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PAULO SÉRGIO COELHO VIEIRA

INDUSTRY ANALYSIS OF THE HIGH FREQUENCY TRADING INDUSTRY.

An assessment of the industry boundaries, environment and strategic options.

SÃO PAULO - SP

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Dissertação apresentada à Escola de Administração de Empresas de São Paulo, da Fundação Getúlio Vargas, como requisito para obtenção do título de Mestre em Administração de Empresas.

Linha de Pesquisa: Estratégia

Orientador: Prof. Dr. Sérvio Túlio Prado Júnior

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Para minha esposa Simone, e nossa filha Isabelle, pelo amor e apoio.

To my wife Simone, and our daughter Isabelle, for their love and support.

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INDUSTRY ANALYSIS OF THE HIGH FREQUENCY TRADING INDUSTRY.

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ABSTRACT

U. S. Equity Trading Industry has evolved quickly over the last decade. The U.S. equity market became an open architecture in which entrants with innovative technology can compete effectively. Several regulatory changes and technological innovations have enabled profound changes in market structure. These changes, along with improving high-speed technology, have acted as a catalyst, giving rise to a new approach to trading, named High Frequency Trading, hereafter referred as HFT. HFT Firms emerged and took over in large extent the market making business in providing liquidity. Although HFT has been growing massively, over the past four years, HFT firms have been far less profitable, since more firms entered the industry eroding the margins. Within this context, therefore, this thesis sought to provide a brief review of HFT business, followed by the analysis of its industry boundaries and the characteristics of the HFT environment. To this end, the thesis conducted an extensive literature review of previous research, qualitative public documents, such as, newspapers, meeting minutes and official reports. The thesis employed a series of frameworks, Entry Barriers and Mobility Barriers (Porter, 1980); Models of Industry Evolution (McGahan, 2004); Information-Intensive Industry Structure (Sampler, 1998), to analyze the boundaries of the HFT industry. Additionally, it employed Models of Industry Evolution (McGahan, 2004) and PESTEL (JOHNSON, SCHOLES, and WHITTINGTON, 2011) frameworks to analyze the industry and the environment surrounding HFT business. The analysis concluded that the firms employing HFT to compete in the Securities Trading industry compose an independent industry.

Keywords

High Frequency Trading, US Equity Trading, Industry Dynamics, Industry Boundaries.

INDUSTRY ANALYSIS OF THE HIGH FREQUENCY TRADING INDUSTRY.

An assessment of the industry boundaries, environment and strategic options.

RESUMO

O Mercado Acionário Americano evoluiu rapidamente na última década. Este tornou-se uma arquitetura aberta em que participantes com tecnologia inovadora podem competir de forma eficaz. Várias mudanças regulatórias e inovações tecnológicas permitiram mudanças profundas na estrutura do mercado. Essas mudanças, junto com o desenvolvimento tecnológico de redes de alta velocidade, agiu como um catalisador, dando origem a uma nova forma de negociação, denominada Negociação em Alta Frequência (HFT). As empresas de HFT surgiram e se apropriaram em larga escala do negócio de formação de mercado, no fornecimento de liquidez. Embora HFT tem crescido massivamente, ao longo dos últimos quatro anos, HFT perdeu rentabilidade significativamente, uma vez que mais empresas aderiram ao setor reduzindo as margens. Portanto, diante deste contexto, esta tese buscou apresentar uma breve revisão sobre a atividade de HFT, seguida de uma análise dos limites deste setor, bem como, das características do macroambiente do HFT. Para tanto, a tese realizou uma extensa revisão do histórico literário, documentos públicos qualitativos, tais como, jornais, atas de reunião e relatórios oficiais. A tese empregou um ferramental de análise, Barreiras de Entrada e Mobilidade (Porter, 1980); Modelos de Evolução Setorial (McGahan, 2004); Estrutura do Setor de Informação Intensiva (Sampler, 1998), para analisar os limites do setor de HFT. Adicionalmente, empregou as ferramentas de análise, Modelos de Evolução Setorial (McGahan, 2004) e PESTEL (JOHNSON, SCHOLES, and WHITTINGTON, 2011), para analisar o setor e o contexto que envolve o negócio de HFT. A análise concluiu que as empresas que empregam HFT para atuar e competir no mercado acionário, compoem um setor independente.

Palavras-chave

Negociação de Alta Frequência, Mercado Acionário Americano, Evolução Setorial, Limites Setoriais.

LIST OF FIGURES

LIST OF TABLES

TABLE OF CONTENTS

1 INTRODUCTION

1.1 Context

Equity Trading Industry has undergone a transformation over the last decade. The U.S. equity market became an open architecture market in which entrants with innovative technology can compete effectively. The driving forces for such changes were regulation and technology (HALDANE, 2011).

Several seminal regulatory changes, with the intent to attract new entrants and boost competition, as well as, technological innovations have enabled profound change in market structure. Proliferation of faster and less expensive hardware has leveled the playing field, enhancing competition and increasing liquidity. The U.S. Equity market structures have fragmented.

In the U.S. Equity Market, Order flow in exchange-listed equities split across many trading venues, approximately 11 public Stock Exchanges, over 40 Alternative Trading Systems, and more than 250 broker-dealers. Such fragmentation, along with improving high-speed technology, have acted as a catalyst, giving rise to a new approach to trading, named High Frequency Trading, hereafter referred as HFT (Securities and Exchange Commission, 2014).

HFT Firms emerged and evolved, and their trading strategies took over in large extent the market making business in providing liquidity to the market place.

The term HFT is relatively new and is not yet clearly defined. It typically refers to trading activity that employs extremely fast-automated programs for generating, routing, canceling, and executing orders in electronic markets. High frequency traders submit and cancel a massive number of orders and execute a large number of trades; trade in and out of positions very quickly, with a typical holding period in terms of seconds or milliseconds; and finish each trading day without a significant open position (Securities and Exchange Commission, 2014).

Over the past years, since its inception back to midst 90's, HFT has expanded rapidly, in a manner that by 2010, HFT firms were believed to account for more than 60% of all trading volume in US equities, 40% of volumes in US futures and 20% of volumes in US options. In Europe, HFTs account for around 30-40% of volumes in equities and futures. In Asia, HFT is

believed to account for between 5 and 10% of Asian equity volumes. Moreover, in China, HFT is still incipient (HALDANE, A. G. 2010).

Although HFT has grown massively, in profit and amount of transactions, this is still unclear what the exact extent of its impact on the market is. There are many controversies surrounding the theme, such as, Does it improve liquidity? Does it reduce Volatility? Does it enhance price discovery? Do its trading strategies work? Does it provide any valuable service to the markets?

All of uncertainties made HFT subject of considerable public and regulatory attention.

Many studies, related to HFT, focus on its impacts on the quality of the market, pricing, the potential influence on regulatory, and investor confidence. However, there is none aiming to identify the boundaries of its industry, or the potential strategic actions perceived as critical to achieve success within the HFT business, taking into account the inevitable forthcoming changes in this highly dynamic industry.

1.2 Purpose of the Dissertation

The main contribution of this research is to provide a brief review of the HFT business, followed by the analysis of its industry boundaries and the potential strategic actions to achieve success in the high frequency trading industry.

Additionally, the study aims to set forth the strategic actions to contribute to firms, in the High Frequency Trading industry, to become ready to manage the consequences of changes in their industry trajectory.

This examination becomes relevant because firms need to understand the course of transformation in their industry, by looking into not only their own inherent industry, but also determining if new technologies or new ways of doing business, coming from other industries, are displacing, or changing their own industry trajectory.

Moreover, this study aims to provide a contribution to managers and practitioners in the field of industrial organizational economics and industry dynamics, decision makers, and regulators within the High Frequency Trading industry, so they can leverage thoughtful decisions using the Dissertation’s recommendations.

1.3 Main research questions of the Dissertation

The research questions posed are “What are the boundaries of the HFT industry?” and “What are the main characteristics of the HFT industry?”

1.4 Delimitations

The central objective of this analysis is to understand the changes happening in the High frequency trading industry. To support a better understanding of the changes, this thesis conducted an analysis on the emerging High Frequency Trading business only, which is the main subject of this research. The scope of the analysis will not discuss the Investment strategies, or structure, or the economic fundamentals of the Financial Markets.

1.5 Method

The thesis takes an overall theoretical point of departure supported by an empirical application. More specifically, the thesis employs a theoretical analysis to develop the managerial model used on the assessment of the specified industry, thereby answering the research question of the thesis.

Moreover, the thesis uses empirical research to uphold the theoretical reasoning, creating an interwoven application of theoretical and empirical research.

To this end, the thesis conducted an extensive literature review of previous research, qualitative public documents, such as, newspapers, meeting minutes and official reports. The thesis employed a series of frameworks, Entry Barriers and Mobility Barriers (Porter, 1980); Models of Industry Evolution (McGahan, 2004); Information-Intensive Industry Structure (Sampler, 1998), to analyze the boundaries of the HFT industry. Additionally, it employed Models of Industry Evolution (McGahan, 2004) and PESTEL (JOHNSON, SCHOLES, and WHITTINGTON, 2011) frameworks to analyze the industry and the environment surrounding HFT business.

1.5.1 Data collection

The dissertation evolved on the balance of three categories of empirical data and information.

Firstly, this study gathered information on the history, investment strategies and Securities market regulation changes, that pertain to HFT business, and that pertain to the sample HFT firms, by studying the companies' webpages, regulator´s press releases, and academic researches.

The fundamental mechanism underlying Equity Trading, including mechanism underlying the modern electronic exchange such as the NYSE, have been also studied.

Furthermore, a large number of in-depth research reports on the emerging High-frequency trading industry from a wide range of different consulting and investment firms, including Goldman Sachs, Boston Consulting, Capgemini Strategic Analysis Group, have been reviewed.

1.6 Structure of the Dissertation

The remainder of the thesis is organized as follows. Section 2 presents the Theoretical Foundation employed for the analysis of the HFT industry, including the fundamental mechanism underlying stock market structure, industry dynamics theory, and the related literature review.

Section 3 presents the research design and methodology, where the study approach and methods of data collection and analysis are described.

Section 4 starts by presenting the sample players and the playing fields, as well as, their evolution and characteristics. It also demonstrates the application of the developed managerial model, and presents its results.

Section 5 concludes with a discussion of the implications and limitations of the analysis. It also presents a set of recommendation for future research.

