency Trader

financial instruments and trading in general. These computers are equipped with trading programs that are based on mathematical formulas, known as algorithms, so it has basically changed the way in which the stocks are evaluated. There are not more traders, but rather programs that are deciding what should be invested and where. Some of the trading programs can perform simple or even more complicated commands that are previously set by the traders and others will perform in an automatic way by executing the orders. However, a completely different means is high-frequency trading, those programs that can independently pursue complex strategies with remarkable speed, competing with one another to ensure no risk of running losses. Their keywords are faster, more flexible, and more independent. So somehow, we can define and separate market traders in two different type: ordinary and high-frequency traders. The first ones, for example, are pension funds, corporate treasuries, municipalities, and small investors that use the information provided by the market and establish predictable strategies, setting the standard asset pricing models. Basically, the main difference from the second trading group is based on the speed at which orders are placed, high-frequency traders using the same information, mispricing, and completing the transaction before the market absorbs the signal is due to their financial resources. The Securities and Exchange Commission (SEC) refers to high-frequency traders as "professional traders acting in a proprietary capacity that engage in strategies that generate a large number of trades on a daily basis… characteristics often attributed to proprietary firms engaged in HFT are […] the use of extraordinarily high-speed and sophisticated computer programs for generating, routing, and executing orders […] very short time-frames for establishing and liquidating positions […] ending the trading day in as close to a flat position as possible" (SEC, 2010, p. 45).

Executing their orders independently but following a similar strategy is going to create a movement in the same direction; thus, their collective actions will impact the market. In the case that the selling price falls, they will see a buying opportunity and act upon it, which will cause the price to rise. To generate excess returns, also called alpha, high-frequency traders use an alpha generation platform which is producing trading strategies through trading algorithms, some as index arbitrage or momentum traders. However, HF traders are price takers, differently to as it might be

thought, and so they do not anticipate the impact they will cause on the market and on the price. (Jarrow & Protter, 2012)

Although the high-frequency traders represent a small part of all traders, they were responsible for about two-thirds of all of US stock volume transactions according to a report by Bloomberg of 2010. However, this percentage fell to around 50% by 2013. Germain & Rousseau's (2020) paper help us retrieving some numbers, nowadays, HFT handles between 40% and 70% of the US equity market. The percentages in Europe are lower, 38%, and even less in Asia, between 10% and 30% of the total equity market. Even though it started with the equity market, HFT is present in other asset classes, such as fixed income markets, foreign exchange markets as well as the futures market. Some experts define HFT as a "permanent phenomenon with a temporary effect", as the advantages disappear more-and-more as the number of users of the new technology rises (Germain & Rousseau, 2020). The basic strategy of high-frequency traders stands on trading as much and as quickly as possible, since the profit is very small for the single transaction. Massive and faster small amounts must be built up, in order to add up to billions. To enable that the transactions are faster than other programs, enough to beat them, the physical location is important - closer to the stock market makes it easier to defeat other orders by milliseconds. In addition, it presents a very short holding period of securities positions. According to Brogaard (2010), HFT is defined as extremely short-term buying or selling with the purpose of profit from minimal price fluctuations. So, it is an automated trading platform employed by large investment banks, hedge funds and institutional investors, that are using sophisticated software (algorithms) and hardware (co-located close to exchange market) to perform orders at high speeds. It is not anymore about the quality of the investment; it is about the quantity of them. In this way we will have consequences directly on the market quality and so the liquidity, the focus of which is moving from the long-term shareholders to rapid trading (Jones, 2013).

1.1.2   Strategies adapted

Considering that HFTs are a subset of AT (algorithmic trading), the decision of submitting and cancelling an order is taken by computer algorithms that are working to

achieve a specific goal, earning even small profit amounts per trade. There are no single trading strategies followed by most of HFT, but some exemplifying strategies could be found such as I. formal or informal market-maker, II. relative value and arbitrage trading and III. directional trading. Let us now examine the main strategies one by one, including what they carry with them.

I.   Market-making

What market-makers mainly do is to post electronic book limit orders[2] on both trading sides and provide liquidity to those who want to trade quickly. By doing that they are buying at the bid price and selling at the ask price, that is why what they earn is called the bid-ask spread. The risk they could incur is that the other parties are more informed than they should be and that is their reason why they fix limit orders, and they update them as fast as possible to incorporate more information on the prices. They are also trading ETF and future contracts, not only stocks, but that are also better representing the current situation on the market. Hence, they are moving to submit and cancel their orders, to follow the flow of the market. Two types of market-makers could be distinguished: the formal one is providing liquidity, also earning liquidity rebates[3] but have to be registered on trading venues, whereas the informal market-maker is not. The choice of being one or the other focuses on the advantages and obligations associated with them - differences between assets and trading venues. In any case, it is now more common to have electronic market-makers than human ones due to their lower costs of trading which are harder to be taken down by an informed counterparty.

II.   Relative value and arbitrage trading

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[2] A limit order is a type of order to buy or sell a security at a specific price or better. (Investopedia)
[3] it is usually a fraction of a penny per share, that is provided by Electronic Communication Network (ECN), an automated system that matches buy and sell orders for securities. It connects major brockages and individual traders so they can trade directly between themselves without going through a middleman.

HFT, in this case, acts as arbitrage to regulate i.e., some correlated financial instruments when they are not reacting in the way that the market should expect. A remarkable example could be the S&P 500 and the relative ETF (Exchange-traded fund) so-called SPY. Being the mirror of the first one, the ETF should follow the same path, and when it is not happening the intervention of HFT by buying or selling the other instrument could restore the balance. Let us say that a big order is placed in the S&P 500, the arbitrageur could supply to the difference between buying SPY and selling S&P futures contracts. HFT will earn from this movement, at the same time settling the market, but not letting anything else to the other market participants, the slower ones, that lose the opportunity, as far as the two instruments prices come back to be at the same level. The nature of the strategies is winner-take-all for HFT oriented to arbitrage.

Another possible situation could be between indices and the components of themselves when raising a mismatch, or better to say, it could happen that if the index is increasing its price, some of its elements could not move in the same way or at the same speed. HFTs intervene to re-establish the proportions on the increment for all the parts that compose the index, buying those underlying stocks as well.

HFT could exploit relative value trading when two linked securities diverge from each other or even when one of the two is moving, by predicting the shifting of the other as well, and by doing that it could make it move, creating a profit for them.

III.   Directional trading

HFT could also adopt a third strategy that is focused on reading and analyzing instantaneously the news released and taking immediate decisions in that direction. Not only news could be read but also signals from order flows, as a huge order of buy could be seen as a positive sign for them, who are willing to buy likewise. The flip side of this strategy involves large institutional traders that could put in place an investment that is splatted in many parts. When HFT realized that, they could take advantage of their speed buying before them and selling at a bit higher price, leading the prices up. To avoid it, institutional traders could eventually misdirect HFT placing the order thinned, to look like a common, uninformed investor, or trade in dark

pools[4] to hide their real intentions. It is peculiar how institutions employ algorithms, starting a battle between computers to discover their strategies. This is similar to the second world war when the first computers were created to understand and translate the encrypted messages. It is important and curious to notice, however, that institutional trading costs continue to fall whilst HFT is getting more used, diminishing importance to their link (Jones, 2013).

1.1.3 Diversity among HFTs

To follow our analysis, it is important to define some technicality. There are two kinds of agents that drive the market called limit orders (LOs) and market orders (MOs). The difference is represented by the fact that in the first case, who places the order sets a specific price at which it is willing to sell or buy a specific quantity of an asset, waiting till the market meets the request. On the contrary, MOs execute the order immediately, at any cost. So basically, in LOs we normally have a leap in time between the order being sent and when it is executed. This distinction is fundamental to understanding how the market is determined, how the orders are scheduled, and how algorithms are using the timing and different types of orders to trade, predicting price movements and analyzing what signals others are supposed to send to the market. In Cartea, Donnelly, & Jaimungal's 2018 paper they use Nasdaq data to prove that limit order book (LOB) information is employed in trading algorithms, and to see the pressure they are producing in the market. Limit Order Book (LOB) could be used to build a measure that is a good indicator or a signal of further MOs rates, an indication also of the price movement and its direction and magnitude. If they can predict future changes, they are going to adapt their strategy and optimize it, improving their performances. Using these signals will benefit AT from price movements and the reduction of adverse selection[5] costs. The study was using data

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[4] Dark pools are private exchanges for trading securities that are not accessible by the investing public. Also known as "dark pools of liquidity," the name of these exchanges is a reference to their complete lack of transparency. Dark pools came about primarily to facilitate block trading by institutional investors who did not wish to impact the markets with their large orders and obtain adverse prices for their trades. (Investopedia)

[5] "Adverse selection refers generally to a situation in which sellers have information that buyers do not have, or vice versa, about some aspect of product quality—in other words, it is a case where

from Nasdaq to track how many MOs were posted at the best price (bid and ask) and how market-making strategies performed financially posting knowing in advance the best bid and ask prices. They came to two considerations in the specific case taking into account the equity market. The volume posted only at the best price was between 91.6% and 99% of MOs, giving us the other side of the coin, only from 1% to 8.4% of LOs, at the best price, have been executed. The other consideration was about market-making strategies, which is based on gaining the spread between two opposite orders placed by them, a LO for buy and the other for sell, at the best quote, but as they are affected by the adverse selection, so the difference could not produce a gain. These two findings shed light on the potential performance of the market-making models that decide how deep LOs are in the LOB. For large tick stocks, those that regularly trade with a bid-ask spread of one tick, most market-making models proposed in the literature result in strategies that mimic a market maker who is always posting at-the-touch. These market-making models include strategies that control exposure to inventory risk.

High-frequency data has proven a positive relationship occurring between order flow, corresponding to the volume of buy subtracting the volume of sell MOs, and stocks' price. It has also shown how to target volume-weighted average prices using trading algorithms (Cartea et al., 2018). Right now, algorithmic strategies are impacting the equity markets more than anyone else. Since the introduction of AT, in general, the equity markets have seen an incremental submission and cancelation of a limit order, consequently a higher price volatility intraday (e.g. flash crashes, that will be discussed in next chapter), as a volume fragmentation in the market.(Hagströmer & Nordén, 2013).

The NASDAQ exchange is a market that is formed as an electronic limit order book, having prices and timing priorities and other specific characteristics. We cannot simplify the behavior of all HFTs. We could have different strategies applied as disruptive strategies, as an intentional spoofing, or we could discover that some behaviors have different impacts on the market quality (Carrion, 2013). What is more important is to understand and analyze the quality of the market in the following chapter why and how they are going to make some decisions.

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asymmetric information is exploited. Asymmetric information, also called information failure, happens when one party to a transaction has greater material knowledge than the other party."

I. Agency algorithms and proprietary algorithms

Another important distinction before continuing is between agency algorithms and proprietary algorithms. The first case is referred to a service supplied that aims to minimize the trading impact on prices, whereas the other case is used by firms that want to take advantage of the trading process. Since now we were talking about the second because HFT uses proprietary algorithms. We are not always able to distinguish between AT and HFT strategies since with LOs most traders operating in the market are not directly identified. After analyzing the strategies mentioned before, we can consider them split into two major categories, market-making, and opportunistic strategies, the last one is incorporating arbitrage and directional, as previously described.

II. Market-making and opportunistic strategies

Market-making HFTs are proprietary-only firms that engage algorithms to submit their orders in the limit order book at the best bid and ask prices. From a study it came out that market-marker strategies place around 70/80% of the total HFT limit order submission, however having a close-to-zero inventory, being in most of their trades on the passive sides. This leads us to consider them having a higher-order-to-trade ratio than opportunistic HFT and low latency, as they should respond faster to the information of the market to reduce their risk to be adversely selected. On the other hand, opportunistic traders are compared to non-HFTs in terms of latency and order-to-trade ratio (Hagströmer & Nordén, 2013). HFT strategies are mainly aimed at earning from high liquidity and low volatility present in the market and we can divide them into two macro-categories. Market-making strategies, such as liquidity providing strategies, and opportunistic strategies, such as statistical arbitrage strategies. However, as we said before, HFT is not market makers per se, they just act as market makers, so they are not obliged to produce liquidity, and as we will notice, they are acting in their interest, proving it or taking it when it is necessary (Germain

& Rousseau, 2020). Another important difference stays on the fact that market makers aim is to gain the bid-ask spread, whereas the opportunistic traders generally must pay it.

The SEC has defined some metrics to determine HFT and the purpose in section, and in the study conducted by Hagströmer, Nordén (2013), is to understand in which strategies they hold. The several activity dimensions of HFT are guidelines of how they tend to behave:

a) the inventory is close to zero at the end of the day.

b) submit and cancel limit orders very frequently.

c) use sophisticated algorithms and co-location to minimize latency.

d) holding periods are very short.

Hagströmer and Nordén, 2013, took a sample of HFTs with the help of the expertise of NASDAQ OMXS and categorized them. Between 2011 and 2012, after some considerations, in the OMXS 30 stock, around 25% and 50% of trading activities were implying HFT activity. Analysing the results, it came out with some relevant differences between our main strategies applied.

Starting from the first metric, *inventory*[6] daily data has been collected, showing that both strategies are trying to take a low inventory position if costs of clearing and capital are applied to overnight holding. However, this can be circumvented by using central clearing on some exchanges, as cross-market arbitrage strategies, which leads to thinking that some arbitrage strategies (part of opportunistic ones) can have a higher inventory.

The second point is characterized by the continuous research from HFT of the optimal quotes and, as long as the market is ceaselessly moving, their decisions change as fast as the price is. *Order-to-trade ratio* (denoted as q/t)[7] is considered one of the more appropriated metrics to measure the frequency of submissions and cancellations. To proximate, the number of AT activities, Hendershott, Jones, and Menkveld (2011) have used the number of limit order submissions and cancellations per $100

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[6] The sum of all signed trading volumes of a day divided by daily trading volume.

[7] The number of limit order submissions across members and stocks on a given trading day, divided by the number of executions across members and stocks on that day.

of the trading volume. In our sample, the q/t ratios for market makers are signifi-cantly higher than for the opportunistic traders, thus the latter in some cases is closer to the non-HFT.

The third and fourth dimensions are about trading's speed and low latency, meas-uring the time between the execution of orders and their cancellation and call-ing *minimum latency* the minimum lifetime of limit orders.

Limit order duration, instead, is the lifetime on average of limit orders. The data re-trieved from these measures lead to the proof that low latency is the characteristic of all HFT and in 2008, 2-3 milliseconds was the time needed to respond to new information in the market. With this purpose HFT tends to overinvest in technolog-ical tools, using low latency to gain at the expense of slow traders. Minimum latency is significantly higher for opportunistic traders, which means that they are slower than market makers. Market makers need to be faster responding to the new infor-mation or they risk losing some trading quotes and incur adverse selected costs. Whereas the limit order duration is more extended for market makers, moreover, longer in case of less volatile periods, thus between the submission and its execution or cancellations occurs less time for opportunistic traders.

Another important point is also if and how often they are acting as a liquidity sup-plier, so in other words, when limits orders are reached by market orders. Hag-strömer & Nordén, 2013, have proved that this happens, on average, 58% of the times for the total of trades, in the sample they took into consideration, a clear sign of market-making's presence.

This analysis proved how different could be the strategy applied by HFTs, and that in some cases an opportunistic trader could look like more a non-HFT than a similar algorithm. So, a distinction is more than necessary between high-frequency traders and slow traders, also between market makers and opportunistic traders (Hag-strömer & Nordén, 2013).

1.1.4   Differences with low frequency trading (mimicking technique)

The introduction of HFT have changed the way that also non-high-frequency traders act, thus the behavior of both is radically different. As we already know, HFT is able,

using sophisticated devices, to react faster to the information presented on the market, so they can trade more than others. If we have more than one HFT, the market should have benefits, as market liquidity, by reducing bid-ask spreads, and price efficiency. Nevertheless, other agents, slower traders, lose part of their market gains, not being able to execute at the same speed as them, due to lower latency and faster incorporation of the news on the prices. The time is what is needed to process the information that both traders receive, but having different timing of response makes the difference, besides, slow traders cannot use information foretold by fast traders to trade. To beat others, however, HFTs must invest in expensive equipment, along with co-location of their software at a market exchange. Co-location permits the trades to locate the servers as close as possible to the places where most of the financial movements are executed, as the Stock Exchange. Co-location has the purpose of reducing the time of receiving the information, elaborating, processing, and executing orders. Biais et al. (2015) focused on investment problems that HFT could face, remarking that they would probably overinvest in the technological components since they are not realizing the exploiting asymmetric information and what they are causing to slow traders.

HFTs earn exploiting bid-ask spread, which is not more than cents each transaction, so how they can survive? If they could not modify the amount of each one, they should increase the number of trades. However, increasing those figures to a certain level after that the profitability starts to decrease. But why is that? The faster transactions become, the more aggressively traders compete, and unfortunately, we could not consider slow traders a competing part of the market, not being able to race with HFT. Our examination seems glaring how HFT cannot lead to a good implication from the point of view of slow traders, because even though they receive the information at the same time, the first can carry out plenty of transactions before the second ends up with one. It seems clear how fast the price can change meanwhile the transfer of slow traders is taking place, which means that the price they were convinced to pay for is not the price at which the order will be undertaken. We assist in a shift of prices due to HFT which causes inconvenience to others, and it is also a basis to understand the spoofing technique we will discuss late.

We have just obtained evidence from the study of L. Germain and F. Rousseau, 2020, that the speed of transactions is directly correlated to the poor success of slower

traders, and the more the first is increasing, the more the latter is going in the opposite direction. Their research was not able to define the connection with price volatility; however, we can highlight an effective increase in price efficiency and liquidity if speed increases. Nevertheless, we cannot ignore the bad performance that will project on the trades that do not use the sophisticated tools, that produce an advantage that is not fair.

So, in the end, who is taking benefits from the appearance of this financial subject? The market, by the creation of liquidity, if competition between them is strong, and HFT themselves, but not less important we should think that others will suffer for their introduction on the market (Germain & Rousseau, 2020).

1.2   What do we know about HFT?

We should start analyzing what the introduction of HFT brings and how it will affect liquidity, because, since the usage of those algorithms has increased, the economy has seen a rise in liquidity, but we should analyze if these enhancements are linked to each other. To do so, it is important to lock down the other changes on the market and after experimenting with this on the economy, a real improvement in liquidity and on market quality is still noticeable. The reason behind the improvement lies in a better allocation of resources due to new information, including the fact that more liquidity allows obtaining the smaller cost to raise capital for companies, and the real economic benefits from that too. If we are taking a look at the entire economy, it is not necessary that all the participants are producing benefits for a healthy economy.

Conditioning the market and the liquidity has also side effects because as it could be positive for the market, it could inevitably transform its strengths onto weaknesses. The market could be more fragile too, if large moves are more probable, it could present extreme illiquidity in some cases. The main example occurred on May 6, 2010, the so-called Flash Crash, due to the short duration and the huge loss. Even though at the beginning they tried to stabilize prices, when they realized that no profit was possible, they left overwhelming, worsening the fall of the economy.

Since then, some boundaries have been imposed such as short-term individual stock price limits, as well as trading halts, to avoid the situation to repeat itself. We will focus for the moment on the reason, or better, on strategies that move HFT traders, and discuss the regulation stated in the second chapter.

1.2.1   Selected HFT strategies

As the main strategies have been introduced, we should make a distinction to have deeper analysis and understanding of our research paper, which would like to see if, or better when, HFT is harming the market or realising it, which will lead us to the pros and cons of this technological type of trading. There is a dividing line especially between passive and aggressive strategies that will be further discussed below.

A.   Passive HFT strategies

a.   Passive market making

First, we denominated it as a market-making strategy that aims to meet the necessities of the buyer and the seller to trade immediately, providing them the liquidity that market makers could not fulfil, using their own securities inventories. The profit came from the difference between the bid price, at which the buyers are ready to pay, and the asking price, and at which the seller will agree. It is interesting how the opportunities for making a profit for them are bigger when the market is particularly volatile. Moreover, according to a study of the SEC, passive strategies of HFT bring benefits as the decreasing bid-ask spread and price volatility. (SEC, Equity Market Structure Literature Review Part II)

If it is seen from the outside, most of the time HFT traders are better informed than others, due to the speed of their processes. In general, the part that has more information tends to buy when prices are low and sell when are high because they know the moves of the market, which lead them to gain. Vice versa, when the part has less information will tend to buy high and sell low, occurring in a loss. The so-called adverse selection, as the traders that know less move toward bad deals.

The SEC analyzed the effect of HFT as passive market makers and revealed how this strategy reduces adverse selection.

b. Arbitrage trading

HFTs that adopt this strategy are gaining when differentiating prices of correlated securities are present, as for an ETF and its underlying asset, if, for example, they are regulated in different stock markets or for derivatives of a specific stock. A particular form of this strategy is named slow market arbitrage, focused on small differences between stock exchanges. In its complex, SEC did not reveal as a useful practice that reposts positive effects on the market.

