June 2010

Research Department

Working Papers - n°9

Equity trading: A review of the economic literature for the use of market regulators

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AUTORITÉ DES MARCHÉS FINANCIERS

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EXECUTIVE SUMMARY

In the United States, as in Europe, regulatory frameworks supporting competition between stock trading venues were introduced in late 2007. As their effect on how these markets work is under review, various short term (financial crisis) and structural developments (such as the increase in high frequency trading) require to perform a fundamental assessment the issues at stake.

Academic research on market microstructure, focusing specifically on the effects that market organisational characteristics have on their operation, is therefore quite helpful. Providing both theoretical and substantial empirical insights, it defines and measures useful indicators to evaluate the service rendered to the economy by secondary stock markets. It underscores the importance of considering "implicit" costs related to market liquidity in addition to direct ("implicit") trading costs (commissions, taxes, etc.). It also suggests evaluating the quality of the price formation process and the use of information asymmetries by market operators in order to derive strategic views on markets that are useful to the regulator. In the past, particularly in the United States, this line of research has significantly contributed to guiding policy making by financial regulators. Its contributions and limitations should therefore be reassessed in the present environment, particularly in Europe. The research provides three main lessons:

- In Europe, the expected benefits of the directive's implementation are significant. As a result of market fragmentation and competition that it introduces between trading service providers, explicit transaction costs, and several dimensions of liquidity have improved. This conclusion is robust to the volatility regime and therefore largely strips out the effect of the economic crisis. A noticeable decline can be seen in the quoted spread for blue chip securities. This decline demonstrates the markets' increased ability to provide liquidity. The lower cost of liquidity effectively consumed (effective spreads) confirms this perception, less dramatically than in the United States, however, and less than for quoted spreads. These conclusions call for some qualification, however. Firstly, the analysis of the change in the depth indicators (quantities available on the market) has yet to be completed. Secondly, the costs of impact appear to have increased, likely due to the sharp drop in the average transaction size. Thirdly, the benefit of fragmentation on liquidity is strongly influenced by the ability of "best execution" requirements to constrain operators to effectively consolidate the market, which could explain the reduced benefit of the European directive on Markets in Financial Instruments (MIF directive, or MiFID) for liquidity in Europe. Finally, there must be a deeper examination of the impacts of an increased level of high-frequency trading (HFT) on liquidity (see below).

- Assessing the impact of liquidity fragmentation, across trading venues using variable degrees of pre-trade transparency, on the process of public price formation is at the heart of issues surrounding revisions to the MiFID. The findings of studies prior to the directive's implementation underscore the ambivalence of the effects of transparency on liquidity and thus stress the need for fine tuning the degree of market transparency. These findings, however, are not revisited in the recent context of the proliferation of dark pools. In fact, literature on the subject focuses on showing the ability of new trading technologies to improve price formation. The result is a lack of analysis for this need for regulators. This lack might reveal weaknesses in analysis tools when evaluating the market's efficiency and the quality of price formation, as this involves comparing observed prices with inherently unobservable market prices (which would prevail in the absence of inefficiency sources). Statistically, it also highlights the difficulty of measuring reduced pre-trade transparency, which takes many forms in different venues. In addition, it would be worthwhile to evaluate the OTC market's contribution to public price formation (and liquidity), an issue that has not been fully addressed in literature on the equity markets.

- The development of algorithmic trading, and more specifically high frequency trading, now at the root of most blue chip orders, has introduced radical changes to market structure. These changes include not only trading and market access infrastructures, but also the pricing of trading services and the type of services offered, which has moved toward providing data processing tailored specifically to this type of player. Finally, these changes have direct (in the case of algorithmic trading) and indirect (in the case of high frequency trading) implications on the nature and quality of services provided by market intermediaries. The social utility of this type of trading has been questioned in the media and in the political forum. However, it is premature to perform a cost-benefit analysis at a time when data access and processing is costly and much of the information remains confidential, particularly information relating to implemented strategies and their profitability. Early empirical studies show the benefits of algorithmic trading for liquidity (on the NYSE) and for the price formation process (on Deutsche Börse).
  But a number of risks have been identified, which must still be assessed. These include:

  – Fair market access and competition among those involved. Although it has yet to be properly documented, several factors suggest that the benefits of the lower cost of liquidity have been unevenly distributed among the different participants in the market. The question rests not only on this, but also on the extent to which parties themselves benefit from information asymmetries that they use strategically. In other words, in a situation where the profitability of high frequency strategies has yet to be determined, questions are raised about the access that final investors (institutional investors,

individuals, etc.) have to these trading techniques and about their ability to create competition among those implementing such strategies.

– Fluctuations in market prices, possibly of a systemic nature. Market liquidity experiences natural fluctuations, which alternate liquidity supply and consumption. The literature provides theoretical explanations regarding the impact of algorithmic trading on these daily liquidity cycles. The events of May 6, observations of market regulations, and more generally market changes in recent years, as measured in various studies (ex. Khandani and Lo (2008), Angel, Harris, and Spatt (2010)) highlight the importance of conducting further analyses, particularly empirical ones, of the dynamics at work.

– Market integrity and methods of market surveillance. There are several reasons for the increased risk for market integrity, including increased interaction between different markets, liquidity fragmentation among various venues, the proliferation and complexity of market structures, and the increased ability to automate manipulative or abusive strategies. In market surveillance, they are represented by the difficulty of interpreting algorithmic strategies because the significant amount of information and the greater number of very short term orders, which are often not meant to be executed. Trade-offs between innovation and competition in market structures and the means required to monitor them can thus have structural impacts. At a finer level, the question posed by O'Hara (2010) – and implicitly by Hasbrouck and Saar (2009) – has to do with the need to clarify the line between permissible and prohibited practices in the new market environment.

The analysis of these risks will have implications for financial regulations. The potential magnitude of the issues is evidenced by the consolidated order trail that the SEC wants to establish in the United States, whose cost is estimated at several billion dollars. In terms of both general orientations and in the specific formulation of market rules, microstructure research will make a valuable contribution. However, without underestimating related costs, this environment encourages regulators to adopt a strategic view of its available and desired resources, especially in terms of data and analysis of stock market order flow and transactions. The remainder of this document is intended to fuel discussion on the issue by showing the benefits and limitations of the primary indicators proposed in the literature (Part I), suggesting some general conclusions from the literature (Part II), describing recent market developments in algorithmic and high frequency trading (Part III), and more closely examining the benefit of analysing the risks confronting regulators and the research needs to be addressed against this background (Part IV).

SOMMAIRE

I. THE EFFECT OF ACADEMIC RESEARCH ON MARKET STRUCTURE ANALYSIS

I.1. Preliminary remarks on the effect of microstructure research on market regulators

Academic "microstructure" research of the markets has highlighted the need to theoretically and empirically analyse different organisational and regulatory (structural) characteristics of secondary markets. Theoretically speaking, the foundations for a traditional analysis of how the markets are working – Walrasian *tâtonnement* (or trial and error) and assumptions of underlying pure and perfect competition – are undermined by a solid analysis of financial markets[1]. The shortcomings of conventional theory then lead to consider continuous time, returning to the traditional assumptions of consistency, product atomicity (trading services), and a lack of friction (cost and informational transparency). Models thus take into account complex interactions and various external factors that are specific to markets. Empirically, in an environment where seemingly minor changes to trade conditions can have significant impacts on traded volumes[2], the approach focuses mainly on assessing the importance of the "technical" characteristics of trading methods, measuring (as much as possible) the effect of changes that affect them individually. Also, circumstances for testing "all things being equal" assumptions[3] (a change affecting one market segment but not another, etc.) pave the way for these empirical approaches. These are called "natural experiments".

Due to its strong empirical content, this line of research has contributed a great deal to public debate in the United States, with the establishment of the National Market System in the late 1970s, thus interconnecting stock markets. Academic researchers have therefore made strategic recommendations to market regulators. This academic trend has had a significant influence on financial regulation, documented here by two simple observations:

[1] Biais, Glosten & Spatt (2005).
[2] Biais, Glosten & Spatt (2005) state: "For example, in 2002 and 2003, roughly 360 billion shares traded on the NYSE alone. A transaction cost charge of only 5 cents implies a corresponding flow of USD18bn. This represents an important friction with respect to the allocation of capital. Large transaction costs increase the cost of capital for corporations and reduce the efficiency of portfolio allocation for investors, thus lowering economic efficiency and welfare". A significant amount of literature fueling international financial and economic journals concurs.
[3] Lacking an experimental field, the authors are especially interested in structural changes that can be observed in isolation, such as when they occur in one market segment, but not across the board.

- Nasdaq's reform in the 1990s – the SEC's ATS regulation to open up competition from ECNs – was largely the result of a publication in the Journal of Finance identifying the presence of collusion between dealers[4];
- In the past, the SEC has relied heavily on academics, specifically:
  - Lawrence Harris, *Chief Economist* and Director of the Office of Economic Analysis, from 2002 to 2004, who greatly inspired the *NMS Regulation* which, like the MiFID, is intended to promote competition between trading venues and the use of automated transactions (gradually phasing out the floor);
  - Chester Spatt, *Chief Economist* from 2004 to 2007;
  - Erik Sirri, Chief Economist from 1996 to 1999 and again from 2006 to late April 2009, successively Director of the Division of Market Regulation and Director of Division of Trading and Markets.

The extent to which current work on the impact of dark pools and high frequency trading on market structures[5] will involve the academic world has yet to be observed.

I.2. Three Key Indicators: Liquidity, fragmentation, and price formation quality

I.2.1 Liquidity: A complete concept and useful indicators

I.2.1.1 The concept of liquidity: Scope and limitations

The concept of liquidity has been developed and clarified through academic research. Intuitively, it evaluates the ability of agents to immediately perform transactions on the market. Fundamentally, it therefore represents a synthetic measure of the financial service provided to investors and an assessment of the quality of the contribution that secondary markets make to efficiently funding the economy. This indicator, however, is highly sensitive to the specifics of how markets are organised and regulated (which is also the main premise in microstructure research). Also, in practice, specifying an indicator is complicated because it has to take multiple dimensions into account[6]:

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[4] Christie, Harris and Schultz (1994) and Christie and Schultz (1994).
[5] On 13 January 2010, the SEC announced the next publication of a concept release on the structure of securities markets, more specifically on the following topics: "Market Quality Metrics"; "Fairness of Market Structure"; "High Frequency Trading"; "Co-Location" and "Dark Liquidity" (http://www.sec.gov/news/press/2010/2010-8.htm).
[6] For example, see Hasbrouck & Schwartz (1988).

- **Immediacy**, meaning the time required to complete transactions. This corresponds to the speed at which orders are likely to be executed. Immediacy obviously decreases as the size of orders increases. For small quantities, it is often estimated using various indicators, including the duration between two consecutive transactions, the duration between the time of the transactions and the preceding order, etc.
- **Tightness** of the market, measured by the cost of a round trip (purchase-sale). There are generally three types of indicators for this:
- The quoted spread, which measures the cost incurred by an investor when buying and immediately selling a quantity (number of) shares available at better prices (best limits) at both the time of purchase and the time of sale[7]:

$$\text{Quoted spread} = \frac{(\text{best limit at sale} - \text{best limit at purchase})}{\text{mid - point of spread}}$$

- The effective spread, which measures the cost incurred by a liquidity consuming investor, who is performing a transaction immediately, affecting a quoted price on the market. It is expressed as the difference between the price of the transaction and the midpoint of the spread of purchase and sales prices immediately prior to the transaction[8]:

$$\text{Effective spread} = 2 \times \frac{\left| \text{transaction price} - \text{mid - point} \right|}{\text{mid - point of spread}}$$

- The realised spread represents the difference between transaction price and the price prevailing in the absence of information inconsistencies (fundamental asset value), and therefore decreases in the presence of informed investors:

$$\text{Realised spread} = 2 \times \frac{\left| \text{transaction price} - \text{fundamental price} \right|}{\text{mid - point of spread}}$$

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[7] Note: In order-driven markets, the quoted spread corresponds to the best limits offered for purchase and sale. In dealership markets, each dealer must display a price spread at the time of purchase and sale, for a minimum quantity. The consolidated market spread, or inside bid-ask spread, is then based on the best bid price and the best asking price, with these prices typically coming from different dealers.