2 THEORETICAL FOUNDATION

2.1 Introduction

Modern electronic exchanges function in a manner that provide the Market Participants with equal access to Liquidity. Bid-offer spreads are narrow in comparison to the price of the traded underlying instrument, volumes are high, high-frequency traders compete to make markets, and information regarding price discovery is disseminated at nearly the speed of light (Brogaard et al. (2013) and Hasbrouck and Saar (2013)).

With the evolution of Equity Trading to such a competitive scenario, High Frequency Trading firms emerged providing liquidity to market participants, and consequently supplemented and displaced the Traditional Liquidity Suppliers.

This section presents the Theoretical Foundation employed for analyzing the boundaries of the industry, where HFT firms are in, as well as, for setting forth the strategic actions to contribute to HFT firms to become ready to manage the consequences of changes in their industry.

This is split in three parts as follows:

First, the section presents the analytical frameworks to analyze the HFT industry boundaries. Second, it presents the analytical frameworks to analyze the HFT environment and the strategic options. Third, it describes the fundamental mechanism underlying the majority of modern electronic exchanges throughout the world, including those of the U.S. equities markets, which is the primarily focus of this study. Finally, this study presents a review of the literature around High Frequency Trading.

2.2 Industry Boundaries Definition

The definition of Industry Boundaries has been one of the most fundamental questions for industry structure and Industrial Organization (IO) economics, and this is because this influence on industry concentration, the role of substitutes, and many other factors (SAMPLER, 1998).

For IO economics and much of the traditional strategy literature, the key unit of analysis was the industry, and SIC codes were the dominant way of measuring this (Schmalensee, 1985; Wernerfelt and Montgomery, 1988; Scherer and Ross, 1990; Rumelt, 1991; Powell, 1996; McGahan and Porter, 1997).

Furthermore, most of the studies mentioned above, have focused on examining manufacturing-based industries, with the exception of McGahan and Porter (1997), which extended the analysis to service-based industries. Jeffrey L. Sampler (1998), from the perspective of

resource-based strategies, made propositions to define the boundaries of information-intensive industries.

Given that the emergence of HFT firms has been propelled by a series of environmental events, as well as, technological innovations, this study relies on a variety of frameworks to analyze the HFT firms industry and its boundaries.

The frameworks are, Entry Barriers and Mobility Barriers (Porter, 1980); Buyer, Supplier, Competitive intent, and Technical platforms commonalities (McGahan, 2004); Information-Intensive Industry Structure (Sampler, 1998). They are briefly described below.

2.2.1 Entry Barriers and Mobility Barriers

According to Porter (1980), the proper definition of a company's industry, or industries, has become an endlessly debated subject. An important motive in this debate is the fear of overlooking latent sources of competition that may someday threaten the industry.

Any definition of an industry is essentially a choice of where to draw the line between established competitors and substitute products, between existing firms and potential entrants, and between existing firms and suppliers and buyers.

The conventional approach takes firms, within an industry, as identical in all economically important respects except for their size. Then cost conditions either define an optimal scale for the firm, leaving no explanation why size should change, or render scale indeterminate, providing no clue as to what could deter infinitesimal changes in a firm's scale. Additionally, the conventional view implies that barriers to entry into the industry protect all incumbent firms as a group, a logical consequence of assuming that they are homogeneous.

2.2.2 Buyer, Supplier, Competitive intent, and Technical platforms commonalities

The other very important reason for determining the boundaries of the HFT business falls under the light of the antitrust laws, which primarily objective is to mitigate and punish unfair competition. The extent of the HFT industry has been widely discussed over the previous two years, since there were many companies and News articles accusing HFT firms of unfair behavior, as well as, unfair advantage over the institutional investors.

To define the boundaries, the proposition is to examine if the adjacent industries with which HFT firms compete, shares common buyers and suppliers, common competitive intent, and common technical platforms.

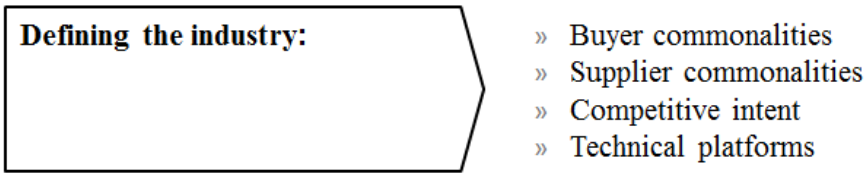

Figure 1 – Defining the industry

Source: adapted from (MCGAHAN, 2004)

2.2.3 Information-Intensive industry structure

Jeffrey L. Sampler, in his study Redefining Industry Structure for the Information Age (1998), presents a framework that makes propositions for characterizing the nature of industry structure in information-intensive industries. In doing so, he develops strategic characteristics of information, such as information "separability" and information "specificity".

The main concept supporting Sampler´s proposition is the fact that with the advancements in information technology, and the increasing ability to capture, manipulate, store and transfer information, the information itself can now be viewed as a source of value creation, not as a cost.

Additionally, Sampler draws upon the Transaction Economics (TCE) (Coase, 1937) in order to characterize the information in terms of its alternate use, meaning, it defines the extent to which the value of an asset is restricted to specific transactions. In this case, transaction regards to the separation and capture of the information assets from their originating events.

Building on the terminology of TCE, information specificity is the extent to which the value of information is restricted to its use and/or acquisition by specific individuals or during specific periods of time (Choudhury and Sampler, 1997), and furthermore it can be divided in two types:

Knowledge Specificity - is defined as the extent to which the acquisition and/or use of information is limited to certain individuals.

Specificity in Use – information that can only be used by individuals with the necessary specific knowledge. In the other hand, the acquisition of the information may not necessarily require the same specific knowledge.

Knowledge Specificity in Acquisition – only a person with the necessary specific knowledge can acquire it. Meaning, the value of the information may not be perceived without specific knowledge.

Time Specificity - is defined as the extent to which the time span for the acquisition and/or use of information is limited.

	Time specificity	Knowledge specificity
Specificity in acquisition	Information that must be acquired immediately, or very shortly after, it first originates or becomes available.	Information that can be acquired only by someone with the requireds pecific knowledge.
Specificity in use	Information that decreases in value unless used immediately, or very shortly after, it becomes available.	Information that can be effectively used only by someone with the required specific knowledge.

Table 1 – The specificity of information

Source: (SAMPLER, 1998)

Consistent with the evolving resource school of strategy, and extending the idea that entry barriers are resource barriers (Collis and Montgomery, 1995), the above example suggests that the location of critical information defines the relevant competitors. More formally stated, this leads to the following proposition:

Proposition 1: Firms possessing sufficient amounts of critical information for the same market (e.g., customers) define the industry boundary.

In light of the technological advancements, and following the notion of information separability described above, Sampler developed a series of propositions to explore the evolving nature of industry structure for information-intensive industries. In particular, propositions exploring fundamental aspects of industry structure (Scherer and Ross, 1990), such as industry boundaries, concentration of firms, extent of diversification, and the rate of innovation. They are presented as follows:

Industry Concentration

Proposition 2a: For industries, whose critical information is both low in knowledge specificity in acquisition and use, comparative advantages in the breadth of critical information possessed by firm(s) will influence the level of competition and profitability.

Proposition 2b: For industries, whose critical information is high in knowledge specificity in use, comparative advantages in the volume (breadth x depth) or critical information possessed by firm(s) will influence the level of competition and profitability.

Diversification

Proposition 3: For certain types of industries, information is an appropriate resource for defining related diversification.

Innovation

Proposition 4: Rate of critical information movement directly affects the rate of innovation within the industry.

2.3 HFT Environment Analysis

2.3.1 Models of Industry Evolution (MIE)

In her book How Industries Evolve (2004), Anita McGahan develops a broad theoretical foundation on how to determine the current evolution of an industry. The focus of her book on industries is managing change in the trajectories of industry evolution. Michael Porter was renowned for looking at the environment in order to asses competitors positions (Porter 1985), McGahan follows in his footsteps and argues that firms should understand and adapt to its industry basic trajectory of evolution before it can make smart investments. She develops her model based on empirical data from comprehensive industry data and defines four broad trajectories of evolution, into which industries fall.

The process for analyzing the evolution can be broken out in four steps, Step 1 – Defining the Industry Boundaries, Step 2 – Determining whether Change is Architectural, Step 3 – Determining whether Change is Foundational, and Step 4 – Assessing the Stage of Industry Evolution. The figure 2 below illustrates this process.

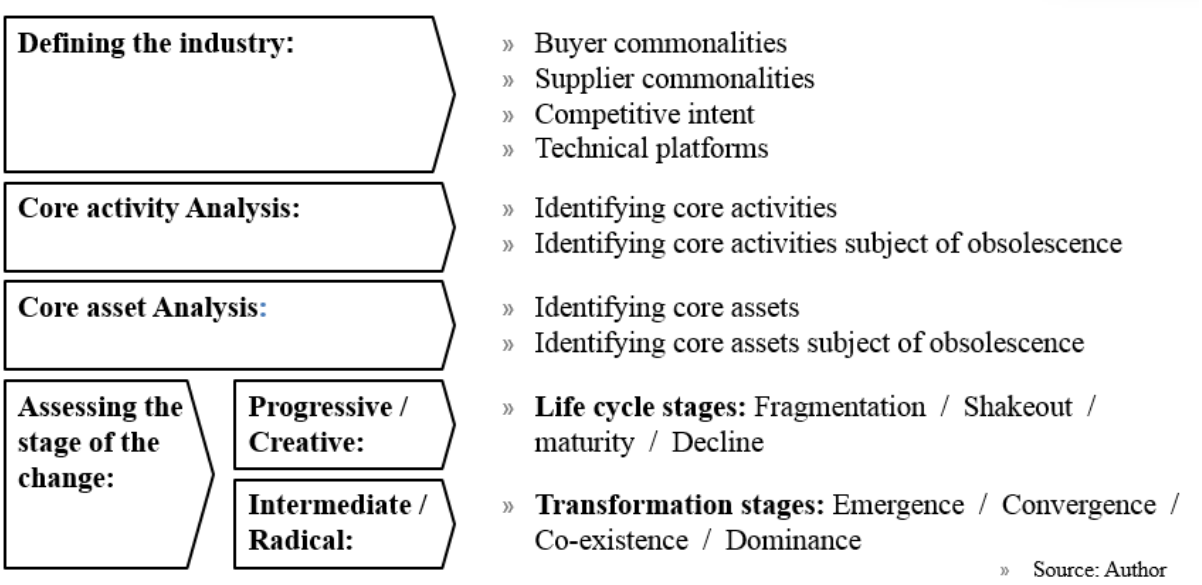

Figure 2 – Models of Industry Dynamics (MIE)

Source: Author - adapted from (MCGAHAN, 2004)

The thesis presents the MIE analysis based upon the path of industry evolution, with the intent that managers in the field of business strategy can apply this model and use it as a framework for conducting corporate strategy in their industry.

