Playing it again: new financial innovations and renewed financial fragility

Maryse Farhi – Professora-doutora do Instituto de Economia da Unicamp.

Daniela Magalhães Prates – Professora associada do Instituto de Economia da Unicamp e pesquisadora do CNPq.

Abstract: After the 2008 global financial crisis, U.S banks and other financial institutions have launched new financial innovations with the aim of circumventing two post-crisis regulatory changes: restrictions on bank trading imposed by the 2010 Dodd-Frank Act; and increased capital requirements, also enclosed in Basel III. The aim of this paper is to analyze the features, impacts, and potential risks of those recent innovations that are changing market´s dynamics and posing serious threats to financial stability.

Key words: Financial innovations, financial fragility, global financial crisis, regulatory arbitrage

Resumo: Após a crise financeira global de 2008, os bancos e outras instituições financeiras dos Estados Unidos lançaram novas inovações financeiras com o objetivo de contornar duas mudanças regulatórias adotadas após da crise financeira global: restrições à negociação bancária imposta pela Lei Dodd-Frank de 2010; e os maiores requisitos de capital também incluídos no acordo Basileia III. O objetivo deste trabalho é analisar as características, os impactos e os riscos potenciais dessas inovações que estão mudando a dinâmica do mercado e colocando sérias ameaças à estabilidade financeira.

Palavras-chave: Inovações financeiras, fragilidade financeira, crise financeira global, arbitragem regulatória.

JEL codes: F32, G15, G2

Área 5: Comércio e finanças internacionais

1. Introduction

The challenges of the global financial crisis (GFC), which began in 2007 in the United States (U.S.) subprime mortgage market, were responded by governments around the world with proposals of supervision and regulation reforms. In 2015, Basel III final touches have being announced. U.S. Dodd Frank´s law is starting to be enforced, yet at a slower pace than previously proposed. Both still face many hurdles, mostly because the sense of urgency of their implementation waned and as a result of president´s Trump pledge to overhaul financial regulation. Anyway, as Wray (2011) pointed out, they would not have prevented the financial crisis even if they had been in place back then. "The problem is that the architects of reform are working around the edges, taking current bank activities as somehow appropriate and trying to eliminate only the worst excesses of the 2000s".

This financial regulation approach, which is called herein "edging regulation", has put in motion, once again, the so-called regulatory arbitrage process. In other words, banks and other financial institutions, as profit-seeking agents, actively react to regulatory, institutional and macroeconomic changes. As Minsky (1986) stressed, this is mostly done through the introduction of financial innovations that, usually, make existing regulations obsolete, requiring improvements in the regulatory framework.

Just like the industrial innovations studied by Schumpeter, Minsky´s PhD supervisor, innovations in financial markets encompass new instruments, new practices, new strategies, new markets, and even new institutions. Some former financial innovations (asset backed securities and credit derivatives), little known outside the universe of market agents before the 2007/2008 financial crisis, had a significant impact in its depth and extension. It showed the necessity of keeping track of financial innovations to assess financial fragility and the potential threat of a new crisis.

Confirming Minsky´s analysis, these more recent financial innovations mainly reflect the search of financial institutions to circumvent the post-crisis regulatory changes. As they did previous to the 2008 global collapse, U.S banks and other financial institutions have been leading the regulatory arbitrage dynamic fostered, mainly, by circumventing two new rules: restrictions on bank trading imposed by the 2010 Dodd-Frank Act, including the ban on banks' proprietary trading (Volcker rule[1]); and increased capital requirements (Collins amendment[2]), also enclosed in Basel III. But,, as Schumpeter's industrial innovations, recent financial innovations are also directly linked to technological advances that have been shaping the economy in general, and the financial system specifically.

The convergence of financial services and technology industries encompasses various activities affecting infrastructure and operations for existing and evolving business models. Firms created in this movement, called Fintech, are the latest members of the unregulated segment of financial activities (shadow banking system; see Prates and Farhi, 2015). They took the lead of the heavy use of technology in finance, while banks caught in the headlights of regulation and cost reduction followed suit. They used a

[1] The rule ban proprietary trading by commercial banks, whereby deposits are used to trade on the bank's own accounts, although a number of exceptions to this ban were included in the Dodd-Frank law. The rule's provisions were scheduled to be implemented as a part of Dodd-Frank on July 21, 2010, but were delayed. On December 10, 2013, the necessary agencies approved regulations implementing the rule. On January 14, 2014, revised final regulations were adopted.

[2] Dodd-Frank Section 171, commonly known as the Collins Amendment, requires that the appropriate federal banking agencies establish minimum risk and leverage capital requirements on a consolidated basis for (i) insured depository institutions, (ii) depository institution holding companies, and (iii) nonbank financial companies supervised by the Fed. On December 18, President Obama signed it into law.

technology closely related to the Artificial Intelligence, also employed in robotics. These firms engaged in three main spheres: consumer-facing companies that offer digital tools to improve the way individuals borrow, manage money and finance startups, investment management and back-office ventures that help financial institutions streamline their operations behind the scenes (Robinson, 2017).