B. Aggressive HFT strategies

a. Momentum ignition

When the main aim is to cause fast price movement, the proprietary trading firms submit a large number of orders followed by the immediate cancellation of most of them and executing only some, to induce other traders to see the movement. This behavior may spoof the algorithms of other trades and let them act more aggressively, by making decisions to buy or sell because they have seen the executions before it happened. We are talking about price manipulation when HFT traders indirectly create a liquidity condition and a price movement. However, in this situation, the new price will not represent the real value of the financial instrument, moreover who will realize that will be who takes advantage of it, the same who had created the situation. There is a thinner difference between Momentum ignition and spoofing, which is, by the way, considered illegal in the Commodity Exchange Act (CEA). In the second case, the SEC has defined it as a manipulative practice, which is violating anti-fraud and anti-manipulation prohibitions regarding securities disposition.

b. Order anticipation

It is also named liquidity detection trading because it is using the algorithms to detect larger orders done by institutional entities, also when they are operating in the dark pools or other trading sites. HFT may decide to try to find those huge, covered orders by placing small ones randomly, with a specific purpose to investigate using the algorithms strategically. When they discover the interest of institutions, they may trade ahead of them, which will keep moving the prices higher, creating benefits for the high-frequency trades only. As for the before mentioned aggressive strategy, we have another prohibited practice, then is not so far from this one, known as front running. It is basically when the trade is already aware of the intention of others to place a large order, placing it first for themselves. Since now it seems exactly as the order anticipation, but the SEC specifies that unlawful occurs when there is a violation of a fiduciary duty to a larger buyer or seller by taking advantage of the expected price movement when the anticipation is made. The duty must exist to be considered violated, otherwise must be determined that the presence of a larger part, which intends to buy or sell, and the action does not comport an information's embezzling or misbehavior from the other side. For example, if the existence and the interest of those large buyers/sellers are public and those traders use it to benefit thought advance instruments we are talking about front running. The SEC has distinguished them by this violation, although can consider analyzing case by case when we are in front of order anticipation or a front-running practice, by the effects they are creating.

c. Aggressive strategies consequences

Specific studies have been made by SEC staff and reported in Miller paper in 2016, related to the two aggressive strategies we had just mentioned, momentum ignition and order anticipation, and they find out both positive and negative effects by different analysis. One of them proved how these strategies could increase price discovery aspects in the short term, which is up to 10 seconds. Meanwhile, another one has proved how this price discovery has a good effect on lag-cap stocks, more the non-HFT does, but at the same time are not creating particular good effects on mid-

or small-cap stocks. Even if, as it seems like the short time behoves from an aggressive strategy, the long term, up to 2 minutes, price discovery is better determined by passive non-high-frequency traders. A study evidenced how this behavior will cause higher adverse selection costs than it will fall on the shoulders of non HTF. Moreover, for institutional investors, it is getting worse for market trading transaction costs, as we could expect when an aggressive strategy is applied, considering also how they are increasing the market volatility.

Miller, 2016, talking about order anticipation specifically, argued how the SEC considers it as a harmful practice for market quality and institutional investors, without taking information on the price, either creating more liquidity. In particular have been associated with this practice the creation of a fragile marketplace, increasing also volatility, an example could be the Flash Crash of May 6, 2010, or on August 24, 2015, with the fall of DJI and more on October 15, 2014, when the Treasury markets were highly volatile. All these crashes have been analyzed to see if their frequency was related to each other, and different ideas had come out, with the possibility that a relationship could not directly exist between high-frequency trading practices and the fragility and volatility of the market (Miller, 2016).

1.2.3 HFT profitability

At this stage of our study of high-frequency trading, it is important to understand the basic sources of its profitability, we need to find out what led them towards the choices they took and what they gain from helping the market produce liquidity because we are not talking about public institutions which aim to generate public benefit to the market. (Carrion, 2013). It has already been mentioned HFT philosophy of "winner-take-all", when only who is fast enough can profit from that, so HFT traders and proprietary firms make huge investments on the location of their servers as close as possible to marketplaces. The term co-location means that the HFT computers are placed where the computer servers of the exchange market are housed, allowing them to beat others for milliseconds. Against remuneration, they can reach the market and reduce latency, even if most of the trades produce small amounts of profits (Jones, 2013).

It is interesting for a better understanding, to decompose the revenues of HFT, particularly to distinguish two different points of view of HFT: the one that considers it as a new market or seen it against other investors. In the below graph it is illustrated how an HFT may produce a profit, the two ways are aggressively speculating and passive market making.
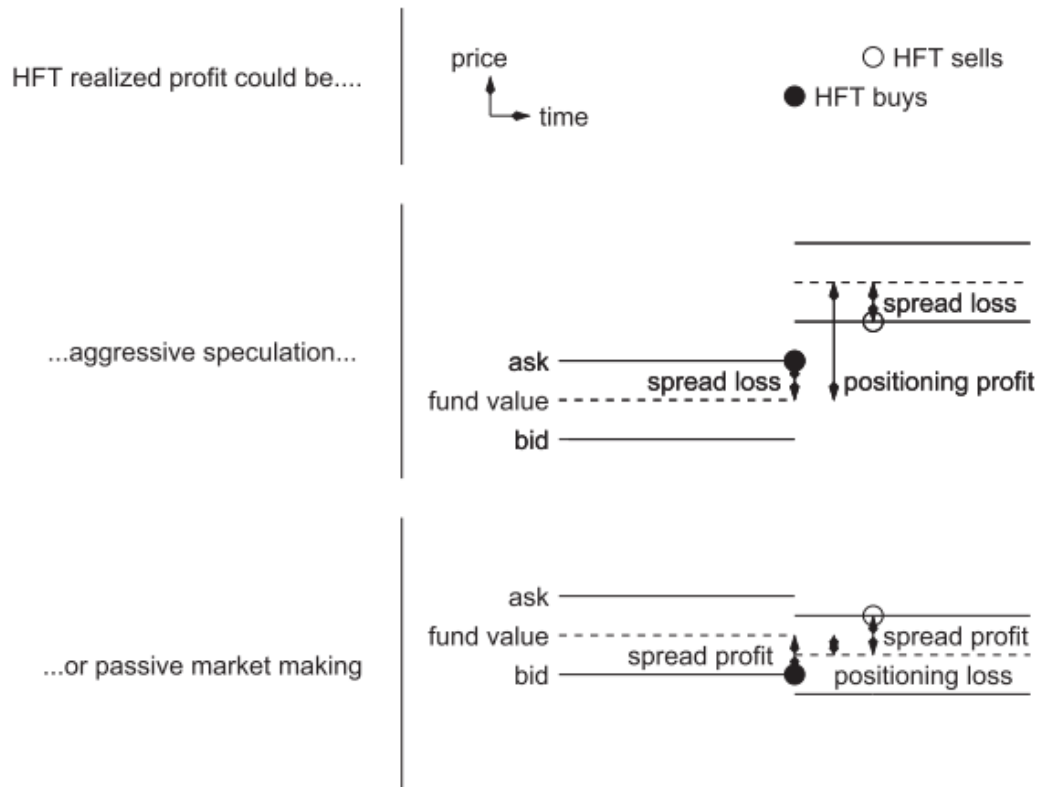

Fig.1 Trade revenue decomposition: spread vs. positioning revenue. Source: High frequency trading and the new market makers, Menkveld, Albert J.,2013 page 725

The first graph in Figure 1 represents the basic inventory cycle of HFT to profit: buy security, then sell it in a second moment at a higher price. However, there are different ways to profit like this. The second graph shows one of them, the HFT aggressively speculates, that it is characterized by the usage of liquidity to achieve a fundamental value change. As we can notice we are having a positioning profit but a spread loss because it is paying twice. In the last graph, we notice an opposite situation, when the HFT is a passive market maker, and it is supplying liquidity. We are having a spread profit, whereas positioning is having a loss, more specifically because HFT is buying a security when the bid is finding its ask offer and after the order is settled, the fundamental price falls. As the HFT is acting as a market maker, it will profit the spread.

The study conducted by Menkveld in 2013 demonstrates that most of the HFT are market makers, and this is important to understand how they are earning. If we are fixing this theory, they are generally gaining the bid-ask spread but losing on the net position. The paper was analyzing the correlation between HFT traders' actions and the price changes, and at microstructure levels, they could be two way causing the price movements: adverse selection and price pressure. As we said HFT traders are those who react first to information provided by the market, but another informed trader might beat and harm them causing losses, becoming who are adversely selected. In this case, we can note how the permanent price change is negatively correlated with the change of HFT position. For instance, if an informed trader decides to sell his position, the price will fall permanently, and the market makers will see their position rise (Menkveld, 2013). Based on the permanent price impacts[8] of HFT we need to test the adverse selection costs and since they elaborate faster the data, they have more information about the market. In the scenario where they are providing liquidity, they need to adversely selected, so be more informed. While, when demanding liquidity, they have to impose adverse costs to other traders, as they have a better insight on the market (Carrion, 2013).

Price adjustments are affected not only in the long term, but also in the short run and as it is negatively correlated, that will change the fundamental value and so price pressure. So basically, both temporary and permanently price changes have a negative correlation with HFT position change. HFTs may skew quotes to get out of their position and they could generate enough price pressure, which is more than half of the bid-ask spread's average. Another evidence of the study of Menkveld is surprising, it seems that during the trading day the correlation between the HFT position change and permanent price changes is negative, whereas overnight seems to be the opposite. Finally, looks like fees are an important profit for HFT returns, consequently they are more attractive in the exchange market, those new low-fee venues (Menkveld, 2013).

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[8] "The permanent price impact represents any new information permanently impounded into the security price and the resulting price changes give rise to a new equilibrium price level that sustains well after the institutional trade is completed."

1.3   Pro and cons of HFT for the market

In this section we will try to distinguish the pro and cons of HFT and the impact they have in market quality, however, the limit is not extremely sharp, it is important to understand the distinction we made since now it was necessary. A different point of view of the two main strategies could be seen analyzing their different approaches. On one hand, how market makers generally interchange selling orders and buying orders in the short run, to cover the excess of demand or supply, moreover, their price position change very fast. On the other hand, opportunistic settle a direction based on the price movement, and they do not change it, as sell when it is falling, vice versa buy when it is rising (Lattemann et al., 2012).

There are opposite opinions about whether HFT is producing benefits or is harming the market, depending on who is judging, could be market participants, regulators, or agents, or what we are taking into consideration if it is just a part of the market. The main points around this result are also related to the effect on the market quality caused by the nature of the trading practices. The most common function attributed to HFT is market-making, and from this point of view, the market generally takes advantage of having more competition which increases liquidity, so basically more HFT is better. Another benefit caused by the HFT is that it may make prices more efficient, incorporating more information, also known as price discovery. However, on the other hand, we might think that liquidity produced by this practice it is not real for the economy because it might be created by practices such as spoofing[9] or herding, predatory trading, and others (Carrion, 2013).

Different experts conducted a study on the benefits the market boasts from the activity of this entity, i.e., Chabaud et al. (2014) proved how HFTs enhance market efficiency by rising liquidity whereas dropping volatility in the short run. If liquidity is increasing one of the beneficiaries is liquidity traders, who see their trading costs falling. Another important consideration was raised by Jain et al. (2016) who said

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[9] Spoofing will be discussed in the following chapters, but it is basically an illegal market manipulation put in place by traders, high-frequency traders in this case, which place an order that they do not intend to execute, doing that they are causing an illusion in the market of higher demand that increase prices without a real value-added.

that this trading was increasing systemic risk exposure. (Germain & Rousseau, 2020). To limit the downside of HFT we can appeal to regulate the market, thus it should be supported by the incrementation of the number of HFT and so the competition between them. To do that, it could limit the speed of trades by imposing a speed limit to decrease the advantages and permitting fairer participation on the market. Another way could be, using fees that affect several small orders or simply limiting the number of trades executed (Germain & Rousseau, 2020). However, this will be largely analyzed later.

It seems evident that not all HFT strategies lead to the same result, and they could produce opposite impact in the way they are used, e.g., if they are liquidity supplier or liquidity consumer. In fact, HFTs that consume liquidity are those that execute their trades using market orders (opportunistic or aggressive traders), while when they are providing liquidity (market-makers or passive traders) use limit orders.

From a European point of view, *MiFID[10] II* summarize most of the benefits and risks of fast traders that European legislators had recognized, which are accepted also from most experts. Benefits are defined as follows, along with increasing liquidity and narrow spread, a wider participation of traders in the market, reduction short-term volatility as well as a better execution in general of orders. However, relative risks have been identified too, e.g., the risk of overload the trading venues, when large number of orders are made, malfunctions in generating erroneously orders by the algorithms or overreacting to market events. Previously mentioned there is also the gap that have been created between other market participants, as non-HFTs (Busch, 2016).

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[10] The Markets in Financial Instruments Directive (MiFID) is one of the cornerstones of EU financial services law setting out which investment services and activities should be licensed across the EU and the organizational and conduct standards that those providing such services should comply with. Following technical advice received from the European Securities and Markets Authority (ESMA) and a public consultation, the European Commission (the Commission) published legislative proposals in 2011 to amend MiFID by recasting it as a new Directive (MiFID II1) and a new Regulation (MiFIR2). The legislative proposals were the subject of intense political debate between the European Parliament, the Council of the EU (the Council), and the Commission. However, informal agreement between the EU institutions was finally reached in February 2014. The final MiFID II and MiFIR texts were published in the Official Journal of the EU (OJ) on 12 June 2014 and entered into force 20 days later on 2 July 2014. Entry into application will follow 30 months after entry into force on 3 January 2017. (https://www.nortonrosefulbright.com/en/knowledge/publications/6d7b8497/mifid-ii-mifir-series)

Since now we made the distinction between opportunistic and market makers, and now we will talk more about the latter category, as it is more predictable, as its behavior can be tracked. Moreover, it is the larger part of HFT and finally is the one will produce more positive effects to the economy.

If the focus is trying to be given to the advantages towards the market, and even though it is very controversial and hard to prove univocally the benefits taken by market-making HFT, the main ones, are evidenced on liquidity and price discovery. The aim will be to understand the connection between activities of HFT and changes of market quality. HFT can provoke either good or bad consequences on the market even analyzing only one aspect, staring from liquidity it will be seen that (Lattemann et al., 2012). We will talk about all the characteristics that are producing advantages and disadvantages, as long as destringing their effect is a matter of strategy adopter and who is analyzing the specific situation. The authors who have studied the HFT consider aspects differently, in particular authors such as LINTON and O'HARA, BROGAARD and EGGINTON argue that the HFT has positive effects on the market both in terms of liquidity and volatility but also in terms of information efficiency and systemic risk. Other authors such as Kirilenko et al., Zhang and Jarrow and Protter say that the effects of the HFT on liquidity and volatility are only negative. (Mirella Pellegrini CANDIDATO Salvatore et al., 2015)

Let us now pass those characteristics one by one.

1) Liquidity

A high level of liquidity is when a trading partner to execute an order can be found easily and liquid markets are more suitable for trading and preferred even by HFT. So, in this condition they are acting as the trading partners providing the liquidity needed in a precise moment. However, it should be noted that they are not obliged to do so. As previously said pros and cons are not clear divided and in case, they are not covering the demand-offer gap, as in crisis situations, they will amplify the downfall (Lattemann et al., 2012).

Liquidity has unquestionably increased in the recent years, what is not certain is the direct correlation of this increment with HFT circulation. Most of the studies have shown that a positive relationship exists, whilst others prove against the theory of

fast traders as good market player. The mismatch between opinions could be because a proper definition of market quality does not exist. Another possible misleading could be the so-called ghost liquidity, when HFT orders do not permit a clear idea of how deep the market is. If we focus a moment on an opportunistic strategy, there is the case when the execution of its order, is making disappear the previous shown liquidity, creating an illusion of liquidity, that is not real (Busch, 2016).

Investors normally have a benefit when the bid-ask spread is decreasing, because more liquidity is provided and that is a proper measure, reported on Gomber's (2011) study. It should be taken in mind that, the faster the trading are matched; the more liquidity is produced, and as an evidence the drop of bid-ask spread it is followed by a rapid drop of holding period. Since the face of the market has changed, it is not more carrying about where you are investing in but how fast you are doing it, gaining on quantity rather than quality. That is what algorithms have introduced, speed more than skills, money to invest more than knowledge of the market.

Another issue is regarding perceptible market liquidity and bid-ask spread that are not a suitable measure or the real market liquidity and does not represent the efficiency of the market. It needs to be the correlation between the fundamental value and the price to determine the quality of the market, insofar the HFT are the major traders the connection to fundamentals will be lost (Lattemann et al., 2012).

Liquidity is also conditioned by asymmetric information across market participants, known as adverse selection, when the better-informed trader profit at the expenses of less-informed trader. Whenever HFT have been adversely selected the liquidity will decrease (Jones, 2013).

2) Price discovery

Nevertheless, whether HFT are the better-informed part, thanks to the speed of its trading, prices will be updated faster, which means that they are contributing to price discovery. If stock prices are containing more data, faster, they are more efficient, and investors will benefit from it, because it has been reduced information disadvantage, hence a narrower bid-ask spread. In other words, it has been proved that more price discovery leads to an improvement of market quality considering that is easier to adjust their quotes to automated liquidity suppliers (Jones, 2013).

Therefore, from a microstructure point of view, HFT are part of the process of creating prices and influencing the transaction costs of financial instruments. The bright side stay on the fast incorporation of information considered a kind of double-edged weapon, faster does not mean that the intrinsic value has been correctly determinate, indeed it is looking to short term data, whereas it is processing short term information that are not crucial for intrinsic values evaluations (Lattemann et al., 2012).

3) Short-term volatility

A step forward is to examine price volatility and bid-ask spread. It is influencing the activities of HFT, whether the effect will be on increasing their activities when price volatility is higher besides when spread is narrow, which means that transaction costs are reduced. Now on, attention will be paid to the consequences HFT is causing to volatility, and the two type that can exist, "good" and "excessive". To define them, "good" volatility it occurs when price changes are due to fundamentals' new information and are integrated on the price, instead if changes are not caused by any informational modification, is so named "excessive" volatility or "noise". "Noise" could be created by situations e.g., in the case of reduction of inventory during the overnight time, no intrinsic information has been taken with the movement of prices, no more than a simple settlement of the outstanding balance. The signals cannot be always distinguished, thus a certain level of noise could be taken as tolerable, so the market is able to sustain it, otherwise benefits created by the presence of HFT will be cancelled (Lattemann et al., 2012). Academically, the effects of volatility are controversial too, it has been showed that in normal circumstances they are reducing it, instead when the situation is tense, they are leaving the market, creating even more inconveniences (Busch, 2016).

Hagströmer and Nordén (2013) have shown, using a statistical hypothesis testing and by isolating the HFT market-maker's impact on volatility, that an increase of this one and a decreasing of opportunistic strategy leads to a fall of short-term volatility. Black (1976) sustain an inverse relationship between volatility and prices and named leverage effect, thus according to it when the stock prices are falling, volatility is increasing, and vice versa (Hagstömer & Nordén, 2013).

Although very volatile markets are riskier with the presence of HFT, that is why regulators come into play and should try to limit the damages. Withdraws in bad times, cause serious consequences on the market as the flash crashes have shown in the last decades. Panicking is a human reaction whereas an algorithm that did not find an opportunity of profit from a trade just left the market, and in the case of fast traders, it will do it immediately letting behind slow traders, that will take a different price. The point stays in the stimuli that are receipt from both traders and the time of reaction, from the part that is strategically located closer to the financial markets, the response will arrive earlier, so the price will be favorable. Nevertheless, it should be taken into consideration how HFT market makers, in normal situation, are performing better than the average respect to other market makers (Lattemann et al., 2012).

4) Overloading trading systems

As HFT become widely spread, the number of orders has increased as well, leading to a phenomenon called quote stuffing[11]. After placing a huge number of orders, they will cancel them before it has been executed, causing a mismatch between the perceptible market liquidity and real trading volume. In addition, the costs of transaction seem be low, hiding implicit higher costs, because for processing large number of data implies costs that are not unconcern for other market participants. Overloaded systems are problematic and not easy to be read, and some HFT could use these huge orders to conduct others to pursue their purpose. This behavior does not give a choice to institutional investors that needs more time to execute all the orders they intend to, experimenting on average a 64% price increase. Unless investing in "dark pools", not under the control or influence of HFT that cannot make a profit so easily (Lattemann et al., 2012).

To summarize, most studies recognize the improvement of liquidity and the reduction of trading costs, thanks to HFT. Price discovery is faster and so more efficient.

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[11] Quote stuffing is the practice of quickly entering and then withdrawing large orders in an attempt to flood the market with quotes, causing competitors to lose time in processing them. (https://www.investopedia.com/terms/q/quote-stuffing.asp)

Competition in market making have increase while bid-ask spread is lower. However, in situations of high volatility they are not trying to avoid it, and even if it seems that HFT did not directly cause flashes crashes, particularly the one occurred on May 6, 2010, instead it amplified their effects on the market, as it helped to restore the balance. In the following chapter, the point will be extensively discussed.

Finally, we should focus on the consequences on market quality, in a way related to the market efficiency. (Carrion, 2013).

1.4 Consequences on market efficiency

1.4.1 Importance of liquidity

Liquidity is one of the most debated benefits of HFT, and it is important to consider the market implications before passing to the second part of our debate with the effects on the real economy. We already defined liquidity, but to simplify we might say that is the ease to buy or sell, in the short run, large number of financial instruments without affecting the market price. So, the elements that are fundamental are three: time, size and price. One of the goals of HFT may be reducing execution costs while they are increasing liquidity.

Therefore, the **sources of illiquidity** that should be considered are the following:

Explicit cost of transactions (e.g., brokerage commissions, order-handling fees and transactions taxes)

Implicit cost of transactions (e.g., the bid-ask spread is imposed if you are demanding liquidity, thus you buy at the ask price, while sell at the bid)

Price pressure or price impact

For the third point, an example is in the situation when a market participant wants to sell immediately his financial instrument, it needs a counterparty willing to buy it. If his request is not met, a market-maker must intervene to maintain the liquidity. Although the market-maker is taking a risk which needs to be covered by raising the price. That is not the only scenario in which a price shift could occur; private information could also cause some changes. E.g., When a large sale order is put, other participants will assume they are missing something significant and cause the price

to fall. Whereas a part is more informed beforehand, so-called adverse selection, they will anticipate the market flows, so that they will amplify the effects on the market.

A second step is to identify **measures of liquidity** and has been recognizing several of them, generally correlated with each other, but they can conduct to different conclusion.

Bid-ask spread it is considered the easier to observe. They can be quantified as a fraction of the amount of trading (relative spread) or as cents per share. It could be considered as the cost of buy and sell transactions. Moreover, it is continuously updated by the market makers and transmitted to investors. Although the orders are not taking place at the bid or ask price, because market makers can offer a price improvement, which means a better price for the transaction. This liquidity measure is useful for those who trade less and small amounts.

Price impact, better measure for institutions which need to invest larger amount of money in longer period by minimizing their trading costs. It is calculated by the reaction of share prices to a specific trade.

Implementation shortfall, it could be considered a good measure of the trading costs if we are taking into consideration the institution, as it is the average execution price, compared with the price before accomplishment. It is reported in basis points, as have being proportionated to traded amount.