For firms to make strategic choices based on the trajectories of their industry evolution, the application of the theory in a model, which can help a firm determine their industry evolution and how they should take up their strategic position in accordance with their industry's evolutionary trajectory.

Determining whether change is Architectural

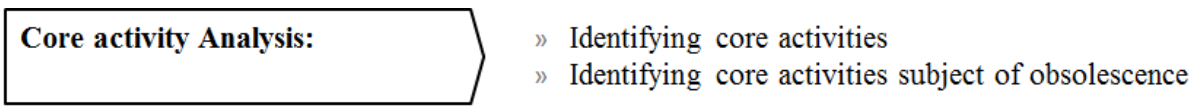

Figure 3 – Core activity analysis

Source: adapted from (MCGAHAN, 2004)

At this point, the objective is to assess the core Activities, meaning, those activities essential to the HFT industry's value creation and consequently its profitability. In addition, once the activities are identified, examine the potential threats of obsolescence to these core activities.

For example, in the HFT industry, the capability to execute electronic stock orders with very low latency has been demonstrated to be crucial for the industry's value creation and its profitability, in such a manner that competitors within the HFT industry have been making massive investments on technology to support this core activity. This subject will be further discussed in the third section of this paper.

Determining whether change is Foundational

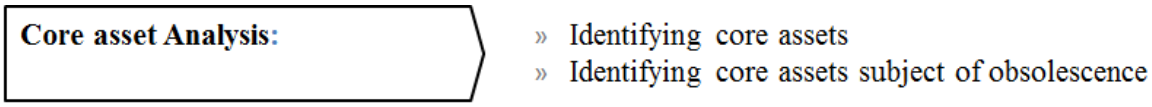

Figure 4 – Core asset analysis

Source: adapted from (MCGAHAN, 2004)

The objective, at this point, is to assess the core Assets, meaning, those assets essential to the HFT industry's value creation and again its profitability. Moreover, once the assets are identified, examine the potential threats of obsolescence to these core assets. An example of core asset, the massive investment that HFT firms make in information technology. Although the investment in technology is a good example of core asset, this is not necessarily under threat of obsolescence, since there is no new approach currently compromising its rate of depreciation.

In the other hand, a "Collocation service" contract that grants an HFT firm with the rights to collocate its own equipment inside the stock exchange site, and consequently have direct access to the market (DMA) with very low latency, could be considered an asset under threat of obsolescence, shall the contract be subject of not being renewed. This subject will also be further discussed in the fourth section of this paper.

Assessing the Stage of the Industry Evolution

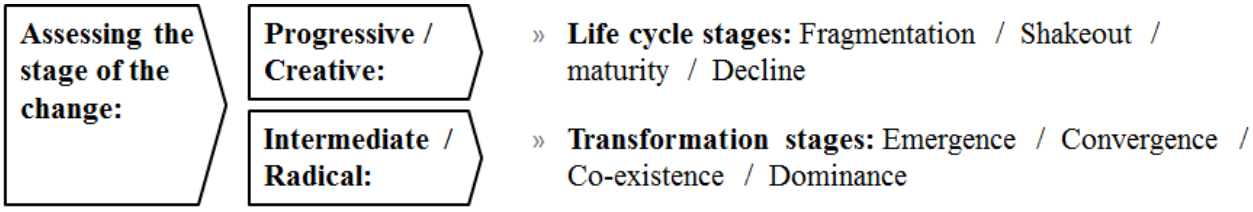

Figure 5 – Assessing the stage of evolution

Source: adapted from (MCGAHAN, 2004)

In this final step of the industry assessment, the objective is to look into how the volumes within the industry are performing, in order to be able to identify the trend of the industry among the Fragmentation, Shakeout, Maturity, and Decline points; or among the Emergence, Convergence, Co-existence, and Dominance points.

Finally, once the path and stage of evolution are identified and understood, the final steps of the research will be defining the prerequisites and strategic choices for conforming to the pattern of change in the HFT industry. Consequently be able to improve a firm capability to generate strategic options ahead of the competition, be prepared for the forthcoming changes, and capitalize on the opportunities emerged by the implications of such changes.

2.3.2 PESTEL Framework

In order to support the analysis towards responding to the main research question, the PESTEL framework of political, economic, social, technological, environmental and legal was employed to analyze the environment surrounding the HFT business, and its impact on HFT firm's strategic options.

The PESTEL framework is a "mnemonic used in strategic management to group macro-environment factors to help strategists look for sources of general opportunity and risks" (Witcher & Chau 2010, p.91). This is divided into six major factors: political, economic, social, technical, environmental and legal factors (John Tennent & Graham Friend, 2011).

The PESTEL framework analyzes the external business environment to understand the ‘big picture’ in which the organization operates thus enabling them to take advantage of the opportunities and minimize the threats faced by the organization’s business activities.

2.4 Market Structure

2.4.1 LOB - The open limit order book.

The most common method of trading in financial markets is via a Limit Order Book, hereafter referred as LOB. While LOB-based markets may differ on some subtle points, they share common properties. This section contains a brief overview of LOBs and does not intend to be a complete description of the rules governing trading on every Exchange, or other LOB-based markets.

A LOB is a collection of orders, which any trader can submit, to express a willingness to buy or sell. Orders sent to the LOB for a particular security are processed serially, in the order that they are received. In general, there are two types of messages: limit orders, and cancellations.

Incoming limit orders are processed as follows. First, it is checked whether the incoming order makes possible trade with any orders residing in the LOB. If so, then the order leads to an execution at the price of the order in the LOB. If orders residing in the LOB must be rationed, they are done so first according to price and then according to time. If there is no match to that given order, then the order is added to the LOB. The LOB is thus a collection of active limit orders that are sorted according to price-time priority.

2.4.2 Liquidity as a Service

Trades result only when willing Buyers and Sellers can meet and negotiate terms. Traditionally, traders came to exchanges where they, or their brokers, could locate one another and arrange their trades. Finding a buyer or seller in an infrequently traded stock can be quite difficult.

For the purpose of this study, Stock Liquidity means how easily and timely a share of stock can be converted to cash. Moreover, the market for a stock is said to be liquid if the shares can be rapidly sold, and the act of selling has little impact on the stock's price.

Liquidity can also be interpreted as a service offered by market professionals to execute the buy and sell orders of investors, consequently providing Liquidity and making the market. As long as the same market participant simultaneously submits buy and sell orders, with a spread between them, this market participant behaves as a Market Maker.

A Market Maker is a participant at the stock exchange, which assumes the position to maintain a market in the trading of a given stock. The main subject of this study is the analysis of the HFT firms as Automated Market Making participants in the NYSE.

2.4.3 Market Making

The term market making refers to the strategy of quoting a simultaneous buy and sell limit order (quote) for a financial instrument in order to profit from the bid-ask spread. This can be either imposed by mandatory requirements set by market operators/regulators for entities covering that role for instance the Designated Market Maker at the NYSE, or voluntarily, meaning, without a determined obligation to quote. Several different terms are used to denote this kind of designated liquidity provision, for example market making with obligations, designated market making and registered market maker.

Market makers frequently employ “quote machines”, which provide the respective electronic markets with their quotes. Quote machines are programs, which generate, update and delete quotes according to a pre-set strategy. Due to the varying degree of sophistication among these programs, some of them employ HFT techniques, while others rely on the involvement of a human market maker (GOMBER, 2011). Since market making is a well-known HFT strategy (Tradeworx 2010a), the figure 6 below highlights the relationship between HFT and market making.

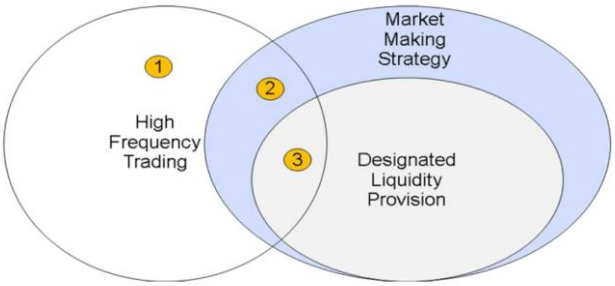

Figure 6 – Relationship between HFT and Market Making

Source: GOMBER, 2008

Figure 6 above shows the interferences denoted by numbers from one to three that span the activities of HFT in market-making:

(1) represents all other HFT strategies apart from market making,

(2) represents HFT that applies market making strategies without acting as a designated liquidity provider and

(3) represents HFT that applies market making and is registered as a designated liquidity provider, e.g. GETCO and VIRTU are Designated Market Maker at NYSE (Bunge and Peterson 2010).

2.4.4 The Automated Market Makers

One of the most common HFT strategies is to act as a liquidity provider / Automated Market Maker. While many HFTs provide the market with liquidity like registered market makers, they frequently do not face formal obligations to quote in the markets in which they are active.

HFT liquidity providers have two basic sources of revenues. First, they provide markets with liquidity and earn the spread between bid and ask limits. Second, trading venues incentivize these liquidity provides by granting rebates or reduced transaction fees in order to increase market quality and attractiveness

2.4.5 Smart Order Routing - SOR

In fragmented markets, real-time investigation of different accessible order execution venues and of available order limits and quotes can improve execution results in agent and proprietary trading. Smart order routing (SOR) systems enable to access multiple liquidity pools to identify the best order routing destination and to optimize order execution (Ende 2010). They scan pre-defined markets in real-time to determine the best bid and offer limits or quotes for a specific order, thereby achieving the best price or other pre-defined execution benchmarks. Figure 7 illustrates this process and shows how a given order can be distributed among multiple venues.