Though late in the game, banks are competing fiercely in this area as the industry enters a new era of automation, fueled by cheap computing power and fears of losing customers to startups. Most of the previous financial innovations had low sunk costs, making them easily copied by others. Their relatively short life cycle made for both a fast pace of launching new innovations and a bias towards customization in an effort to render them less easily copied and increasingly complex (Freitas, 2007; Guttmann and Plihon, 2010). In the present wave of innovations, investments and highly qualified work force are initially very high, In a longer run, though, their cost is compensated by the competitive edge and the reduction of employment in financial activities. Among those activities of Fintech, this paper focuses on two innovations linked both to regulatory arbitrage and technological evolution, due to their potential threat to financial stability. The first one is High Frequency Trading (HFT), a class of electronic trading[3] featured by high-speed connections and the use of complex algorithms. HFT comes from the convergence between finance and technology replacing human decisions in the issuing of orders in the markets. The second is the expansion of "dark pools", electronic trading platforms that are a kind of squared Over the Counter Market (OTC) that interacts with HFT. In these platforms, as its name evidenced, secrecy and opacity are supposed to be the absolute norm. These two intertwined financial innovations, on the contrary of most previous ones, are featured by high sunk cost due to their strong technological content, compensated, in part at least, by a reduction in cost as less and less human labor is required to run a trading desk. At the same time, the very stiff competition among financial institutions and technological advances has been fostering constant updates (new algorithms, faster cable connections, etc).

These two innovations are changing market´s dynamics and posing serious threats to financial stability. McConnell (2015) even considers them to cause systemic risks. The aim of this paper is to analyze their features, impacts, and potential risks to the world economy. The arguments are organized as follows. In the first two sections, each of those innovations is scrutinized (respectively, HFT and dark pools). Section 3 presents some final remarks, focusing on their threats to financial stability and to the governance of the financial system.

2. High Frequency Trading

One of the most significant recent financial innovations is High Frequency Trading (HFT), typically performed by powerful computers able to execute electronic transactions within milliseconds even microseconds, generating a huge number of trades on a daily

[3] The term "electronic trading" is used in many ways. In this paper, we adopt the definition of Allen et al. (2001). It refers mainly to trading in wholesale financial markets (as opposed to e-commerce more generally; see, for example, Long (2000) for a survey of the latter) and focuses on the central feature of electronic trading systems, which is the automation of trade execution. Such systems usually also feature electronic order routing and dissemination of trade information and may link through to clearing and settlement. Electronic trading both removes geographical restraints and allows continuous multilateral interaction (whereas telephone trading allows only the former and floor trading only the latter). It allows much higher volumes of trades to be handled, and in customized ways that until recently would have been technically impossible or prohibitively expensive.

basis. Speed allows them to take advantage of small discrepancies in prices. This new class of electronic trading has specific characteristics, among which:

i. Super-fast dedicated cables;
ii. Extraordinarily high-speed and sophisticated computer programs for generating, routing, and executing orders;
iii. Powerful algorithms;
iv. Use of co-location services[4] and individual data feeds offered by exchanges and others to minimize network and other types of latencies;
v. Very short time-frames for establishing and liquidating positions;
vi. Submission of large number of orders, frequently cancelled shortly after;
vii. Ending the trading day in as close to a flat position (in which no net positions are carried overnight, thus are not recorded in the balance sheets) as possible.

Although its emergence in stock trading goes back to mid-2000[5], HFT have boomed only after the 2008 global crisis due to banks and other financial institutions reactions to the financial regulations changes, the so-called regulatory arbitrage. In face of the ban on banks' proprietary trading (Volcker rule), large American banks started to reduce the big trading positions they once carried. Competition among non-banking financial institutions to grab part of this business and to restore liquidity in the markets became fierce. In this setting, many HTF firms were created with that same aim. This firms that can trade in microseconds are usually trading for themselves rather than fulfilling clients' orders. They are usually designated as proprietary firms. As such they are not required to be registered and are absolutely unregulated

Meanwhile, big banks searching for new sources of revenue have engaged in HFT for their proprietary trading as they allow them to make trading profits while not carrying assets that need to be included in their balance sheets. This activity allows them to comply with the Volcker rule and, at the same time, retain at least part of those profits. The banks' rush to maintain or regain their places as brokers is still going on and involves making HFT available to their clients. For instance, Goldman Sachs that has long been one of the top two stock brokerages in terms of revenue and customer rankings saw his status slipping because its technology did not keep up with client demands for ever-faster trades. In March 2015, Goldman hired dozens of technologists and support staff to elevate its position in a fast-growing slice of the market and win back business from its chief competitor, Morgan Stanley (MacCrank, 2016).

Fostered by this stiffer competition between proprietary firms and banks, HFT has rapidly spread to trade in all different kind of assets and their derivatives, all over the word. According to Zhang (2010); "high-frequency trading has become a dominant force in the U.S. capital market, accounting for over 70% of dollar trading volume". In foreign exchange markets, for instance, HFT is largely employed in cross rates operations. Chaboud, Chiquoine, Hjalmarsson and Vega (2009) use the example of the pairs euro/dollar, dollar/yen and euro/yen to underline that "in this cross-rate, computers have a clear advantage over humans in detecting and reacting more quickly to triangular arbitrage opportunities, where the euro-yen price is briefly out of line with prices in the

[4]Exchanges built or are building huge data centers where traders, members and non-members alike, after paying a fee, can place computers containing their trading algorithms next to an exchange's engine, which matches "buy" and "sell" orders. This "co-location" shaves crucial milliseconds from the time it takes to complete a trade. (Financial Times Lexicon, Available at http://lexicon.ft.com/Term?term=co_location)
5 For a historical perspective of HFT, see Agarwal (2012).

euro-dollar and dollar-yen markets". A recent McKinsey study (2015, pg4) estimates that "trading through electronic channels now accounts for 90 percent or more of spot G10 FX[6] and equity transactions and is increasingly common in certain areas of rates and credit".