Price efficiency, it is different from the previous measures, as it is focusing on the deviation from the efficient price, instead not focusing on the trading costs. Econometric models are used to calculate the average deviation size from the efficient price and consider the order flow of information. As these price movements are temporary and will be eliminated or reversed, then the inefficiencies of prices are econometrically measured looking to price reversals.

It is important to consider how liquidity is influencing share prices. Indirectly, when explicit costs are applied to the transaction, share price is directly touched from both sides, from the seller that has to pay for it and the buyer who one day will sell the share and incur in that cost too. The share price is reflecting the present value, along with the future transaction costs. Hence, also a reduction of transaction costs will have a positive increment for share prices. Higher share prices will be a lower cost

of capital for firms and good for the economy, because it means also more investments can be made by firms. Finally, GDP will increase as investment are part of it, consequently average standard living will too. (Jones, 2013) See below the GDP composition:

$$\textbf{GDP} = C + \textcolor{red}{I} + G + NX$$

It is a simple example of how HFT can have social implications, as it can actively touch important parts of the overall wealth. Moreover will be discussed in American regulations how policymaker should decrease transitions costs to allow more liquidity in the market. (Jones, 2013) The facts will be more detailed in the second chapter.

1.4.2   HFT, is it playing a dysfunctional role on the market?

As we know from the previous part, algorithms trading may be related to pursuing a specific goal, that are basically reassumed in two points.
- Reducing execution costs meanwhile increasing liquidity or
- Try to find mispricing and market signals in order to beat the competition.

Now, in the second case HFT are used to trade faster before mispricing fade or market signal become incorporate on market price.

Jarrow & Protter, in 2012, had made some hypothesis to analyze the specific case, where the market is competitive and in perfect conditions, so it is liquid, and the bid-ask spread does not exist. Let also assume that all the participants are price taker, so their actions will not affect the prices. And, as previously mentioned, there are 2 type of traders, ordinary traders and high frequency traders.

As the first trader will apply predictable strategies, the second one will not, adapting to the process, also called optimal processes.

It can be also considered as a hypothesis that HFT are acting to the same signal, in the same way, at the same time, and this will cause a huge impact on the market that will act like a single and large trader, since everyone is moving in the same direction.

If so, a quantitative impact will compromise market price, in two directions, depending on their action. If they are all selling, prices will decline, on the opposite, if they are all buying the price will assist to a rise. This may happen to those HFT who are using the same trading strategies, as arbitrageurs or momentum traders. (Jarrow & Protter, 2012)

From the study of Jarrow & Protter, the argument about the improvement or not of market efficiency with HFT emerges. In contrast to other literatures, that consider HFT a way to reduce bid-ask spread and market volatility while improving liquidity, this study has reached other conclusions. When we are starting from a market that is already with no bid-ask spread and a good amount of liquidity, the evidence showed how volatility will increase after the introduction of HFT. (Jarrow & Protter, 2012)

The real question is, when those two opposite conclusions are applying? The next section's goal will be to find it out.

1.4.3   Market Timing analysis and Market efficiency

It has been studied by A. Carrion, in 2013, the market timing [12]decomposition and at what horizon HFTs have the market timing ability.

He was analyzing the effects of HFT trading on a sample of NASDAQ traders. His paper shows that its trading performance, measured using Volume Weighted Average Price (VWAP) analysis, reflects market timing, producing strong effects on the long-term period. He obtained that lower trading costs are applied, and the prices reflect better and faster than the information presented on the market, when HFT is more operative, so the prices embody in fewer time changes in order. Moreover, another piece of evidence highlighted by this analysis through trading costs is that HFT takes liquidity when there is too much of it, whereas they provide it when there is not enough. It is important to notice how this evidence is strictly correlated to the sample he took and cannot be taken as absolute for all HFTs activities.

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[12] Market timing is an investment or trading strategy in which a market participant attempts to beat the stock market by predicting its movements and buying and selling accordingly. Moreover, market timing is the opposite of buy-and-hold, a passive strategy in which investors buy securities and hold them for a long period, regardless of market volatility. https://www.investopedia.com/terms/m/markettiming.asp

It might be expected that HFT are more able to concentrate on the short time horizon, due to their low-latency investment addiction. It is referred to the nature of intraday return predictability, where HFT should be prepared to take the risk of their capital expecting price changes, that will not give immediate results, along with potential effects that will transform price.

It came out how short-term timing performance has a negative effect on liquidity-demanding traders. Moreover, without intraday market timing skills of HFT, they are not having the short-term timing ability to overwhelm the bid-ask spread. The Menkveld study, on the other side, has find out how HFT is profitable only for spreads and positions that are lasting up to five seconds, while when they are holden for more than a minute will produce losses. The comparison is taking out the differences of which HFT strategies we are dealing with. If this was applied to the Carrion study a negative intraday timing performance should have be measured for liquidity-demanding trades. Furthermore, Menkveld that was analyzing the HFT's positions, also across markets, and has discovered how net long or short positions last up to hours having the possibility of earning significant intraday market timing profits to HFT. For all high frequency traders, the intraday market timing performance is doing better than short-term timing performance, which can be proved also for liquidity-demanding trades. Whilst the spread effects are negatively affecting intraday market timing performance.

So, to summarize what this leads to:

- HFTs have intraday market skills, they buy with temporarily low prices, exploiting temporary high prices for sell;
- The first point must be related with the predictability of intraday prices;
- Timing skills are not the result of very short-term signals, nor for shifty prices;
- HFT liquidity-providing trades are outperforming their liquidity-demanding trades;
- Trading costs are lower when HFT are part of the market;
- Spreads are wider when HFT are providing liquidity, while tighter when they are taking it;
- In general, HFT are consuming liquidity when it is in excess, whereas they are providing it when the market needs it.

From A. Carrion's study, it results that more than a half of HFT trading volume is liquidity-demanding, although it could be possible that both trades are combined to create a more complex trading strategy. It could also be that liquidity-demanding trades are motivated by different reasons diverged from profit as for inventory re-balancing or other risks. Some HFT could also be moved by time-sensitive information, more than liquidity-supplier do. It is noteworthy to understand how heterogeneity are HFT's activities and how hard is to consider the behavior of one as the rule of all. There are different strategies and different profitability. (Carrion, 2013)

They can be distinguished if they are asking or offering liquidity, for instance, Brogaard, J., Hendershott, T., Riordan, R., in 2013, had established how HFT that are demanding liquidity are apporting information into the market, meanwhile they are imposing adverse selection on other HFT that are supplier of liquidity, not just on non-HFT. They have also figured out how useful algorithms are in the prosses of price discovery, trying to eliminate "price errors", however, this cannot be a proof of more efficient prices, as they did not perform analysis on the efficiency on time series of prices.

Market quality is mostly based on pricing efficiency. According to Fama (1970), an efficient market is when "security prices at any time 'fully reflect' all available information." So, prices should be updated anytime, even though it has been proved in 2008 by Chordia, Roll, and Subrahmanyam that also inefficiency in intraday prices can lead to efficiency in the long horizon, thus investors will take time to react to information. Moreover Brogaard (2012), have produced some evidence about HFT reducing volatility that in some sort of sense could be considered as the opposite measure of efficiency, if we are considering the volatility per se, also called fundamental volatility. Instead, if we are considering excess volatility, where we are reducing it, it can be considered as more efficient. Total volatility is the composition of fundamental volatility and excess volatility. And finally, HFTs are increasing liquidity, as already been discussed, that is a good measure of market efficiency.

Carrion's research in 2012, could lead us to think that not only market-maker strategies could produce advantages in the real market. Instead think that heterogenic approaches could produce more positive effects than only one strategy. But in the

following chapter we will analyze more some manipulative strategies and in the last one how they are related to ethics. (Carrion, 2013)

1.5   Conclusions

In this chapter we had an overview of what HFT is, as a subset of the algorithmic trading ('AT') that have invested in sophisticated technology components in order to reduce the latency of order's execution, increasing the speed of the processes.

We talked about its different strategies, which will lead to totally different outcome. They have been distinguished in two main passive strategies, market making and opportunistic strategies. The first aims to gain the so-called bid-ask spread placing limit order book whereas the second is paying for it. Market makers strategy is the most adopted and it aims to provide liquidity while passive strategies, in general, should lead to reduce price volatility and bid-ask spread according to SEC. There are also aggressive strategies like momentum ignition and order anticipations, but in this case, they are not producing benefits for the financial market, contrary they are increasing volatility and harming the quality of the market. These practices are at the limit of legality, whereas there are other practices, slightly different, like spoofing and front-running that are considered manipulative strategies. Latters will be discussed in the following chapter before introducing regulation.

The differences between HFT and non-HFT are reducing the profit margin to the second group. The key word is time, as HFT are faster they will absorb the market signal before other can operate. However, it is an expensive investment on equipment along with co-locating their software closer to Stock exchange, paying fees for it. To cover those costs, we asked how they profited and as a result, we distinguished between aggressive speculation, where are paying the bid-ask spread and gaining positions, while passive market making does the exact opposite.

Then, to have a prospective of how complex is the instrument we listed pros and cons. Since experts have opposite opinions about the HFT harming or not the market we mainly took into consideration the most neutral opinion expressed in MiFID II, where the benefits are: increasing liquidity, narrowing bid-ask spread, implementing market participation, reducing volatility and guaranteeing a better execution of

the orders. On the other hand, the risks may be overloading the trading venues, increasing the possibility of erroneous orders, and overreacting to market events.

Finally, we define an efficient market, and analyze HFT arbitrage influence in the economy, as what the economy want is the welfare of their participants and of the overall system. The mean that are used to achieve that goal are important as the result they are carrying with. Now on we can do a further step, based on this basic information we have acquired.

The next chapter will begin with one of the events that have had a bigger eco on financial markets regarding this sophisticated instrument, HFT, the so-called Flash-Crash. Later, we will discuss how this tool is regulated, but for the moment we should keep in mind that, even though the market can regulate itself, sometimes guidelines are necessary, especially when the effect of HFT trades is not completely clear in terms of speed and number at which the market is working optimally.

Chap2   Effects on the real economy

2.1   May 6, 2010, Flash Crash

In the previous chapter the concept of HFT and the theoretical role it plays in the market was introduced, but are we sure that is applicable in the real-world market? In this chapter, it is important to analyze the effects on the real economy. Firstly, starting from the flash crash[13], one of the events more significant correlated to the fast-trader's name.

A flash crash occurs in electronic financial markets when the withdrawal of stock orders accelerates price declines. As a result, there tends to be a rapid sell-off of shares that can occur in a matter of seconds, resulting in significant declines. (Investopedia)

The Nanex[14] homepage cites define what a flash crash is more specifically. So, a (down) flash crash is occurring when the stock price is doing one of the following:

- Ticking down at least 10 times before ticking up;
- Price changing is occurring within 1.5 seconds;
- Price changes more than -0.8 per cent.

Several of them have occurred in the last two decades, according to the Nanex, only in 2013, more than 100 flash crashes have taken place, as more than 40 in the first semester of 2014 (Borch, 2017). A more recent one, for example, is known as the Flash Crash of the Japanese Yen on January 2, 2019. However, in our paper we will dwell on the most significant one, that happened in 2010, that is in the center of a lot of discussions.

After listing the advantages and disadvantage that HFT provide in the financial

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[13] A sequence of events which made prices plunge throughout the US stock market (Lattemann et al., 2012)

[14] Nanex, headquartered in Chicago, provides streaming market data services as well as real-time analysis and visualization software. Their customers, who are usually traders and other financial consulting companies, receive data on all market transactions.

market, it is easier have a clearer idea of consequences of their actions that could be related to the circumstances of flash crash. In 2010, the Security and Exchange Commission (SEC) along with the Commodity Futures Trading Commission (CFTC) have reported evidence about flash crashes and how they have been caused by incorrect trading algorithms by companies that did not use high frequency trading. Ever since the debate has started, a spotlight has been directed to HFT's world, raising the interest of regulatory authorities, intending to investigate and examine their effects on the global capital market. Different, or even opposite, perception of HFT have been expressed. For example, according to Brogaard's (2010) study the consideration that HFT damage the market and create the so-called flash crashes, have been rejected. Instead, he has considered its importance reaching the best bid ask quote. (Lattemann et al., 2012)

On May 6, 2010, one of the most memorable events in the last decade occurred, regarding the financial market fasted go down. Flash Crashes need to be under control to reduce the risks in the short and long run consequences, as their nature is unpredictable, it is not easy to foresee them. Moreover, as we said, these events are repetitive in the financial market, some of them are kneel the entire economy for some minutes, stimulating fear. The 2010 Flash Crash is the most representative case.

We will reattach to our main topic, HFT, by introducing what happened on May 6, ever since it was initially considered part of the cause. First, it will be analyzed what E-Mini contracts are and why they are an important part of this fell of markets. Second, facts will describe what have happened and what consequences have arisen with the Flash Crash.

2.1.1   A brief background of what the E-mini contract is

The E-mini future contract has been introduced in 1997 by the CME (Chicago Mercantile Exchange). Its name is due to the fact that it is traded electronically and respect to the original S&P 500 future contract is five times smaller. It has been used as a hedging instrument against U.S. basket stocks or to speculate on the entire stock market. E-mini, compared to all U.S. equity index products, have a greater impact on the price discovery as representative of the major American index, as futures,

options, or ETF. "The contracts are cash-settled against the value of the underlying S&P 500 equity index at expiration dates on March, June, September and December of each year. The contract with the nearest expiration date, which attracts the majority of the trading activity, is called the 'front-month' contract." (Kirilenko et al., 2017) Thinking about May 6, 2010, the 'front-month' was June 2010. At that time, the nominal value on the E-mini contract was 50$. As Kirilenko et al. explained that the S&P500 index fluctuated marginally above 1,000 points from May 3 to 6, 2010, making each E-mini contract worth approximately $50,000. The E-mini's price increment, or "tick," is 0.25 index points, or $12.50; a price shift of one tick reflects a 2.5 basis point fluctuation. The E-mini is only traded on the CME Globex trading platform, which is a completely electronic limit order market. Trading occurs 24 hours a day, seven days a week, with the exception of one 15-minute technical maintenance break each day.

The CME Globex matching algorithm for the E-mini follows a "price-time priority" law, which means that orders with more favorable prices are executed ahead of orders with less favorable prices, and orders with the same prices are executed in the order in which they were received by Globex. The E-mini market is transparent both before and after trade. Pre-trade transparency is offered by broadcasting in real time to the public the amounts and prices for buy and sell orders resting in the central limit order book, up or down 10 tick levels from the last transaction price. Transmitting to the public the prices and amounts of completed transactions provides post-trade accountability. Individual traders submitting, canceling, or changing bids and offers, as well as those whose orders have been executed, do not have their identities made public. (Kirilenko et al., 2017)

Now that we know what E-minis are, we will go forward talking about the event of 2010.

2.1.2   What happened on May 6, 2010

On May 6, 2010 a strong and temporary selling pressure primarily caused the market to suffer a 15-minutes sharp fall of prices in the S&P 500 market. That early afternoon, starting at 2:32 p.m. (central time), a mutual fund complex begins processing a selling program to unload 75,000 E-mini contracts to hedge an existing

equity position. By doing that they used an automated algorithm to place the offers, feeding the orders into the June 2010 E-mini market. The created selling pressure was initially absorbed by HFTs and other participants in the future markets. Some of them were fundamental buyers, others were performing opportunistic strategies by cross-market arbitrage, transferring the sell pressure to the equity market (e.g., on SPY, ETF of S&P 500). From that moment the prices of the E-Mini started to fall sharply in the following 13 minutes reducing the buy-side market to less than 1% respect to the beginning of the same day. The intervention of CME was necessary to stop the triggering of price decline of E-Mini future contract and of SPY contracts. However, their recovery plan was not working as long as some individual securities and ETFs decided to sell their positions as well. The lowest point the price reached was 60% less than at 2:40. (Kirilenko et al., 2017)

Huang and Wang (2009) have analyzed a model developed by Grossman and Miller (1988) in which, if a single individual intends to short a large position briefly, the situation will create a tense period of temporary and large selling pressure, causing the market crash, even without fundamental shocks. The incoming excess of selling orders overwhelms the insufficient capacity of risk-bearing of market makers. Considering that the involvement of market makers has a cost, they should try to maintain the risk of exposures lower as possible. However, if there are huge sell orders, it is necessary that the price is dropping to guarantee that the risk market makers are taking is covered by a lower buying price.

It is quite clear how the meeting between buyers and sellers does not happen simultaneously and an intermediary is necessary. Ever since the technology has been introduced in the financial market, intermediation endure a transformation. Now most of market makers are HFT, that are not obliged to help the market, but under payment of a fee they are providing the same service of intermediation as other market makers. The matter of this part of the paper is to discuss how these electronic intermediaries are supposed to react in periods of temporary stress and pressure, from the buyer or seller part. (Kirilenko et al., 2017)

The impact that is associated with the Flash Crash will be pointed out and critically analyzed. I supposed that, as people are scared to lose their money, so the fear is moving their consideration about the Flash Crash, fear of technology and fear of herding. That is the main reason it had such an extensive wide appeal, especially in

the high frequency trading world. As we said the US financial market had a massive blow that day, specifically the Dow Jones Industrial Average ('DJIA) a drop of more than 9%, which corresponds to around a trillion dollars. The drop was mostly concentrated between 2:41 p.m. and 2:45:27 p.m., basically in four and a half minutes. It was suspended for the following 5 seconds. Afterwards the giant sell order, HFT intervene initially, but as the amount of selling was increasing even more, they decided to leave the market, letting the price drop. It was felt as a high volatility situation. The dropping of prices leads to a large number of trades been cancelled later; due to the irrational price they have been sold at. Worthy of note is the use of the adjective "Flash", which is referred to both fell and recovery of the price. Among the causes of May 6, 2010, there could be a problem of the market microstructure or the fully use of automated computer algorithms with no human intervention. (Borch, 2017) However, the problem judging the event is that is not taking into consideration the actual effects, rather than the potential effects. The paper of Borch (2017) analyzes how the real economic effects are not substantial as previous "similar" crashes, e.g., in 1987.

Fig. 2   30 minutes of Flash Crash, source: Bloomberg

The HFT was accused and put under inspection after the event occurred. However, Sornette & von der Becke, in 2011, declared that the new trading method was no more being looked at after a while, even though the doubt about its involvement remains for a lot of experts, beside be more skeptical of HFT in general. The HFT were not considered able to bear the risk of potential disrupting the market and thus its introduction into the financial market was a possible correlate to market crashes. The Chief economist of the US Commodity Futures Trading Commission (CFTC) from 2010 to 2012, Dr. Kirilenko, has argued the real impact that HFT algorithms onto May 6 crash was significant too. So, we should face that there are controversial looking to computer algorithms, but what we should realize is that is not an once event. The crash-dynamic is not something so exceptional, are events that are part of the market cycle, but what occurs in 2010 was used as a symbol to capture something progressively more typical. It is normal to underestimate the frequency that this little crisis has been occurred ever since now, and we tend to look to what had a major impact on the news. Certainly, it had influenced the financial markets, and will be discussed the potential impact it had. (Borch, 2017)

2.1.3 The impact of the Flash Crash

Now the spotlight will be direct to the effect that HFT may have produced since it has been introduced so it might be clearer what its correlation with the flash crashes is.

It has been individualized three major impacts that are thought to be important in the present market, caused by the HFT:

i. Perception for the market participant of the market itself has changed.
ii. Economic effects have been generated, e.g., massive loss of value.
iii. Systemic risks linked with algorithms.

The first impact could lead to different ways to react, especially related to whether and how they were involved in trading during May 6, 2010. What moves market participants is the fear of losing money and see market collapsing has a shocking impact.

The SEC chair from 2009 to 2012, Mary L. Schapiro, has described it as a "market

failure". Although, analyzing the previous crashes, e.g., in 1987, they were longer-lasting. In 2010, it has a flash recovery as well. Moosa I., in 2015, reconsidered the role played by high frequency traders in that May day, whereas all other long-term traders were left.

The problem was that market participants were not more trusting the market structure after the falls of the crash.

A survey was conducted by BlackRock, one of the world's largest asset manager, regarding to the impact of the Flash Crash. The majority of 380 retail financial advisors interviewed minimized the effects of market disruption. Later they realized that following cancellation of most trades had rebalanced a bit the catastrophic situation was created in four and a half minutes. Consequently, the rebound had limited the economic effects, nonetheless had caused a new systemic risk, linked to financial algorithms.

Sornette and von der Becke defined the financial markets as "complex systems" with periods of extreme events and sudden "state-transition" and most of the time in an unpredictable state. The unpredictable state has raised an augmentation against the HFT actions, that have been accused of producing "pro-cyclicality mechanisms" that lead to "unsustainable regimes, ending in crashes and crises". When the market is already unstable, the effects are amplified by HFT and instability becomes crashes.

We should think to those algorithms as models. As those models are created by human being, models should be logic, and intuitive. E.g., when one stock start to receive a lot of requested, then traders would think that there is an interest, and will invest increasing the price of that stock.

Introducing sociology could help find more pieces for our research. Beunza and Stark (2012) find out that some quantitative traders create dissonance went they are modeling their trading. If only the quantitative traders are using this model, the problem does not exist. However, the main problem is herding when other market participants produce so-called "cognitive interdependence[15]", a mental state characterized by a pluralistic, collective representation of the self-in-relationship. Others could not be aware of some details and so their investing decisions will be affected. So, individual's errors will be amplified by reflective modelling and

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[15]https://www.researchgate.net/publication/211380607_Cognitive_Interdependence_Commi-ment_and_the_Mental_Representation_of_Close_Relationships

whereas those modelling are improving trading, based on dissonance, then financial distressed may happen. However, human behavior should be smoothed by the intervenient of HFT in the market.