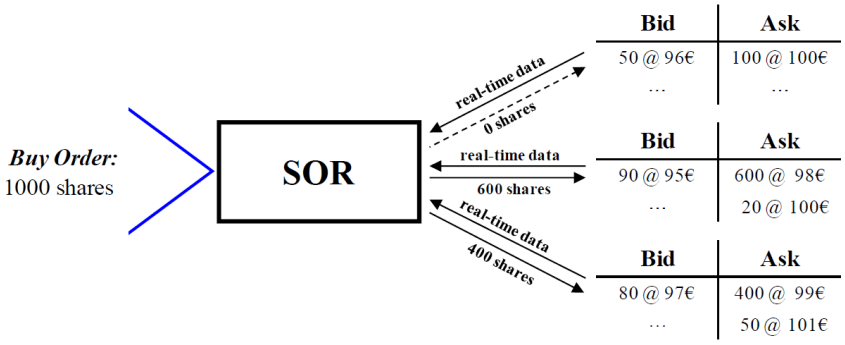

Figure 7 – Smart Order Routing – basic principle

Source: (GOMBER, 2008)

The smart order router selects the appropriate execution venue on a dynamic basis, i.e. real time market data feeds are used by a rule framework. Such provisions support a dynamic allocation of the order to the execution venue offering the best conditions at the time of order entry including or excluding explicit transaction costs and/or other factors (e.g. the current technical latency of the venue). In order to achieve the best result in order execution on a real-time basis, i.e. price and explicit execution costs, two steps are required: first, at order arrival a routing system of an investment firm has to screen the respective execution venues for their order book situations, i.e. the execution price dimension. Second, the system has to incorporate a model that enables to calculate the total execution price of trades in different markets including applicable trading, clearing and settlement fees or even taxes, i.e. the explicit costs dimension (Domowitz 2002).

2.5 Review of the Literature

HFT concept started showing up in the academic literature around 1993, due to researches around the subjects of Time series (HASBROUCK, J; SOFIANOS, G, 1993), Limit Orders (BIAIS, B; HILLION, P; SPATT, C. 1995), and specially studies related to the regulation change, named Decimalization, (HARRIS, L. 1999). Trading in pennies: a survey of the issues. Unpublished working paper, University of Southern California, 1999; and (JENNINGS, R. 2001). Getting “Pennied”: The effect of decimalization on traders’ willingness to lean on the limit order book at the New York Stock Exchange. NYSE Document, v. 1, 2001.

Since the name High frequency trading started showing up as a relevant activity, it has received little attention to date in the academic literature. In addition, data to conduct research in this area has not been available.

Some examples are Kearns, Kulesza, and Nevmyvaka (2010) show that the maximum amount of profitability that HFT can make based on TAQ data under the assumption that HFT enter every profitable transaction. Cvitanic and Kirilenko build the first theoretical model to address how HFTs affect market conditions.

Moreover, the extensive review of the literature has revealed that the majority of the researches has been group according to the market structure intricacy of the moment. Meaning, events related to alteration in market structure regulation that motivated the studies. In the Figure 8 below, note that the studies have been coincidently broken out by decades, according to the regulatory alterations that acted as a catalyst for the emergence of the HFT.

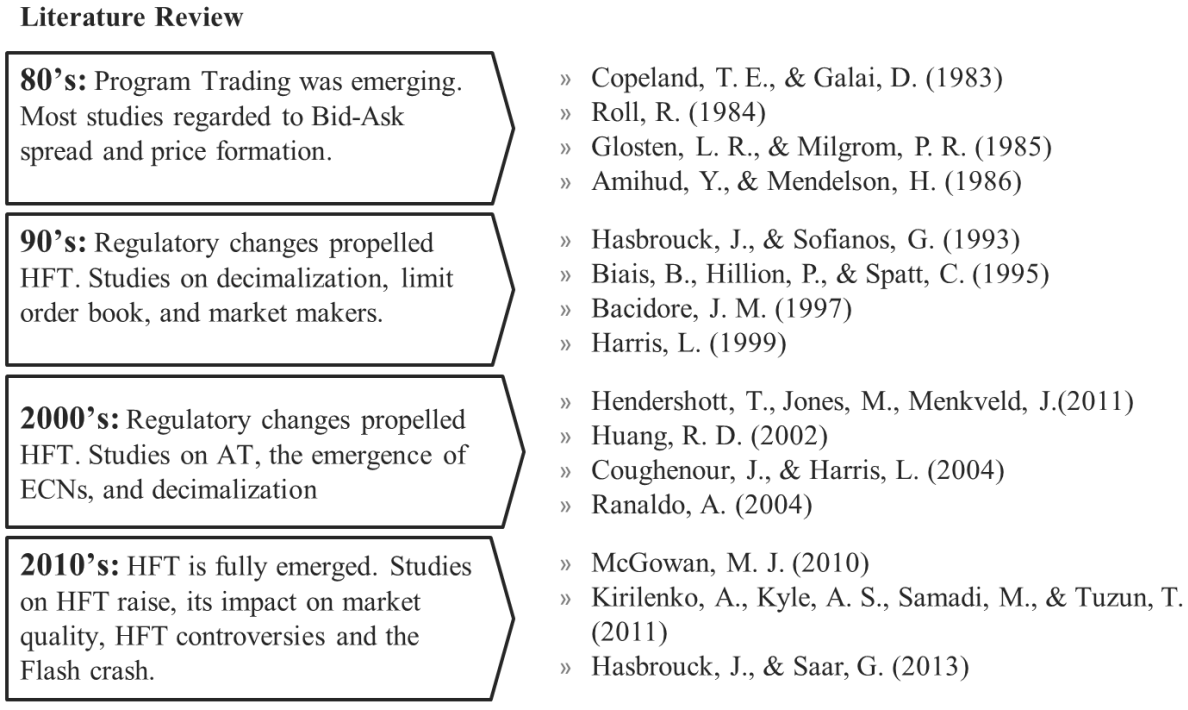

Figure 8 – Literature review

Source: author

3 RESEARCH DESIGN AND METHODOLOGY

3.1 Study Approach and Method

This study aims to respond the research question using the exploratory qualitative method to analyze the data collected.

Klopper (2008) states that the qualitative research is applicable when at least one of the following conditions are met: the subject is unknown, the context of the research is poorly understood, the limitations on the subject is not clearly defined, the nature of the research subject is not measureable, the nature of the problem is not clear, or when the researcher understands that a given event should be re-examined.

According to Klopper, in order to employ this method, the research must have clear perspective of the phenomenon, as well as, of the research questions. Additionally, the researcher must be prepared to improvise, alter, or adjust the approach to the investigation. For this reason, the author states that there is not a pre-defined framework for a qualitative research.

Given that this study aims to raise conclusions of a phenomenon within a broadly context, and supported by a variety of analysis, this research will adopt the multi-case study. This also allows a comparison between the findings from different sample firms (Klopper, 2008).

The main objective of this research is to set forth the strategic actions to contribute to firms, in the High Frequency Trading industry, to become ready to manage the consequences of changes in their industry trajectories. This examination becomes relevant because firms need to understand the course of transformation in their industry, by looking into not only their own inherent industry, but also determining if new technologies or new ways of doing business come from other industries.

3.2 Data Collection and Analysis

Firstly, the research has gathered information on the history, investment strategies and Securities market regulation changes, that pertain to the HFT industry, and that pertain to the sample HFT firms, by studying the HFT companies' webpages, regulator´s press releases, and academic research.

This research has also studied the fundamental mechanism underlying Equity Trading, including mechanism underlying the modern electronic exchange, such as the NYSE.

This study has furthermore reviewed a large number of in-depth research reports on the emerging HFT industry from a wide range of different consulting and investment firms, including Goldman Sachs, Boston Consulting, Capgemini Strategic Analysis Group.

3.3 Limitations

Due to the extreme secrecy of the firms operating within the High Frequency Trading industry, the data collection was be based upon an in-depth research on reports about the emerging High-frequency trading industry, from a wide range of different consulting and investment firms, including Goldman Sachs, Boston Consulting, Capgemini Strategic Analysis Group

4 RESEARCH RESULTS

The purpose of this section is to present the research findings and conduct an analysis of the High Frequency Trading industry, using the frameworks described in section two, towards responding to the empirical research questions.

For such, it first presents a sample of the HFT firms, commonly appointed as the top 15 firms in the specialized news media, as well as, how these firms are currently classified in the NAIC (North America Industry Code), and the SIC (former Standard Industry Code).

Secondly, it uses the frameworks described in section two and concludes that the firms employing HFT to compete in the Securities Trading industry compose an independent industry.

Third, it assesses the trajectory of the industry evolution using MIE framework

Finally, it uses PESTEL analysis to present the characteristics of the HFT industry environment, as well as, the MIE to present the characteristics of the HFT industry evolution.

4.1 The Players

The analysis focused on companies that provide liquidity relying on a platform that is fully based upon advanced algorithms and low latency technology. These firms are commonly termed, in the academic studies and the specialized news media, as the High Frequency Traders.

The table below denotes the 15 firms that are commonly appointed as the top 15 HFT firms, in terms of volume of transactions in the U.S. Security market.

Note that the majority of the companies have been classified to different SIC and NAIC codes, and under the Financial and Insurance sector.

HFT firm	SIC code	SIC category	NAIC code	NAIC category
Tradeworx	8742	management consulting services	52393002	investment advice
Tower Research Capital	6799	investors, nec	52393002	investment advice
Virtu Financial	6799	investors, nec	52393002	investment advice
Two Sigma Investments	6799	investors, nec	52391001	miscellaneous intermediation
Flow Traders	6799	investors, nec	52229303	international trade financing
Two Sigma Investments	6799	investors, nec	52391001	miscellaneous intermediation
Citadel	6722	management investment offices	525910	open-end investment funds
Tradebot Systems	6289	Services allied with the exchange of securities or commodities, nec	523999	miscellaneous financial investment activities
IMC Financial Markets	6231	security and commodity exchanges	52399902	miscellaneous financial investment activities
KCG	6211	security broker, dealers, and flotation companies	52392002	portfolio management
Renaissance Technologies	6211	security broker, dealers, and flotation companies	52393002	investment advice
Allston	6211	security broker, dealers, and flotation companies	52393002	investment advice
Wolverine	6211	security broker, dealers, and flotation companies	523120	security brokerage
Jump Trading	5199	miscellaneous non durable good	424990	other miscellaneous non durable goods
Hudson River Trading	5199	miscellaneous non durable good	99999004	unclassified establishments

Table 2 – Top 15 HFT firms and Industry codes

Source: author

The picture 9 below shows the typical flow of actions and information necessary to find either a Buyer or a Seller in the stock market prior to 1990's. Note that HFTs did not exist by that time, and a minimal portion of the large broker dealers had Electronic Order Transmitting System (DOT) with the stock exchange implemented.