Strategies employed by HFT traders are manifold. They may be differentiated into liquidity providing strategies (market-making), statistical arbitrage and liquidity detection. Deutsche Bank Research (2011) depicts these strategies. "Liquidity-providing strategies mimic the traditional role of market makers – but unlike traditional market makers, electronic market makers (liquidity providers) have no formal market making obligation. These strategies involve making a two-sided market aiming at profiting by earning the bid-ask spread. As much of the liquidity provided by high frequency traders (HFTs) represents opportunistic liquidity provision, the entering and exiting of large positions is more difficult. Pursuing statistical arbitrage strategies, traders seek to correlate prices between securities and to profit from imbalances in those correlations. Subtypes of arbitrage strategies range from arbitrage between cross-border or domestic marketplaces to arbitrage between the various forms of a tradable index and so-called cross-asset pairs trading, i.e. arbitrage between a derivative and its underlying. In terms of liquidity detection, HFT trading rely on the speed to decipher whether there are large orders existing in a matching engine by sending out small orders (pinging) to seek for large orders. When a small order is filled quickly, there is likely to be a large order behind it."

In face of the HFT booming, a great number of electronic trading venues were created such as Bloomberg Terminal, Thomson Reuters 3000 Xtra (replaced by Eikon platform, in 2010), BondsPro, Thomson TradeWeb or CanDeal. Conversely, these new venues have fostered even more the boom. In that setting, a new regulation that forces broker houses to seek among them the best execution for their orders was launched. With trading currently spread, in the US, over 11 public stock exchanges, uncounted electronic trading venues and more than 40 dark pools (trading venues that do not publish prices, volumes and the origin of bid and ask orders, that will be discussed in section 3), market operators are dependent on HFT firms for liquidity and revenue. To cater to them and in a framework of intense competition, the exchanges and dark pools sell advantages to HFT firms: myriad special-order types, faster data, price rebates, and co-location (the right to put their computers in the same data centers as the exchanges so they can trade even faster).

For stock trading, the process of connecting counterparties through electronic trading is supported by the Financial Information Exchange (FIX) Protocol. Used by the vast majority of exchanges and traders, the FIX Protocol is the industry standard for pre-trade messaging and trade execution. Both HFT and the FIX Protocol has been further developed to accommodate commodities, foreign exchange, derivatives, and fixed income trading.

This fragmentation of financial trading venues and electronic trading provided the ideal environment for the HFT to thrive. The fragmentation´s beginning is linked to the implementation of Regulation Alternative Trading System in 1988. As a result, bid and ask spreads narrowed drastically, as did the amount of money traders could make per day trade. Automated trading firms made up for that with sheer volume of trades. In 2007, the establishment of Regulation National Market System (or Reg NMS) created the concept of a National Best Bid and Offer in which speed of execution became paramount. In preparation for its enforcement, the stock exchanges had reinforced their systems and

[6] Advanced economies currencies foreign exchange transactions.

changed from member-owned, non-profit corporations, to private for profit exchanges. Many of them became publicly traded companies. "The changes brought about by REG NMS have turned the market from an investor-focused mechanism which welcomes traders and investors of all types and speeds, to a trader-focused mechanism" (Arnuk & Saluzza, 2012). In other words, the actual business model reflects the interest of HFT traders at the expense of "slow investors" (every investor that does not trade through HFT, or investors whose HFT is slower than others), making the markets more dangerous and unstable.

The algorithms are linked to numerous news feed and programmed to react very quickly to specific key words. It also allows HFT to perform almost simultaneous arbitrage trade in various markets and, by its superior speed, to buy or sell assets in the time lapse that large orders take to reach the market at a slower pace, forcing "slow investors" to buy at a higher price or sell at a lower one. In other words, these investors find themselves unable to execute orders at the prices and volumes their trading screens indicate are available (Arnuk & Saluzza, 2012; Lewis, 2014).

This kind of operation is far from being new. The trading strategy that attempts to make many profits on small price changes has been long known as scalping. While trading occurred on the floor of the exchanges, scalpers were common figures, located at the bottom of the scale of financial resources and risk taking. Back then, their attempts to buy (or sell) at the bid (or ask) price and then quickly sell (or buy) them a few cents higher (or lower) for a profit were based on their feeling of the short-term market´s trend. Then, Internet trading became the norm and scalpers switched to online day trading.