[8] Note:
- Book-based transactions are, at best, two best limits. The effective spread must therefore be greater than or equal to the quoted spread.
- A transaction performed at the midpoint has an effectively nil spread.
- Applications on Euronext are performed within the spread of best purchase and sales prices in the book. The effective spread must then be less than or equal to the quoted spread.

In practice, because the fundamental share value is not directly observable, it is usually estimated by the midpoint shortly after the transaction[9] (after dissipating the transaction's potential impacts). A lower spread is then interpreted as a greater ability of the market to offer liquidity in a volatile environment. Also, the difference between realised spread and effective spread represents an opportunity cost or adverse selection cost[10], resulting from the fact that the others involved in the transaction use an informational advantage but do not pay for it.

- **Price resilience** measures the speed at which shocks are absorbed by the market (speed at which market prices incorporate pertinent information to return to their fundamental/efficient value). In other words, it indicates the speed at which transitory price variations due to market inefficiencies (temporary imbalances between buy and sell orders, etc.) are corrected (by the arrival of new orders).
- **Market depth**, which means the amount available on the market for immediately executing at a given price (ex. at the best limits). By extension, it means a market's ability to absorb large-scale transactions without significantly impacting prices. This measure relates to the average size and the total number of executed transactions to the extent that it reflects the fact that large-scale orders must be fragmented. It is also affected by sidedness, or the imbalance between quantities available for purchase and sale.

I.2.1.2 Post-MiFID measures of liquidity

Based on the above, synthetic liquidity indicators can be calculated. Their relevance is obviously based on the choice and specification of underlying indicators and, more fundamentally, the inability to directly observe relevant variables. This specifically relates to the impact measurements that refer to a "fundamental price" concept (incorporating all useful information in an efficient market). In addition, for composite indicators, the relative weight of the indicators (and the interactions between them) is obviously crucial.

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[9] With a "fundamental price" considered to be equal to the midpoint 5 minutes after the transaction, this definition, like the definition for effective spread, matches what SEC provides in its 600 rule. These indicators are part of the monthly reporting by U.S. markets on their execution (requirement of the SEC's 605 rule). Although Hendershott, Menkveld and Jones (2010) provide this specification, the literature has used others (Venkataraman refers to the midpoint occurring 30 minutes after the transaction, and others use the session closing price).

[10] The concept of adverse selection characterises a risk related to the presence of informational asymmetries, namely that uninformed agents benefit from market information on the level of asset prices without paying for it. The occurrence of this risk translates into a reduced incentive for informed agents to reveal information they have when operating on the market, thereby lowering the quality of the price formation process. In practice, this phenomenon is embodied particularly in deteriorated conditions for performing large orders that provide information to the market and cannot be performed instantly (impact cost), and by wider spreads. Fewer informed agents leads to a development of opaque market structures (hidden orders, dark pools, etc.). Hendershott, Jones and Menkveld (2010) show that adverse selection has decreased on the NYSE between 2001 and 2006.

It results in a certain discrepancy between interpretations, according to sources.

Different market sources claim to provide a significant improvement in liquidity since the MiFID went into effect:

- TABB Group notes a significant drop in effective spread for blue chip securities[11] between September 2005 and September 2009, most specifically since the introduction of the MiFID.
- NYSE Euronext[12] establishes a similar conclusion based on statistics concerning the depth of order book best limits for CAC40 securities (see figure 1 below). The market shows a 53% increase in the number of available titles at the order book's best limits between September 2008 and September 2009. The same source, however, qualifies this conclusion[13], noting a stability in the average spread weighted by the volumes of CAC40 and AEX securities. These liquidity indicators provide useful guidance, but they are still quite sketchy. Specifically, they account for a single market, without regard for consolidated liquidity – through multiple trading venues – for the relevant securities.
- In the United States, Goldman Sachs (see figure 3 below) provides an original indicator – effective spread adjusted for depth and volatility – with surprisingly low volatility. This indicator clearly shows a long-term trend toward an increase in liquidity. Without methodological precision (an exact calculation) and additional statistics (sampling, data frequency), it is difficult for us to judge the reads of these findings.

Chart 1

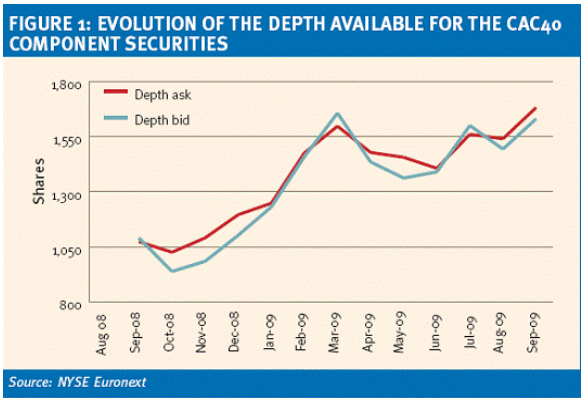
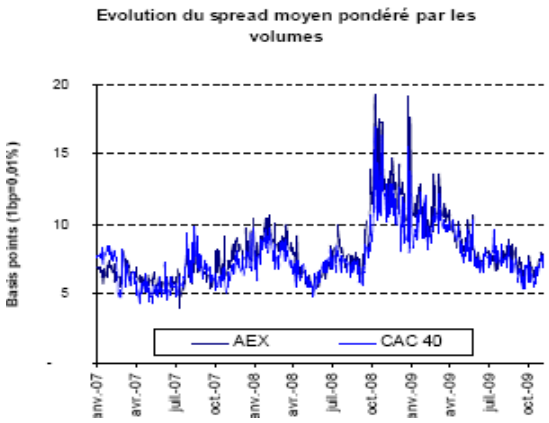
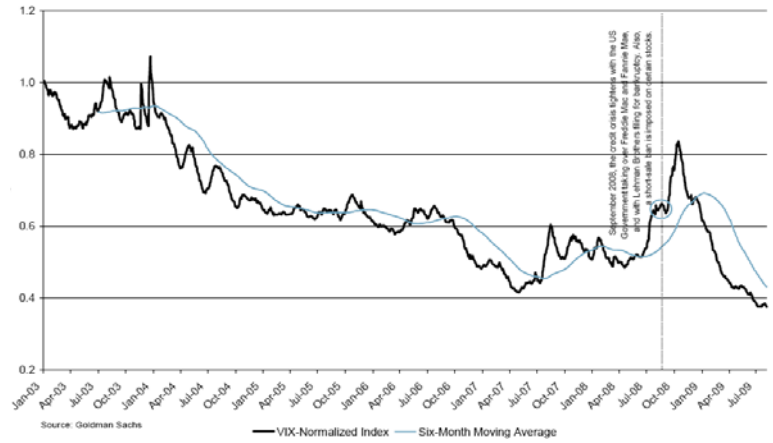


Chart 2



[11] TABB Pinpoint report, 'Effective Spreads in European Equities' from early February 2010 cited by The Trade on 10 February 2010.
[12] Impact of market fragmentation on liquidity, The Trade, October-December 2009.
[13] L. Fournier presentation at the OEE conference "MiFID 2 ans après, Premier bilan de la concurrence entre les marchés" on Nov. 9, 2009 (http://www.oee.fr/html_f/publi02.htm).

Chart 3 - Effective spreads adjusted for depth and volatility (VIX) based on securities in the Russell 3000 index



Source: Goldman Sachs

Other analyses seem to provide more transparency or to be more complete, which reach more nuanced conclusions, namely that liquidity does not show a drastic improvement post-MiFID.

A study by the Bank of France, which led to a publication by Idier, Jardet and Le Fol (2009), puts forward (see figure below) a synthetic liquidity index based on four underlying indicators:

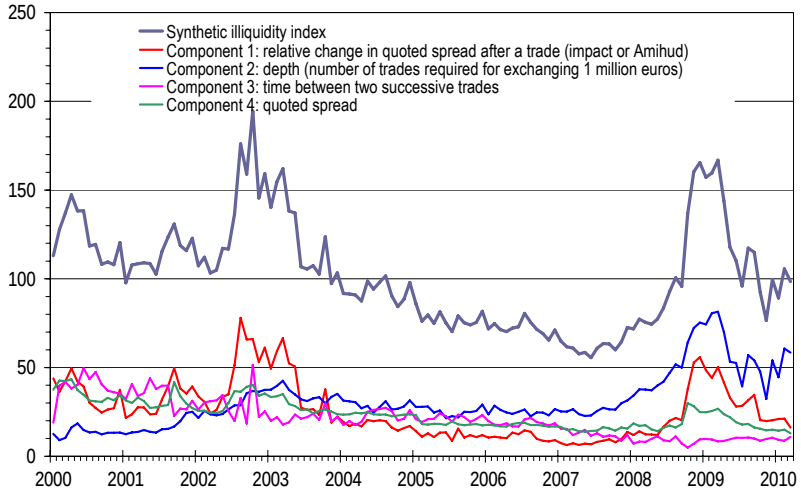
- the daily average quoted spread (tightness),
- the daily average duration (in seconds) between two transactions (immediacy or delay),
- the number of transactions required to trade a million euros – being the number of daily transactions divided by the daily volume of trades, or the inverse of the average transaction size for a given day (depth),
- the relative variation of the quoted spread consecutive to the occurrence of a transaction in order to measure the impact of transactions on the quoted spread (resilience or Amihud),

and uses the Reuters database (*Datascope Tick History*), which consolidates market information on the relevant trading venues.

This indicator – called an illiquidity indicator since high levels reflect a reduced liquidity – measured for securities in the Euro STOXX 50 index[14], has varied as follows:

[14] The cited publication considers four securities – Lehman Brothers (NYSE), AIG (NYSE), Dexia (Euronext Paris) and BNP-Paribas (Euronext Paris). The synthetic indicator was compiled after the publication for Bank of France's tracking needs.