To conclude this part, during the Flash Crash experts were used to see only the negative aspects that HFT have taking to the event, forgiven the positive ones, e.g., flash recovery. They pointed out two major tropes, technology, and herding. However, a lot of studies have been conducted on the argument and, even if controversial solutions were expressed, turns out that HFT were not one of the causes of the Flash Crash, but something that helped relieving. (Borch, 2017)

Four years after the event, the CFTC-authority itself declared that the high frequency traders "did not cause the flash crash but contribute to it by demanding immediacy ahead of other market participants. Immediacy adoption activity of HFTs results in price adjustments that are costly to all slower traders, including the traditional market makers". (Kirilenko et al., 2017)

However, a year later, in 2015, when the US Department of Justice arrested Navinder Singh Sarao[16], a British stock market trader, accused to have played an important role in the Flash Crash. Though his future company, he was involved in some market manipulation, particularly the so-called spoofing[17]. (Busch, 2016) To have a better idea of the dimension of his affairs, in the previous five years was estimated he gained around US$ 40 million by manipulating the E-mini S&P 500 futures, regulated in the CME. As his affairs were managed in London, he was not directly correlated to the 6 May, 2010 event. Sarao has developed algorithms that were able to place and cancel order at lighting speed, allowing him to operate for over 400 trading days without been suspected, while he was in the United Kingdom. The technique was letting the other participants think that the prices were going to fall. As previously analyzed, during the flash crash a huge sell order was placed, which caused the turning point in a few minutes. As the market perceives a strong pressure on prices, consequently this is what will going to happen. Prices will fall. As long as Sarao obtained what he wanted he bought at a lower price. As the sell order was places by him, he cancelled his order, letting prices rise again. That is the exact moment when he was selling his futures, making profits.

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[16] https://www.bbc.com/news/business-35863848 BBC news
[17] A manipulative strategy that will be discussed later in this chapter.

CFTC declared that Sarao was involved in the activity of the day when the flash crash happened. Spoofing techniques were put into practice. This tactic is prohibited in US, as a crime, since 2010 and considerate as market manipulation in Europe, as in UK. (Busch, 2016)

The intuition of Sarao was that, if high frequency traders used identical technologies, they would all travel in the same direction. Wherefore, he has placed thousands of orders and then quickly cancelled them, generating artificial demand for other traders to buy or sell the asset. [18]

However, the theory that Sarao on his own have caused the flash crash seems to be a bit unrealistic, he is an important part of it.

In the next section, a legal part regarding algorithms trading and how they have been regulated recently will be discussed, but first let us talk about manipulative strategies starting with spoofing technique, just mentioned. (Busch, 2016)

2.2   Manipulative Strategies

There are a number of manipulative trading strategies that attempt to move prices away from their real value to profit from the manufactured discrepancy. Most of them are low frequency strategies but some of them can also be implemented using high frequency technology. Such manipulative strategies are generally illegal violations of the anti-fraud provisions of the Securities Exchange Act of 1934.

1) Spoofing

A particular spotlight has been raised on a certain practice called spoofing by CFTC[19]. The Title 7 of the United States Code, or 7 USC[20], define spoofing as "bidding or offering with the intent to cancel the bid or offer before execution". The Commodity Exchange Act (CEA) explicitly prohibit destructive trading practices,

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[18] BBC news by By Andy Verity & Eleanor Lawrie, 28 January 2020.
https://www.bbc.com/news/explainers-51265169
[19] Commodity Future Trading Commission (CFTC), is an independent agency of the US government, that oversees regulate U.S. derivatives market (future, swaps, options). (Wikipedia)
[20] Commodity Exchange Act (CEA), aim avoid fraudulent trading of derivatives. After 2008, CFTC want to be more transparent with the Dodd-Frank Wall Street Reform and Consumer Protection Act.

among which violating bids or offers practices that is fitting with the definition of spoofing.

However, when it comes to be applied to our specific case, HFT, it is not that easy to distinguish as a specific action. As the bids and offers are places in milliseconds and cancelled at the same speed, it cannot be established so simply when we are talking about spoofing.

As was previously mentioned, in 2015, Nivinder Singh Sarao was accused by CFT of had manipulated the market with the practice of spoofing, particularly the E-Mini S&P 500 futures contract, contributing to the Flash Crash. What is it really happening and what is the mechanism behind this strategy? At once it will be illustrated how spoofing it works, a simplistic mode.

Market Mirage | Stock-price manipulators try to fake out rival trading systems to capture quick profits through a technique known as 'spoofing.' Here's how it works:

Shares of Company X are available to buy at $10.

A would-be spoofer, who owns 1,000 shares of Company X, places a bid to buy **100** shares at $10.01.

Automated trading systems raise their own bids in Company X stock to $10.01.

The spoofer at the same time cancels his or her 100-share order and enters an order to sell his/her **1,000** shares at the **new price.**

The spoofer can pocket **$10** more than he or she would have selling the shares at $10 apiece.

Fig.3   Illustration of spoofing, source: the Wall Street Journal

As shown in the Wall Street Journal source, let's hypnotize that, if the demand is at $10 as spoofer will try to move the price higher if it owns shares, so let say at $10,01. Doing it, he will try to buy shares at 10,01 without ever executing the order, just raising the bid in the market. That is the moment when he will cancel his order and sell his shares at the higher price, created by themselves. The gain will be the difference between the two amounts, times the number of shares previously owned. So, no matter if it is a very low amount, as they have several shares. (Miller, 2016)

2) Front running

Front running occurs when a market participant discovers that another investor is

about to make a large transaction and then ''runs in front'' of the trade. For example, suppose a broker receives an order to buy five million shares of stock. This large order will probably take several hours if not days to complete. With the knowledge that the large order will push the price up, the broker then buys stock for his own account before executing the client's order. This pushes up the price that the client ends up paying for the shares.

Several critics allege that the use of high frequency technology can be used to front run other orders. So-called ''predatory'' algorithms, or ''algos,'' figure out that a large order is in the process of execution and jump in front of it. This is one of the predictive strategies discussed above. While it is clear that brokers who front run their own customers are violating their ethical duties to their customers, it is not clear that there is anything wrong with investors using information that is publicly available to everyone to make their trading decisions. But is it fair if some investors have access to faster computers than others? We will return to this question below. (Angel & McCabe, 2013)

3) Order Triggering Strategies

A classic manipulation is a ''bear raid'' in which the raider enters a short sale order large enough to push the price down. Other investors may view the drop in price as an indication that somebody knows something and follow suit, pushing the price down even more. If the price falls enough, it may trigger further sales from stop orders and liquidated margin accounts that will depress prices further. The manipulator then buys stock back at a lower price to ''cover'' the short and thus make a profit. Modern perpetrators of this type of illegal manipulation may use computers to search out situations when such an abusive activity may be most profitable, such as when there are very few visible orders on the buy side of the market. (Angel & McCabe, 2013)

4) Wash Sales

A wash sale is a fictitious sale that is reported for the purpose of making it appear that there is more trading activity in the stock than there really is. For example, a

manipulator may put in simultaneous buy and sell orders through different accounts to make it look like there is trading interest in the stock. The manipulator does this at higher and higher prices to make it appear that the market is more liquid than it really is and that there is upward price pressure on the stock. The intent is to attract still more trading interest in the stock from gullible investors. (Angel & McCabe, 2013)

5) Quote Stuffing

It is possible to use high speed computers to send thousands of orders into a stock exchange and then cancel them immediately. The alleged intent is not to trade, but to slow down other traders whose computers are slowed down by all the message traffic. Such intentional "quote stuffing" is clearly an abusive practice that should be punished. However, it is not clear that all instances of high cancellation rates are intentional. Some might be the unintentional consequence of poorly designed software or the complex interactions of different computer systems. Regardless of the cause, excess cancellations are a form of pollution that imposes costs on everyone who has to deal with the massive quantities of data generated by these instances. Whether the product of scienter or carelessness, authorities should take action to reduce this quote pollution and to punish intentional manipulators. (Angel & McCabe, 2013)

Chapter 1 talked about the main strategies that are allowed in a regulated market, as not all HFT strategies are bad for market quality. But as we will see some restrictions have been made to guarantee an efficient market. Regulation have been settled in order to avoid or at least reduce manipulative strategies.

2.3   Regulation adopted

Regulation is necessary to lead to clear menage of the current situation of the market. However, to regulate the algorithms trading, authorities need to distinguish between the different types of them. As their actions can lead to different goals, for example they may pursue market manipulation in their strategies. It occurs when the placed limit orders are fake or intend to do quote-stuffing, as previously

discussed. The practice is considered against the law and since this manipulative strategy happened in the market, its regulation seems necessary to avoid these behaviors as much as possible. Flash Crash can be considered only the top of the iceberg, as the event that makes start all the control around the AT world. Later intensification was made in the regulation of different countries and the rules are applied based on the strategies the single HFT is pursuing. Although regulation it is a fundamental element in financial market, the applications to all the scenarios become not an easy task, especially when traders could operate hiding their true nature, or in dark pools.

In a second stage, it is important to notice how we are in front of formulas settled by humans, that are following their own strategy. Furthermore, many market participants now use algorithms for trading, allowing computers to automatically decide aspects of orders with little or no human involvement. The increasing risk makes regulating the market more necessary.

Obviously, it would be better taking all the advantages it is apporting, avoiding the negative parts and doing it regulation should facilitate.

We will talk about two of the main legislations in the world of HFT. Some of these regulations are applied in the European territory and others settle in the American financial market. It can now be differentiated between these two different methods, which have a common aim of preventing business failures but use different approaches to accomplish it.

2.3.1 European Legislation

As we said, due to the technological advances, financial markets have changed dramatically over the last decade. Since many market participants are now engaged in algorithmic trading, the market should be regulated. Moreover, computer algorithm decides elements have no human involvement, along with its continuous expanding through asset classes, from more developed equity and interest rate markets to commodity markets. As a result, dramatic shifts in market dynamics and microstructures have occurred, necessitating the adaptation of EU legislation to this new paradigm. For a long time, one of the most hotly debated issues in the financial industry has been the effect of algorithms used for routing and executing trades in

financial instruments. (Ii & Trading, 2020)

1) MARKET IN FINANCIAL INSTRUMENT DIRECTIVE II (MiFID II)

Since January 2018, the Market in Financial Instruments Directive II (MiFID II) was adopted. Biding directives at European level, which settle the financial sector. Regarding the high frequency trading, this practice it not prohibited. Instead, the Directive regulates the supervision related to the specific risk of algorithm trading are causing. In the recital 59 of MiFID II is specified that, according to Busch, 2016, trading technology has advanced dramatically over the last decade, and it is now widely used by market participants. Many market participants now engage in algorithmic trading, which involves a computer algorithm, thus the risks associated with algorithmic trading should be regulated. (Busch, 2016)

MiFID II introduced the definition of HFT in its Article 4(1)(40) as "an algorithmic trading technique characterized by:

(a) infrastructure intended to minimize network and other types of latencies, including at least one of the following facilities for algorithmic order entry: co-location, proximity hosting or high-speed direct electronic access;

(b) system-determination of order initiation, generation, routing, or execution without human intervention for individual trades or orders; and

(c) high message intraday rates which constitute orders, quotes or cancellations."(Ii & Trading, 2020)

Then MiFID II talks about the benefit the HFT is apporting to the market and to the market participants, as increasing the participation, the liquidity, narrowing spreads, reducing short-term volatility, leading to a better execution of the orders. Including in its preamble the potential risk they are facing as well, as overloading the trading venues or generating erroneous orders or the possible overreaction to market situations.

In the previous MiFID I the supervision rules where not established, even though MiFID II is not completely innovative. Most of them are based on ESMA[21] Guidelines

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[21] European Security and Market Authority. One of the three ESA (European Supervisory Authority) established in 2010, that were created to build a common European Union supervisory culture and consistent supervisory practices. ESMA develop draft regulatory technical standards.

entitled "Systems and Controls in an Automated Trading Environment for Trading Platforms, Investment Firms and Competent Authorities."

It is interesting the background of the institution that, together with the other two ESAs, in 2010, after the famous crisis of 2008, have been introduced to regulate financial markets. The ESAs are autonomous, EU-funded bodies of experts from EU member states (the "Member States") that advise on new financial legislation, facilitate supervisory convergence, and generally serve as an EU-level "system management" role rather than day-to-day supervision. (Authority, 2012)

The rules have been included and formalized in MiFID II in order to supervise algorithms trading and in particular HFT and now more attention is put on them from the supervisory authorities.

Most regulators consider algorithmic trading has the major potential cause of market manipulation. Concerns have been raised about the high order cancellation rate, the increased risk of overloading networks, increased volatility, algorithmic traders' ability to remove liquidity at any moment, and inadequate oversight by competent authorities. MiFID II tightens up the supervision and oversight of algorithmic trading, enforcing additional and more detailed criteria on algorithmic traders (even if they are excluded from authorization under MiFID II in some cases) and the trading venues where they trade (including regulated markets (RMs), multilateral trading facilities (MTFs) and organized trading facilities (OTFs)). (https://www.nortonrosefulbright.com/en/knowledge/publications/6d7b8497/ mifid-ii-mifir-series)

Article 17 of MiFID II discusses the details of AT and HFT's regulation, in particular:

i.   introduces some requirements for investment firms that are using AT and HFT for internal system and controls.

The internal system and controls must guarantee and maintain some standard of the trading market, such as its resiliency, capacity, some limits, avoiding erroneous signals or any kind of disorder. They cannot go against the Market Abuse Regulation (MAR)[22], and that a business continuity must be guaranteed, independently from the

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ESMA is dealing with legislation and regulation that aim to enhance the European financial market, protecting investors and support the co-operation between authorities.

[22] Its aim is to improve market integrity and investor protection.

investment activity and possible failure, besides those activities are controlled and tested.

ii.   Imposes to them duties related to the information and record.
When an investing firm is using AT and HFT in a Member State, fundamental information about their trading must be communicated to the competent authorities of the home Member State along with the trading venue it is using. All the activity must be shared to the competent authorities as well as the strategy by the home Member State. The information needs to be tracked and reported to permit an analysis afterwards.

iii.   Imposes requirement when the AT and HFT are considered market makers.
When the investment firms that using HFT or AT that are pursuing market making strategies, they must follow some requirements. For example, a proportion of liquidity must be produced, moreover when the market is in some bad condition, the firms cannot withdraw suddenly the market, as it is when market makers are more needed. An agreement about the obligation should be written and respected. (Busch, 2016)

The ESMA is developing the draft regulatory technical standard specifying the points just mentioned. It is ESMA task create this draft to settle the discipline and then submit them to the European Commission.

Moreover, article 5 of RTS 6 states that before deploying or making a significant upgrade to an algorithmic trading system, trading algorithm, or algorithmic trading strategy, an investment firm should create and evaluate such systems, algorithms, or strategies using clearly defined methodologies.
These strategies should, in particular, ensure that the algorithmic trading scheme, trading algorithm, or algorithmic trading strategy: (a) does not act in an unintentional manner, (b) complies with the investment firm's obligations under this Regulation, (c) complies with the rules and structures of the trading venues accessed by the investment firm, and (d) does not lead to disorderly trading coexistence. (Ii & Trading, 2020)

According to RTS 6, an investment company can verify the conformance of its algorithmic trading systems and trading algorithms with the trading venue's and the direct market access provider's systems in a variety of cases. Such conformance checking should ensure that the fundamental elements of the algorithmic trading system or trading algorithm function correctly and in compliance with the specifications of the trading venue or direct market access provider. It is also stated what the testing should check for this reason. Recital 6 of RTS 6 states that trading algorithm testing should be focused on the possible effect that such algorithms which have on the overall equal and orderly operation of the market, and that pure investment decision algorithms should be exempt from testing criteria.

ESMA would like to point out that, while other conditions on algorithmic trading may be assumed to be excluded in cases where algorithms have a limited impact on the overall fair and orderly functioning of the market, such a limited impact may be difficult to check. (Ii & Trading, 2020)

2) DIRECT ELECTRONIC ACCESS (DEA)

MiFID II is not the only regulation and supervision form of HTF and other AT, but it defines other ones. Investment firms are to secure themselves by providing to their clients the direct electronic access (so-named DEA) to perform transactions that are under certain supervision. However, when they are providing the DEA they must respect specific systems and risk controls. Moreover, provider of DEA must conduct due diligence relative to their clients, and continuous supervision must be provided. DEA is allowing those that are not considered participants of a trading venue, to transmit their buying or selling orders using a trading code. As long as they do not know the exact moment the orders will be executed, the code will avoid further delays. For this reason, DEA separates AT and HFT, and it is not considered a high frequency trading technique. Therefore, it is used mostly by investment firms that employ AT, instead of HFT, because most of them are not considered participants of trading venues. Instead, when investment firms are using HFT, most of the time are considered part of trading venues, which means that they are not needing trading code. It is interesting how the provider of DEA could be the firms which use HFT or AT themselves.

There are benefits and risks of DEA, not directly mentioned in the MiFID II. Benefits as to permit the client of been in control of their decisions of investing which on the flip side of the coin consist in a risk that the client is taking all on his own.

DEA is used by many market participants and regulated in article 17 of MiFID II where they

i. introduces some requirements for investment firms that provide DEA for internal system and controls.

The investment firms must guarantee to the clients that are using DEA a proper service that is at the same time monitored. The risk they are passing to the client is modest and will not cause or contribute to the market disorder or problem to the investment firm itself. Moreover, it must be ensured that the control of risk will prevent any market abuse, so not going against the Market Abuse Regulation.

ii. Imposes requirement related to the relationship they have with clients.

A binding agreement is establishing the rules of the contract between the investment firm and the client. Rights and obligation between the parties for the service provided must comply with the regulation of MiFID II. Also in this case, it is the ESMA that is drafting regulatory technical standards (RTS) which oblige the investment firm to fulfil with due diligence towards the client. Not less important is the continue monitoring of their transactions to avoid violation of MiFID rules and MAR.

iii. Imposes obligations related to the information and records.

Finally, the competent authority of the home State Member and of the trading venue must be advised about provisions of DEA services by investment firms. It must be provided to the competent authorities also all information that are regarding the system and control of these contracts. Additionally, an appropriated record should be kept by investment firms to ensure a viewing from the competent authority that can verify the effective compliance with rules. (Busch, 2016)

3) MARKET ABUSE REGULATION (MAR)

Moreover, in Europe, a new Market Abuse Regulation (MAR) was settled, forbidding numerous algorithms trading strategies, specifically HFT strategies, that could hurt the market participant and the market itself.

i. Do not allowing to place large volume of orders that will perturb trading systems.

ii. Do not hamper other traders by placing orders that are not going to be executed.

iii. Do not create misleading supply or demand signals of financial instruments. (Busch, 2016)

4) TRADING VENUES

MiFID II, as we said, have introduced rules that AT and HFT traders must follow in order to maintain trading market balance, but they are not the only ones that have responsibilities. Trading venues where AT and HFT traders are playing a role have duties too, as for those that can be reached though DEA.

The ESMA regulatory technical standards (RTS) are setting additional requirement for internal system and controls that trading venues must respect in the following cases.

i. Trading venues to which HFT and AT traders are connected

The trading venues are obliged to respect some requirement and fulfil some self-assessment settled by RTS 7. Part of its requirement are regarding a proper protection against misuse or unauthorized access to the systems of trading venues, as ensuring the integrity of the data. Moreover, if requested from the competent authority they must provide all information, algorithms that have executed the orders too, even though it not obvious that at the end they will be able to understand all the algorithm.

ii. Trading venues to which users of DEA have access

Only the authorized investment firms and credit institutions can provide DEA

service. Some standards regarding risk and control must be established that using this access could cause. Nonetheless, trading venues have normally the possibility to track and eventually suspend or stop orders and DEA access of their clients, whenever they are going against the requirement established. (Busch, 2016)

2.3.2   American Legislation

Now the American stance regarding the algorithm trading will be analyzed. The two legislations have treated HFT practice with different regulation approaches.

In United States the distinction of the strategies is a basis to regulate the different situations. In the previous chapter the distinction between two main strategies has been discussed: passive and aggressive strategies. The Security and Exchange Commission has paid particular attention to the second one, specifically with respect to the two practices that are called momentum ignition and price anticipation, taking into consideration both aspects, positive and negative.

The Securities and Exchange Commission has conducted more than one study analyzing the effects in the market of adopting one strategy rather than another. Some of their result that have been obtained in different survey are simplified below, as in the paper of Miller (2016). They will be listed to identify better all the aspects.

- Aggressive strategies are helping price discovery in the short run (up to 10 seconds)
- Passive non-HFT traders have a higher impact on the price discovery in the long run (up to 2 minutes)
- A distinction between the form of capitalization of the firms leads to different results, e.g.,
  - For large-cap stocks the price discovery has a higher impact using HFT rather than non-HFT
  - Mid-cap stocks seem to be inconclusive
  - Small-cap stock, on contrary to the large-cap, the price discovery impact is lower using HFT.
- Aggressive HFT are increasing the adverse selection costs that will impose upon non-HFT

- Aggressive HFT tend to increase for institutional investors the market trading transaction costs while increasing the volatility of the market

Thus, traders that are using kind of strategies are entering into the market only when they will have economic advantages and so, they will not make the price more informative, even less the market more liquid.

Moreover, they have been considered one of the causes of the fragility and volatility of market as the Flash Crash have shown, not as direct cause. (Miller, 2016)

A. REG AT (Regulation Automated Trading)

Nevertheless, CFTC is regulating HFT without saying so specifically, it is called the Regulation Automated Trading (Reg AT). CFTC has set rules and instructions that will be applied for executing trading strategies, as the number of automated trading that is taking place in the future exchange market still increasing. On the other side the two largest exchange operators that are working in United States which are the CME Group, the owner of Chicago Mercantile Exchange, Chicago Board of Trade, and New York Mercantile Exchange and the Intercontinental Exchange (ICE) have defined on average how many times an order can enter in one millisecond to execute it electronically.

The main reason behind the creation of Reg AT is to adapt to the evolution of the market toward electronic trading. The purpose is to minimize potential problems that may be caused by malfunctioned algorithms, creating, and executing automated trade orders. Reg AT try to take under control these risk that may be start in the market exchange, from large financial firms (even called clearing members of the exchange or firms that are operation in the market exchange for their own). In the American market also the proprietary traders that are using algorithms on regulated exchanges are supposed to be registered in the so-called direct electronic access. DEA will permit them to enter in the exchange electronic market directly, after paying a fee to the authorized algorithms trader, without passing from a broker. Basically, the main goal that have moved CFTC is to have an oversight of al the activities in the electronic market.