Actually, HFT´s scalping is a huge business, relying on speed alone to make a profit, in part based on the prior information of "normal" (also called "slow") investors´ orders that trigger an electronic reaction. Most of the time, the difference in price can be counted in fractions, but many small profits can easily compound into large gains as some extraordinary performance among prominent HFT firms show. A report from Barron's (2010), for example, estimates that Renaissance Technology's Medallion– a quantitative HFT fund – achieved a 62.8% annual compound return in the three years prior to the report. For the banks, scalping presents an additional advantage as they allow them to bypass Volcker´s rule restrictions.

However, on one hand, those returns are very unevenly distributed. HFTs are competing among themselves by investing in small increases in speed. Then, there are differences in their algorithms and their strategies. Baron et al. (2014) show that "HFT firms who specialize in liquidity taking (aggressive) strategies generate substantially more revenue than those who specialize in liquidity-providing (passive) strategies. Moreover, revenue persistently and disproportionally accumulates to the top performing HFTs, suggesting winner-takes-all market structure". On the other hand, HFT's returns´ best days may be behind it as its success and proliferation intensifies competition and reduce benefits.

The rise of high-frequency trading (HFT) in the U.S. and around the world has been rapid. Competition mechanisms led to a huge expansion. Biais (2011) describes the situation in which agents invest in HFT because it is costlier to remain slow while others get faster. He compares that investment to an arm's race: expansive, socially useless, but if others do it, you must equal them. According to a report by the Bank of England, by 2010, HFT accounted for 70% of all trading volume in US equities and 30-40% of all trading volume in European equities. As the proportion of HFT increases, slow traders are evicted from market. Thus, fast traders stop realizing all potential gains from speedy trade. In other words, they mostly trade amongst and against each other and have to rely on the quality of their algorithms rather than on speed alone to obtain a profit.

While HFT was being implemented, it remained relatively unknown. As it expanded, news of its existence started to become known, mostly based on information provided by disgruntled non HFT traders. In 2009, Oloffson and Gandel, as the result of a paper by Sal Arnuk and Joseph Saluzza, co-founders of Themis Trading, wrote about HFT and pointed to one of its biggest element, known as co-location. In co-location: after paying a fee to an exchange, firms are allowed to rent server space within or near the NYSE or another exchange's computer servers to get access to trading statistics faster — just milliseconds faster — than competing investors. At that time, about 130 NYSE clients used the co-location services, according to the NYSE website, where the service is marketed as something of an advantage "when proximity to the market can give your business model a competitive edge. That edge can translate into huge profits for high-frequency-trading firms like Goldman Sachs, which, according to Bloomberg, made more than $100 million in trading revenue on a record 46 separate days during the second quarter of 2009, or 71% of the time — partly thanks to high-frequency trading". According to the authors, "one thing the exchange is not doing is telling the public just who it is that uses the exchange's special access to conduct high-frequency trades. The NYSE plans to keep secret the small group of investment firms that collectively make what could be billions of dollars a year off their special access". (Oloffson and Gandel, 2009)

The same Arnuk & Sacuzzi, of Themis Trading, wrote their own book on the subject, Broken Markets (2012). In its introduction, they state that "we believe that there´s something wrong with the stock market. It has changed drastically and quickly from the model it was based on for more than a century (..) Now it is a loosely connected mess of more than 50 different exchanges, dark pools and alternative trading venues focused on short term trading (..) operating at insane speeds".

HFTs really made the headlines after the publication, in March 2014, of Michael Lewis' bestseller book[7] The Flash Boys: A Wall Street Revolt. Written almost as a novel, overcoming the complexity of the subject, Lewis´ book used the testimonies of different traders and computer scientists that became the main characters of the book. He explained the way Wall Street had developed an overly complex, opaque system for trading stocks that levied a tax on investing. His main allegation that the market is "rigged" in favor of high-frequency traders relies essentially on the finding that those venues sold access to HFT technology that allows it to gain speed and pricing advantage over public orders. None of these was new information, yet it was the first time that they reached the broad public and provoked real impact.

Its success sent shockwaves through the financial system. A year later, the author wrote a follow-up piece of his book (Lewis, 2015). He discusses some of the legal actions brought in the wake of the book, and notably the practice of retail brokerages selling their orders to dark pools where the counterparties are high-frequency traders. "In the days after *Flash Boys* came out, the Justice Department announced its own investigation, and it was reported that the F.B.I. had another. The S.E.C[8]., responsible in the first place for the market rules, known as Reg NMS that led to the mess, remained fairly quiet. Its enforcement director let it be known that the commission was investigating exactly what unseemly advantages high-frequency traders were getting for their money when they paid retail brokers for the right to execute the stock-market orders of small investors. The initial explosion was soon followed by steady fallout of fines and lawsuits and complaints, which, I assume, has really only just begun". Yet, despite the

[7] Lewis' *Flash Boys* stood four consecutive weeks at Number 1 on the *New York Times* nonfiction list.
[8] U.S. Securities & Exchange Commission

depicted initial explosion, in reality no substantial new regulations were adopted or are even being so far discussed to counter the present asymmetry in the markets.