Chart 4 – Synthetic liquidity indicator based on securities in the EURO STOXX 50 index



Source: Bank of France – Department of Monetary and Financial Studies - Economics Research Centre

This data is interpreted based on the choice of underlying indicators (the choice itself being limited to available data), which deserves a discussion of the potential biases affecting each of them and by the equal weighting of the index components[15]. It shows, however, that once the impact of the economic crisis has partially dissipated in early 2009, liquidity levels remained the same as what was observed at the start of the period (from 2000 to mid-2003), which is must lower than before the MiFID took effect. More specifically, the authors note:

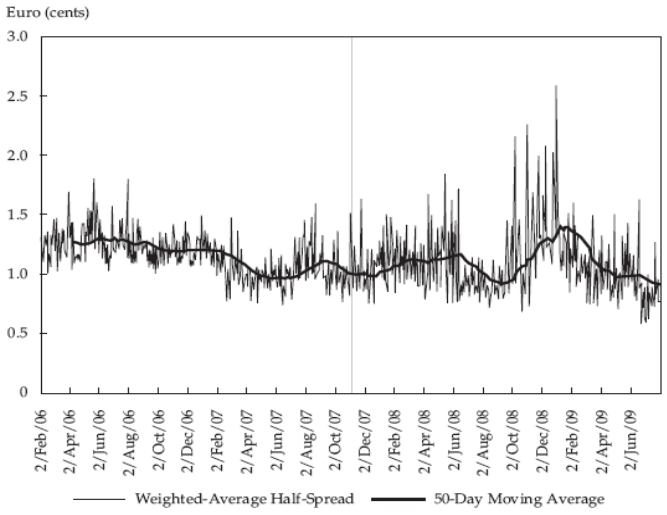
- "*If trading frequency remains stable and quoting spreads go down, the impact of trading (Amihud) continues to be significant, especially as those in the market continue their trend of splitting their orders based on an illiquidity that is perceived as being relatively strong*" and "*Given the uncertainty (…) in terms of illiquidity perceived by agents (…), transaction volumes [remain] (…), still far from their level prior to the economic crisis*";
- In the second half of 2009, "stock market illiquidity continued to normalise. The correction of the 12-month aggregate illiquidity index is about 40%, still far from pre-crisis levels."

CFA (2009) suggests a nominal half-spread analysis[16] using 44 securities that factor into the DJ STOXX 50 index (see figure below). Because it accounts only for daily close indicators and considers only one dimension of liquidity (tightness), analysis of this indicator is rudimentary and

[15] According to the authors, some techniques (factorial models) could prevent having to use an arbitrary weighting.
[16] Daily series of the measured difference in euro cents between the best purchase price and sales price at market close. To express a distance in relation to the spread midpoint, this indicator is divided by two.

does not allow the authors to distinguish a significant change in liquidity between the period prior to November 2007 and the period thereafter. However, it shows that the decline in spreads is significant for most British securities (23 out of 24) and French securities, to a lesser degree (4 out of 7)[17].

Chart 5 – Weighted half spreads for 44 securities factoring into the DJ STOXX 50 index



Sources: FactSet, CFA Institute calculations

The Gresse study (2010b) sponsored by the AMF, comparing samples of non-financial securities listed on Euronext Paris and the London Stock Exchange for periods of comparable volatility (October 2007 and September 2009, see tables on the following page), shows:

- A significant decline in consolidated quoting spreads through the markets since October 2007 for blue chips (from 9.21 to 5.43bp for the FTSE 100, from 6.04 to 4.46bp for the CAC 40) and less significant for other SBF 120 securities (from 14.52 to 11.98bp), which indicates a likely impact of fragmentation and competition.
- A lower reduction of effective spreads for blue chips and no decline at all for SBF 120 securities outside the CAC 40.
- An opposite trend in depths quoted at the best limits, divided (nominal value) by 3.7 for FTSE 100 securities, by 2.2 for CAC 40 securities, and by 1.7 for SBF 100 securities outside the CAC 40. There are several arguments, however, that moderate the significance of the change in market depth. Valuation effects (lower prices) explains a substantial, or even

[17] CFA (2009) notes, however, that British securities, whose trading is the most fragmented, was especially affected by the decline in transaction volumes, despite the increase in trading volumes of bank securities, especially in the United Kingdom.

major, part of this decline, as well as the decline in average transaction size, and more particularly a technical limitation for this indicator, calculated once per second, while the refresh frequency for depth has certainly increased considerably and can therefore not be observed.

In an environment where transaction volumes, adjusted for valuation effects, have remained roughly stable over the given period, the study ultimately concludes that "increased competition has resulted in lower implicit transaction costs", specifying that the quoted spreads have improved significantly for large-cap consolidated markets, which is not the case for each individual market and therefore not necessarily true for those operating in a single market (Those not "consolidating" markets cannot reap the benefits of fragmentation). In addition, the overall benefit of the MiFID in terms of market liquidity must be qualified because only the larger caps (blue chips) have seen a substantial benefit.

I.2.1.3 Interpretive limits

Although it is necessary to observe liquidity changes – which actually remains a challenge in practice – more needs to be done for the purposes of financial regulators as several limitations that have been observed, including:

- Interpreting liquidity indicators requires identifying its determinants in order to isolate the impact of regulations (namely MiFID). Other factors of changes in liquidity thus also need to be identified: short-term developments (the financial crisis), technological progress, industry initiatives of competing firms. The growth in high frequency trading, in particular, promotes the generation (and cancellation) of many small-size stock market orders on multiple trading venues. This probably introduces a "technical" trend toward improved liquidity, which is not directly due to fragmentation, although it may be related.
- More generally, the European regulator – whose best execution rules apply to various cost sources that are likely to affect the transaction – needs to analyse the various cost sources likely to affect investment decisions, including direct execution costs (explicit trading costs that have declined significantly under the effect of competition), research and information consolidation costs, and clearing and settlement costs (post-trading).
- More fundamentally, the liquidity indicators provide little information about the quality of public price formation, which is yet another major objective of the financial regulator.

Below, we will return to recent research on each of these points, including the last, which is abundantly covered in the literature.

Liquidity indicators from samples of non-financial securities – Gresse (2010b)

Transaction volumes

Sample	Period	Volume Traded (KEUR)	Euronext	LSE	Deutsche Börse	Chi-X	BATS Europe	Tur-quoise	Nasdaq OMX Eur.	PLUS	*Fragment-ation Index*
CAC 40 Securities	Oct. 2007	105,322,607	96.45%	2.92%	0.63%	0.00%	0.00%	0.00%	0.00%	0.00%	*1.07*
	Jan. 2009	66,111,453	76.41%	1.63%	0.61%	13.07%	1.28%	6.93%	0.08%	0.01%	*1.65*
	June 2009	67,564,708	70.35%	1.18%	1.30%	16.42%	6.18%	3.74%	0.84%	0.00%	*1.90*
	Sep. 2009	75,847,834	72.44%	0.72%	1.24%	15.29%	3.89%	5.21%	1.19%	0.01%	*1.81*
FTSE 100 Securities	Oct. 2007	191,653,000	0.00%	99.99%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%	*1.00*
	Jan. 2009	76,368,643	0.00%	75.94%	0.00%	14.72%	1.72%	5.82%	0.29%	1.52%	*1.66*
	June 2009	90,706,502	0.00%	71.59%	0.00%	17.14%	4.36%	4.58%	0.71%	1.62%	*1.83*
	Sep. 2009	78,769,760	0.00%	68.96%	0.00%	17.26%	6.26%	5.49%	1.19%	0.84%	*1.95*
SBF 120 Securities Outside CAC 40	Oct. 2007	17,582,701	99.99%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	*1.00*
	Jan. 2009	8,569,064	92.87%	1.15%	0.01%	5.11%	0.31%	0.51%	0.03%	0.01%	*1.16*
	June 2009	9,625,224	80.61%	0.95%	0.02%	13.87%	2.11%	2.26%	0.19%	0.00%	*1.49*
	Sep. 2009	11,937,753	82.47%	0.40%	0.23%	11.90%	1.30%	3.22%	0.47%	0.01%	*1.44*

* This index is calculated like Fidessa's FFI (see below).

Quoted spreads

Sample	Period	*Volatility of Securities*	Overall – All Markets	Primary Market	Chi-X	BATS	Nasdaq OMX	Turquoise
CAC 40 securities	Oct. 2007	*1.37%*	0.0604%	0.0617%				
	Jan. 2009	*9.74%*	0.0644%	0.0943%	0.1121%	0.1871%	0.3566%	0.1107%
	June 2009	*4.41%*	0.0502%	0.0735%	0.0714%	0.0850%	0.1191%	0.1728%
	Sep. 2009	*3.58%*	0.0446%	0.0595%	0.0606%	0.0933%	0.0989%	0.0833%
FTSE 100 securities	Oct. 2007	*1.66%*	0.0921%	0.0921%				
	Jan. 2009	*9.99%*	0.0898%	0.1129%	0.1275%	0.1688%	0.2803%	0.4060%
	June 2009	*6.03%*	0.0638%	0.0864%	0.0862%	0.1024%	0.1295%	0.1614%
	Sep. 2009	*3.81%*	0.0543%	0.0707%	0.0695%	0.0801%	0.1100%	0.0949%
SBF 120 securities outside CAC 40	Oct. 2007	*1.63%*	0.1452%	0.1454%				
	Jan. 2009	*12.12%*	0.2502%	0.2644%	0.3064%	0.2848%	0.2975%	0.0053%
	June 2009	*4.99%*	0.1615%	0.1945%	0.2650%	0.3375%	0.3924%	0.4252%
	Sep. 2009	*4.85%*	0.1198%	0.1399%	0.2722%	0.3017%	0.2882%	0.2553%

Effective spreads

Sample	Period	*Volatility of Securities*	Overall – All Markets	Primary Market	Chi-X	BATS	Turquoise	Nasdaq OMX
CAC 40 securities	Oct. 2007	*1.37%*	0.0493%	0.0493%	-	-	-	-
	Jan. 2009	*9.74%*	0.0614%	0.0612%	0.0637%	0.0592%	0.0597%	0.0730%
	June 2009	*4.41%*	0.0506%	0.0511%	0.0509%	0.0468%	0.0460%	0.0630%
	Sep. 2009	*3.58%*	0.0414%	0.0408%	0.0442%	0.0413%	0.0425%	0.0461%
FTSE 100 securities	Oct. 2007	*1.66%*	0.0744%	0.0744%	-	-	-	-
	Jan. 2009	*9.99%*	0.0721%	0.0716%	0.0780%	0.0739%	0.0642%	0.0833%
	June 2009	*6.03%*	0.0669%	0.0756%	0.0547%	0.0508%	0.0518%	0.0574%
	Sep. 2009	*3.81%*	0.0591%	0.0680%	0.0496%	0.0428%	0.0464%	0.0433%
SBF 120 securities outside CAC 40	Oct. 2007	*1.63%*	0.1130%	0.1129%	-	-	-	-
	Jan. 2009	*12.12%*	0.2010%	0.2010%	0.0778%	0.1055%	0.0161%	0.1122%
	June 2009	*4.99%*	0.1408%	0.1394%	0.1443%	0.1585%	0.1334%	0.2323%
	Sep. 2009	*4.85%*	0.1129%	0.1117%	0.1147%	0.1309%	0.1091%	0.1674%

Depth available at the best limits (in % of the midpoint)

Sample	Period	*Volatility of Securities*	Overall – All Markets	Primary Market	Chi-X	BATS	Nasdaq OMX	Turquoise
CAC 40 securities	Oct. 2007	*1.37%*	132.637	137.146				
	Jan. 2009	*9.74%*	43.280	41.015	34.062	32.386	33.172	33.798
	June 2009	*4.41%*	44.582	43.194	29.296	25.813	23.562	23.224
	Sep. 2009	*3.58%*	59.401	54.846	38.263	27.556	18.279	28.664
FTSE 100 securities	Oct. 2007	*1.66%*	531.017	531.017				
	Jan. 2009	*9.99%*	118.782	113.545	106.008	78.746	16.484	88.798
	June 2009	*6.03%*	137.711	159.549	131.612	83.381	51.881	36.401
	Sep. 2009	*3.81%*	142.950	134.107	116.373	68.551	68.272	38.685
SBF 120 securities outside CAC 40	Oct. 2007	*1.63%*	35.028	35.222				
	Jan. 2009	*12.12%*	16.937	16.919	8.329	7.079	6.285	0.339
	June 2009	*4.99%*	17.955	18.216	14.489	12.610	13.069	13.110
	Sep. 2009	*4.85%*	21.113	21.594	14.378	13.153	11.432	13.459

Source: Gresse (2010b), on the IFS database.