Reg AT is only a part of the measures the CFTC had took for facing the recent growth

of all AT activities in the market, that have been accused of creating a more fragile market and increased the volatility. In US we cannot only talk about a single episode of extreme volatility of the market, so an example is what happened on October 15, 2014 in the US Treasury securities and futures markets. After events like that, CFTC and other regulators had changed the way they are looking to automated trading. Since they had considered them part of the problem that have caused an increased market disruption, even more in period of high stress, a closer focus has been directed to regulate those markets. Moreover, CFTC decided to pay more attention also to the price manipulation.

In Reg AT have been listed policy concerns over HFT that are operating in securities' and derivatives' market, regarding risks automated trading may cause.

Some of the risks that may occurs using HFT are such as,

- Operational risks, when the algorithms are malfunctioning or are reacting to data that are inaccurate or unanticipated.
- Market liquidity risk, when the trading strategies are suddenly changing.
- Risk of adopting illegal behavior caused by the provision of new tools provided by automated trading, like spoofing.
- Market shock risks, when erroneous orders are placed and are impacting more markets, not the only one where the AT were working on.
- Risk of not have a sufficient settlement risk mitigation, ever since more traders have the direct electronic access to the trading platforms.
- Risk of being less efficient ever since more traders are faster, because when only selected traders can be faster than others, they are helping price discover. When most of the traders are fast, is withdrawing advantages.

On the other hand, the importance of HFT in the market has been acknowledged by reducing the bid-ask spread and trading costs, the lowering of short-term volatility and increasing of market liquidity. (Miller, 2016)

B. FINRA (Financial Industry Regulatory Authority)

In order to take under control, the algorithms traders that may cause some problems in the market, the SEC, in 2015, has requested to the HFT broker-dealer operating on the securities market to register with the Financial Industry Regulatory Authority

(FINRA).

FINRA is a self-regulatory organization that has been created as front-line regulator for broker-dealer, from the merger of the National Association of Securities Dealers and the New York Stock Exchange's regulation committee. In this case, SEC is monitoring FINRA, and as most of the broker-dealers must register on it, as an oversight on most HFT dealer. The registration to FINRA involves also been under the supervision, requirements and rules that must be respected by their participants.

Initially the SEC was allowing some HFT to be exempted from FINRA registration in the case they were trading using a third-party broker-dealer on other exchanges or in an alternative trading system. In 2015 this exemption was limited since SEC purpose was to improve his regulatory oversight of proprietary trading firms, especially high frequency traders.[23] (Miller, 2016)

C. How could abuses be reduced?

Price limits and trading halts have been adopted by a lot of regulators, but as in US

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[23] "Barclays and Credit Suisse. In January 2016, Barclays Plc and Credit Suisse each settled allegations with the New York attorney general (NYAG) and the SEC that they had misled their investors in managing their private trading platforms known as dark pools. As part of its settlement, Barclays agreed to pay $70 million, to be evenly divided between the NYAG and the SEC. Specifically, Barclays was alleged to have made client misrepresentations on how it monitored its HFT dark pools. Separately, Credit Suisse agreed to settle its charges by paying a $30 million penalty to the SEC, a $30 million penalty to the NYAG, and $24.3 million in disgorgement and prejudgment interest to the SEC for a total of $84.3 million. The SEC charged that Credit Suisse failed to operate its dark pool and alternate trading systems as advertised.
Athena. In October 2014, the SEC reached a $1 million settlement with Athena Capital Research LLC, a HFT trader, which was charged with employing $40 million to rig prices of various stocks in 2009. Athena was charged with manipulating shares of Nasdaq-listed stocks, which weakened the exchange's end-of-day procedures for reducing stock price volatility, according to the SEC. More specifically, the agency charged that Athena "placed a large number of aggressive, rapid- fire trades in the final two seconds of almost every trading day during a six-month period to manipulate the closing prices of thousands of Nasdaq-listed stocks." It did so through an algorithm that was code-named Gravy to engage in this practice known as marking the close in which stocks are bought or sold near the close of trading to affect the closing price.
Briargate. In October 2015, the SEC reached a $1 million settlement with Briargate Trading LLP and co-founder Eric Oscher. Between October 2011 and September 2012, Briargate was charged with orchestrating a scheme that involved placing sham trades called spoof orders for the purpose of creating "the false appearance of interest in [New York Stock Exchange] stocks" to manipulate their prices. After it entered spoof orders, Briargate's trading protocol reportedly placed bona fide orders on the opposite side of the market for the same stocks, taking advantage of the artificially inflated or depressed prices—then immediately after the bona fide orders were executed, it cancelled the spoof orders." (Recent SEC Enforcement Actions in HFT)(Miller, 2016)

as abroad those are not the only initiatives for avoid market abuses by HFT. Even though most of the problems that are rising adopting HFT exist also for non-automated payments, for instance, the effect of two-tiered market. Nowadays the speed of trading is running into different tiers. In the floor-based era we are dealing with the access to the trading floor, and most of the abuses that are concerning the floor-base era may be caused by lack of competition. So, it become important to enforce the competition on the market to minimize market abuses, although competition is not the only problem creating market failure. (Jones, 2013)

Below will be reported some of regulators' initiatives that aim to avoid situations of market shortfalls.

Consolidated order-level audit trails: To guarantee confidence in markets, continuous audit trails are needed. Since the introduction of HFT aggressive strategies, regulators need to reach order-level data[24] from multiple venues, ever since the information that order-level data are included (e.g. level I including bid price, bid size, ask price, ask side, last prize and last size) can be manipulated from those strategies. Like that they will define the costs and the benefits they are facing, having a more complete oversight of the market. (Jones, 2013)

Order cancellation or excess message fees: Since the trading venues are overloaded by orders, it might be appropriated to fix a fee that will be applied to those who are charging costs to another participant by cancelling their orders before they are executed. Currently a fee it is imposed in Nasdaq market, even though it is not easy to have the real effect to market. On the other side, imposing a cancellation fee will reduce liquidity and so market depth. In case of considering boarder-based fees, it should be cautiously weighted. (Jones, 2013)

Minimum order exposure times: another initiative it may be to settle a minimum period that guarantee not cancellation order, thinking around 50 milliseconds. Once again liquidity will get hurt, which might rise a doubt about what they are pursuing. As liquidity is good for the market, those moves will lead to the opposite direction.

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[24] "One of the tools day traders use to make their trading decisions is various types of market data, commonly referred to as Level I and Level II market data. This market data includes information about current prices and recently completed trades. Level II data provides more information than Level I. Traders decide which data feed they require for their trading, and then subscribe to that data feed through their broker." (https://www.thebalance.com/order-book-level-2-market-data-and-depth-of-market-1031118)

(Jones, 2013)

Securities transaction taxes: this last one will compromise share prices which will fall, volatility and trading costs will increase, price efficiency will be lower as liquidity, as academic research indicates. (Jones, 2013)

From my prospective, if we are taking into consideration the first three regulator's initiative, first of all some of the manipulated strategies will be discouraged, such as spoofing with a minimum order exposure time or quote-stuffing by introduction of excess message fees. Though, no securities transaction taxes should be applied, as they will hurt more the market rather than automated traders, causing more volatility.

Another evidence was from the research carried out by Salvatore d'Angelo in 2015 and the study on the HFT. He affirmed that cannot be said with certainty whether the HFT has a negative or positive impact on the financial markets, but he made some personal considerations, that in my opinion I agree with. In terms of liquidity and volatility, it is appropriate to link up with the operational strategies used by each HFT. Each market participant operating through high-frequency operating strategies aims to create a distorted market reality or aims to make a profit. In conclusion, international and European legislators should not only seek to standardize industry regulation as much as possible, but also seek to deepen as much as possible the regulation of the phenomenon of High-Frequency Trading, which is destined to become increasingly popular within the financial markets. (Mirella Pellegrini CANDIDATO Salvatore et al., 2015)

2.4   Conclusions

This chapter was aimed to analyze a stereotyped situation when the high frequency trading started to be considered as a threat for the economy, the Flash Crash of May 6, 2010. Even though flash crashes are very frequent and common, the one of 2010 has some reasons to be remembered. First, because it is considered as the fuse that makes burst the interest of regulatory authorities dealing with high frequency trading. Many experts have different ideas and approaches about the good or bad involvement of these algorithms according to the outcome in that situation. They

can be considered as the ones that helped the market to recover faster or the primary cause of is initial fall of prices, while they were consuming liquidity. We can consider the advantages they are taking in normal times, but we cannot ignore their actions during distressed times and what consequences will lead to. So, it is a good example of how the market can react in situation of high stress and to uninspected events.

Anyway, it has impact on the market perception, the economic effects that might be generated and the risks linked to algorithms, even though in the real life HFT can bring advantages to the market participants, e.g., liquidity, or take advantages of it, e.g., front running.

This event is also interesting as it was considered, only after a few years, a case of manipulative strategy. Sarao Navinder, a British trader, is considered the main author of this huge fell of financial market. He used algorithms and intuition to destroy the market in a few minutes. As HFT are using the same technologies they are also following the same direction, and on this awareness Sarao practices the so called "spoofing". Creating a huge selling order, so the illusion of market movement and he cancelled the orders before being executed.

There are other manipulative strategies in the market that are restricted o violated by the law, in addition to spoofing, like front-running, order triggering strategies, wash sales and quote stuffing.

Finally, we talked about legislation that is touching this delicate instrument, and how hard is to reduce abuses without hurting the market itself. US and Europe have had different approaches that are going to protect investors, mainly non-HFT, avoiding market failures and market manipulation.

Among with MiFID II, in Europe, have been settled rules to impose internal control and the transmission and record of the information regarding their activities. They also specify some rules related to the specific task of market makers that need to follow specific requirements to guarantee liquidity and stability in the market. It is also regulating the Direct Electronic Access (DEA), which is issued by the investment firms that use HFT by providing a service to their clients.

Whereas in America, the SEC has defined more what is forbitten instead of what should be done to respect the market's participants. In the Regulation Automated Trading (Reg AT), that is created by CFTC, they are paying more attention to the

price manipulation and to the potential risks. Moreover, in order to take under control the financial market, HFT must register into the Financial Industry Regulatory Authority (FINRA).

What the research is looking for now is to understand the ethic behind algorithms and co-location, and that will be the subject of next chapter, ethics.

Chap3   Fairness and High frequency trading

3.1   Ethics in age of automation

In the previous chapters we talked about high frequency trading and its consequences in the real economy. We have now arrived at the core of your discussion, related to how it can be considered fair as instrument. But instead of talking about the ethics of automated trading, we will talk about ethics in finance in the age of automation. Ethics can be defined as standards of conduct (rules, principles, or ideals) that are considered morally applicable to a specific group and will affect the way of making decisions. (Davis et al., 2013)

Pros and cons of HFT have been expressed in the first chapter, and we know that automation can produce bad effects as well, now is a matter of why it is doing it.

HFTs tend to run out of the market when there are periods of crashes, first because they are not obliged to stay, and second because when they see the event coming, they can react before others, so they can avoid incurring in huge losses.

In financial markets, ethics may take the form of "codes", e.g., those of the Chartered Financial Analyst (CFA) (2008) and Certified Financial Planner (CFP) (2008), that are fixing standards of conduct. In those codes ''integrity, objectivity, competence, fairness, confidentiality, professionalism and diligence.'' are demanded (Ragatz and Duska, 2010) The point is that no ethical codes have been developed for automated traders, neither ethical responsibilities. As automation is evolving, ethics should take some steps forward too in this financially relevant field, including not only fiduciaries (as money managers) or intermediaries (as broker and investment advisor), but financial engineers (as mathematicians, also known as quants), software engineers and computer engineers too. An additional problem is that the participants in the automated market have different purposes but neither of them is taking responsibilities for their activity consequences. (Davis et al., 2013)

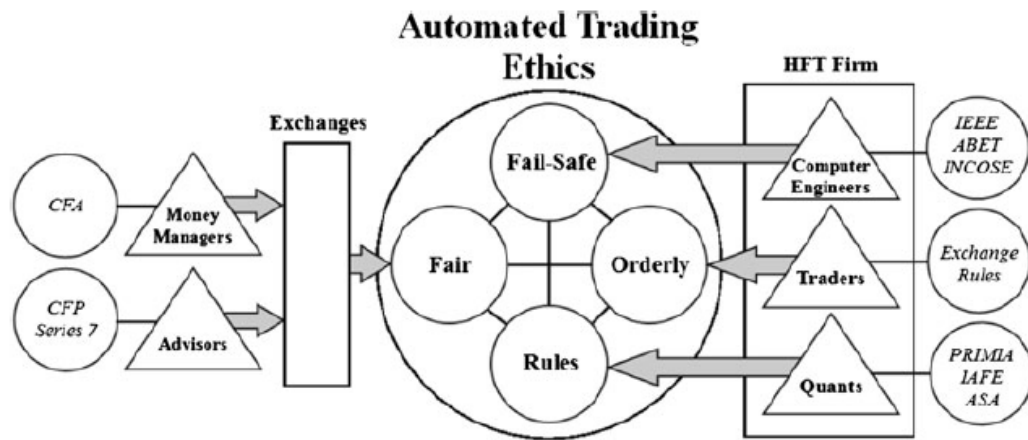In automated trading, there are ethics codes that are represented in the following Fig.3.1

Fig. 3.1 Ethics in automated trading, Source: Ethics, Finance, and Automation: A Prelinary Survey of Problems in High Frequency Trading, Davis et al, 2013

The traditional ethics of fiduciaries and intermediaries—money managers and investment advisors—are depicted on the left. Exams for CFA[25], CFP[26], Series 7[27], and other professional designations include ethical standards. The right-hand side represents the participation of trading firms in high-frequency trading (HFT).

The HFT firm contains three functional areas each with its own ethics. Computer engineers' ethics—derived from IEEE[28], ACM[29] and INCOSE[30] codes—focus on software testing and fail-safe mechanisms. Traders' ethics derived from exchange rules traditionally focus on maintenance of orderly markets. Quant's ethics, which are based on professional organizations like PRMIA[31] and ASA[32], emphasize mathematical accuracy and adherence to rules and regulations. The ethics of the exchanges are centered on the operation of fair markets. The interfaces between the four ethical foci are depicted in the lines connecting them. This is where a new conversation about finance ethics will (and should) begin. (Davis et al., 2013)

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[25] Chartered Financial Analyst
[26] Certified Financial Planner
[27] General Securities Representative Exam
[28] Institute of Electrical and Electronics Engineers
[29] Association for Computing Machinery
[30] International Council on Systems Engineering
[31] La Professional Risk Managers 'International Association
[32] Automotive Service Association

SEC Rule 15c3-5 have restricted direct market access too, establishing organizational obligations for regulating order entry to electronic exchanges but they fall short of creating an ethical environment across the industry. As a result, according to the American Society for Quality's principles, the risk of not being able to create this new habitat still exists.

To make matters worse, the SEC rule gives the impression of security by simply moving the financing constraints from trading firms to brokers, assuming that brokers' systems are of better quality. As a result, the ethical issue persists. Direct market access touches on all the interfaces in Fig. 3.1 from an ethical perspective. Trading firms must be able to test the fail-safeness of their systems and the robustness of their quantified strategies in order to meet all ethical viewpoints.

Software-quality practices address procedures for testing exchange network gateways to meet ethical obligations at the fairness-fail-safe interface between a firm's computer engineers and the exchange. However, strategies cannot be safely vetted without complete testing environments and specified acceptance tests. As a result, existing rules cannot satisfy the fairness-rule interface between quant and exchange ethics, nor the orderliness-fairness interface between traders and exchange ethics.

To minimize the risk of a global trading system breakdown in the age of automation, the financial industry requires a comprehensive cross-cultural ethical framework to bridge the gap between innovation and regulation. Instead of short-term regulatory containment of undesirable outcomes, properly framing ethical problems will allow root-cause analysis and long-term fixes. A broad ethical framework must ensure prudence without jeopardizing trading firms' required independence.

A problem that rises is, how should we keep this automated trading socially useful? We have seen how regulation could try to limit the shortfall caused by automated trading. However, we have also said that too many restrictions could lead to the opposite result with no benefits to the market. But neither the government, nor the exchange market itself could bring to adequate social result. According to Davis et al, 2013, only self-regulation guided by ethics could provide social results. In finance, as Boatright, 2010 said, the problem is that "people... believe that the task of creating and enforcing ethical rules and standards is the job of legislatures and regulators, not themselves."

In the case of regulation in the US market, the SEC and the CFTC has prohibited the practices of "manipulation", without defining the term. So, it is left to the single to make the relative decisions.

But what can be done is to divide manipulation into strategies and technology.

Root cause	Manipulative outcome		Prudence
	Intentional	Reckless	
Strategy	A	B	Q
Technology	C	D	

Fig. 3.2 Market manipulation breakdown, Davis et al., 2013

Table 1 shows the four types of market manipulation that resulted. A company manipulates a market by creating a manipulative trading strategy, as shown in box A of Table 1. Even though the technology is of high quality, a company in box B uses a risky approach in a trading system. Traders and quants create a strategy that, due to its lack of thought, may perform unexpectedly in certain market conditions. The strategy in box C may have been thoroughly investigated and tested, but malicious technological implementation may introduce manipulation into its implementation. In box D, sloppy coding could introduce software bugs, and a lack of testing could allow a system to go haywire after deployment. Box Q reflects caution in both strategy and technology research and development. But, in terms of trading system research and development, what constitutes prudence or good faith? At the intersection of quantified trading strategy and technical implementation, ordinary regulation ends, and new ethical territory begins. Specific deliberate strategic manipulation is often prohibited by exchanges and governments (i.e. box A).

Flash trading[33], quote stuffing[34], and spoofing[35] are the most well-known examples. (Davis et al., 2013)

One issue with financial ethics is that market outcomes (as with all outcomes) are inherently uncertain and ambiguous. Ethical lapses can lead to good outcomes by accident, or vice versa, resulting in "ethics in perception" ("no harm, no foul") (Davis et al., 2013).

Since a formal review of the evolving ethical climate of finance eventually leads to ideas for new standards, some proposals have been raised, for example, for quality standards that fill gaps between disciplines, which now seem to be responsible for many of the financial disasters arising from electronic trading. Other industries have turned to "quality" to satisfy the ethical interface between disciplinary climates. Quality is not only a software testing or statistical framework, but also an ethical framework (in the sense that the standards in question are ones that everyone in the relevant disciplines at their rational best wishes everyone else in that discipline to follow even if it means doing the same).

To return to the specific case we discussed in Chapter 2, the valuation of a trading firm's decision to stop trading, as well as the variety of ethical viewpoints now interacting, was demonstrated by the Flash Crash of May 6, 2010. As they believed it was the right thing to do, some automated trading firms shut down their systems. After all, something seemed to be wrong with the market, and profiting from its infrastructure's operational failure would be unethical. This argument is motivated by the fail-safe ethics of computer engineers. Others chose to keep their machines running because they believed it was the right thing to do. Traders' ethics, as well as a focus on orderly markets, are the driving forces behind this reasoning.

Liquidity providers had two choices: (1) shut down their systems until the issues were resolved, at which point they would restart and reconnect to the exchange

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[33] Flash trading is the practice of an exchange exposing a trade request to data feed subscribers but not publishing the best price in the national market system. The exchange will perform the trade (and keep the associated fees) before routing the order to another venue if any company wants to take the other side of the trade.

[34] Quote-stuffing is an attempt to overwhelm an exchange's network by sending and canceling thousands of trade requests per second, preventing other market participants from accessing the market, a practice that is not only unjust but also contradictory even in a well-ordered market.

[35] Spoofing creates a fake market by sending trade requests to an exchange with the explicit intent of canceling them before execution, with the intention of fooling other market participants or their systems.

servers, a process that could take up to 20 minutes; or (2) continue to provide quotes to the market, but with broader bid/ask spreads to protect the company. (For example, bids of one cent instead of the forty of a few minutes ago), so that actual bids and offers could be posted immediately once the issues were settled. Is it fair that (even ethical) liquidity providers purchased stock for a cent? "). (Davis et al., 2013)

3.2   Market abuses

HFT proponents argue that there is no link between HFTs and market manipulation. This is the conclusion reached by the Sydney-based Capital Markets Cooperative Research Center after analyzing data from 2006 to 2011. According to the study, despite the recent spike in global interest in high-frequency and algorithmic trading, empirical research directly examining the effect of these innovations on market quality and integrity is still lacking. High-frequency trading is also found to be negatively correlated with end-of-day price dislocation in the study, implying that more high-frequency trading equals less market abuse.

The repercussions of one's actions, on the other hand, are the final basis for any decision about the rightness of that conduct in consequentialism[36] field. According to consequentialists, a morally right act (or omission) is one that will result in a good outcome or consequence.

Instead, what is considered right or wrong according to act-utilitarianism[37] is based on the effect or result. The best good is determined by who or what stands to gain the most from the action. (Madonna,2013)

What are the ethical consequences of engaging in high-frequency trading?

High-frequency trading may expose the financial system to new types of serious risks. In the Flash Crash of May 6, 2010, both algorithmic and high-frequency trading

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[36] Consequentialism is a normative ethical theory, which means, it is a theory about ethical action and a proposed method for deciding how one should choose the right ethical act. (Feiser) Consequentialism says that the consequences of an action are all that matter when taking an ethical decision to act.
[37] Utilitarianism is a consequentialist moral theory focused on maximizing the overall good; the good of others as well as the good of one's self. (https://sevenpillarsinstitute.org/ethics-101/apply-ing-utilitarianism-are-insider-trading-and-the-bailout-of-gm-ethical/#:~:text=Utilitarian-ism%20is%20a%20consequential-ist%20moral,the%20good%20of%20one's%20self.&text=One%20difference%2C%20how-ever%2C%20is%20consequentialism,good%20as%20the%20desired%20outcome.)

were found to have contributed to volatility. The Dow Jones Industrial Average hit its highest intraday point loss, but not percentage loss, in history, only to recover a large portion of those losses in minutes.

HFTs, who dive in and out of markets at incredible speeds, narrowing bid-ask spreads and offering liquidity while causing risky and excessive price swings, are chastised by traditional investors. If HFT actually causes unhealthily fluctuating prices, it is unethical.