On the other hand, market´s behavior also called attention to the impacts of HFT. In May 6 2010, a "Flash Crash"[9] occurred in the United States, lasting for approximately 36 minutes. Stock indexes, such as the S&P 500, Dow Jones Industrial Average and Nasdaq 100, collapsed and rebounded very rapidly. The Dow Jones Industrial Average had its biggest intraday point drop (from the opening) up to that point, plunging 998.5 points (about 9%) within minutes, only to recover a large part of the loss. The prices of stocks, stock index futures, options and Exchange Traded Funds were extremely volatile, thus trading volume spiked during that short period in which nearly $1 trillion in market value waned.

A joint report from U.S. Commodity Futures Trading Commission (CFTC) and S.E.C. (2010) described it as one of the most turbulent periods in the history of financial markets: "some equities experienced even more severe price moves, both up and down. Over 20,000 trades across more than 300 securities were executed at prices more than 60% away from their values just moments before. Moreover, many of these trades were executed at prices of a penny or less, or as high as $100,000, before prices of those securities returned to their "pre-crash" levels".

The report points its origin to a large sell order totaling 75,000 EMini S&P 500 futures contracts (valued at approximately $4.1 billion) from a fundamental trader (a mutual fund complex) as a hedge to an existing equity position. This large fundamental trader chose to execute this trade via an automated execution algorithm ("Sell Algorithm"). The algorithm was programmed to execute the trade "without regard to price or time," which meant that it continued to sell even as prices dropped sharply. Normally, a sale of this size would take place over as many as five hours, but the large sale was executed in 20 minutes, the regulators said.

In the New York Times, Bowley (2010) described the process of contagion to other markets. "The selling pressure was then transferred from the futures markets to the stock market by arbitrageurs who started to buy the cheap futures contracts but sell cash shares on markets like the New York Stock Exchange. Automatic computerized traders on the stock market shut down as they detected the sharp rise in buying and selling. Altogether, this led to the abrupt drop in prices of individual stocks and other financial instruments like exchange-traded funds, and caused shares of some prominent companies like Procter & Gamble and Accenture to trade down as low as a penny or as high as $100,000. The rout continued until an automatic stabilizer on the futures exchange cut in and paused trading for five seconds, after which the markets recovered".

As underlined by Scannell and Lauricella (2010**),** the report placed relatively little blame on the broad structure of U.S. financial markets, created and overseen by the S.E.C. and CFTC. It did not answer a key question: If one trade could cause so much turmoil, why hadn't that happened before? It is also worth to take into account that the market´s liquidity seemingly provided by HFT can quickly vanish in periods of tension. A BIS report on HFT (2011) in foreign exchange markets states that: "HFT market-makers have no binding obligation to stay in the market and place quotes in an adverse market environment". This raises questions about the liquidity provided by HFT traders in stressed market conditions, particularly since they are highly sensitive to risk and tend to hold positions on an intra-day basis only.

The 2010 flash crash exemplifies the risk created by a new and accelerating trend: the market's shift towards and reliance on automated computer systems in trading; and

[9] Flash Crash is a very rapid, deep, and volatile movement in security prices occurring within an extremely short time.

accordingly, a new class of risk to the markets – the computer-based trading malfunction. Since then, other computer-based trading malfunctions, or "glitches," have occurred, highlighting at-risk areas in the global trading system. For instance, on Aug. 1, 2012, Knight Capital suffered a technical problem in its algorithmic trading systems, causing more than 140 stocks to be misquoted, eventually costing the firm more than $440 million and forcing it to raise significant capital. In October 2013, a flash crash occurred on the Singapore Exchange, which wiped out $6.9 billion in capitalization and saw some stocks lose up to 87 percent of their value. Others occurred be it in the public bond markets like the "flash rally"[10] in US Treasury bonds in October 2014 or in the gold market that suffered one of the biggest and fastest moves in its recent history in July 2015. The latest was an abrupt tumble of 1000 points in Dow Jones Index in just a few minutes at the opening, on August 24 2015, before rallying later in the day.

Those incidents led to changes to regulatory and procedural safeguards by capital markets regulators, in many countries. These changes are largely designed to mitigate the potential risk of volatility or damage caused to the markets and have not, at least so far, addressed the question of markets 'structure and the very existence of HFT. Regulatory changes generally fall into three categories:

i. Circuit breaker modernization: designed to prevent trades in individual securities from occurring outside of specified price bands (percentage levels above and below a security's average reference price over a preceding five-minute period). It also implements rules that affect the treatment of such things as stop and at market orders; specialist and market maker quoting obligations; declaration of trading halts by exchanges; and obvious or catastrophic errors.
ii. Erroneous trade breaking rules: rules following the flash crash outlining when an erroneous trade would be broken. These erroneous trade rules, which clarified when–and at what price- completed trades will be cancelled by the exchanges. They were designed to foster a sense of certainty to reduce the likelihood of market panic and capital flight when computer glitches occur.
iii. New rules to strengthen minimum quoting standards: rules following the flash crash outlining when an erroneous trade would be broken.

Requiring registration for firms that carry out automated trading is still under consideration in a context in which HFT is now prevalent across different Wall Street institutions. Meanwhile, the European Union (EU) and England (that includes a number of European Union rules) had passed in July 2014a legislation[11] specifically targeting HFT techniques. This regulation applies to trading in shares, bonds, structured finance products, emission allowances and derivatives. It includes i) regulation of hitherto unregulated trading venues (including dark pools, voice brokers and interdealer brokers), ii) defines what venues qualify for regulation, iii) requires venues to be authorised by

[10] On October 15, 2014, US Treasuries yield on the 10 year note fell 34 basis points from 2.2% to as low as 1.86% in a matter of minutes. The volatility in that day has been surpassed only once in the past 50 years.