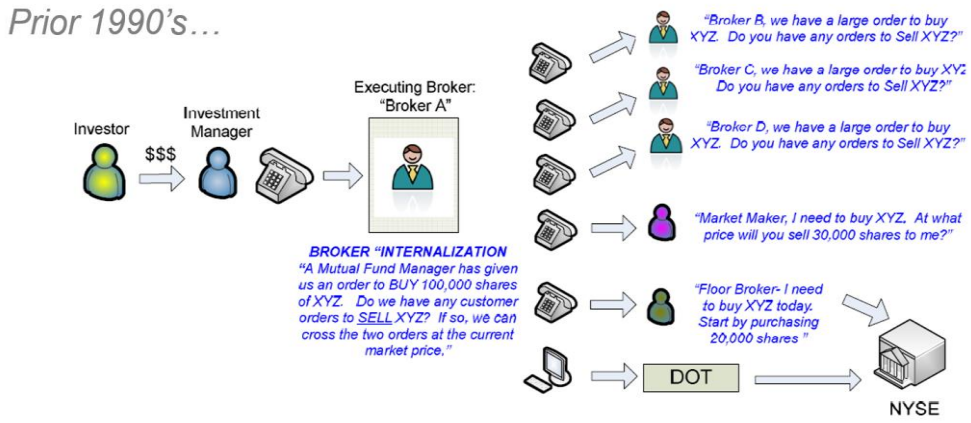

Figure 9 – Liquidity service prior 1990's

Source: Goldman Sachs, 2009 – market structure report

Figure 10 below shows the common "Liquidity" service provided by HFT industry. The picture above shows the typical workflow that an order currently go through to be executed. Note that computers and algorithms dominated the equity markets, and automated systems replaced the manual execution services. HFT firms figure among the Automated Market Makers.

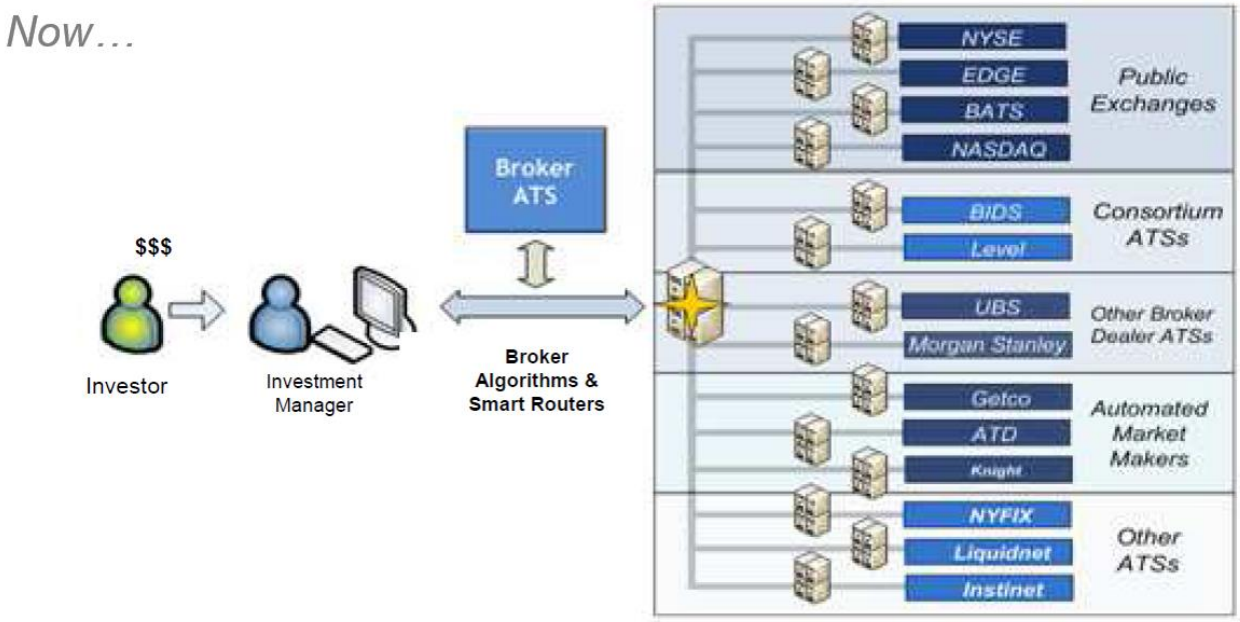

Figure 10 – Liquidity service currently

Source: Goldman Sachs, 2009 – market structure report

History and Development of HFT.

While computerized trading in the 70's and 80's was dominated by trading on the NASDAQ and NYSE, the game changed in the late 1990's with the emergence of other electronic trading venues known as electronic communications networks (ECNs). An electronic communication network is a type of computer system that facilitates trading of financial products, such as stock and currencies, outside of the traditional stock exchanges. This might have been the first most important regulation change that established the opportunity for HFT business out of the category of Algorithm trading.

ECNs became very popular in the late 90's after the U.S. Securities and Exchange Commission (SEC) authorized their existence with its Regulation Alternative Trading Systems (Reg. ATS). After Reg. ATS, the emergence of these alternative trading systems made it possible for individual investors to trade after-hours outside of the exchanges, and eventually allowed more computer systems to be developed to facilitate the entry and execution of orders electronically, by algorithms. The growth of these ECNs in the late 1990´s led to the wider use of algorithmic trading and eventually the rise of independent high frequency trading firms.

Another milestone, and most likely the one that propelled the rapidly expansion of the HFT business throughout the U.S. stock markets, came on Jan, 29th 2001, two years after Reg. ATS, when stock exchanges started quoting stock prices in decimals instead of fractions. This "decimalization" of the exchanges changed the minimum stock tick size from 1/16th of a dollar to $0.01 per share and further encouraged algorithmic trading by ECNs. This might have been the second most important regulation change that established competitive advantage in favor of HFT business.

It seems that alterations in regulations were present in many of the relevant development in the history of HFT, in a manner that, back in 2005, SEC pushed through Regulation National Market System (Reg. NMS), a series of initiatives promulgated by the SEC, which was designed to modernize and strengthen the national equity markets. Through these alterations, the SEC has promoted a national market system, which includes rules such as the Trade through rule (Rule 611), the Access Rule (Rule 610), the Sub-Penny Rule (Rule 612) and the Market Data Rules.

Such dramatic increase in HFT was most likely due to its profitability, which certainly attracted other players to HFT business. Despite the economic recession, high frequency trading has been

considered by many to be the biggest “cash cow” on Wall Street and it is estimated that it generated approximately $15-$25 billion in revenue (MCGOWAN, M. J., 2010).

By 2006 the U.S. HFT industry was composed by a handful of other big electronic trading firms such as Getco, Knight Capital Group, and Citadel, and the business had grown out of the trading floors of the mercantile and futures exchanges in Chicago and the stock exchanges in New York.

Another event that represented an important milestone in the history of the HFT took place on May, 6th, 2010, when in the course of about 30 minutes, U.S. stock market indices, stock index futures, options, and exchange-traded funds experienced a sudden price drop of more than 5 percent, followed by a rapid rebound. This brief period of extreme intraday volatility, commonly referred to as the “Flash Crash”, raised a number of questions about the structure and stability of U.S. financial markets, and consequently put HFT permanently on the radar of public and regulatory attentions (KIRILENKO, A. 2011).

The deep and choppy waters in the history of HFT took place from 2009 and 2010, but, since late 2010, profits started shrinking, some HFT firms ran out of business or were merged. This scenario pushed that by early 2013, more HFT firms were resorting to something called momentum trading, by using methods that sense the way the market is going and bet big. This strategy can be lucrative, but comes with enormous risks. Figure 11 below shows the timeline of the HFT industry.

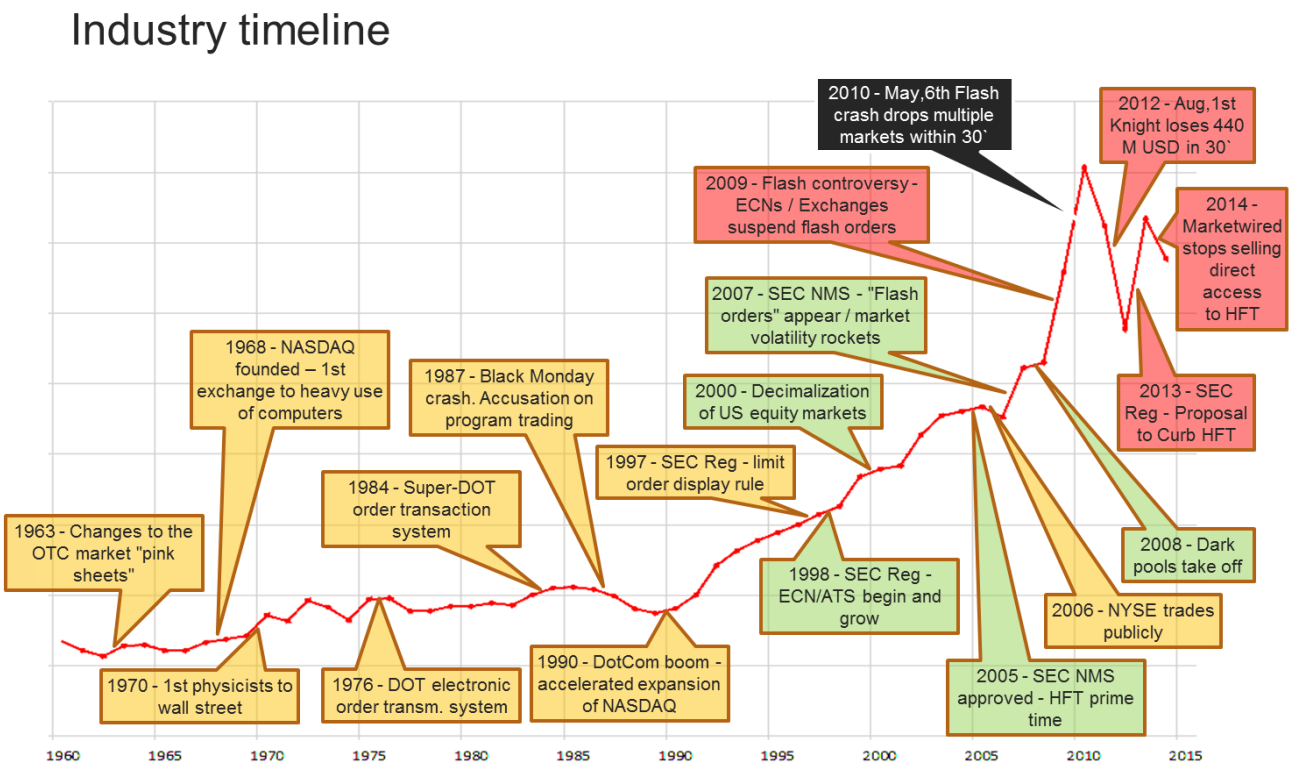

Figure 11 – HFT industry timeline

Source: author

4.2 Assessing the Industry Boundaries

In the vast extent of studies and publications about HFT, only very few times it has been referred as High Frequency Trading Industry. Moreover, this is typically referred as a trading activity. The table below shows academic studies where HFT is referred as an independent industry.