HFT is accused of not caring about the benefit of society, of contributing little value, and of not adding value. (Madonna,2013)

Now we want to go deeper in the definition of what is fair in financial market for later relate to our specific case of HFT and confute or confirm the thesis of Madonna, 2013, about being ethic or not.

3.3   Concept of Deception and Fairness

Before moving on to the notion of fairness, it is necessary to define deception first. Deception is described as "causing [someone] to believe something that is not true, typically in order to gain some personal advantage," according to the Oxford English Dictionary. When the attempt succeeds and the intended false belief or conclusion occurs, actual deception occurs. Some argue that since a limit order is intended to reflect an intention to trade, real deception may occur, such as when the sender does not intend to trade but instead intends to cancel the order before it can be executed. Our minds seem to be hardwired to favor equitable results. According to brain imaging research, reaching a fair result in an ultimatum game stimulates the same reward centers in the brain as other pleasurable tasks, according to Tabibnia et al. (2008). Unfair results make other areas of the brain function harder. As a result, we are wired to favor fairness. But what is the exact formulation of fairness?

There are dozens of definitions of fairness in the dictionary, one of those described by OED as a noun to gets to the moral context:

"10. a. Of conduct, actions, arguments, methods: Free from bias, fraud, or injustice; equitable, legitimate. Hence of persons: Equitable; not taking undue advantage; disposed to concede every reasonable claim. Of objects: That may be legitimately

aimed at; often in fair game, fig.; fair wage" (Oxford Dictionary)

Fairness and justice have been discussed since antiquity. In book 5 of Aristotle's Ni comachean Ethics (1908), he defines justice as fairness and states that there are dif fering views on how goods should be distributed among "unequals." Rawls (1958) draws on the idea of justice as fairness as well. A fair outcome is one that will be preferred by people in the "initial place," who are hidden behind a "veil of ignorance," in that they have no idea what part they play in society." As a result, they will prefer the method or outcome that helps the least fortunate the most. Leventhal (1977) argues that both the fairness of process and the fairness of delivery should be investigated. Economists have also attempted to describe justice in more restricted circumstances. Subjects are prepared to sacrifice payoffs to punish those who treat them unfairly, according to Kahneman et al. (1986a, b). Fairness is described by Fehr and Schmidt (1999) as "inequity aversion," in which people are willing to give up a reward in order to avoid an inequitable result. Pava et al. (1999) distinguish between basic fairness, which states that "one person should not achieve a benefit by imposing an equal loss on another," and nuanced fairness, which states that "one person should not achieve a relatively large gain by imposing a relatively small loss on another."

The US Congress created a restricted concept of unfairness that applies only to consumer financial products: (A) the act or practice causes or is likely to cause substantial injury to consumers that is not fairly avoidable by consumers; and (B) such substantial injury is not outweighed by countervailing benefits to consumers or competition. It is worth noting that, like Pava's description, this one emphasizes the tradeoff between harm to others and societal benefits.

Fairness, according to Shefrin and Statman (1993), is a "claim to entitlements" in various dimensions. They describe seven dimensions of fairness in the financial markets:

• **Freedom from coercion** Transaction's participants are not free to participate or not participate.

• **Freedom from misrepresentation** Fraud is not implicated.

• **Equal information** There is no insider trading since all participants have access to the same details. Fairness is embodied in our securities laws and regulatory framework, which aim to level the playing field by requiring the disclosure of relevant information.

• **Equal processing power** There are no differences in the participants' ability to interpret information. This is closely related to the criterion of equivalent knowledge. What good is information to someone who does not comprehend it?

• **Freedom from impulse** The participants are insulated from their own unreasonable desires. For example, drug bans or cooling-off periods that allow anyone to cancel a transaction after it has been completed.

• **Efficient prices** Prices are based on all available data in the industry.

• **Equal bargaining power** There is no major difference in the participants' power relationships. (Angel,2013)

When the definition of fairness come to be applied to the context of HFT, it should be considered that some cases are not such an easy attribution. In the last part of the previous chapter, we talked about manipulative strategies. As far as I can tell, there are no chances of defining such situations fairly in any circumstances, as they are taking advantages of the market, leading prices away for the real one. They are misrepresentative, taking advantages of the information to hurt others' interests, they are not guarantee equal processing power and equal bargaining power. Only citing the Shefrin and Statman dimensions.

Order triggering techniques, for example, steal from other traders and offer little profit to other buyers by manipulating prices away from their true value in order to induce others to sell. The moral equivalence of deliberate quote stuffing is intentional waste. What about other approaches, though?

We should focus on the aspect of HFT that is likely to generate the most debate related to fairness. The most critical aspect of this method of trading is the speed at which orders are processed. Algorithms and co-location are responsible for this benefit. As long as algorithms are the product of science and human skill growth, the only argument that might be debated is if those propriety companies hired someone simply to pay him more money. So, in my opinion, this is vague and unreasonable because there is no proof of unethical behavior.

The co-location of their servers in stock exchange data centres is another common denominator of HFT strategies. There is nothing wrong with co-location in terms of procedural fairness as long as it is open to all on the same terms. It would be unfair for a stock exchange to refuse certain participants access to co-location space.

In the context of distributional fairness, co-location raises the question of the unequal endowments of society. Many, if not most, investors lack the resources to purchase expensive computers and rent space inside stock exchange data centres. Furthermore, this is not the only inequality in our financial markets in that many investors have resources to acquire one type of edge or another in the markets.

Are investors who are not co-located at a disadvantage because others can execute orders a few millionths of a second faster than they can? The co-locators clearly believe they have a competitive advantage worth paying for. Only investors competing in the same forms of speed-sensitive trades as HFT traders, such as arbitrage and market making, would be at a disadvantage. Long-term investors do not try to benefit from split-second inconsistencies. They do, in fact, benefit from the liquidity generated by market makers as well as the price quality imposed by arbitrageurs. Market making and arbitrage have always required substantial investments in money, trading technology, and professional workers, so it is difficult to argue that introducing computers to these activities suddenly changes their fairness or morality. (Angel, 2013)

Arbitrageurs and market makers help to increase the market's quality for all. Despite the fact that market makers and arbitrageurs are strong rivals, no one has to trade with them. Also non-investors benefit from the advantages that well-functioning capital markets offer to society, as well-functioning capital markets promote effective capital allocation to beneficial uses.

Shefrin and Statman's (1993) multiple dimensions can be used to determine the fairness of co-location and HFT in general. As there is no fraud involved, HFT will obviously be deemed fair under the dimension of freedom from misrepresentation. Other participants have power over their acts, so freedom from impulse is not a problem. Similarly, there seems to be no disparity in negotiating power between co-located companies and other traders when it comes to obtaining access to stock exchange co-location facilities, and there is no coercion associated with co-location.

The other dimensions illustrate that there has been such a media concern by presenting a grey area. Co-locating HFT computers in exchange data centres, on the other hand, may be considered a breach of the equal information dimension, since their proximity to the exchange enables them to access data quicker than those who are miles away. Many investors cannot afford HFT firms' access to vast quantities of computer processing capacity. Will they have an unfair advantage as a result of this? As we said most investors do not care about seconds of delay because they are not competing with other arbitrageurs or market makers, and those other investors profit on average from the arbitrageurs' and market makers' services. A similar point of contention is the dimension of efficient prices that represent all market knowledge. Just those traders who are competing for the same kind of arbitrage and market making trades suffer as the price shifts. The effect on the quality of prices is a more pressing problem. Is the market as a result more volatile? Is there a decline in market quality? This is an empirical topic, and there is currently a lot of empirical work being done on it. HFT practices, according to Brogaard (2010), are neither harmful nor beneficial to the industry. Different trading strategies would obviously have different effects on market quality, as beneficial players increase it while abusive players undermine it.

Do HFT investors profit from causing similar losses on others? It will be unjust if high frequency traders' actions result in significant losses for other investors or otherwise disrupt the market in a way that is out of proportion to the benefits they offer. Regulation is taking into consideration the impact. Some claim that trading is a zero-sum game, and that the profits made by HFT traders come at the detriment of others. Some people claim that HFT traders make money in both up and down markets strikes, which is an unequal risk and return distribution. According to Angel and McCabe (2012), trading is not a zero-sum game since all parties willingly join a deal hoping to profit. Since financial products are risky, each party can believe that it is better off because it has better controlled its risk and price.

An investor who is willing to sell, for example, does not want to risk the stock falling in the near future, so he or she sells to a market maker at the market maker's bid price. The investor may have put a maximum order to sell at a higher price, but then had to wait for a buyer willing to pay that higher price to enter the market. There is a chance that no such buyer will exist. As a result, accepting the market maker's

lower bid price is essentially a kind of protection for the seller against potential losses. Instead of inflicting losses on the buyer by paying a cheaper price, the market maker is offering a profit to the buyer. Consequently, the market maker is selling an insurance-like immediacy commodity.

It is a commodity that is in demand in both rising and falling markets, and there is nothing wrong with making a profit in that case. It cannot be called unfair treatment. (Angel, 2012) However, once again, a distinction must be made between the advantageous applications of high-speed computing technology, which can be used in ways that benefit markets, and the abusive means. HFT users who use it for order ignition, quote stuffing, or other types of coercion are obviously harming others.

As a consequence, they can be categorized as two distinct definitions of fairness:

1. Equal application of the law, or procedural fairness. From a procedural standpoint, there is nothing especially unfair about high-frequency trading if any trader is able to buy a device and co-locate it in an exchange data center. The exchanges have plenty of room in their data centers and provide co-location services to everyone for a set fee.

2. distributive fairness is concerned with equality of outcome. The fact that some traders make substantial profits while others are underdoing its consequences, that concerns about the intrinsic fairness or unfairness of a market economy. In a capitalist economy, our culture tolerates such inequality because market rewards provide a powerful incentive for efficient production of goods and services. However, the issue of endowment disparity has often troubled financial markets. Some investors have more money to begin with than others, and some investors spend more to gain a competitive edge. HFT, like many other aspects of our financial markets, contributes to the perpetuation of life's inherent unfairness (in the sense of equitable outcomes). (Angel, 2012)

The topic of good or harm to others is linked to the distributive notion of fairness. Many HFT techniques do not cause harm to others, so they are not discriminatory in the sense of impose damages. Many of these HFT techniques, in reality, favor other market participants by lowering trading costs and accurately reflecting related instruments' prices.

Traditional manipulative techniques that aim to benefit by shifting prices away from their fundamental values may be used by some electronic traders that use high-speed technology. These are obviously unjust because they want to profit from harming others. Fairness or unfairness is thus determined by how technology is used rather than the technology itself. (Angel, 2012)

It is interesting how, in MiFID II it is used the word fair, referred to the market, and that it is always closed to the term "non-discriminatory". Although the words "non-discretionary rules" and "fair trading" are not defined in MiFID II, they can be interpreted as not giving an illegitimate advantage or benefiting one market participant or a subset of market participants. (Ii & Trading, 2020)

3.4 Fairness and regulation

As mentioned previously, the more HFT are present in the market, the more prices are efficient. Thus, in order to achieve a fair financial market, we must encourage competition, as more HFT guarantee a better achievement of the true price, in a faster way. There are at least four types of regulation that can be used in a competitive financial market: 1) self-regulation (firm-by-firm "corporate responsibility"); 2) venue regulation (the New York Stock Exchange, Chicago Mercantile Exchange, or other similar venues); 3) Industry or venue federation regulation, such as the Financial Industry Regulatory Authority (FINRA) or another self-regulatory organization (SRO); and 4) government regulation (state, federal, or intergovernmental, such as the SEC or the Organization for Economic Co-operation and Development).

According to Nielsen (2010), regulatory transparency must minimize systemic risk. Any proposed regulatory change, on the other hand, provides an incentive for those affected to try to influence the final rule. After all, since regulatory changes are implemented millions of times per day in financial markets, even minor changes can result in significant profits. Transparency will not help if a biased rule has been implemented. When all else is equal, the best way to prevent moral hazard is to keep regulation to a minimum. Complex financial markets, as Ryan et al. (2010) point out, have a greater problem with information asymmetry than other markets. Because

the market's work is, at least in part, price discovery, as in complex financial markets, simplicity of regulation and restraint, have been proved, are virtues to a greater extent than in other areas of finance. Ryan, et al. (2010) continue by asking what the ethical obligations of those who trade for their own account should be. As we will argue, the high frequency trader's responsibility should be to act prudently and send out messages that can be replied to, leaving the rest to the invisible hand. (Cooper et. al, 2015). However, as we said in the previous chapter, some initiative could be taken, as exchanges should limit quote-stuffing and spoofing by fining companies based on a message-to-fill ratio, say 50–1. Firms that do not execute at least one trade for every fifty messages (trade requests) sent to the exchange server are in violation.

What level of messaging encourages a reasonable level of fairness in the market without impeding the growth of otherwise ethical trading strategies? Behavior should be guided by ethics (Davis et al., 2013). Human emotions, on the other hand, can get in the way of both rational thought and ethical behavior. Emotions are also a part of the issue when it comes to trade. Fear and greed make it difficult to make good decisions. Emotional reactivity and effective trade are negatively correlated, according to Lo et al. (2005) and Steenbarger (2002). Even the most experienced trader displays significant emotional response during certain transient market events such as increased price volatility or intra-day breaks in trend, according to Lo and Repin (2002). Emotional responses, such as fear and greed, are known to encourage ethical breaches (see Sims 1992). ") (Davis et al., 2013)

The invisible hand operates through the competitive interaction of traders, who each supply or demand securities to buy or sell in accordance with their own preferred approach. Overall, if financial markets are fairly voluntary, transparent, informationally efficient, and credible, competition will usually encourage a socially beneficial outcome.

Although when all these conditions are applicable?
1. A financial market is voluntary if all costs are internalized, and participation is based on free choice rather than coercion or deception.

2. A financial market is transparent if trade and quote data is disseminated in real time, allowing all traders to make informed decisions (Bloomfield and O'Hara, 1999).

3. A financial market is informationally efficient if observed prices have all relevant information (Roll, 1984).

4. A financial market is reliable if there is a high probability that it will adequately perform its intended purpose—processing transactions in financial securities, enabling price discovery—in all economic environments (or, at least, in all those having a significant probability of arising). Because of the high cost that technological failure can impose on both the market and society, reliability is an important stipulation.

Let us define effective markets as those that have these four qualities. Financial markets that are efficient tend to reduce the costs of capital formation and risk transfer. Effective financial markets also attract investors because they demonstrate trust in the market's overall trustworthiness, including price fairness.

Cooper et al. (2015) suggested a framework that can be used to measure algorithmic trading prudence. That framework is based on ideas from quality-control literature. It necessitates that an algorithmic trading strategy meet three requirements:

1. The strategy must always be statistically controlled in terms of its key characteristics, and real-time monitoring must be in place to ensure that the trading strategy does not operate outside of expectations (see also Cooper and Van Vliet, 2012).

2. The strategy's loss behavior must be appropriate (i.e., reasonable risk).

3. The strategy must be able to consistently generate enough revenue to cover its costs with reasonable certainty over a period of time that is acceptable to the investors served. (For more information, see Kumiega et al., 2014.)

If these three criteria are fulfilled, whether the algorithmic trading strategy succeeds or fails, it is unlikely to cause harm to the company, the trader, or other market participants. Cooper et al. (2015) argue that this framework is a sufficient standard, one that, if applied by reasonable people or at least certified by a firm of reasonable

people, would meet any reasonable definition of prudence. Moreover, we now say that an efficient market requires a marketplace of prudent strategies. Without the fear of out-of-control strategies or incorrectly assessed risks, such a marketplace would have strategies to eliminate market inefficiencies. Prudence, on the other hand, is only a necessary condition for success. It is insufficient because it does not ensure justice. The ability of one trading algorithm to mislead another, that is, the ability of one trading algorithm "to take advantage of the order placement strategy of another not-so-smart computer with the possible effect of prices being driven away from equilibrium (Stoll, 2006)," appears to be at the heart of the debate over the fairness of certain high-frequency trading strategies (Cooper et. al, 2015).

3.5   Conclusions

After having introduced regulation analysis in the world of automated trading we have tried to fill the gaps of the discipline by introducing some quality standards. Especially during the May 6, 2010, Flash Crash, what HFT did was ethical? They increased the volatility in the market and creating unhealthy fluctuations cannot be considered ethical. We argued that the actions are what should be considered to determine the rightness of a conduct, according to consequentialism, while act-utilitarianism are looking to the results.

Later, we have considered what is it fair in financial markets and we redefined how manipulation strategies could be classified by root cause: strategy or technology. Although it is also about the intention, the instrument per se cannot be considered unfair, it is how is it used that matters. People are naturally averse to inequality and the US Congress also emphasized fairness as the tradeoff between harm others and societal benefits. In 1993, Shefrin and Statman were defining the seven dimensions of fairness in financial markets, that can still be considered contemporary, so HFT cannot be considered an unfair instrument as they are respecting most of these dimensions. In general, most of HFT techniques do not aim to harm others, whereas manipulative strategies tend to shift prices away from their fundamental value, that is unfair. (Angel, 2012)

In the following chapter, we will conduct an empirical study on how regulation and fairness are viewed in financial markets, with a focus on HFT.

Chap 4   Empirical research on ethical behavior

4.1   Introduction

In the last part we wanted to prove the literature of previous chapters, so it has been formalized a survey, testing some hypothesis. We conducted an original online survey, prepared in Qualtrics and distributed through social networks.

The survey was prepared to explore some questions that may have raised about regulation and ethical behavior in finance and how they can be connected. The sampling method was direct to obtain the opinion of common people that have mainly a background in financial subjects plus experts in the fields that may experiment personally the consequences of more regulation may produce. The research is also looking to the ethics of financial markets, how online trading is considered based on different personal elements, and what they rate as fair.

As previously said, people are naturally prone to fairness, but what can change is how they see some behavior. Therefore, we will express two main hypotheses that we had tested on our sample.

First, we wanted to test if more intervention of regulatory authorities is considered able to increase an ethical financial market movement. Regulation was implemented after important market shocks to diminish their intensity. However, the literature is pointing out that more regulation could lead to a more confusion in the market and that the best way to prevent moral hazard is to keep regulation to a minimum. It will be seeing if the intervention of regulators is important for the correct working of financial markets according to not experts.

Second, we would like to understand how fair it is considered to invest in financial market, specifically in the case of high-speed trading, and how the perception of fairness is deviated from the vision of regulators.

Now we present the heterogeneity of our participants to which was presented the survey. The graphs of this chapter are realized with the data results of my survey,

that can be found in the appendix.

4.2 Participants

Participants were 47 subjects, 86% between 18 and 25 years old, 12% having 26 up to 40 and one between 56 and 70. We are talking about a young sample, of which 53.06% are students, while around 44.81% is working, full- and part-time.
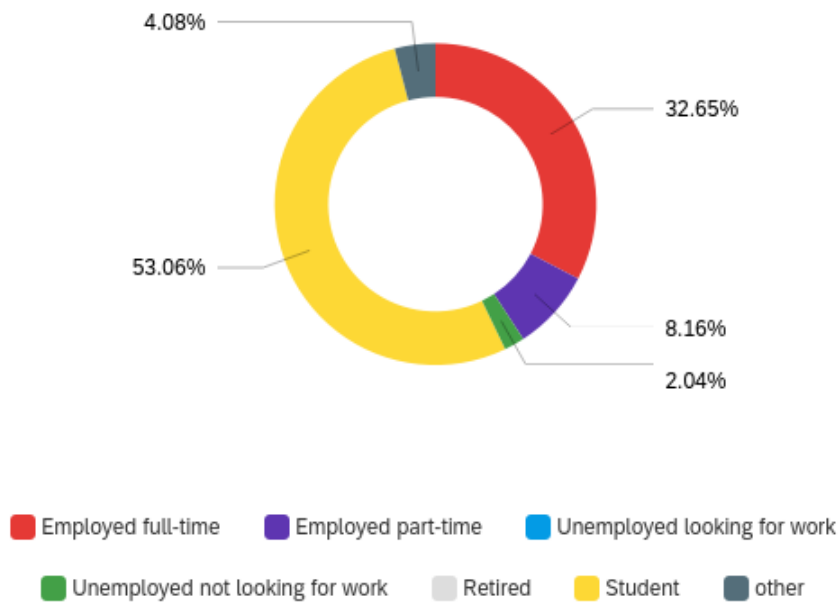

Fig.4.1 Q1_What is your current employment status?