I.2.2 Fragmentation: Easy to measure, hard to analyse

I.2.2.1 Fragmentation: Scope and limitations

Market fragmentation is a complex notion put forward by the literature, which provides the basis for the calculation of synthetic indicators followed by various market stakeholders. Its importance is all the greater as the regulator has fostered it to promote competition between trading systems, and these indicators show (for the purpose of best execution) to market participants where the relevant trading venues are. The concept itself is intuitive, characterising a trading organisation in which trading services come from multiple suppliers entering into competition, which therefore differs from a concentrated market. However, it is not exempt from ambiguity. Specifically:

- The scope of trading services considered. The concept can be applied to the industry as a whole or to each market in isolation. It can apply to more or less specific services in the order processing chain (information distribution, order processing, transactions, etc.) that are intended to satisfy various investment needs.
- The product (service offering) perspective does not necessarily reflect the positioning of those involved and the competition. An analysis of governance (capitalistic links between competitors) especially appears to complement fragmentation. It is also important to distinguish between fragmentation and segmentation, such as when market segments are interconnected.
- The existence of substitutes (to shares and therefore to trading services) can complicate fragmentation analysis. This could be a research topic on its own.

Gresse (2001) also distinguishes between different degrees of fragmentation, depending on whether a security is handled on multiple systems in a single market (satisfying the needs of different trades), on multiple interconnected trading systems (possibly with arbitrageurs as an informal link between markets), or in extreme cases, on different trading systems without any sort of formal link to organise competition.

I.2.2.2 Measures of fragmentation

In practice, Gresse (2010a) differentiates two forms of fragmentation:

- Fragmentation between what we qualify here as "public" markets (regulated markets and multilateral trading systems subject to pre-trade transparency obligations) and "off-market" (dark pool, systematic internalisation and OTC). An indicator consists of the simple ratio of trading volume on "public" markets to the total volume traded on all markets. Its relevance is strongly conditioned by the – currently low – quality of information on the "off-market".
- More specifically, fragmentation between various trading venues of trading flows on public markets. In an environment where regulated markets (or "traditional operators") have seen their market share erode, the author assesses the extent of fragmentation by the market share of the historically established regulated market, which corresponds, for example, to market share indicators published by Transactions Auditing Group or Intelligent Financial Services.

Fidessa, an agency broker, also suggests an indicator of this second type[18] of fragmentation.

Chart 6 – Fidessa Fragmentation Index (FFI)

Source: http://fragmentation.fidessa.com/

Table 1 – Fidessa Fragmentation Index (FFI)

FTSE 100	2.33
FTSE 250	1.95
CAC 40	1.93
AEX	1.90
DAX	1.90
BEL 20	1.73
SMI	1.65
OMX S30	1.64
OMX H25	1.56
FTSE MIB	1.48
ISEQ	1.45
OMX C20	1.23
OSLO OBX	1.19
PSI 20	1.14
IBEX 35	1.01

[18] CA Cheuvreux (2010b) suggests an alternative specification in the form of an "entropy index".

The Fidessa Fragmentation Index (FFI) is calculated for Europe's main markets (Table 1). The index is calculated per share and per index as the inverse of the sum of squares of the market shares of each individual trading venue, or the inverse of the average market share, weighted by market share:

$$FFI = \frac{1}{\sum_i (\text{market share}_i)^2}$$

where i describes the security trading venue (including dark pools and OTC).

An FFI of 1 indicates no fragmentation, and Fidessa considers an index greater than 2 as characterising a security (or index) that no longer has a reference market, which we believe is objectionable in an environment in which the LSE continues to count for about 60% of trading volumes subject to the pre-trade transparency obligation.

Examination of early 2010 FFI:

- Emphasises the FTSE 100 as significantly superior, meaning that it is clearly more fragmented than any other major European blue chip indexes (the CAC 40, the AEX, and the DAX, with indexes between 1.7 and 1.8). The most reliable statistics on volumes traded on regulated markets and the MTFs also confirm the general perception (see Figure 5).
- Shows that the large cap securities (blue chips), understood largely as the set of liquid CESR securities[19] and strictly as the securities that make up key indices in European markets, generally form the bulk of markets in which order fragmentation is observed and there is competition between markets. However, Gresse (2010a) finds the opposite relationship to be true in the United Kingdom, namely a higher degree of fragmentation on lower cap securities.
- Calls some reservations on the quality of underlying statistics on OTC markets, whose variability is significant, with likely effects of double-counting. This makes it difficult to assess the actual level of fragmentation in European security markets. However, it is undeniable that fragmentation has grown.

[19] For the purpose of defining regulatory responsibilities and implementing MiFID provisions related to pre-trade transparency, applicable to systematic internalisers, this concept was defined in the Official Journal of the European Union on 2 September 2006. The list of liquid securities is available on the CESR site: http://mifiddatabase.cesr.eu.

These fragmentation indicators may be useful as indicators of the level of competition between markets. They are typically analysed in terms of their relationship with liquidity indicators:

- Citing the findings reached by O'Hara and Ye (2009) for the United States (see 2.1.2 below), Foucault (2010) reiterates the findings of Foucault and Menkveld (2010), a study said to show the benefits of competition between the LSE and Euronext on Dutch securities in 2004. Fragmentation can improve consolidated liquidity. It is important in that respect to consider liquidity consolidated through markets and to take into account the effects of competition on explicit trading costs. Fundamentally, however, this finding is strongly qualified by the ability to violate price priority rules in the consolidated market[20]. The best execution specification is important here. In order to obtain collective benefits from fragmentation, it is necessary that, even when there is very little individual benefit to order routing compared to the costs involved, the best execution obligation must be followed. The regulator's involvement is therefore necessary in order to prevent "trade-throughs". It is therefore necessary to establish:
    - . Interconnectivity between markets (as in the United States);
    - . Smart order routing systems (involving substantial costs in the absence of standardised market data).

- Gresse (2010a) initially confirms this analysis using post-MiFID data from April to June 2008. "*Turnover and fragmentation are positively correlated, a high turnover favouring fragmentation, and reversely, fragmentation generating more volumes*," but Gresse qualifies, *"The factor that most determines market-traded order flow fragmentation appears to be the primary exchange's competitiveness."*

  More specifically: "*The average correlation between local effective spreads and the fragmentation rate of the total order flow is weakly negative (but significant at the 10% level). (…) As for global quoted and effective spreads, they significantly decrease with the fragmentation of market-traded order flow.*"

  The scope of these conclusions is certainly limited by the granularity of data available to the author. Further work (on behalf of the AMF) by Gresse (2010b)[21], however, tends to confirm them.

[20] A simple price priority on the consolidated market, whose Consolidated Tape infrastructure reflects the best limits, is the U.S. "best execution" specification. Violations of this rule are called trade-throughs.
[21] Professor at Université Paris-Dauphine and AMF scientific board member.

I.2.3 Price formation efficiency is measured rather crudely

I.2.3.1 Incomplete research on relevant concepts

Measuring the quality of security price formation is still an empirical and theoretical challenge. Like Hasbrouck and Schwartz (1988) and Hasbrouck (1995) and consistent with literature use, Gresse (2010a) is based on a theoretical framework in which informed agents and uninformed agents interact on efficient markets. The author accordingly derives an indicator based on deviations from efficient market prices:

> " *Theoretically, if prices are perfectly efficient, they should follow a random walk and price autocorrelation should not be significantly different from zero. In the absence of auto-correlation, a variance ratio reporting k times the variance of returns measured on -minute intervals to the variance of returns measured on k -minute intervals should equal one. In the case of sticky prices, -minute returns are positively correlated, so that the ratio exceeds one. Conversely, in case of over-reaction, -minute returns are negatively correlated, and the ratio is lower than one. The closer the ratio to one, the more efficient the prices.*
>
> *I use two variance ratios: a ratio reporting 15 times the 1-minute mid-quote return variance to the 15-minute mid-quote return variance, and a ratio reporting 6 times the 5-minute midquote return variance to 30-minute mid-quote return variance.*
>
> *The distances between those ratios and 1 can be considered as inverse measures of price quality. They will be referred to as price inefficiency coefficients and thus denoted PIC. More explicitly, PICs are calculated as follows*:
>
> $$PIC_{i,t}^{1-15} = \left|1 - 15\frac{Var_{i,t}^{1\min}}{Var_{i,t}^{15\min}}\right| \quad PIC_{i,t}^{5-30} = \left|1 - 6\frac{Var_{i,t}^{5\min}}{Var_{i,t}^{30\min}}\right|$$
>
> *where* $k.Var_{i,t}^{\alpha\min}$ *represents the part of the variance* $Var_{i,t}^{\alpha k\min}$ *observed by uninformed agent, thereby making it possible to analyse the impact of strategic behaviour on information (see Biais et al. (1997)* ".

There are some remaining questions on how to set up these indicators (which also explain the use of several of them). More basically, their theoretical foundations remain fragile, and their interpretation limited by the diversity of factors that may influence price formation, which are not restricted solely to the effect of market structure and, more specifically, fragmentation. Biais et al. (1997) mentions various elements that may play a role: information costs, the ability of agents to influence market prices, etc. More generally, the authors note that models studying the transmission of information by prices typically involve five strong assumptions: The market

includes a risk asset and a risk-free asset. Agents, who are divided into informed and uninformed agents, are risk averse and form rational expectations about asset prices. Uninformed agents have a competitive behaviour. Some studies examine some point of the analysis more deeply, but there is not a benchmark indicator at this time.

I.2.3.2 Measures of market efficiency

Based on an analysis of data from April to June 2008, Gresse (2010a) uses an econometric examination of correlations between PIC and fragmentation to show "*a positive correlation between inefficiency coefficients and market-traded order flow fragmentation, that is a deterioration of prices' quality*".

Based on daily indicators, comparing the 440 days before the MiFID's entry into effect and the 440 days after it, CFA (2009) uses much more basic statistical and econometric means. It finds that:

- The volatility of returns and quoted spreads have increased sharply (and significantly), and the correlation between daily return volatility and the Fidessa fragmentation index is positive and meaningful;
- "Price formation efficiency tests", or the extent to which daily closing prices follow a random walk[22], does not support the conclusion of a structural change between the two periods under observation: "*We can conclude that price movements must be approximately equally random over the two periods; there is no evidence to suggest that price formation is any more, or any less, efficient since the implementation of MiFID.*"

It is probable that these conclusions are largely qualified by the frequency of observed data, by the effects of the crisis and by the methodology implemented. The first one seems to provide relevant information because the increased return volatility and bid-ask spreads seemed observable, even before the economic crisis. The second, however, seems unreasonable because it is overly dependent on the daily frequency of the data and subject to methodological weaknesses of implemented tools.

[22] Simple stationarity tests with and without a trend.