reference	citation
ALDRIDGE, Irene. High-frequency trading: a practical guide to algorithmic strategies and trading systems. John Wiley & Sons, 2013.	“From the original rudimentary order processing to the current state-of-the-art all-inclusive trading systems, **high frequency trading** has evolved into a billion-dollar **industry**.”
POIRIER, Ian. High-Frequency Trading and the Flash Crash: Structural Weaknesses in the Securities Markets and Proposed Regulatory Responses. HASTINGS BUSINESS LAW JOURNAL, v. 8, p. 2.	"This note will illuminate the relatively unknown **high-frequency trading industry**."
VIRK, Amardeep et al. Twitter: The strength of weak ties. 2011.	"These two seemingly unrelated developments have the potential to impact the **high-frequency trading industry** in a unique way, by giving banks the ability to scan tweets for news ..."
CLARK-JOSEPH, Adam D. Exploratory trading. Unpublished job market paper). Harvard University, Cambridge MA, 2013.	However, should the structure of the A-**HFT industry** indicate the existence of some barriers to entry, the A-HFTs' apparent economies of scale could potentially act as one such barrier."
RAMIREZ, Luz Orlando. High Frequency Trading. Working Paper, 2011.	"As newer and faster technologies become available, high frequency trading firms spend millions to upgrade their systems to ensure that they are staying competitive in the **high frequency trading industry.**"
GUILBAUD, Fabien. Contrôle optimal dans des carnets d'ordres limites. 2013. Tese de Doutorado. Université Paris-Diderot-Paris VII.	"Issues faced in **high-frequency trading industry**"
MOONEY IV, John J. Adjusting the capital asset pricing model for the short-run with liquidity proxies, while accounting for denials and deceptions in financial markets. 2014. Tese de Doutorado. Monterey, California: Naval Postgraduate School.	"and requiring a 50 ms minimum quote life to discourage the processing/speed arms race in the **high-frequency trading industry** (Reed & Crapo, 2012, pp. 36–39)."
PERLMAN, Sarah. How One Trade Could Change the World: High Frequency Trading and the Flash Crash of 2010. 2012.	"Therefore, the **high frequency trading industry** is at an incredibly interesting point in time."
IRWIN, Thomas. Creative Clustering: Agglomeration Effects in Innovation. 2012. Tese de Doutorado. Ohio University.	"This is the source of the phenomenon of co-location in the **high-frequency trading industry**, where we see many firms paying high premiums for server floor space in the buildings where the exchange servers are located."
ENGSTRAND, Peter. An investigation of high frequency trading and the unusual market events of May 6 th, 2010.	"It is impossible to say what percentage of blame should be placed upon the **high frequency trading industry** as a whole for what occurred on May 6 th , 2010."

Table 3 – HFT as an independent industry

Source: author

4.2.1 Entry Barriers and Mobility Barriers

This research has identified two key elements that are most critical to the success of HFT, and consequently they represent the major barriers that need to be considered by any firm seeking to enter the HFT market. They are, low latency and Continuous development of Algorithms.

The dependence of the HFT firms on technology, as an enabler and differentiator among the competition, has led to a technological race, where each firm strives to become faster (lower latency), and smarter (better algorithms), than its direct competitors.

The race for low latency is due to the fact that the continuous improvement in technology is constantly bringing down latency levels. The study also identified that the factors contributing to low latency are, fiber optics for long distance communication, bandwidth to allow great volumes of data to be pushed through their networks, co-located services, and raw data feeds.

Moreover, the study also identified two reasons for the run for continuous development of new algorithms, to accurately reflect market changes and allow for reassessing the trading strategies, and due to the reverse engineering that competitors do to decipher each other's strategies.

To this extent, the use of the entry barrier framework to analyze the HFT business concluded that only a firm employing low latency technology could pose a direct competition for a HFT firm. That implies that any firm that does not employ low latency technology will be interpreted as a substitution threat, not as direct competition. Thus, all the firms employing HFT to compete in the Securities Trading industry compose an independent industry termed High Frequency Trading Industry.

4.2.2 Buyer, Supplier, Competitive intent, and Technical platform commonalities.

In the tables 4, 5 and 6 below, the thesis presents a sample of the firms that have been delivering liquidity to market participants over the past decades. The intent of presenting these players, as well as the brief description of their evolution, is to support the assessment of the Industry Boundaries using the MIE.

In order to define if HFT firms compose an independent industry, as opposed to the Designated Market Making industry, the thesis employed the MIE framework, which proposes an assessment to identify commonalities of Buyers, Suppliers, Competitive intent, and Technical platforms.

As mentioned in more detail in the section Evolution and Characteristics of the NYSE Designated Market Makers, since the inception of the NYSE Specialists, back in 1871, the NYSE changed its rules several times in order to allow and propel the floor Specialists firms to evolve from small and closely held firms to larger firms owned by public corporations. These rules gradually decreased the number of firms, from 123 unique specialists firms that existed by 1933, typically composed by very few partners, to 65 slightly larger corporations by mid-1980, and then to 31 by late 1990, and finally to 18 by December 2000. The table 4 below

shows the Specialist Firms, predecessors of the current Designated Market Makers, from June 1, 1999 to December 31, 2000.

Specialist firm	**Date specialist firm ceases to exist**
Bear Hunter Specialists LLC	
Benjamin Jacobson and Sons LLC	
Bocklet and Co. LLC	
Buttonwood Specialists LLC	
CMJ Partners	October 20, 1999
Corroon, Lichtenstein	March 10, 2000
Einhorn and Co.	July 19, 1999
Equitrade Partners	June 21, 1999
Fagenson/Frankel/Streicher	June 1, 2000
Fleet Specialist	October 27, 2000
Freedom Spec./Adrian/RPM Spec.	
Henderson Brothers Inc.	June 6, 2000
KV Specialists LLC	June 21, 1999
LaBranche and Co.	
Lawrence, O Donnell, Marcus	
Lyden, Dolan, Nick and Co., LLC	
M.J. Cohen and Co.	October 20, 1999
M.J. Meehan and Co. LLC	
Performance Specialist Group, L.P.	
Phoenix Partners L.L.C.	November 3, 2000
RPM Specialist Corp	
Scavone, McKenna, Cloud and Co.	
Spear, Leeds, and Kellogg LLC	
Stern and Kennedy	
Stuart, Scotto, Cella Co./ MJM	October 13, 2000
Surnamer, Weissman, and Co.	July 19, 1999
Susquehanna Specialists	
Wagner Stott Mercator, LLC	

Walter N.Frank and Co. LLC	
WEBCO Securities Inc.March	March 10, 2000
Weiskopf, Silver Specialists, LLC	

Source: NYSE daily Specialist Directory files
(COUGHENOUR; HARRIS, 2003)

Table 4 – Specialist Firms – from June 1, 1999 to December 31, 2000.

Source: adapted from COUGHENOUR; HARRIS, 2003

With the evolution of market structures towards electronic limit order markets, this is not only the traditional Specialists that can provide liquidity to the markets anymore, but any market participants provide liquidity to the market themselves (SKJELTORP; ØDEGAARD, 2014). Additionally, with the fragmentation of the Equity Market structure and the technological advances towards the low latency trading, High Frequency traders emerged as the modern market makers, and gradually started phasing out the traditional floor-based style of market makers.

The table 5 below shows all the Designated Market Maker firms and Supplemental Liquidity Provider firms that currently hold membership at the NYSE. Note that none of them is remaining from the 31 Specialist firms listed on the table above, but High Frequency Traders.

Designated Market Maker firm DMMs	**Supplemental Liquidity Providers SLP-Prop**
Barclays	Barclays
Brendan E. Cryan and Co., LLC	BofA / Merril
IMC Financial markets	Goldman Sachs & Company
J. Streicher & Co., LLC	HRT Financial LLC
KCG Americas LLC	KCG Americas LLC
VIRTU Financial Capital markets, LLC	Latour Trading, LLC
	Tradebot Systems,Inc.
	VIRTU Financial Cap. markets, LLC

Source: NYSE Directory - Dec 2014

Table 5 – DMM and SLP listed in the NYSE in 2014.

Source: adapted from NYSE directory, 2014

Furthermore, the table below shows a short list of U.S. based firms that operate primarily with High Frequency.

High Frequency Trader firms
KNIGHT / KCG Americas LLC
VIRTU Financial Capital Markets, LLC
LATOUR / TOWER Research Capital
CITADEL Securities LLC
TRADEBOT systems inc.
TRADEWORX'S
RGM Advisors

Source: author

Table 6 – HFTs listed in the NYSE in 2014.

Source: Author - adapted from NYSE directory, 2014

The analysis concluded that HFT firms do not pertain to the same industry as the Designated Market Maker firms, including the former Specialists. Indeed, they all provide the same service, which is Liquidity, and target in a large extent the same "consumers", which are the market participants in general. Nevertheless, they do not share the same Suppliers.

In fact, one important distinction between the HFT firms and the traditional DMM / Specialist firms is the technical platform employed by High Frequency Traders. This difference implies that a variety of new suppliers is critical to the success of their business, such as the Stock Exchanges with supplying Direct Market Access (DMA), Sponsored Access (SA) and Co-location services.

The need of low latency for the success of most of their trading strategies also implies that constant innovations on the development of new algorithms and technological platform are critical for success. That means significant investments on information technology and R&D.

In order to support the assessment of the Buyer Commonalities, the study revisited the definition and fundamental characteristics of High frequency Trading.