The participants were divided almost in half between women and men. In our research it is important also to identify the field of study, as 66.67% of our sample were dealing with finance or computer science area. We want to test if an academical preparation in specific subjects is influencing the matter of judgement of ethical behavior.
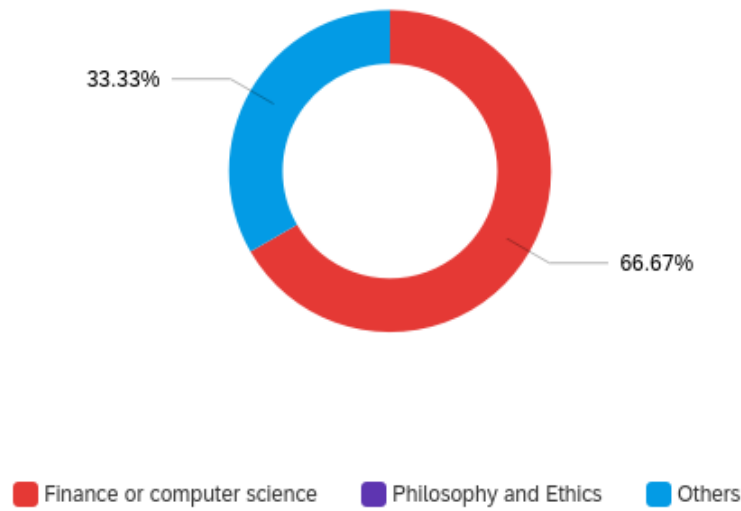
Fig.4.2 Q32_Field of Education

Last but not least, we considered the economic health situation to test if it is an important measure. 66.67% is in the first class of financial status, having an annual income up to 14,999€, as most participants still student. Four participants are entering into the second and four in the last ranking, relative 15,000 to 24,999€ and more of 70,000€. Only 15.55% percent is between those two classes.
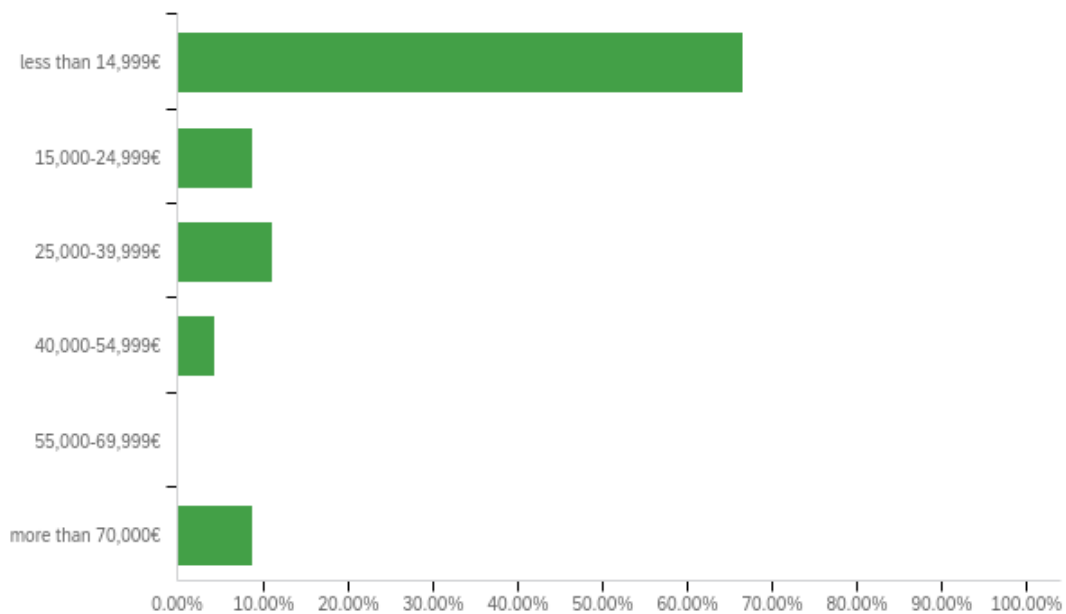
Fig.4.3 Q34_Net annual income wealth

After presenting the characteristics of our participants we would like to introduce the results that our survey has led to.

4.3   Results

4.3.1   First hypothesis: importance of regulation

We introduced the concept of High frequency Trading as follows:

"High Frequency Trading (HFT) is a subset of the algorithmic trading ('AT') distinguished by the speed at which it processes and determines plays in the market. The sophisticated technology components are reducing the latency, which is the time occurring between when the order is placed and when it is executed. They are integrating more information into the price and rising liquidity in the financial markets. This is supposed to increase efficiency."

To identify as our knowledge are plagued by what we think we know, I tested first if they have ever heard about high frequency trading after giving the previous definition. And in a second moment I asked if HFT could help improving efficiency. When it has been asked if the HFT are implementing efficiency, based on the knowledge of the participants we received positive considerations. If participants have never heard about the practice, they are basing their considerations on what have been told to them. In our case they do not have the time to inform during the survey, so they trust what have been said to them. When we listed the advantages that HFT is apporting to the market, like liquidity and price discovery, they may consider it in a critical way, so maybe they are increasing efficiency, but they have not considered the possibility that it is harming the market in some way. Instead, when they have already heard or worked with it, some considerations about its not efficiency could arise, even if it is a minimal part. Therefore, people that already know the concept are more skeptical.

		Have you ever heard about High Frequency Trading?	
		Yes	No
Do you think that the introduction of HFT has helped the market become more efficient?	Yes	46,4%	38,9%
	Maybe	39,3%	55,6%
	No	14,3%	5,6%

Fig. 4.4 Crosstab between Q11 and Q12 of survey

It is also interesting valuating the perception regarding the intervention of regulatory authorities. Provided that regulation already determines what market, participants are or are not allowed to do in financial markets, there are some other circumstances where the determination of what can be done it is left to the good judgment of agents. In the 45% part of people that are currently working we investigate if they are working in financial market, and from our sample came out that two have worked for a bank, of which one also in other institutions, one for regulatory authorities, and one in asset management.
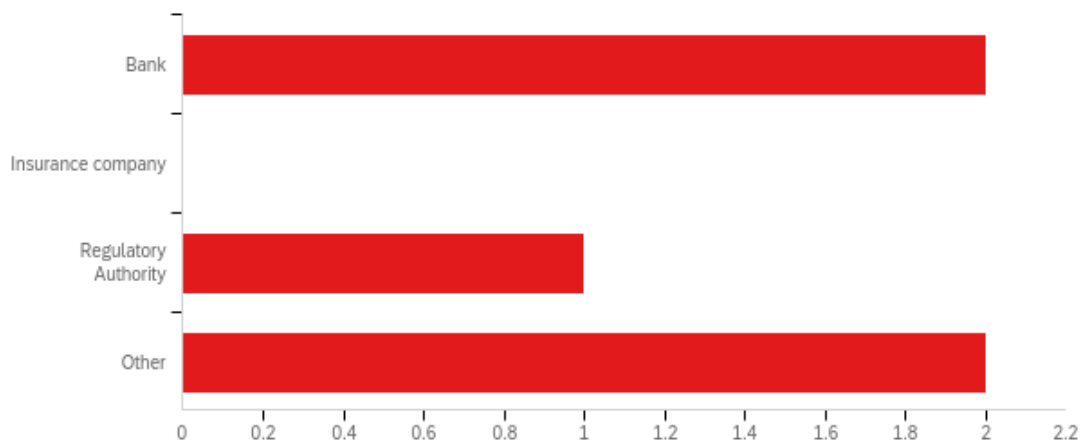
Fig. 4.5 Q5_Which institution have you worked in?

Now we tested the two data in the below crosstab to consider how important is the intervention of regulatory institutions to solve market fluctuation. In our research we explained how the intervention of regulation has improved after events like Flash Crash to guarantee less manipulation, as the introduction of MiFID II in Europe. What we are interested in is, based on who is working in financial markets, how different jobs are influencing the judgement of how this intervention of

regulatory authorities is considered positive. We have two extreme situations were who have worked in regulatory authority itself considered mostly necessary, while an asset manager and a banker do not. The other banker is more positive on the intervention of authorities.

		Q5: Which institution have you worked in?			
		Bank	Insurance company	Regulatory Authority	Other
Q16: Do you think more regulation is necessary in the financial markets to avoid uncertainty situation, such as high fluctuations of prices on the market?	Definitely yes	0%	0 %	0%	0%
	Probably yes	50%	0%	100%	0%
	Probably not	0%	0%	0%	0%
	Definitely not	50%	0%	0%	100%

Fig, 4.6 Crosstab between Q5 and Q16_ How financial worker consider regulation intervention.

As they cannot be taken as pure as they are, we will also consider the experience in the financial field, as analyzed in the below crosstab. In this case, the asset manager and regulator have less than 5 years of experience. While the bankers have more than 10 years. However, we can think that more experience is given less confidence in the power of institutions, as we cannot only base on the type of job.

		Q6: How long have you worked in financial markets?		
		0 - 5	5 – 10	+10
Q16: Do you think more regulation is necessary in the financial markets to avoid uncertainty situation, such as high fluctuations of prices on the market?	Definitely yes	0%	0%	0%
	Probably yes	50%	0%	33%
	Probably not	0%	0%	0%
	Definitely not	50%	0%	67%

Fig. 4.7 Crosstab between Q6 and Q16_How experience rate regulation intervention.

As we see the responses of all our sample, we will note that, in general, people have the perception that more regulation is equal to less market fluctuation, and that the market should not be left to the invisible hand of Adam Smith. In the previous chapter was mentioned that to guarantee a better market condition less restrictions should be imposed. So probably no expert's perception is a bit deviated, thinking that more rules will reduce financial market abuses.
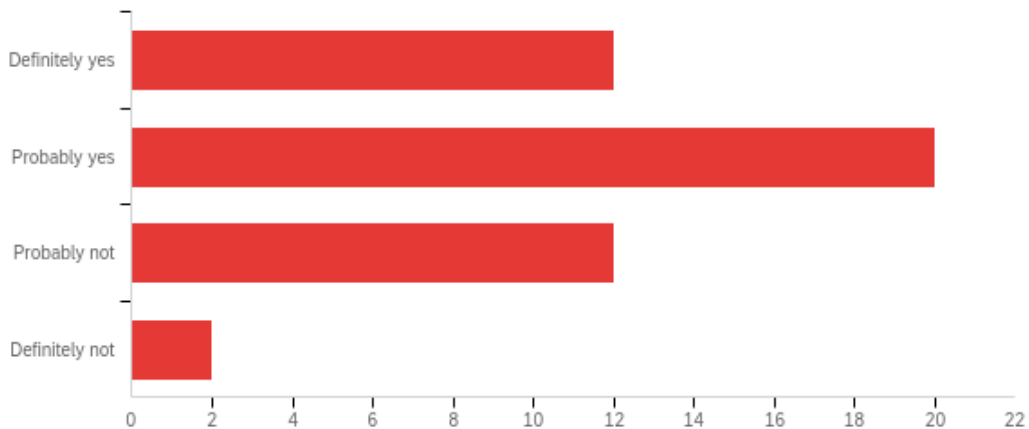

Fig. 4.8 Q16_ Do you think more regulation is necessary in the financial markets to avoid uncertainty situation, such as high fluctuations of prices on the market?

4.3.2 Second Hypothesis: Perception of financial market fairness

It is a matter of interest to analyze if people have ever invested in financial markets and how did they invest. Our results highlight that 54% have already invested in marketplace where securities are traded. 58,33% of them are investing directly, using online trading platforms, while the rest are using financial intermediary.

We have asked to evaluate how much do they consider ethic in money making the following situations, where 1 is unfair and 5 is fair.
It is interesting how people consider less fair the same action as investing in online trading when they have different outcome as gain or lose. So, seems like people are judging an action also based on the result, as when you are losing money it cannot be consider fair as when they gain. This is a common bias.

	1 (Unfair)	2	3	4	5 (Fair)
Gain in online trading a large amount of money?	4,35%	6,52%	17,39%	28,26%	43,48%
Lose in online trading a large amount of money?	4,35%	15,22%	15,22%	28,26%	36,96%
Gain in milliseconds a large amount of money?	6,52%	15,22%	30,43%	21,74%	26,09%
Lose in milliseconds a large amount of money?	13,04%	15,22%	28,26%	19,57%	23,91%

Fig. 4.9 Q22_How much do you consider fair?

On the other hand, we obtained a bit controversial result respect to our previous finding, when we asked how we should judge the feasibility of a market investor.

We defined two main type of evaluation. One that may focus upon the conduct adopted, concerning the actions of the agent, or another that may focus upon the results obtained, concerning the consequences of the actions put into place. We asked what it is considered most effective evaluation. The results are point out that most of participants are preferring judge the conduct of an action, but when the result is not what they expected, like losing in the previous table, their judgment change.
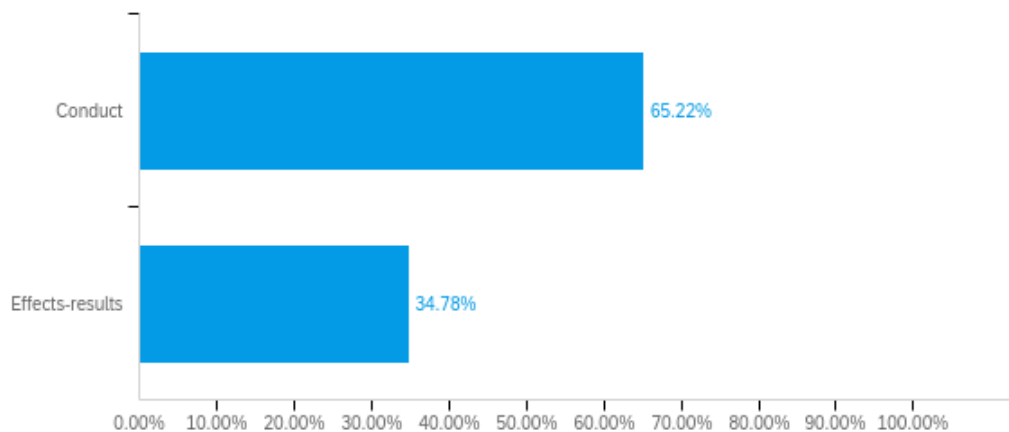
Fig.4.10 Q15 Conduct or effects-result.

The last two questions of the Fig. 4.9, we are touching the perception of HFT effects without telling the participants. As we have evidenced financial operation are carried out in less time, milliseconds, the behavior is considered less fair.

Here we are not considered how efficient it is, but how they consider it equitable,

and the idea of losing money very fast is not good considered. What most people do not realize that the market when one part is gaining, another is losing, as the money it is just moving, not creating.

Another important element of HFT is the use of sophisticated computers and have a high cost of maintenance, so not all have access to those programs. When we asked if it is fair that some people have access to faster computers that is what we obtained. Almost the same amount of people is considering lower than the average fair as above the average. It is an expensive tool that produce a lot of money for those who have enough money to invest.
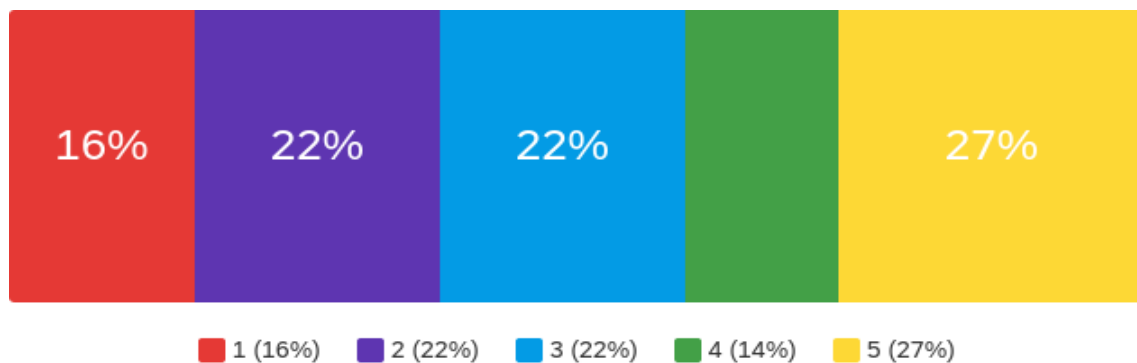
Fig. 4.11 Q22_5 That some people have access to faster computers?

4.3.3   The dimensions of Shefrin and Statman

We have also tested several of the dimensions of Shefrin and Statman (1993), previously discussed in chapter 3; Let us see them one by one, analyzing what people think of them, and how we can apply them to our case of high frequency trading. Sometimes people have to choose between fairness and efficiency as they are not always going in the same direction.

Freedom from coercion

Do you think that people like to freely choose what to do in the financial market?

People think that we should all have the opportunity to choose where we should invest in, as shown in the below graph. So why should be unfair what high frequency

trading are doing as they are investing in a free market.

We can also consider that, for example, the prohibition of insider trading is going against the right of trading freely, so in order to pursue market wellness, it is not possible to let freedom of coercion.

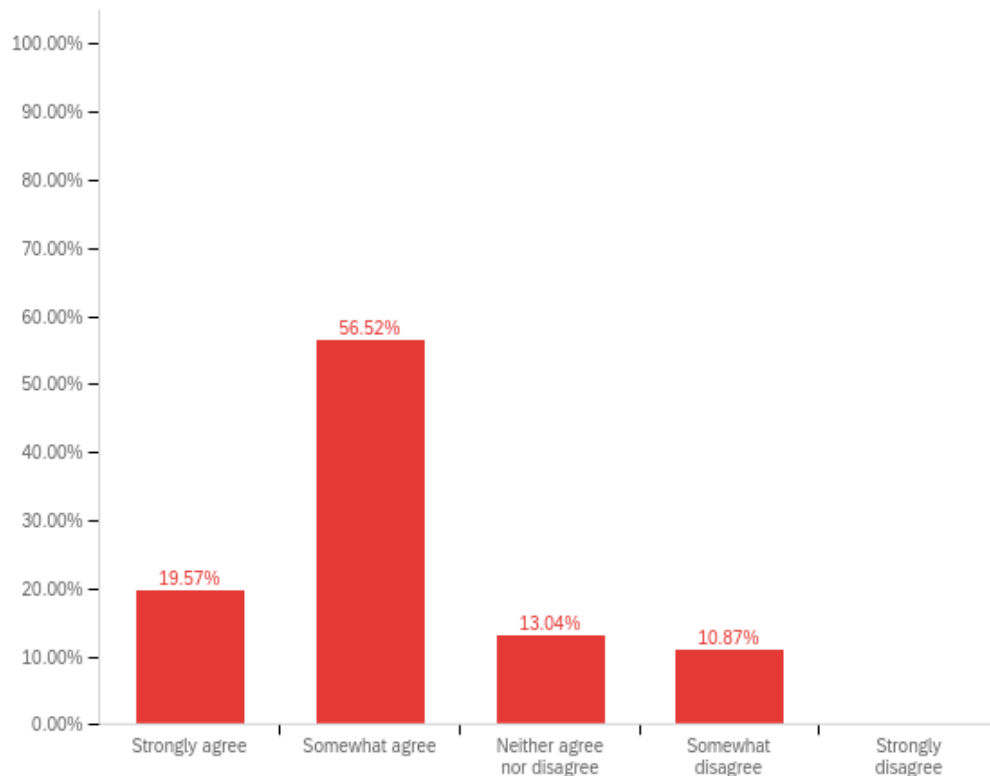Do you think that people like to freely choose what to do in the financial market?

Fig. 4.12 Q21.1_ Freedom from coercion

Freedom from misrepresentation

Do you think the manipulation of information is acceptable in order to get another party to sign a contract if you believe that it is in the interest of this party to agree?

Manipulating information is clearly against fairness of the market, as it is deviating the perception of prices and conditions, not giving a true vision of the situation. Even if the intention of the other part is not aiming to hurt others, participants have expressed their disagreement to this practice.

As we discussed sometimes high frequency trading is used for some manipulative

strategies to take advantages of information, they acquire faster than other. It is important to understand that this dimension is not violated if they have not as a first goal to mislead others.

Do you think the manipulation of information is acceptable in order to get another party to sign a contract if you believe that it is in the interest of this party to agree?
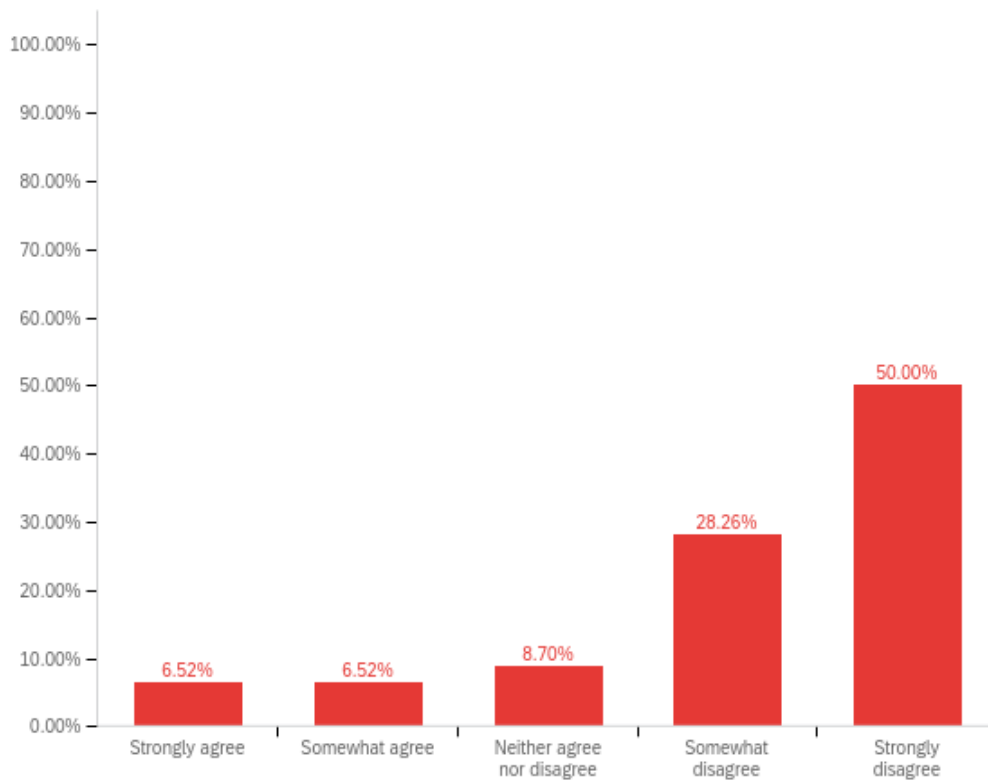
Fig. 4.13 Q21.2_ Freedom from misrepresentation

Equal information

Do you think that information is useful if you can understand it only partially?

Here people are not taking a strong position in favor or against this information. It is important that all market participants are able to reach all data, but does it really matter if they do not understand? Regulation is not giving a distinction if it matters or not, they want to guarantee that equal information is provided.