II. GENERAL GUIDELINES PROVIDED BY ACADEMIC LITERATURE

On these bases, academic research identifies major regulatory trade-offs and furthers the analysis with a view to systematically isolate the effects at stake. The two main types of regulatory arbitrage emphasised in academic literature are: consolidation versus fragmentation and transparency of trades versus liquidity, with the understanding that these types of arbitrage are not mutually exclusive. It should be noted, however, that the former category stresses transaction costs as an evaluation criterion while the latter focuses on the quality of price formation.

II.1. Fragmentation and consolidation: two contrasting market trends

II.1.1 Consolidation of order flows: a natural trend

Traditionally, the markets are supposed to be all the more liquid in that orders (which reflect the intention to carry out transactions) are directed towards a single point of confrontation, offering each the maximum opportunity to find one or more counterparties. In this respect, the market is interpreted as being two-sided, with the satisfaction of one type of participant's needs (the buyer's) complementing that of the other type of participant (the seller's)[23]. From this standpoint, the market can be considered as a network, for which the value of services provided (liquidity) increases with the number of participants (members)[24]. As market operators anticipate the placement of orders (liquidity) on a given market, their orders tend to converge towards a single platform. In this set-up, liquidity begets liquidity and the consolidation of liquidity in a single place of execution is self-reinforcing: the markets are natural monopolies. In the past, such assessments supported the regulatory principle of the consolidation of orders, particularly the market monopoly prevailing in France.

A certain number of positive aspects are associated with consolidation:

- Fixed costs associated with the management of market infrastructures generate economies of scale;

[23] See Rochet and Tirole (2001) for more details on the definition of two-sided markets.
[24] Mendelson (1987); Shapiro and Varian (1999. Chapter 7), show the positive impact of network externalities from a general standpoint; Economides (1996, 2001) show their implications in finance. Domowitz and Steil (2001) examine the impact of these externalities on the financial securities markets.

- The cost of obtaining information is reduced (as well as, potentially, brokerage costs)[25];
- There is greater sharing of risks between market participants[26].

Conversely, fragmentation can have negative effects in that it:

- Generates trading infrastructure duplication costs as well as market information consolidation costs;
- Can negatively impact the price discovery process. In fact, certain empirical studies show that the dominant market has a more efficient price discovery process[27];
- Where there is information asymmetry, Gresse (2010a)[28] notes an increase in the risk of adverse selection[29]: Chowdhry and Nanda (1991) demonstrate that the costs of adverse selection rise with the number of (multiple)venues. Easley, Kiefer and O'Hara (1996) and Bessembinder and Kaufman (1997) also establish that a market can cream skim uninformed – the most profitable – orders, thus hurting the liquidity of the primary market. According to Glosten (1989), in the event of strong adverse selection, fragmentation can spark risks (which could be labelled systemic) that the market as a whole might not return to equilibrium prices.

Under certain conditions, however (see Moinas (2009)), fragmentation is neutral, particularly:

- If liquidity providers have free access to the various markets, their inventory management automatically leads them to consolidate the markets[30];
- If investors have free access to the various order books, if the markets are pre-trade transparent and investors fragment their orders[31].

II.1.2 Fragmentation does have advantages, however

The market's monopoly also has disadvantages: it has no incentive to reduce (explicit) trading costs or to innovate in order to take investor preferences into account. Furthermore,

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[25] Flood, Huisman, Koedijk, Mahieu (1999).
[26] Pagano (1989)
[27] According to Easley, Kiefer and O'Hara (1996), there is a significant difference between the information content of orders executed on the NYSE versus orders executed on the Cincinnati exchange. Hasbrouck (1995) establishes the prevalence of the NYSE's price discovery process. Biais, Glosten and Spatt (2005) discuss these studies and place them in perspective.
[28] See also Admati and Pfleiderer (1988).
[29] See footnote 10, for more information on the concept of adverse selection.
[30] Lescourret and Moinas (2007).
[31] Biais, Martimort and Rochet (2000).

management of a monopoly raises practical issues in terms of appropriate market governance[32]. Finally, openness to competition does not necessarily generate losses for the established monopoly insofar as it enjoys the advantages of the "first comer", and an established liquidity pool – as the above-mentioned externalities work against newcomers – is difficult to contest.

On these bases, Hamilton (1979) demonstrates the ambiguity of fragmentation effects: on the one hand, it increases competition and the incentive to provide better prices; on the other, it can reduce liquidity on each market and/or consolidate (consolidation generates positive externalities, fragmentation generates symmetrical effects). Concretely, the author measured a positive net effect (though small) of competition between the NYSE and regional exchanges in the US at the time the National Market System was set up[33].

A substantial volume of literature has reviewed, mostly prior to the entry into force of the MiFID, and more particularly in the US, the impacts of market fragmentation from a variety of angles[34]. Overall it has placed fragmentation in a positive light, and as mentioned has had a significant influence on regulations. Schematically speaking, the benefits of fragmentation are shown as attributable to the impact of competition on direct transaction costs and implicit costs (liquidity), in a context where the market participants' various trading requirements require to be taken into account.

Table 2 – Selection of articles from international journals on the impacts of fragmentation on market structure (*Journal of Finance*, *Review of Financial Studies*, *and Journal of Banking & Finance*)

Authors	Market	Methodology	Main Finding
DeFontnouvelle et al.(2003), JoF.	U.S option markets	Compare measures of liquidity after and before the advent of competition for order flow in US option listings	Spreads decline and depth increase when options become listed on multiple markets
Mayhew (2002), JoF	U.S option markets	Compare options traded on a single market with options traded in multiple markets	Options with multiple listings have smaller bid-ask spreads
Boehmer and Boehmer (2004), JbF	U.S ETF markets	Compare measures of liquidity after and before entry of the NYSE in the trading of 30 ETFs	Significant reductions in bid-ask spreads and increases in depth after entry of the NYSE.
Fink et al.(2006), JbF	U.S equity markets	Changes in liquidity measures for Nasdaq stocks from 1996 and 2002	Decline in bid-ask spreads, in part due to increased competition from ECNs.
Hendershott and Jones (2005), RFS	U.S ETF markets	Compare liquidity measures after and before Island goes "dark" for 3 ETFs in 2002	Significant increase in trading cost. Decrease in quality of price discovery

Source: Foucault (2010)

[32] Grillet-Aubert, Oriol (2007)

[33] Without the necessary data, the author could not take OTC transactions into account, which constitutes a second unobserved source of fragmentation.

[34] Fishe and Harris (2003), Mayhew (2002), Battalio et al. (2004), Biais, Bisière and Spatt (2004), Foucault and Menkveld (2008), O'Hara and Ye (2009) and Gresse (2010).

More specifically, the following benefits have been associated with fragmentation:

- Trading fees (explicit costs): competition encourages the markets to offer competitive prices. For example, Declerck and Moinas (2009) emphasise the self-perpetuating effect of decreased trading fees on Euronext in 2004 on liquidity. The drastic decline in regulated market prices following the adoption of the MiFID in Europe revealed a similar phenomenon in 2008-2009.
- Liquidity: two recent publications are of particular interest here:
- Foucault and Menkveld (2008) show that the competition provided by a second order book (specifically, the Dutch Trading Service launched by the London Stock Exchange in 2003 to compete with the Amsterdam exchange) deepens the market by allowing liquidity makers to work around the time priority of orders;
- O'Hara and Ye (2009), looking at six different liquidity and market efficiency indicators on the U.S. market from January to June 2008, note a greater improvement on stocks for which trading is fragmented than on those for which it is not[35]. In other words, fragmentation is associated with lower transaction costs and higher execution speed. The strength and significance of these impacts differs according to the size of the firms and depending on the market on which the stock is listed. True, fragmentation increases short-term volatility; however this impact is statistically insignificant.

  On these bases, the authors believe the improved liquidity to be linked to the fragmentation between highly interconnected and "virtually consolidated" markets. Consequently, it is thought to be closely linked to the existence of consolidated tape, the presence of efficient order routing systems and the specification of the "trade through rule" (which requires the offering of the best market price). It should be noted that in this case, fragmentation is measured by the percentage of total off-board transaction volumes[36]; however, the relationship of this indicator with the transparency of transactions has not been reviewed, due to lack of data[37]. Consequently, the observation concerning the capacity to consolidate market data cannot be supported by more specific arguments on the impact of transparency on the benefits of fragmentation.

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[35] The authors correct the potential biases linked in particular to the size of the company (large and small caps) and the level of the stock price (small caps usually come with higher transaction costs).

[36] Fragmentation appears to be highest for Nasdaq shares, with Nasdaq small caps being more fragmented than large caps. However, while NYSE shares are usually less fragmented, large caps are slightly more fragmented than small caps on this exchange.

[37] Data on consolidated tape transactions (which, for best execution purposes, centralise the information from Trade Reporting Facilities (TRFs)) still cannot be used to identify execution platforms. As such, the impact of fragmentation cannot be examined in terms of the level of transparency of new platforms.

- Heterogeneity of investors (size, patience, information, costs): the development of alternative trading platforms is made possible by several differentiating factors, i.e. platforms that serve different needs. In particular:

    . The need to reduce the impact of transactions leads, above all, initiators of large orders to seek anonymity[38]. From a more fundamental standpoint, this need can justify the co-existence of multiple, differently-structured trading platforms, as demonstrated by the following two studies:

    . Seppi (1997) compares execution costs on a hybrid market and a limit order book based on the size of investor requirements. He concludes that large institutional investors and small individual investors obtain better execution quality on hybrid markets, while investors carrying out mid-sized transactions should give priority to limit order books. While the markets compete with each other, they nevertheless target different client bases.

    . Gresse (2006) demonstrates the complementarity between a dealer market (DM, governed by prices) and a crossing network (CN) such as ITG's POSIT, where counterparties can trade mid-range, though generating non-execution risks on high orders. Typically, CNs appeal to market makers as they can "pool their risks", i.e. they can use the system to rebuild their inventory of securities after serving as market makers. However, this assumes that the presence of investors liable to make "opportunistic" use of the CN would not generate negative impacts outweighing the benefits of risk pooling. In this context, the author shows that the benefits of the CN (the reality of which has been proven for POSIT) are probably attributable to the fact that the volume of transactions is relatively low compared to the total volume of market transactions.

    . Finally, Foucault and Parlour (2004) show that platforms can distinguish themselves through their pricing structure in order to meet heterogeneous trading requirements. They demonstrate that two platforms can co-exist if they offer different cost structures for related services (trading fees and listing costs), but which affect listed companies differently depending on the type of costs in question (some companies are more sensitive to listing costs, others to trading costs on the secondary market).

[38] Foucault, Moinas and Theissen (2003) prove that the ability to execute transactions anonymously (or not) has implications on market liquidity.

As such, in Europe the pricing structure is probably one of the major pillars of competition exercised by MTFs vis-à-vis the regulated markets. Asymmetrical structures have been adopted that differentiate the prices applied to liquidity-maker orders versus liquidity-taker orders. In some instances, they can even lead operators to pay for liquidity-maker orders or even, as seen in the United States, to pay more for liquidity makers than for liquidity takers (inverted pricing). Some properties of asymmetrical pricing structures are reviewed by Foucault, Kadan and Kandel (2009). We refer to them in the section on high-frequency algorithmic trading.

Colliard and Foucault (2010) establish, however, that the effects of fragmentation on explicit trading costs are predominant, though this point of view calls for further observation (see 4.1.2).