[11] The legislation was divided into two parts: a Directive, Markets in Financial Instruments Directive II (Directive 2014/65/EU) ('MiFID II'), and a Regulation,Markets in Financial Instruments Regulation (Regulation (EU) No 600/2014) ('MiFIR'). They are both available at http://ec.europa.eu/finance/securities/isd/mifid2/index_en.htm

national regulators and iiii) requires these venues to abide by the same transparency rules as regulated venues.

With regard to the high-frequency trading firms, three important obligations stand out:

i. These firms must have in place effective systems and risk controls' to ensure that their trading systems are resilient and have appropriate thresholds and limits to prevent erroneous orders or any other problems that create or contribute to disorder in the market. The firms must also put in place business continuity arrangements in the event of a failed trading.
ii. Firms must notify domestic regulators and trading venues that they are using HFT practices. They must also store in an approved form accurate and time sequenced records of all its placed orders, including cancellations of orders, executed orders and quotations on trading venues', which regulators can request.
iii. Algorithmic trading firms that pursue a 'market making strategy' whereby firms post two-way quotes on trading venues are required to maintain their market making strategy continuously over a specified proportion of the trading venue's trading day (except under exceptional circumstances) to provide liquidity on a 'regular and predictable basis to the trading venue'. It also requires firms to enter a written agreement with trading venues to state their market making obligations and employ systems and controls to ensure the firm meets these obligations. These regulations are intended to stop events such as the Flash Crash—where liquidity disappeared and prices tanked.

Domestically, this regulation of the HFT practice and its venues seems fairly comprehensive. Yet, it only applies to the operations conducted from their territories. While an international regulation is not adopted, national protections can be useful but cannot shield their financial stability from "offshore" HFTs.

3. Dark Pools

Dark pools are one particular form of Alternative Trading System (ATS). Their existence was very little known by the public until the publication of Michael Lewis' book. Mostly all articles dealing with them still start with the question: what's a dark pool? Dark pools are equity-trading systems that do not publicly display orders. Also known as "dark pools of liquidity," they are so named for their complete lack of transparency not only to external eyes but also to it is participants that place their bid unaware of the book of orders.

Dark pools came about primarily to facilitate trading by big investors, who did not wish to affect the markets with their large orders and consequently obtain adverse prices for their trades. It started in the 1980s when some institutional investors got together to trade in a place where they could avoid the prying eyes of public exchanges or brokers. They wanted to be able to buy or sell large quantities of stocks without affecting the market and thus get better execution prices. Around 2005, these dark pools only made up 3%-5% of market activity.

Then things started changing in 2007, when the SEC passed new regulations known as Reg. NMS (Regulation National Market System) that handed investors the option of skipping exchanges if they could find a better price more quickly elsewhere. Broker-

dealers saw an opportunity in this (and in the rise of HFT), and started setting up their own dark pools. Institutional investors and financial institutions started heading over to them (Lopez, 2012).

Some dark pools passively match buyers and sellers at exchange prices, such as the midpoint of the exchange bid and offer. Other dark pools execute orders by their price and time priority. According to the Securities and Exchange Commission (SEC 2010), as of September 2009, thirty-two dark pools in the United States accounted for 7.9% of total equity trading volume. As of mid-2011, industry estimates from the Tabb Group, a consultancy, and Rosenblatt Securities, a broker, attribute about 12% of U.S. equity trading volume to dark pools. The market shares of dark pools in Europe, Canada, and Asia are smaller but quickly growing (Zhu, 2013). In 2015, Trotman (2015) estimates that nearly 40% of stock trades are now taking place away from traditional exchanges

As of April 2014, there were 45 dark pools in the U.S. These trading venues and their strategies typically seek liquidity among open and closed trading systems. They consist of the following three types:

i. Broker-dealer owned**:** These dark pools are set up by large broker-dealers for their clients, and may include their own proprietary traders. These dark pools derive their own prices from order flow, so there is an element of price discovery. Examples of such dark pools, of which there were 19 as of April 2014, include Credit Suisse's CrossFinder, Goldman Sachs' Sigma X, Citi's Citi Match and Citi Cross, and Morgan Stanley's MS Pool.
ii. Agency broker or exchange-owned: These dark pools act as agents, not as principals. As prices are derived from exchanges – such as the midpoint of the National Best Bid and Offer (NBBO), there is no price discovery. Examples of agency broker dark pools include Instinet, Liquidnet, and ITG Posit, while exchange-owned dark pools include those offered by BATS Trading and NYSE Euronext.

Electronic market makers: These are dark pools offered by independent operators like Getco and Knight, who operate as principals for their own account. Like the broker-dealer owned dark pools, their transaction prices are not calculated from the NBBO, so there is price discovery

For institutional investors, the need for dark pools increased with the expansion of HFTs. High-speed traders armed with cutting-edge technology are able to identify, exploit, and profit from large orders. Institutional investors increasingly seeking refuge from this technological assault were attracted into dark pools by promises of "safe" trading. What many of institutional investors were unaware was that to gain even more of an edge, some of the high-speed traders had negotiated special—and sometimes secret—privileges from dark pools, such as greater or faster access to information or specialized order types. Hence, far from be a refuge from HFTs, dark pools presents the same risks than HFT, compounded by the fact that orders are executed in a totally opaque environment.