HFT strategies update their orders very quickly and have no overnight positions. The rapid submission of cancellations and deletions is necessary to realize small profits per trade. It is part of the business model to realize small profits in a large number of trades and hence, HFT focuses mainly on high liquid instruments. As a prerequisite, HFT needs to rely on high-speed access to markets, for instance, low latencies or the usage of co-location services and individual data feeds (GOMBER, 2011).

The table 7 below shows the specific characteristics of HFT, which distinguish it from other market participant, as well as, their implications on the relationship with buyers and suppliers.

Specific characteristics	**Implication on buyer / supplier relationship**	**Type of distinction**
Use of co-location/proximity services and individual data feeds	continuous renovation	technical platform
Low latency requirement	continuous renovation of technological platform is strategic.	supplier
Pre-designed trading decisions	Core work force is primarily quantis, mathematicians and programmers	supplier
Use of Real-time data and Direct Market access	The need of DMA or SA makes exchanges an important suppliers	supplier
No human intervention	Core work force is primarily quanti and programmers	supplier
Very high number of orders	Requires robust software application to support back-office on after trading tasks.	supplier
Used by professional traders	Diversification - providing algo services like EMS (execution management services)	buyer
Focus on high liquid instruments	This limits the variety of customers	buyer
Rapid order cancellation		-
Proprietary trading		-
No significant position at end of day (flat position)		-
Very short holding periods		-
Extracting very low margins per trade		-

Table 7 – specific characteristics of HFT.

Source: adapted from GOMBER, 2011

The study concluded that the HFT firms compose an independent and different industry, as opposed to the Designated Market Making firms.

The importance of defining the boundaries of the industries correctly is to avoiding defining the industry either too narrow or too broadly. If managers diagnosed the industry boundaries incorrectly, the result would drive them to the conclusion that DMM and HFT industries were performing the same path of evolution. Such misinterpretation of the trajectories of both industries would obscure important opportunities for making wise investments according to the correct path of change.

4.2.3 Information-intensive Industry Structure

An important reason the study explored some of the market structure concepts, such as, the limit order book, the order flow, or Liquidity, is because High frequency trading, in a very simplified form, involves the collection of tiny gains, sometimes measured in fractions of a penny, on short-term market fluctuations, and that typically fall within the bid-ask spread. High frequency trading firms hunt for temporary inefficiencies in the market and trade as quickly as possible to make money before the brief distortions go away. Because of this, a high turnover in capital characterizes high frequency trading, which is also dependent on a variety of market components that enable traders to turn a profit.

The study identified that, because of the aforementioned, the distinguishing characteristics of high frequency trading strategies include a dependence on ultra-low latency, the limited shelf life of trading algorithms and the extensive use of raw data.

This research encountered that several exchanges and ECNs provide individual data feeds consisting of their own best-priced quotations and other trade-related information, and that such information is leveraged by HFT firms. This is in contrast to the consolidated data feeds consisting of the best prices and other data from each exchange, some ECNs, and Alternative Trading Systems (ATS) in a single feed that is used by most other market participants. The process of consolidating this data creates some latency, and by the time the data reaches the market participants it is already slightly old.

That explains why HFT firms strive to use raw, individual data feeds, which saves them from the latency that is introduced in processing and consolidating, and consequently confer competitive advantage.

Such dependence on high-speed technology and on the use of both historical and real time raw data suggest HFT to be interpreted as an Information Intensive related industry.

The application of the information-intensive industry structure framework led the thesis to conclude the following:

a) Due to the extensive use of Statistical Arbitrage trading strategy, HFT is considered to be highly Time Specific, both in acquisition and in use.
b) Because the constant development of Algorithms for receiving, manipulating and transferring such amount of information is very costly, HFT can also be considered highly Knowledge Specific in Use.

Based on these definitions and the application of the model, the thesis concluded the following propositions:

c) Because HFT firms collect, process, and deploy an extremely large amount of critical information for the equity trading market, these HFT firms define their industry boundary.
d) Because HFT firms are both highly knowledge specific in use and highly time specific in acquisition and use, comparative advantage in possession of volume of critical will determine the level of competition and profitability.

4.3 PESTEL Analysis for the HFT Industry

Political factors affecting the High Frequency Trading industry

HFT industry attracts significant political attention, especially due to anti-trust laws.
HFT firms are positioning themselves for greater influence through political contributions and through spending on lobby.
SEC – US Securities and Exchange Commission developing Anti-disruptive trading rules.
Negative impact on Institutional investors, due to front run orders.
HFT potentially gives rise to short-term market volatility

Economic factors affecting the High Frequency Trading industry

HFT industry has been often under scrutiny and subject of change in regulation in the US securities market, as well as, Europe and Asia. Such changes aim to mitigate HFT profitability.
Operational risks reiterate the need for strong and robust testing of algorithms and programs at all stage.
Global economic issues, like the global financial crisis of 2007-2010, are also economic factors affecting HFT firms.

Extremely low latency demands significant investments in co-location, high-speed networks, and acquisition of high volume of market data.
Labor and energy costs

Social factors affecting the High Frequency Trading industry

Employment scenario. Scarcity of quant professionals in the market.
The nature of income distribution
Change in Work-career balance, which affects capability to find and hold talents.
Change in the way HFT is perceived (Ethical issues), which affects relationships in HFT's supply chain.

Technologic factors affecting the High Frequency Trading industry

HFT firms depend on use of individual data feeds from exchanges in order to minimize latencies.
Depend on easy access to sophisticated technology.
Access to co-location facilities
The duration of technological life cycles, that requires more investment and management.

Environmental factors affecting the High Frequency Trading industry

The impact of HFT operations on the environment (footprint), and its consequences.
The activities of non-government environmental groups
Global warming issues

Legal factors affecting the High Frequency Trading industry

HFT regulation. Policy makers globally have developed a number of initiatives, consultations, and proposals aimed at HFT regulation.
Practice of Order instantly cancelling for triggering automated orders is an ethical issue.
Rules and regulations specific to the security trading industry.
Government regulations affecting HFT in direct and indirect ways

4.4 Assessing the Trajectory of the Industry Evolution

This section aims to present the findings going through the four steps for assessing the industry trajectory of change and stage of the evolution, proposed by the MIE.

4.4.1 Core Activities Analysis.

The study in this section developed up on the main characteristics, that distinguish HFT firms from other market participants, in order to identify the activities that are essential to the industry's value creation, and therefore to its profitability.
The analysis on the evolution of the HFT industry revealed that the main core activities have a direct relationship with the emerging nature of the industry. They are Operate at Low Latency, Continuous development of newer and faster algorithms, and Manage operational risks.
Additionally to the fact that these activities have been proven essential to the survival and success of the HFT business, the study concluded that they are not being threatened by obsolescence. Therefore, High frequency trading industry is not undergoing any Architectural transformation.
As follows a brief description of these activities and their implications.

Latency

Because of the importance of speed, the objective of HFT is to reduce latency, the time delay between the moment when the price is discovered and the trading algorithm performs the market analysis, and the confirmed placement of an order. Between these two instants, which must therefore be as close as possible to each other, the order must be sent, accepted, executed and confirmed, or, in the event that it is not accepted, confirmed and possibly cancelled.
There are two forms of latency to be distinguished: the "round-trip latency" of the trading platform, and the "proprietary latency" of the market participant itself. "Round trip latency" concerns the time required by a platform's matching system internally to accept an order, process it, confirm it and (if possible) execute it. Round trip latency is measured from the moment when an order enters the system via the demarcation line (the trading platform's firewall), and the moment when the confirmation signal leaves the system via the firewall.
Proprietary latency concerns the latency caused by the distance of the market participant from the firewall of the matching engine, the nature of its access to the platform and the quality of

the connections and speed of the algorithms and computational systems, which it uses. A market participant can minimize its proprietary latency by optimizing its software and hardware and access to the trading platform.

Co-location

One way of reducing latency is to locate the server on which the trading algorithms run as close as possible to the trading platform's matching engine. This is what happens in co-location. This is not a core activity itself, but is essential to support the operation with low latency.
In co-location, a trading platform offers market participants who are members of the platform the opportunity to rent server racks in the same building as that in which the matching engine is located. The member can locate the servers on which its trading applications run here. This set-up means the data has only a minimal distance to travel and reports (such as order book data, transaction data, price data and other notifications) can be sent and received with the minimum delay. See Figure 12 below.

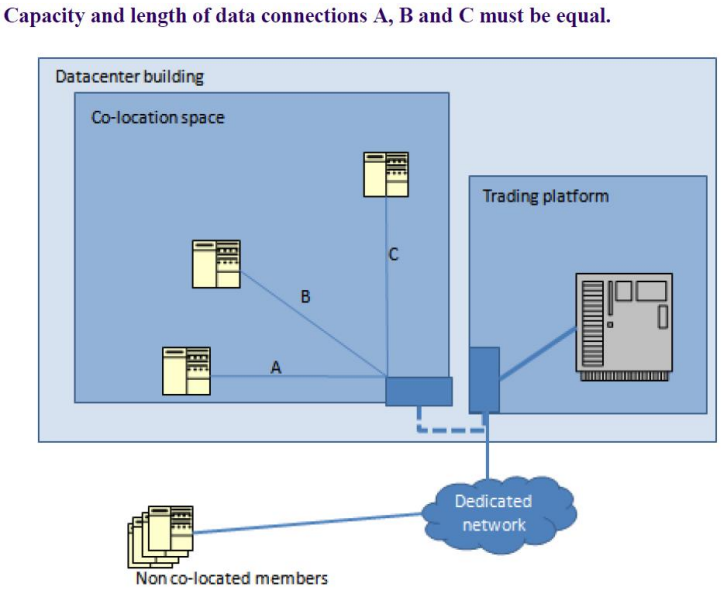

Figure 12 – Diagram of Co-location

Source: (Anuj, 2012)

Continuous development of Newer and Faster Algorithms

Along with low latency, HFT firms require smarter algorithms that are updated constantly to outperform the competition. Firms update their algorithms frequently for two reasons:

Accurately Reflect Market Changes - HFT strategies are based on interpretation of market events and news, and rely on the correlations between several factors such as pricing, interest rates, and different markets events. As a result, traders always need to upgrade their algorithms constantly as their underlying assumptions change based on various market events. This has particularly been true in the last few years, when volatility in the markets has been high and there has been a need to reassess strategies frequently.