- Technological modernisation or "innovation":

  After the creation of an international listing segment by the London Stock Exchange (SEAQ I), the big bang of the European exchanges in the late 1980s[39] inspired the Bourse de Paris to adopt an electronic system, among other things. Similarly, competition between ECNs in the US paved the way for the more systematic use of electronic trading and sped up execution times. It is noteworthy that the major US markets (Nasdaq and NYSE) only later "followed suit", mainly by buying ECNs to acquire their technology. And once the MiFID was adopted in Europe, MTFs set up low-latency trading systems (very high execution speed), ushering in the modernisation of the regulated markets eager to offer the same types of services. Since then, intermediaries and markets have developed market access offerings in which the former provide direct market access (DMA) and the latter develop hosting (co-location) infrastructures within market systems, for intermediary and/or investor trading systems to cut down on execution latency times[40].

On the whole, research underscores the benefits of fragmentation and the resulting competition, i.e. lower explicit costs, satisfaction of heterogeneous trading requirements and modernisation of technological infrastructures. The impacts on liquidity are considered positive contingent upon the transparency obligations (and technical order routing solutions implementing them) that apply to consolidate the market.

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[39] An excellent description of market structure developments during this period is provided by Benn Steil in ECMI (1996).
[40] IOSCO (2009) offers a discussion of the different forms of this concept and its regulatory implications.

II.2. Dark pools and arbitrage between transparency and liquidity

II.2.1 Dark pools: a concept calling for clarification

First of all, one should note that mechanisms for providing liquidity without displaying it on the order books have been around for a long time on regulated markets, where they have taken the form of hidden (iceberg) orders. They now account for a substantial portion of the liquidity on the main regulated markets[41] and inspire considerable creativity on the markets, which have recently created several new types of orders. Research generally confirms the positive impact of using this type of order on liquidity. In particular, Anand and Weaver (2004) show that the introduction of iceberg orders on the Toronto Stock Exchange in 2002 expanded the consolidated depth of the order book. Moinas (2006), however, theoretically demonstrates that, while it is logical for iceberg orders to have a positive impact on market efficiency (price formation), such an impact is not necessarily true on liquidity, and is in that respect largely dependent on the other types of orders authorised on the market.

We must therefore expand upon the definition of a dark pool as an electronic trading platform subject to pre-trade transparency exemptions. This can be done by looking at the nature of interactions with visible liquidity, and according to the types of exemptions that apply – here, under the current European framework, we can distinguish between hidden orders on regulated markets, large in scale orders, reference price orders and negotiated deals[42].

In the competitive environment created by the MiFID, "transparent" MTFs (i.e. MTFs publishing pre-trade data) have attracted most of the liquidity outside the established regulated markets, with transaction volumes in dark pools still low at this point compared to total transaction volumes[43]. Competition between MTFs and regulated markets therefore did not initially develop on the basis of transparency, but rather on the basis of pricing structure, post-market treatment costs and, more temporarily, technology (execution time). It is only recently that - in an environment where regulated markets have adjusted their offering accordingly (reductions and changes in pricing structure, lower execution times, etc.) and competition between MTFs has intensified - the ability to execute orders without pre-trade transparency requirements has

41 Moinas (2006) cites Tuttle (2002), according to whom iceberg orders account for 25% of total depth for Nasdaq 100 stocks at the best quotes, and D'Hondt, De Winne, François-Heude (2004), who estimate it at 45% at the best five quotes and 55% at the best quotes on Euronext Paris. They also note that these orders are often modified or cancelled. We would also point out that orders can only be partially hidden in Europe, whereas they can be completely hidden in the US.

42 See CESR/09-324 "Waivers from Pre-trade Transparency Obligations under the Markets in Financial Instruments Directive (MiFID) - 20 May 2009 Update at: http://www.cesr-eu.org/data/document/09_324_Update_06012010.pdf.

43 In late 2009, dark pools registered as MTFs or segments of MTFs accounted for 1.2% of the total equity transaction volume in Europe (source: Thomson Reuters).

become a significant differentiation criterion. In any event, as far as Europe is concerned, fragmentation and competition have only recently encouraged the expansion of dark pools, either as distinct capitalistic entities or as additional segments of "transparent" MTFs or regulated markets. Their growth has nonetheless been impressive. It could also benefit from the reclassification of certain intermediaries' trading activities. For example, Nomura recently announced that it wanted to register its internal dark pool of liquidity as an MTF.

The concept of dark pools can be expanded further as to include automated executions on crossing networks[44] and even, where applicable, off-market broker transactions. Clarifying the terminology used is therefore a prerequisite to any analysis in this area.

II.2.2 Research's contribution is not cut and dry

In analytical terms, pre-trade transparency on liquidity has ambivalent effects:

- On the one hand, it reduces information costs, makes it easier to anticipate cost of impact (and, therefore, the price of transactions ultimately carried out[45]), and reduces information asymmetry - thus improving market efficiency, especially in cases of significant asymmetry[46]. Furthermore "it is a necessary condition in all developed arguments so that investors can divide their orders between markets in order to reduce their costs"[47].
- Conversely, it increases the exposure of liquidity providers, i.e. the risk of adverse selection. Opacity can thus improve liquidity by reducing order exposure costs (risk of adverse selection) and makes it possible to factor in heterogeneous investor requests. Madhavan (1995) establishes from a theoretical point of view that the lesser transparency of alternative trading platforms not only tends to fragment but also to reduce the quality of the market by increasing volatility and decreasing price formation efficiency.

Two "natural experiments" in the reduction (resp. increase) of North American market transparency provide contradictory results on this point: Hendershott and Jones (2005) on the ETF market segment of the Island platform in the US, which became opaque in 2002[48], and

[44] Note: the crossing networks mentioned here are different from the crossing networks referred to by Gresse (2006). The former are MTFs operating by virtue of pre-trade transparency exemptions. The latter are internal bank systems that automatically match liquidity using algorithms and order routing systems (Smart Order Routers).
[45] Moinas (2009) provides references on this point.
[46] Biais et al. (2004).
[47] Moinas (2009).
[48] Bortoli et al. (2006) also reviews similar changes to the Sydney Futures Exchange and reaches the same conclusion as Madhavan et al. (2005).

Madhavan, Porter and Weaver (2001) on the Toronto Stock Exchange in April 1990 – the year a computerised system was installed to disseminate detailed information on limit orders to the public in real time.

Hendershott and Jones (2005)[49] examine the Island platform's September 2002 decision to go dark on securities in a highly competitive market segment. They show that the decline in liquidity (an increase in spreads observed only on this market) pursuant to the decision resulted in the migration of trading volumes outside of the dark pool, thus enhancing fragmentation on a market segment initially dominated by the Island. The deterioration in the overall quality of the market for the securities in question went hand-in-hand with a deterioration in price formation, as prices take longer to incorporate new information. In October 2003, drawing on the consequences of its market share losses, the Island reintroduced transparency on the securities in question. The efficiency of price formation and liquidity subsequently improved, but the Island failed to regain the dominant position it previously enjoyed. Despite the structural differences which make it hard to transpose conclusions (particularly across the Atlantic), the properties of this "natural experiment" give it a certain degree of universality: beyond a given size, a market's opacity detracts from the liquidity formed on the market as well as the efficiency of the price formation process.

Madhavan, Porter and Weaver (2001) arrive at opposite conclusions in their review of an older "natural experiment"[50]: "Our empirical results strongly support the view that transparency matters in the sense that it has an economic effect on trading costs and liquidity. We find that higher transparency does not improve market quality. In particular, our analysis shows that transaction costs increase after the introduction of the rule change, even when controlling for other factors that may affect trading costs, such as volume, volatility, and price. This finding is consistent with a decrease in liquidity under transparency because limit-order traders are reluctant to offer free options to other traders. Cross-sectional evidence shows that the reduction in liquidity and increase in transactions costs are associated with reductions in asset values, consistent with the predictions of Amihud and Mendelson (1986) and Brennan and Subrahmanyam (1996). There is no evidence, however, that spreads of cross-listed stocks widen in other markets, nor is there any significant order-flow migration from one exchange to another."

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[49] Hendershott and Jones, (2005).

[50] To cite the authors, "A natural experiment occurred on 12 April 1990, when the Toronto Stock Exchange (TSE) instituted a computerised system to disseminate real-time detailed information on the limit-order book to the public. This rule change applied to both the stocks traded on the TSE's floor (the more actively traded issues), as well as to the less actively traded stocks traded on the TSE's computer-aided trading system (CATS), and the rule change allows us to study the impact of a dramatic increase in pre-trade transparency *on the same stocks in the same market structure*."

It should be noted that, as specifically regards crossing networks (dark pools trading mid-range, at prices imported from regulated markets), the results are also contradictory. Hendershott and Mendelson (2000)[51] establish that cream skimming effects, by virtue of which only non-executed orders are redirected to the markets, reduce liquidity and possibly welfare. Hendershott (2010) stresses that this result can remain valid even if the volumes executed on the dark pool are low and despite a potential improvement in the price discovery process. However, these results contradict the above-mentioned results established by Gresse (2006).

The divergence of these conclusions calls for caution: their generality - and their validity in the European environment - must be placed in perspective. In other words, they appear to depend on the context of the study and the market structures under review. An alternative conclusion might be that there is a threshold (some percentage of "opaque" transactions, to be determined) beyond which the negative impacts of opacity exceed the potential benefits.

II.2.3 The effects of opacity on liquidity and price formation need to be reassessed

The trade-off between liquidity and transparency is of greater importance in the context of the development of dark trading (trading not subject to pre-trade transparency obligations, by virtue of the various exemptions authorised by the MiFID). As we have seen, academic studies offer tools to analyse the impact of this opacity, but have not been sufficiently implemented at this point. As far as Europe is concerned, it would be appropriate to examine the dynamics of interactions between the development of opacity and price formation, as market liquidity appears to remain relatively abundant. Certain intermediaries have even expressed concern over this:

> "*Pre-trade transparency, which was one of the major pillars of the MiFID, has deteriorated and liquidity on lit markets has become illusory. The deterioration in the quality of Lit markets on the whole (primary markets and MTFs) has increasingly driven traders towards the Dark (dark portion of MTFs and crossing engines) in order to protect the interests of their clients, which are asking them to access all pockets of liquidity. The concerns that have arisen regarding price formation mechanisms cannot be alleviated by regulating the Dark without discrimination, but rather by restoring the quality of the lit markets.*"
>
> CA Cheuvreux (2010a)

[51] According to Hendershott and Mendelson (2000), cream skimming effects, by virtue of which only non-executed orders are redirected to the markets, reduce liquidity and possibly welfare. This effect can be large even if the dark trading volume is small.

This point of view still needs to be supported, particularly as it is difficult to model the behaviour of traders whose strategies are endogenous with respect to trading rules applicable and information available to them.

Finally, there are three aspects liable to play a role in this type of analysis:

- Given the creativity in terms of market structure, transparency now forms a "continuum". IOIs (indications of interest), for example, are messages that the members of dark pools can transmit to a select group of other members to convey their interest in trading at certain quantities. Without getting into issues relating to equality of market access, they constitute a limited form of opacity whose specific impacts must be observed;
- The size of orders liable to be exempt from pre-trade transparency obligations has fallen considerably due to the widespread use of algorithms fragmenting large orders;
- Finally, best execution methods and in particular infrastructure connectivity and order routing mechanisms are crucial and have not often been studied as such. According to Klagge, Sarkar and Schwartz (2009), "the real concern about the dark pools of today should not be that they are dark; it should be that connectivity may not be a viable substitute for consolidation".