During the flurry of attention to Michael Lewis's "Flash Boys," which denounced the intertwining of HFTs and dark pools, New York State Attorney General Eric Schneiderman announced an inquiry into whether U.S. stock exchanges and Wall Street dark pools provide improper advantages to high-frequency traders. His scrutiny was first directed to dark pools linked to major banks, including Credit Suisse, Deutsche Bank, UBS, Barclays, Goldman Sachs and Morgan Stanley. Civil charges were filed against them. The first one, in June 2014, was a lawsuit of the state of New

York against Barclays, alleging the bank defrauded and deceived investors over its dark pool. In the following weeks, the SEC and the Department of Justice also pledged to investigate.

A central allegation of the suit was that Barclays had misrepresented the level of aggressive HFT activity in its dark pool to other clients. According to Schneiderman, Barclays had "demonstrated a disturbing disregard for its investors in a systematic pattern of fraud and deceit," and "duped investors by telling them its dark pool was a safe place to put their money, when in fact they were exposed to high-frequency trading predators". In January 2015, he announced that his investigation had "uncovered significant and additional wrongdoing". In September 2015, came the news that accord was expected between the state of New York and Credit Suisse Group. The swiss bank would pay more than $80 million to settle state and federal authorities' allegations that it did not fully disclose to its clients how it operated its dark pool, according to a person familiar with the matter. Credit Suisse's Crossfinder platform is the largest alternative trading system in the U.S (Geiger and Mamudi, 2015).

A report published, in September 2015, by Healthy Markets (2015), a non-profit coalition of asset managers[12] working to promote data-driven reforms to market structure, stresses that U.S. regulators need to accelerate their efforts to strengthen the rules governing dark pool trading platforms to better protect investors from poor trade execution and conflicts of interest. It also says that some of the enforcement actions the SEC has undertaken in recent years with dark pools (mainly financial settlements) failed to take into account the true harm these platforms inflicted on investors. It ends by saying that "to date, regulators have not proposed any substantive reforms".

5. Final remarks

The post-crisis financial innovations (HFT and dark pools) creates new risks to financial stability. Exactly because the post-crisis reforms have followed what we could call an edging regulatory approach, they have not reached the core of the finance-led capitalism. In other words, until now, it can be argued that, the 2008-2009 global financial and economic crisis was not the structural crisis of this accumulation regime that succeeded the Fordism in the 1980s[13].

It is worth to bring to light some of the biggest threats to financial stability posed by HFT and dark pools. Despite all the initiatives to develop and implement protective mechanisms, mentioned in sections 2 and 3, not much has changed. These mechanisms may increase the market's awareness and ability to react to glitch-based crashes. However, at best, they will limit the effect of a flash crash — not prevent it. Hence, much remained to be done to limit their risks, among which stand out:

i. HFT algorithms are correlated: HFT traders, using correlated trading strategies, would participate in a large fraction of the trades and impact the market price. In this context, shocks hitting key traders might affect the entire market. Chaboud et al (2009) find greater serial autocorrelation in order types for HFT than humans.

[12] Healthy Markets Association is a non-profit advocacy group that was founded by two equities market experts at consultancy firm KOR Group and headed by Tyler Gellasch, a former counselor to SEC Democratic Commissioner Kara Stein and Michigan Senator Carl Levin.

[13] On the Fordism and the finance-led growth regime, see Boyer (2000).

ii. Liquidity mirage: i) in normal market conditions, HFT creates a more complex and dynamic nature of market liquidity. This mirage was pointed out by Dobrev and Schaumburg (2015) in a research to the Federal Reserve Bank of New York. "Under the new market structure, it has arguably become more challenging for large investors to accurately assess available liquidity based on displayed market depth across venues. The striking cross-market patterns in trading and order book changes suggest that quote modifications/cancellations by high-frequency market makers rather than preemptive aggressive trading are an important contributing factor to the liquidity mirage phenomenon". ii) in stressed markets, many HFTs close their operations as their algorithms are set to small variations of prices and to avoid large ones. Liquidity can "quickly vanish following a market shock as HFTs pull their orders until the market stabilizes. This reaction can exacerbate price movements, since market participants leave stop-loss orders that automatically trigger selling once certain price points are hit. Consequently, there is a risk that these resting sell orders will reinforce each other in a cascade of selling" (Bank of Canada, 2011). Andrew Haldane (2011), Executive Director for Financial Stability at the Bank of England concurs: "far from solving the liquidity problem in situations of stress, HFT firms appear to have added to it. And far from mitigating market stress, HFT appears to have amplified it. HFT liquidity, evident in sharply lower peacetime bid-ask spreads, may be illusory. In wartime, it disappears. This disappearing act, and the resulting liquidity void, is widely believed to have amplified the price discontinuities evident during the Flash Crash. HFT liquidity proved fickle under stress, as flood turned to drought".