Short Utility Period Due to Reverse Engineering: The shelf life of most algorithms remains limited, as competitor firms are generally able to decipher each other's strategies through reverse engineering. Once a strategy is exposed to the competition, it can become extremely risky to execute and can often prove to be counterproductive, as the firm's competitors would know exactly what the firm is doing. It is therefore imperative for firms to constantly update and upgrade their strategy in order to stay a step ahead of the competition.

Technological innovations have made the frequent upgrades of algorithms much easier and far more economical than they were in the recent past. Modern algorithmic trading platforms have a simple interface that allows traders to create, test, and deploy their strategies in the form of algorithms in an extremely quick, simple, and efficient manner.

Operational Risk Management

HFT firms need to be very careful about their algorithms and their impact. They need to ensure that these algorithms are tested completely and thoroughly, before they are deployed on live systems.

Equity markets have experienced certain situations where faulty or improperly tested algorithms have caused severe, undesired consequences: In January 2010, NYSE Euronext fined Credit Suisse, after a faulty algorithm resulted in the exchange trading system receiving hundreds of thousands of erroneous messages.

In February 2010, a runaway algorithm from Infinium Capital Management caused a spike of $1 in oil prices, and the trading program had to be shut down after five seconds. Again, in June 2010, AQT, a proprietary trading team at Deutsche Bank, placed sell orders worth $182 million in error, due to a faulty algorithm. All of these incidents reiterate the need for strong, robust testing of these algorithms and programs at all stages.

The table 8 below illustrates the benefits that the evolution of the market structures brought to the investing community.

Then floor-based Specialists		Current fragmented and automated market
Market participants "liquidity" goes largely undiscovered due to an inefficient and cumbersome process	→	Once inaccessible liquidity can now be connected to and simultaneously accessed with the push of a button.
Broker-dealer liquidity is largely unattainable	→	Broker-dealer buy/sell interest has been turned electronic in ATSs
Relationships provide traders with access to liquidity	→	Electronic trading venues provide participants equal access to liquidity
Market Makers are directed captive retail orders	→	Market Makers must compete for retail orders, resulting in increased willingness to trade, superior execution prices, and faster trading
There is minimal competition between trading venues. Investors compete to find liquidity and exchanges have	→	Trading venues compete for investors order activity and aggressively reduce their pricing

Table 8 – benefits of the market structure evolution.

Source: Goldman Sachs – Market Structure overview, Sep, 2009

4.4.2 Core Asset Analysis.

Developing upon the same method employed to analyze the core activities, the study identified the assets that are essential to the industry's value creation, and therefore to its profitability.
The study observed that over the past decade, HFT has been under strong scrutiny by legislators and specialized news media, due to uncertainties about its either negative or positive impact on markets. Such pressure has been posing a risk of increasing regulation, thus represented a threat not only to some of HFT's core activities, but also to some of the core assets.
Although, over the past few years, many academic studies have been appointing the benefits of HFT to the markets, which made HFT less on the spot of regulators.
Due to this scenario, this study also concluded that HFT firms are not undergoing any Foundational transformation.

4.4.3 Determining the Stage of the Industry Change.

The research concluded that HFT is in the Maturity stage of its Progressive path of transformation. The study employed the alteration on the growth rate, in terms of stock volume traded by HFT firms, in order to observe the point of transition from the Shakeout phase to the Maturity phase of the evolution.

In 2010, HFT was estimated to have accounted for 56% by volume of the entire equity turnover in the U.S., up from 21% in 2005. Note that it peaked with 61% back in 2009.

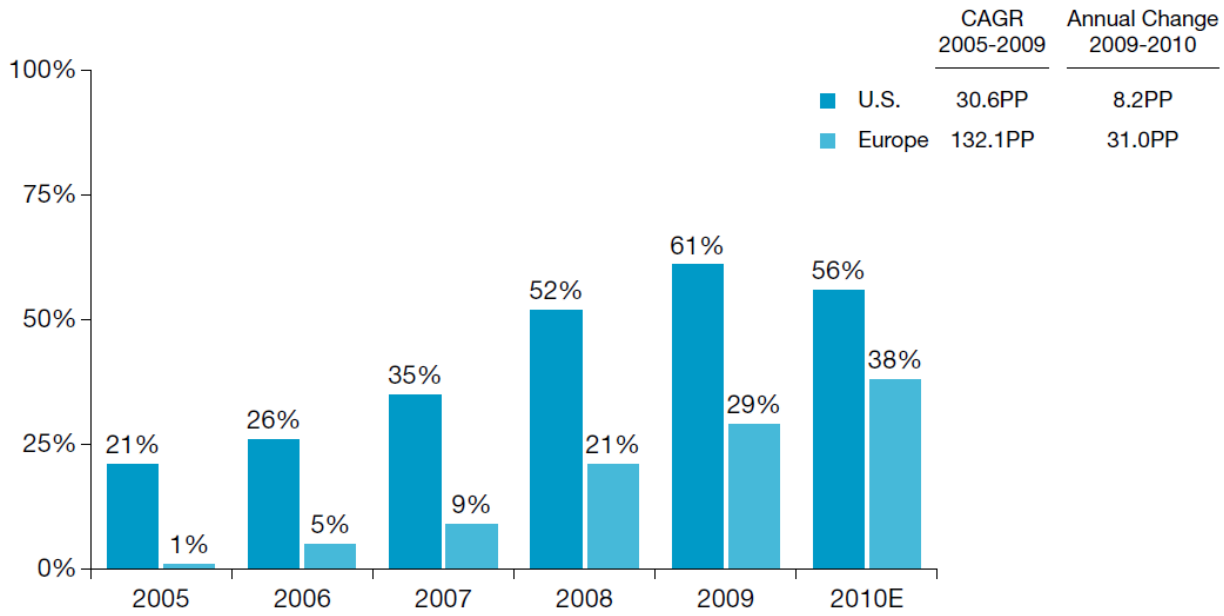

Figure 13 – HFT as a % of Equity turn over by Volume – U.S.

Source: (Anuj, 2012)

5 CONCLUSION AND IMPLICATIONS

This paper has attempted to reexamine if the HFT firms, widely termed in the academic research studies and specialized news media as the High Frequency Traders, compose and independent industry.

The thesis combined the findings from this empirical work with the managerial model to answer the research question.

The main research questions of the thesis were:

What are the boundaries of the HFT industry?

What are the main characteristics of the HFT industry?

The analysis explained along the chapter 4 concluded that the firms that employ HFT to compete in the Securities Trading industry compose an independent industry, termed High Frequency Trading Industry.

The study also identified that, the distinguishing characteristics of high frequency trading include a dependence on ultra-low latency, and the limited shelf life of trading algorithms.

Moreover, the thesis also concluded that the emerging High Frequency Trading industry is on a Progressive trajectory of evolution, where it did not present major signs of threat to its assets or activities. As undergoing a Progressive path of change, firms in the HFT industry should focus on expanding their industry and fine tune their business model in order to leverage further growth.

Furthermore, the analysis concluded that the emerging HFT industry is on a Maturity stage of the Progressive change, which implies that HFT is already the dominant model and that growth rate is diminishing.

Surviving over the long run requires developing an approach to value creation, which does not necessarily depend on sustaining historical growth rates in the business.

One way of pursuing value creation while capitalizing on the HFT core activities is to diversify across other asset classes.

5.1 Conclusions on the Research Problem

The exploratory investigation on tens of academic papers and hundreds of news articles and regulators' press releases concluded that, in spite of some uncertainties involving the impact of new regulations on HFT, it is believed that its popularity and use will continue to grow in the coming years. Additionally, the research found that many of the latest academic research have been confirming the beneficial impact of HFT in the markets, in a manner that regulators attention has been switching over the fragmentation and transparency issued of the equity markets, rather than HFT.

The analysis found that HFT is no longer alone under the scrutiny of the news and regulators, but the lack of transparency of some venues. In spite of this, the fact that the consistent expansion of the HFT industry will come with increase in governance, this is very important that HFT firms improve their Operational Risk and Compliance Management.

HFT is a natural evolution of the securities markets instead of a completely new phenomenon. There is a clear evolutionary process in the adoption of new technologies triggered by competition, innovation and regulation. Like all other technologies, algorithmic trading (AT) and HFT enable sophisticated market participants to achieve legitimate rewards on their investments – especially in technology – and compensation for their market, counterparty and operational risk exposures (GOMBER, 2011).

5.2 Implications and Recommendations

The high frequency trading industry today finds itself at a crossroad. Despite the huge potential for growth, HFT's profitability is threatened by new regulations and greater competition as more market participants adopt this form of trading.

However, as per the conclusions of the Industry Dynamics analysis, HFT is still undergoing its early days in its Maturity phase of the industry evolution. Thus, this is imperative for firms to continue to focus on growth by taking advantage of improving technology in order to capitalize on the benefits HFT holds.

5.2.1 Managerial

The Industry Dynamics (MCGAHAN, 2004) analysis has appointed that HFT industry decreased the growth rate, but should continue growing consistently. Therefore, firms looking to adopt high frequency trading could earn competitive advantage by investing and focusing on certain capabilities beyond their core competencies. This would prepare them for a more mature market and consequently with more governance.
Examples of areas HFT firms should pay special attention are:

Risk and Compliance Management:

As the regulatory burden on HFT firms increases, greater stress is expected on reporting, pre-trade controls and compliance. HFT firms can leverage the offerings of specialist firms to help them manage their various types of risk and compliance.

Code Optimization, Testing and Quality Management:

Speed is of utmost importance to HFT firms, so they need to continuously fine-tune their software code and optimize for minimal latency and system processing time.
Algorithm and code testing have become extremely critical for HFT firms, especially in light of several recent cases where malfunctioning algorithms have caused significant losses to one or more stakeholders. HFT firms should make certain that there is comprehensive testing of their trading applications and strategies. Firms also need to test their strategies using real world simulation, historic and current data as well as by shocking the system for various risk factors in order to ensure their strategy and system is fully robust and stable.

5.3 Recommendations for Future Research

The exploratory research revealed that the majority of the studies around the subject of High Frequency Trading still focuses on a variety of characteristics of market microstructure, and their impact either on the market stability, or on the business. This research is seminal in the sense of analyzing the High Frequency Trading business from a purely strategic perspective.
Additionally, the research concluded that HFT industry should continue growing, and consequently have more public traded firms and governance.

For these reasons, the thesis strongly advise future researches to explore the following subjects:

i. Applications of Low Latency in other industries, beyond financial markets.

ii. The negative impact of the HFT industry secrecy in a firm’s capitalization.

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