Do you think that information is useful if you can understand it only partially?
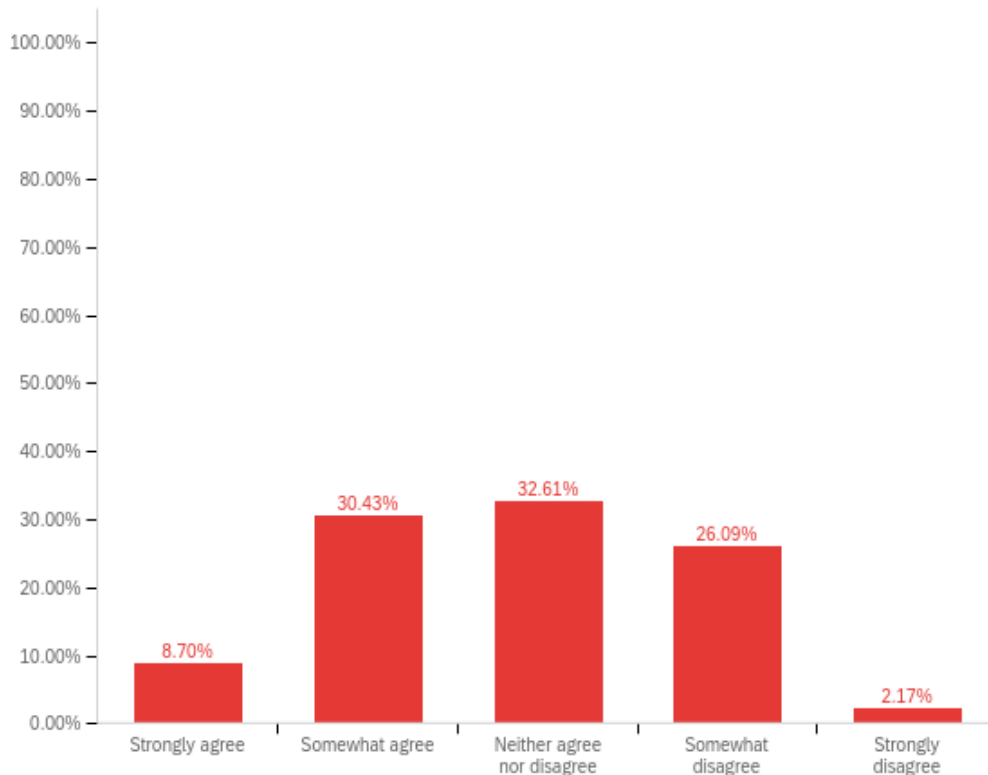
Fig. 4.14 Q21.3_ Equal information

Freedom from impulse

Do you think that human instincts are harming the market, such as fear or greed?

People need to be protected by their own instincts, as fear and greed are creating stressing situation. As people need boundaries to do not cause damages, regulation is trying to help it out. Participants mostly agree that humans are irrationally harming the market, so people generally recognize their limits. This is not creating a fair environment in financial market.

Do you think that human instincts are harming the market, such as fear or greed?
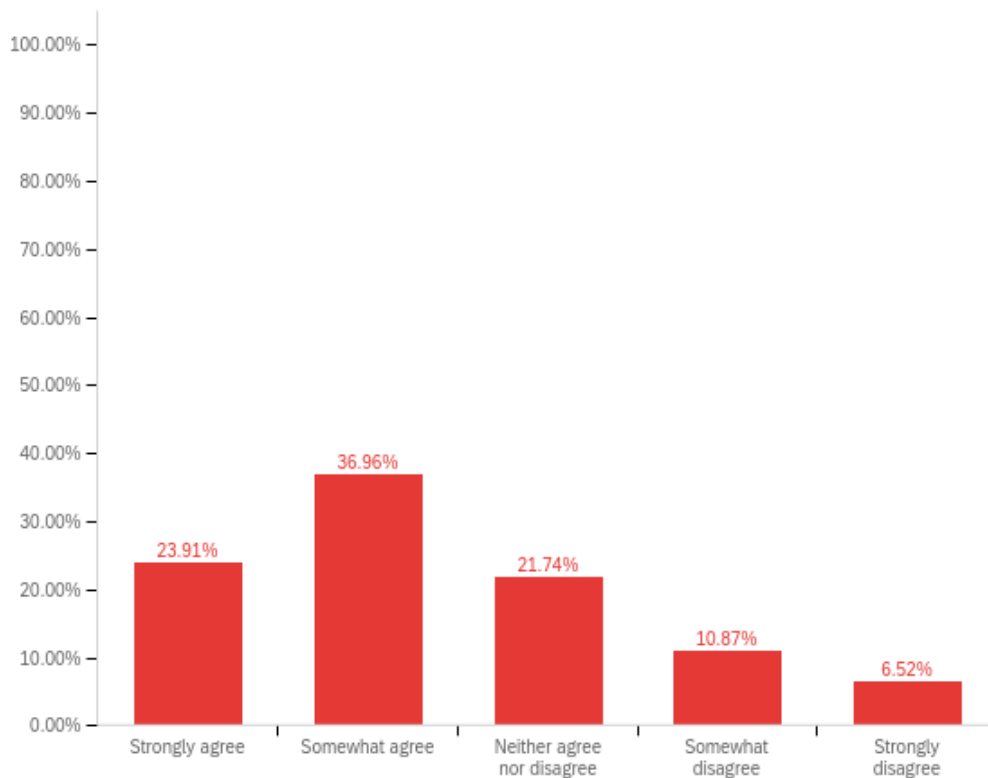
Fig. 4.15 Q21.4_ Freedom from impulse

Efficient prices

Do you believe that the price is truly representative of the intrinsic value of an asset?

People mostly disagree that the price present in the market is representing the intrinsic value of stocks. They may think that it is distorted by market fluctuation, financial bobbles, or an impulsive buying or selling movement. As we have seen market shocks are moving the prices irrationally, as happened in the flash crashes, creating mismatching between market value and real value. Moreover, prices are depending on what people think it will happen too, when they perceive a huge buying order is arriving, they may increment the amount of money they are willing to pay, thinking that a good event will occur soon.

However, we can consider high frequency trading as a fast way to implement information contained in the price, implementing the speed of price discovery.

Do you believe that the price is truly representative of the intrinsic value of an asset?
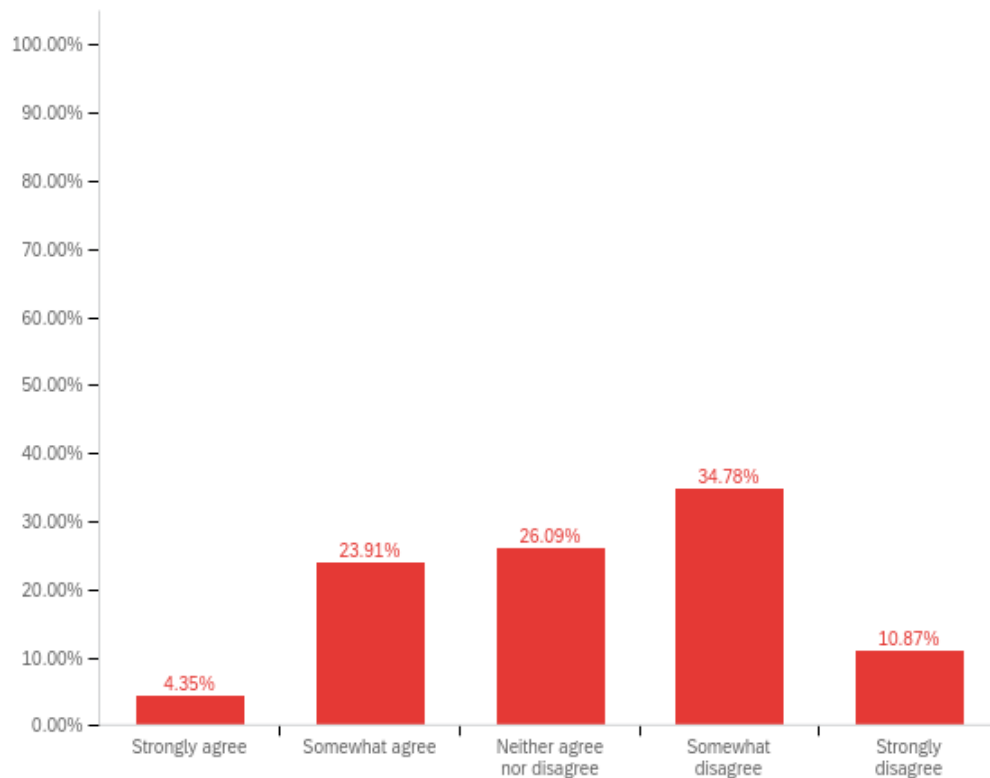

Fig. 4.16 Q21.5_ Efficient prices

Equal bargaining power

Do you think that the most powerful party into negotiation should always determine the good result of transactions?

Regulation have tried avoiding abuse of bargaining power positions, as one part should not be the one that it is determining the sort of negotiation. The perception of our sample regarding the matter is mostly disagree that it should exist a part that is more determinant of a good result. So, as they should have the same right to access to the information and it should guarantee no advantage in the financial relation. HFT cannot be considered the dominant part, but either the less powerful one, they are determination the sort of some transactions as they are the first to arrive, not because they are imposing to others. In this case the intervention of regulation could be helpful to the market.

Do you think that the most powerful party into negotiation should always determine the good result of transactions?
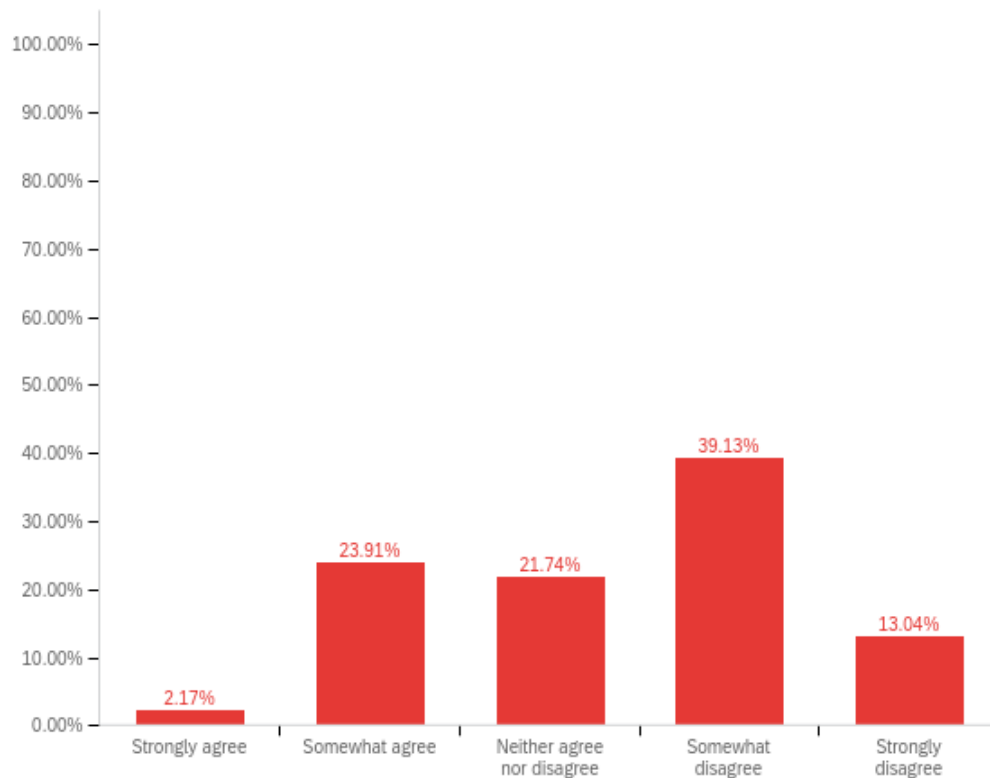

Fig. 4.17 Q21.6_ Equal bargaining power

4.4   Conclusions

Regulation can help to guarantee to have a more efficient financial market, but its intervention should be carefully weighted, in order to do not cause problems, instead of fixing them. Fairness is hard to measure and to apply, as there are concepts that cannot be see black or white, as people have different ideas. Moreover, sometimes it is entering in contrast to efficiency. Can be an inefficient market fair? But for reach an efficient market we could adopt not just behavior? And we go back of one of our research questions, are we more interested in judging the conduct or the result of our actions? As we said people are considering online trading as fair in most of the cases, and they are investing in it every day. But as they are gaining or losing, they are having a behavioral bias judging how fair it is, as when you are losing, you consider it less just. The judgment is even more uncompromising when the time

frame at which operations are taking place become shorted, like milliseconds. Anyway, the use of technology is not a harmful mean, it is the intention and the result that should be considered unfair.

Conclusions

High frequency trading is defined as a subset of the algorithmic trading ('AT') that has invested in sophisticated technology components that aim to reduce the latency of order's execution, while increasing the speed of the processes. It is requiring investing in equipment along with co-locating nearby Stock Exchanges. They may adopt different strategies that could lead to support the market or just hurt other participants. In any case HFT is trying to obtain a profit, that could be more passive or more aggressive. Passive strategies are market making and opportunistic strategies, and in general they are trying to reduce bid-ask spread and price volatility. Whereas aggressive strategies, like momentum ignition and order anticipations, are using information that had acquired to pursue their advantages, increasing volatility and damage the market quality. There exist also strategies that are not considered legal and are going to manipulate financial market, mentioning some like spoofing and quote-stuffing. Since we are in front of a complex instrument, it is not an easy task to define pros and cons. Considering that experts have opposite opinions about the HFT harming or not the market we had mainly taken into consideration a more neutral opinion expressed in MiFID II, where the benefits are increasing liquidity, narrowing bid-ask spread, implementing market participation, reducing volatility and guaranteeing a better execution of the orders. On the other hand, the risks may be overloading the trading venues, increasing the possibility of erroneous orders, and overreacting to market events. Going on with our analysis, one of the events that have burst the interest of regulatory authorities in high frequency trading was described, the so-called Flash-Crash, occurred on May 6, 2010. We have reviewed different opinion about the involvement of HFT in this event, either the primary cause or the faster solution for the recovery. However, it is evident that this instrument is advantage taking in normal situations but in times of trouble is normally taking distances from the market. Furthermore, what makes this case particular interesting is the involvement of a manipulative strategy successfully carried out by a British trader. Sarao Navinder, after five years from the event was considered one of the main causes of the financial market fell, adopting a

manipulative strategy, known as spoofing. The law is condemning other practices illegal as spoofing, like front-running, order triggering strategies, wash sales and quote stuffing. Mainly two approaches have been analyzed, the US, and the Europe one. They are aiming to reduce market abuses and manipulation, but they should be careful to do not produce the opposite effect, also taking the advantages HFT it is generating to economy. MiFID II, in Europe, is aiming to increase internal control, along with transmissions and record of activities' info. While in America, SEC is defining what it is forbitten, trying to avoid price manipulation. However, most of the time regulation is looking to the action of high-speed computers to see if they are going to hurt the market in an efficient way, but not considering the ethical prospective. Taking into consideration the Flash Crash' case, HFT did not avoid the high volatility fluctuation. Should be considered the intention of an action, consequentialism, or the result those actions lead to, act-utilitarianism? The difficulties in considering ethics it that people have different considerations, even though authorities have tried to define some concepts. As fairness is the tradeoff between harm others and social benefits, according to the US congress. Shefrin and Statman, 1993, have defined the dimensions of fairness, and nowadays most of them are already implemented in the regulation. If we are considering those dimensions, we cannot affirm that HFT is unfair per se, but some strategies that may adopt could be.

What our research aim to test is the perception of professionals and the general population regarding regulatory authorities' intervention and how fair is investing in financial markets. To explore these issues, we conducted an original online survey, prepared in Qualtrics and distributed through social networks. While the literature is pointing out that regulation should be used carefully as more could produce side effects, our sample seems to be wanting more, although who has already worked in financial market is a bit more skeptical about this point. This could be an indicator of bad information, as to prevent moral hazard, regulation should be left to the minimum.

Then when was tested fairness, and as the result, gain or lose, as the time, days or milliseconds, is changing, the participants had a different opinion. As the outcome is not predictable, if you decide to invest in financial market, you should expect and be aware that both results have been equally fair. Moreover, when one part is gaining

there is another one that is losing in any case. Operations that are taking only milliseconds are considered less fair, probably because people think that to gain money you need time, and that is probably connected to our mindset. The real question sometimes is about what we want more is the fairness or efficiency. High frequency trading is a practice that could lead to a more efficient market, more liquidity and faster price discovery, but not necessarily fairer. Although we cannot consider the instrument as harmful but the incorrect use of it as not fair.

It is not the mean itself that makes the difference, nor how you use it.

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Appendix

Survey

Fairness and HFT

Q46 Welcome!
My name is Eva Mazzer, I am a student at Ca' Foscari University pursuing the Master's Degree in Finance. The survey you are about to fill in will take only a few minutes and it is related to automated financial markets instruments, which I discuss in my Master's thesis. Your data will be processed in accordance with privacy laws, exclusively in aggregate form for research purposes. Your participation is crucial for my research project.
Thank you for you help.

Q1 What is your current employment status?

☐ Employed full-time (1)

☐ Employed part-time (2)

☐ Unemployed looking for work (3)

☐ Unemployed not looking for work (4)

☐ Retired (5)

☐ Student (6)

☐ other (7) _____

Q2 Financial markets include any marketplace where securities are traded, such as the stock market, bond market, forex market, and derivatives market, to name a few. Do you have a background in financial markets, such as bachelor's or master's

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degree, training courses or direct experience?

○ Yes (21)

○ No (22)

Q3 Where have you acquired your knowledge about financial markets?

☐　　University (1)

☐　　Work (2)

☐　　Personal interest (3)

☐　　others (4) _____

Q4 Have you ever worked in financial markets? (such as in a bank, at a regulation authority, ecc)

○ Yes (1)

○ No (2)

Q5 Which institution have you worked in? Multiple answers are possibile

☐   Bank (4)

☐   Insurance company (5)

☐   Regulatory Authority (6)

☐   Other (7) _____

Display This Question:

If Have you ever worked in financial markets? (such as in a bank, at a regulation authority, ecc) = Yes

Q6 How long have you worked in financial markets? (in years, write zero if less than a year)

▼ 0 - 5 (4) ... +10 (6)

Display This Question:

If What is your current employment status? = Student

Q7
Have you ever invested in the financial market?

◯ Yes (1)

◯ No (2)

Display This Question:

If Have you ever invested in the financial market? = Yes

Q8 Do you invest directly or through an intermediary?

◯ Directly (1)

◯ Intermediary (2)

End of Block: Financial Markets

Start of Block: HFT

Q11 High Frequency Trading (HFT) is a subset of the algorithmic trading ('AT') distinguished by the speed at which it processes and determines plays in the market. The sophisticated technology components are reducing the latency, which is the time occurring between when the order is placed and when it is executed. They are integrating more information into the price and rising liquidity in the financial markets.   This   is   supposed   to   increase   efficiency.

Have you ever heard about High Frequency Trading?

○ Yes (4)

○ No (5)

- -

Q12 Do you think that the introduction of HFT has helped the market become more efficient?

○ Yes (23)

○ Maybe (24)

○ No (25)

Q15 Provided that regulation already determines what market participants are or are not allowed to do in financial markets, there are some other circumstances where the determination of what can be done it is left to the good judgment of agents.

In these cases, there are two main types of evaluations that can be used to determine the   feasibility   of   the   actions   of   a   financial   market   investor:

We may focus upon the conduct adopted, concerning the actions of the agent, or we may focus upon the results obtained, concerning the consequences of the actions put into   place.

 From your point of view, what do you consider the most effective evaluation

approach?

○ Conduct (1)

○ Effects-results (2)

Q16 Do you think more regulation is necessary in the financial markets to avoid uncertainty situation, such as high fluctuations of prices on the market?

○ Definitely yes (14)

○ Probably yes (15)

○ Probably not (16)

○ Definitely not (17)

End of Block: Financial markets

Start of Block: Fairness

Q20   Fair,   according   to Oxford   Dictionary,   can   be   defined   as "Of conduct, actions, arguments, methods: Free from bias, fraud, or injustice; equitable, legitimate. Hence of persons: Equitable; not taking undue advantage; disposed to concede every reasonable claim. Of objects: That may be legitimately aimed at; often in fair game, fig.; fair wage"

Q21 According to Shefrin and Statman (1993) there are several dimensions of fairness in financial markets, I would like to know what you think about each of the dimensions.   Some of these dimensions may be already regulated, but I would like to know your personal opinion beyond the legal status of the facts.

	Strongly agree (1)	Somewhat agree (2)	Neither agree nor disagree (3)	Somewhat disagree (4)	Strongly disagree (5)
Do you think that people like to freely choose what to do in the financial market? (1)	○	○	○	○	○
Do you think the manipulation of information is acceptable in order to get another party to sign a contract if you believe that it is in the interest of this party to agree? (2)	○	○	○	○	○
Do you think that information is useful if you can understand it only partially? (4)	○	○	○	○	○
Do you think that human instincts are harming the market, such as fear or greed? (5)	○	○	○	○	○
Do you believe that the price is truly representative of the intrinsic value of an asset? (6)	○	○	○	○	○

Do you think that the most powerful party into negotiation should always determine the good result of transactions? (7)	○	○	○	○	○

Q22 Please evaluate how much do you consider fair(ethic in money making), where 1 is unfair and 5 is fair

	1 (6)	2 (7)	3 (8)	4 (9)	5 (10)
Gain in online trading a large amount of money? (1)	○	○	○	○	○
Lose in online trading a large amount of money? (2)	○	○	○	○	○
Gain in milliseconds a large amount of money? (3)	○	○	○	○	○
Lose in milliseconds a large amount of money? (4)	○	○	○	○	○
That some people have access to faster computers? (7)	○	○	○	○	○

Q30 Indicate your age

▼ 18 - 25 (8) ... +71 (12)

Q31 Indicate your education level

○ Less than high school (1)

○ High school graduate (2)

○ Bachelor degree (3)

○ Master's degree (4)

○ Some college but no degree (5)

○ Professional degree (MBA) (6)

○ Doctorate (7)

Q32 Field of Education

○ Finance or computer science (1)

○ Philosophy and Ethics (2)

○ Others (3)

Q33 What gender do you identify as?

○ Male (1)

○ Female (2)

○ Prefer not to reply (3)

Q34 Please indicate your net annual income wealth

○ less than 14,999€ (1)

○ 15,000-24,999€ (2)

○ 25,000-39,999€ (3)

○ 40,000-54,999€ (5)

○ 55,000-69,999€ (8)

○ more than 70,000€ (9)

Q35 What is your nationality?

▼ Italian (4) ... Others (6)

Q36 In which country are you currently working/living in?

▼ Italy (4) ... Others (6)

Q37 How many years have you worked/lived in that country? (in years, write zero if less than a year)

▼ 0 - 5 (4) ... +10 (6)

Q57 Please indicate if any of the following events have happened to you

	Yes (6)	No (7)
Gain in online trading a large amount of money? (1)	○	○
Lose in online trading a large amount of money? (2)	○	○
Gain in milliseconds a large amount of money? (3)	○	○
Lose in milliseconds a large amount of money? (4)	○	○

End of Block: about you