III. THE DEVELOPMENT OF ALGORITHMIC AND HIGH-FREQUENCY TRADING IS CENTRAL TO MARKET TRENDS

The development of algorithmic trading, and more particularly of the high-frequency trading (HFT), has major consequences for the organisation of equity markets. As a subcategory of algorithmic trading, the notion of HFT was inspired mainly by consultants (echoed by the media). As such, it warrants being revisited and examined on the basis of all the information available to the market regulator. Its development also crystallises a number of recent changes in market structure that raise both fundamental and practical questions with respect to market regulations. Extending the work on fragmentation and liquidity described earlier, microstructure research has already started measuring the impacts of HFT on market quality. We will look into the existing literature here, and will also identify future areas of investigation.

III.1. The chief characteristics of HFT

III.1.1 The notion of HFT: scope and limits

III.1.1.1 Definition

HFT is generally defined on the basis of two main criteria: the implementation of automated high-frequency trading strategies and the type of investors – proprietary traders – who use such strategies.

On the first point, HFT is characterised by strategies aimed at exploiting investment opportunities of short duration. Very fast market-access (very low latency) is therefore consubstantial to their success. A strict definition of HFT also limits it to the search for opportunities liable to generate small unit gains, which only become profitable when automated trading processes multiply them. The quest for speed accordingly extends from execution to trading, i.e. the process of identifying investment opportunities and generating orders. In practical terms, and in a fairly broad sense, as the presence of trading opportunities is closely linked to the conditions under which orders are executed, algorithms and HFT systems fully factor in these two aspects of trading. Given their sensitivity to market conditions and the strategies of other players, HFT strategies must, lastly, constantly reassess their own relevance. They therefore involve generating, routing, modifying and, frequently, cancelling, very large numbers of orders.

On the second point, HFT operators are characterised by the fact that they invest on own account, whether they be bulge-bracket banks or hedge funds[52]. In that sense, the goal, especially for HFT in the strict sense of the term, is to make gains on a small amount of capital by means of an intensive use of the appropriate trading infrastructure. As such, it is vital that high-frequency traders make economies of scale and that invested capital be turned over very quickly, as market positions are generally closed on a daily basis.

On the whole, the term HFT, which also applies to the traders who use HFT techniques, thus designates funds and investment banks that develop algorithms to industrialise the exploitation of potentially small trading opportunities on their own account.

This definition corresponds to that used by consultants and as such supplies the basis of estimates of the prevalence of HFT used in the media. It also corresponds to the terminology more generally used in the financial industry and is largely consistent with that of the SEC in the United States.[53]

III.1.1.2 Limits

Certain aspects of the definition are nevertheless still debatable. A number of points require clarification, both theoretically and in terms of assessing the HFT phenomenon:

- The distinction between high-frequency trading and **third-party trading** (agency trading) also reflects the fact that brokerage services cover only the part of the transactional chain relative to the execution of orders (not that relative to the identification of trading opportunities), which has implications on the strategies used. **Execution strategies generally aim above all to limit implementation shortfall.** As such, they tend to fragment orders to spread the execution out over time. In practical terms, banks' brokerage services can nevertheless use, where appropriate, the

[52] Those with the highest media profiles include Citadel, Getco, Kyte, IMC, Madison Tyler, Man and Renaissance.
[53] According to the SEC's Concept Release dated 10 February 2010, HFT refers to "professional traders acting in a proprietary capacity that engage in strategies that generate a large number of trades on a daily basis. These traders could be organised in a variety of ways, including as a proprietary trading firm (which may or may not be a registered broker-dealer and member of FINRA), as the proprietary trading desk of a multi-service broker-dealer, or as a hedge fund (all of which are referred to hereinafter collectively as a 'proprietary firm').
Other characteristics often attributed to proprietary firms engaged in HFT are:
(1) the use of extraordinarily high-speed and sophisticated computer programs for generating, routing, and executing orders;
(2) use of co-location services and individual data feeds offered by exchanges and others to minimise network and other types of latencies;
(3) very short timeframes for establishing and liquidating positions;
(4) the submission of numerous orders that are cancelled shortly after submission; and
(5) ending the trading day in as close to a flat position as possible (that is, not carrying significant, unhedged positions overnight)."

same high-frequency trading systems as for proprietary high-frequency trading and automated execution techniques with a similar level of sophistication;[54]

- The distinction between proprietary trading and trading on behalf of third parties also begs the question, in both fundamental and practical terms (for instance when quantifying the scale of HFT), of whether it makes sense to include certain proprietary trading activities within the scope of HFT. **Market-making activities - i.e. the contractual obligation for the market maker** to quote buying and selling prices for minimum quantities of securities[55] – supply a specific service in terms of providing liquidity to the market, which is separate from the potential non-contractual provision of liquidity by other HFT operators. In any event, estimates of HFT flows on record – probably also for practical reasons stemming from the impossibility of separating this type of trading from the mass of trades undertaken by banks and brokers[56] – do not exclude market-making business from the scope of the HFT (see below)[57]. More specifically, it is also necessary, in this context, to determine how the transient interposition of brokers' own account in third-party trades (riskless principal trading) is dealt with[58].

It is in any event symptomatic that, in a quest for information aimed, among other things, at identifying the impact of HFT on market structure[59], the SEC proposes, to avoid any ambiguity, to apply its new declarative rules[60] without directly designating a category of market operators such as high-frequency traders.

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[54] Schematically speaking, two main types of execution algorithms can be distinguished. So-called "rustic" algorithms such as the VWAP (volume weighted average price) spread out the execution of fractions of the initial order with a view to obtaining an average execution price close to the VWAP of the session, on the basis of change in transaction volumes observed during past trading sessions. Complex implementation shortfall algorithms optimise the execution under different constraints expressing the originator's preferences and adapt dynamically to market conditions in order to minimise both risks relating to execution time and the orders' impact cost. Their implementation is often termed black-box trading. But there is an abundance of algorithms on offer, in addition to these two extreme cases.

[55] Note that beyond these criteria, a constraining market-making obligation can also bear on the level of spreads and/or prices quoted. In this respect, the SEC questions, in a report entitled "Preliminary findings regarding the market events of May 6, 2010", dated 18 May 2010, "the need to examine the use of 'stub quotes', which are designed to technically meet a requirement to provide a 'two-sided quote' but are at such low or high prices that they are not intended to be executed".

[56] A report by Rosenblatt Securities (2009), the primary aim of which was to assess the size of the HFT market, notes that "the portion of HFT flows that comes from high-frequency strategies within big banks and the brokerage firms is nearly impossible to sort from those firms' customer and non-HFT proprietary trading businesses, because orders for both are typically sent through the same telecommunications lines without separate identifiers".

[57] An additional complicating factor in the distinction between contractual market making and market-making strategies is that some HFT operators can, as is that case for Getco on the NYSE, adopt market-maker status (i.e. of NYSE Designated Market Maker).

[58] See, for instance, the SEC's rule 10b18-§a12 defining "riskless principal transaction" in the United States.

[59] Judging by, for instance, the questions contained in the Concept Release dated 10 February 2010.

[60] Refer to the SEC's public consultation document dated 19 April 2010 on a proposed Large Trader Reporting System.

III.1.2 Prevalence of HFT

Despite the consensus on the definition, there are sometimes significant differences in the estimates of the prevalence of high-frequency trading.[61] Judging by benchmark consultant publications released in the final quarter of 2009, estimates of the prevalence of HFT flows in total equity trading volumes in the United States vary from 42% to two-thirds[62] (see Table 3). There are fewer estimates for Europe, where the phenomenon is not as widespread. Rosenblatt Securities (2009) nevertheless reckons that HFT accounts for roughly 35% of trading volumes and agrees with Celent (2009) that the proportion is "growing fast".

Table 3 – Prevalence of HFT flows in equity markets in the United States and Europe

	Date of publication	**United States**	**Europe**
TABB Group	*Sep. 2009*	61%	-
Celent	*Dec. 2009*	42%	Rapidly growing
Rosenblatt Securities	*30 Sep. 2009*	~66%	~35% and growing fast

Whatever their differences, these measures generally attest to the fact that HFT now account for a significant and growing share of trading volumes (see Chart 7). As the average size of high-frequency trades is small, HFT's share of trading volumes no doubt underestimates these trades' importance in the process of price formation. Last of all, these observations are backed up by a number of empirical observations made both in the United States and in Europe: increase in the number and frequency of orders (and, to a lesser extent, trades), increase in the ratio of the number of orders to the number of trades, reduction in the size of trades and tick sizes, and, above all, surge in order-cancellation ratios, which are now running at extremely high levels. As an indication, the Surveillance Department of AMF has shown, for instance, that three hedge funds known for implementing HFT strategies on the French market together accounted for 39.6% of orders on CAC 40 stocks in April 2010, and that they cancelled 96.5% of these orders (see Table 4).

In the space of a few years, orders generated by high-frequency traders have therefore – at least as far as the most liquid stocks are concerned – come to represent the lion's share of order books on the main equity markets. As such, they no doubt play a non-negligible role in the price-formation process for the stocks concerned.

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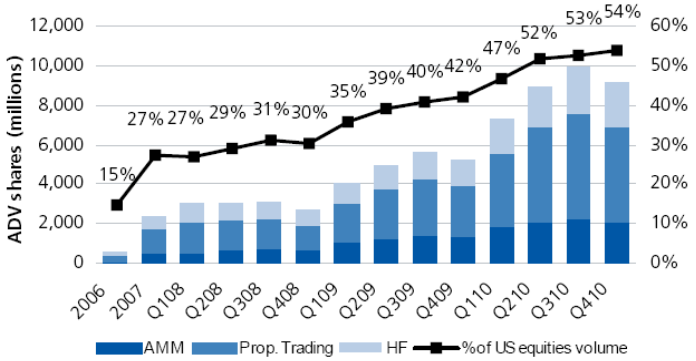
[61] The SEC highlights this point in its Concept Release.

[62] Celent nevertheless includes, as does Rosenblatt, automated market makers, i.e. market makers in the strict sense of the term (subject to contractual obligations to offer securities for purchase and sale), in the scope of its analysis.

Chart 7 – Share of equity trading volumes attributable to HFT flows in the United States



Source: WFE, SEC Rule 605 data, HFR, Exchanges, Celent estimates
Note: There is an overlap with the HFT estimates for hedge funds, proprietary trading, and market-making due to inseparable functions and categorizations (i.e., hedge funds also have significant market-making operations).

Table 4 – High-frequency trading indicators for hedge funds belonging to Euronext Paris and conducting algorithmic trading

	Number of orders per trade*	**Number of orders** (in thousands)	**Average amount of an order on a CAC40 stock** (EUR)	**Cancellation ratio** (%)
PSI1	164.8	15,193	8,402	99.1
PSI2	45.1	24,812	7,060	97.0
PSI3	25.4	175	505,834	97.3
PSI4	23.8	315	29,056	94.3
PSI5	6.9	3,559	11,855	81.6
PSI6	4.7	47	27,568	61.9
PSI7	1.6	7	24,318	49.2
PSI8	0.6	9	719,363	38.8

* NB: large orders can be executed in several trades in which case the ratio will be inferior to 1.