iii. Contagion: HFTs are programmed to link numerous market segments together into trading strategies. So, when they cannot buy or sell assets in one segment of the market, they will rush into another, hunting for liquidity. Since their algorithms are often similar (or created by computer scientists with the same analytical background), this pattern tends to create a "herding" effect. If a circuit breaks in one market segment, it can ripple across the system faster than the human mind can process. Describing this mechanism, Tett (2015) concludes: "this is a world prone to computer stampedes".

iv. Market manipulation: in addition to the impact of flash crash events, there is also concern over the ability of HFT to facilitate market abuse. Some of the tactics used by HF traders are designed to mask deals and prevent other market participants from discovering and exploiting their trading intentions. This is also the motivation for the establishment of dark pools. To the extent that a relatively small number of these traders account for a significant fraction of turnover in a market, they may also engage in forms of market manipulation. Three such forms are "stuffing", "smoking" and "spoofing". "Stuffing" involves HF traders submitting an immense number of orders to the market. This generates congestion. In these conditions, access to the market for slow traders is impaired. They do not have a clear view of the status of trading and it is difficult for them to execute trades. Meanwhile, fast traders who better understand what is

going on and have superior access to the market engine, are able to execute profitable trades at the slow traders' expense. When engaging in "smoking", HF traders first post alluring limit orders to attract slow traders. Then they rapidly revise these orders onto less generous terms, hoping to execute profitably against the incoming flow of slow traders' market orders. Yet another strategy has been nicknamed "spoofing." Suppose the HF trader's true intention is to buy. Paradoxically, he or she will initially place limit orders to sell in the order book. These orders are not meant to be executed. Therefore, they are placed above the best ask. Since the HF trader is faster than the other market participants, he is to assured that will have time to cancel the sell orders before they are executed if good news reach the market. With this assurance in mind, the HF trader places a sequence of limit sell orders above the best ask, potentially for very large amounts. The hope is to scare the market and induce some naïve participant to sell to this discreet order. In April 2015, a young British day trader was accused by U.S. prosecutors of contributing to the 2010 flash crash by "spoofing" and is awaiting an extradition hearing to stand trial in an American court.

v. Adverse selection: Michael Lewis's book about HFT showed that modern markets ceased to be level playing fields. Slow human traders are exposed to adverse selection when dealing with high frequency ones. HFT might deter slow human traders from entering the market to provide liquidity to HFTs when the latter would be subject to a shock. Market Media (2014) quotes Peter Berdeklis, portfolio manager and head of algorithmic trading at Maple Financial "the real business of HFT is the industrialization of adverse selection. HFT is in the business of getting to the front of the queue and getting a free option out of having their order ahead of everyone else's."

vi. Regulated and unregulated markets: Different markets operate with varying levels of regulatory oversight. While the equity market imposes formal regulations and closely monitors it´s enforcement, self-regulated markets such as foreign exchange markets often have their own codes of conduct. Agents must comply with these codes throughout the trading process. However, those codes differ from market to market and their main aim is not necessarily to ensure financial stability.

Beyond the many risks these recent innovations present, it is equally necessary to discuss their role in the shaping of the finance-led system. The combined effects of competition between financial institutions and the decreasing number of slow investors point to a new financial landscape. The 2015 McKinsey´s report states that: "banks will realize that they fall into one of two groups: banks that should go all in on digital and fully implement changes across the value chain; and banks that should take a targeted approach and digitize only where it is likely to prove fruitful." It projects that "banks with significant exposure to products that have moved or are likely to move toward electronic trading have little choice but to invest significantly in digital capabilities. In contrast, banks with franchises weighted toward asset classes less likely to electronify (loans, high-yield bonds, emerging markets, securitized products) can pick and choose where to digitize. In many cases, it will be in their interest to preserve the relatively higher margins

in certain areas." In other words, only banks for whom complex financial instruments are important will keep at least part of their dealings in a non-electronic way. The same analysis can be extended to the other financial agents.

Furthermore, the recent financial innovations result from the interactions of searching for profit institutions beyond the reach of regulation and supervision, such as exchanges and proprietary firms not even required to register. It seems unlikely that new regulations will emerge to reign in their activities for two reasons: firstly, from the view point of regulatory authorities, these non-banking institutions do not pose systemic risks; second, due to the very features of HFT and dark pools linked to high cost technological innovations, makes them much harder to regulate. Thus, it also seems that a new trend of finance-led system is being put in place in which markets are no longer level playing fields and the rules of governance are being replaced by the jungle´s law of the survival of the strongest and the fittest.

Regardless to the inherent risks of HFT´s, the overwhelming reliance of the financial system on electronics is raising widespread alarms on emerging risks to financial stability. Cyber risks are frequently depicted as cyber threats, reducing its scope to the action of hackers and raising the need to improve cyber security. Commenting on a survey conducted by the International Organization of Securities Commissions (IOSCO), Worner (2015) points out that "cyber-security threats in financial markets are now considered a prominent risk by respondents. Previous work by IOSCO has highlighted the point that a successful cyber-security event could have systemic consequences". Yet, as stressed above, cyber risks can be much broader than that and need also to be taken into account to avoid systemic events.

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