III.1.3 HFT operators and strategies

III.1.3.1 The three main types of HFT strategies

We make here a distinction between three main types of HFT strategies:

- Non-contractual market-making strategies[63], which involve placing buy and sell orders on the same stock in order to earn the bid-ask spread. As for all market-making operations, such strategies are exposed to the risk of adverse directional movements in market prices – i.e. the risk of buying in a bearish market and selling in a bullish market. Spreads are accordingly revised constantly to factor in the state of the market. Lastly, one may note

[63] With exceptions, such as that of Getco, cited above.

that market makers also make aggressive (liquidity consuming) trades, when they need to rebalance their holdings (reconstitute their holdings in a stock after a buoyant market phase, reduce it after a selling market). In general, they do this when liquidity is abundant and relatively cheap. This however considerably limits observers' capacity to qualify the behaviour of market makers as such.

- Instantaneous arbitrage strategies. These very diverse strategies aim to identify and benefit from valuation anomalies. Such anomalies are identified by differences in the price of a single stock listed on different trading venues (which implies a fragmentation of the market for the stock concerned[64]), but also between the prices of substitutable or generally highly correlated securities. Such securities can belong to the same asset class – arbitrage can, for instance, be made between equities in a single sector – but also between different asset classes – in which case arbitrage is made between a basket of equities and a corresponding ETF, or between spot securities and derivatives (futures, options, etc.).
- Directional strategies. Directional strategies include mean-reverting strategies, which assume that a price deemed statistically improbable will return to levels closer to the average. They are similar to strategies described in the previous category, but stand out by dint of the fact that the arbitrage is carried out over time. There are also trend-following or momentum strategies, which look for the continuation or the amplification of an upward or downward market trend on a security. As is the case for instantaneous arbitrage strategies, the fundamental difference between these strategies is the nature of the signal on which they are based, whether it is technical, statistical or fundamental, as for event-driven strategies that aim to be the first to benefit – sometimes by automating the interpretation of a market news flow – from the impact of information on prices.

It should be noted that HFT strategies are generally implemented in liquid and electronic markets. The use of pre-trade information, as supplied in regulated equity markets, is not always necessary for their implementation. In fact, while they have reached a high level of sophistication in transparent markets for equities, ETFs and listed derivatives (especially in the US), HFT

[64] Note on this point that Foucault and Menkveld (2008) stress that prior to the implementation of MiFID, market players did not spontaneously and systematically consolidate fragmented markets (in the case in point, the market for Dutch stocks traded on Euronext). As such, these markets offered trade-through opportunities. One may ask to what extent best execution under MiFID has changed this. But as execution policies do not always require brokers to consolidate markets (i.e. to execute trades at the best price across all relevant trading venues), it may well be that things have not in fact changed much.

strategies can also lead their initiators to enter dark pools of liquidity[65] or electronic and highly liquid OTC markets (forex, US Treasuries, etc.[66]).

More specifically in relation to equity markets, HFT strategies in the strict sense of the term defined here above tend to be applied to a small number of stocks, as well as, generally speaking, ETFs of highly liquid blue-chip indices. Taking a broader definition of HFT, strategies can also be applied over longer periods (more than one day) and also be implemented in less liquid markets. The type of stocks traded on Euronext Paris by a certain number of operators identified as HFT (low latency funds) is shown in Table 5 below. This table highlights the bipolarity between operators that rarely trade more than 100 stocks and those that trade several hundred and which as such are present in a much broader range of market segments.

Table 5 – Presence of operators in algorithmic trading (April 2010)

	Number of ISINs traded	CAC 40 + Next 20	SBF 120	SBF 250	All Eurolist	Blue chip ETFs	Sectorial ETFs	Commodity ETFs	Index Warrants
PSI 1	670	■	■	■	■	■			■
PSI 2	261	■	■			■	■		
PSI 3	220	■	■	■		■			
PSI 4	192	■	■			■		■	
PSI 5	175	■				■			■
PSI 6	107	■	■						
PSI 7	80	■	■						
PSI 8	60	■				■			

III.1.3.2 HFT operators are highly diverse

On this basis, HFT operators form a relatively mixed group that can be broken down on the basis of various criteria: their status (broker-dealer, hedge fund, etc.), their size, their strategies, the markets in which they operate, etc. Schematically speaking, there are three types of operators. The first comprises global players, boasting substantial capital bases and heavy infrastructure. Some of these, such as the large investment banks (Goldman Sachs, Credit Suisse, etc.), implement a very wide spectrum of strategies. The second consists of certain hedge funds who specialise in specific strategies, particularly those described as market-making by their initiators, such as Getco, Tradebot or Madison Tyler. There is finally also a diverse group of specialised operators, often mono-[67] or multi-strategy hedge funds (see Tables 6 and 7). Lastly, there is an entire category of players that implement high-frequency strategies on a more secondary basis – for instance to round out a range of private banking services.

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[65] One of the leading global proponents of high-frequency trading, US player Getco, operates a dark-pool platform via its subsidiary GES (Getco Execution Services).

[66] The Wall Street Journal dated 13 May 2010 reports that the standardisation and systematic use of the clearing houses of OTC and, even more so, CDS markets is currently attracting interest among HFT players.

[67] Some significant and acknowledged operators, such as Getco, Tradebot and EWT/Madison Tyler publicly lay claim to a market-making role.

Tables 6 and 7 – Types of operators in algorithmic trading

Broker-dealer-operated prop firms, market-making operations	Instruments	Arbitrage strategies	Exchanges
Goldman Sachs, Morgan Stanley, Getco, Citadel, Tradebot	Liquid equities, foreign exchange, futures, listed equity options	Statistical arbitrage, merger arbitrage, index arbitrage, latency arbitrage	US: BATS, NYSE Arca, Nasdaq, Direct Edge Europe: LSE, Euronext
Boutiques	**Instrument marketplaces**	**Quantitative strategies**	**ATSs, MTFs**
Archelon, Optiver, Schonfeld	Dealer markets, interdealer markets, exchange markets	Trending, predictive strategies, event-driven	US: CrossFinder, Sigma X, PIN Europe: Turquoise, Chi-X, BATS
Quant hedge funds	**Popular instruments**	**Trading costs**	**Dark pools**
Citadel, Fortress, GLG, Amaranth	Highly liquid equities	HFT strategies must provide returns after trading costs are deducted	Rarer, but possible. Preference for dealer-operated dark pools.

Source: Celent, company press reports

Market	Representative Firms
US Equities	GETCO, Citadel, Tradebot, ATD, Lime Brokerage, Sun Trading, QuantLab
Europe Equities	Optiver, IAT, Tibra, Citadel
US Futures	DRW, Jump Trading, GETCO, Citadel, Infinium
Canada Equities	Swift/Biremis, Tradebot, Infinium, GETCO
US Equity Options	Peak6, Citadel, Timber Hill, Ronin Capital
Asian Equities	Optiver
Foreign Exchange	EWT, Jump Trading, GETCO, Fat Trading, Citadel

Source: Rosenblatt Securities

III.1.3.3 The profitability of HFT

The growing prevalence of HFT and an observation of the activity of some recognised operators – which finance access to numerous markets, make substantial technological investments[68], obtain clearing house member status, etc. – is testimony to the profitability of HFT strategies. The financial press, for instance, reports that Getco made a profit of $400 million in 2008, noting that the company was valued at an estimated $1.5 billion in 2007[69]. However, information on this topic is a closely guarded secret among the firms in question, which are afraid that reverse engineering will be applied to their strategies[70] and that their rivals will squeeze their opportunities for profit. In any event, consultants' estimates on the total profits made by HFT strategies on the US equity markets tend to average roughly $10 billion ($8.5 billion, for instance, according to Tabb Group in 2009). Some observations have been made about the risk of this profitability being overestimated. Kearns, Kulesza and Nevmyvaka (2010), for instance, point out that the theoretical maximum profit that an omniscient and "aggressive" (liquidity consuming) operator can make (in under 10 seconds) from all trading opportunities available on the US equity markets is only $3.4 billion. This observation is in our view pertinent, but of little use, as it is highly conditional on what opportunities for profit are taken into consideration. Above all, it does not factor in the market-making strategies deployed by a number of major HFT operators. Rosenblatt Securities (2010) also noted that a profit of $400 million for one of the market's leading players is probably

[68] For instance, a Reuters wire dated 9 July 2009, headlined "Citadel sues former employees who set up Teza Tech", cites court papers showing that "the hedge fund firm said it spent hundreds of millions of dollars to develop strategies, software and hardware, or what is sometimes referred to as the 'secret sauce' of the high frequency business".
[69] "Meet Getco, high-frequency trade king", Wall Street Journal, 27 August 2009.
[70] In other words, that other operators will deduce information on the strategies they implement by analysing their profitability. As the behaviour of an algorithm is predictable, it can, once it is known, be used by other market players.

inconsistent with some estimates cited in the media, putting aggregate profits for the sector at $20 billion. This observation certainly makes a point, but does not shed light on future trends.

III.2. The impact of the HFT on market structure

III.2.1 Interactions with market structure

The very existence of HFT stems from the presence of market structures that create opportunities for profit. Given its importance as a phenomenon, HFT can also have an influence on market structures that are liable to be favourable to it. Without looking at the complexities of this interaction, we will attempt to list some observed or possible effects, in either sense.

III.2.1.1 Factors favourable to the development of HFT

The implementation of HFT strategies is highly sensitive to very specific aspects of the market structure. In schematic terms, we have distinguished three types of factors that are favourable to the development of HFT: exogenous structural factors, short-term exogenous factors and factors related to the functioning of the markets.

- Long-term structural factors are above all related to:
  - Technological progress. The rollout of cutting-edge technologies along the entire order-processing chain, from the collecting and processing of information to market access, is a response to the quest for faster trading and execution;
  - Regulations, change in which is conditioned by technological progress and the resultant financial innovation, not to mention the internationalisation of financial activity (in Europe, through the desire to integrate the internal market), and by the goal of achieving a return on investments in market infrastructure via economies of scale geared towards reducing trading costs. These factors have prompted profound reform of the competitive framework governing securities-market trading, leading ultimately to Reg NMS, MiFID and the current market fragmentation.
- Short-term factors are linked to the liquidity crisis and the ensuing increase in the cost of capital. Against this backdrop, some financial analysts have dubbed HFT a new business model, especially for bulge-bracket investment banks at the time of the liquidity crisis, in

that it allows returns to be generated on potentially small capital commitments by dint of their intensive use[71].

- Endogenous factors in the development of HFT flows represent the measure, more difficult to assess, to which the HFT phenomenon is self-fuelling.

In theory, arbitrage and market-making strategies cease to be profitable above certain thresholds. Intuitively, competition between arbitragists and between market makers should in the medium term lead to equilibrium between the preponderance of HFT flows in trading volumes and the consolidation of HFT operators. The level of this equilibrium, which cannot be defined at this stage, nevertheless characterises a general trait of hedge funds, namely that their performances tend to decrease as the volume of assets they manage increases, as investment opportunities are systematically exploited and become scarcer[72].

In practice, HFT players, given their importance in the revenues and governance of execution venues, also exercise a direct and considerable influence on market structure[73]. High-frequency trading accounts for a big slice of trading revenues, as well as specific services required by HFT players (high-frequency data flows, low latency market access infrastructure, etc.). This influence is demonstrated, for instance, by the LSE's recent about-face: just a few months after adopting a less favourable pricing structure (from September 2009 to February 2010) for HFT operators (remunerating orders by liquidity suppliers), it returned to a structure more suited to their specific needs. It is even more evident for MTFs, of which HFT operators are not only the main commercial targets, but often also shareholders[74]. We will return later to the various aspects of this influence of HFT on the microstructure, but one of the major issues in the competition between execution venues has undoubtedly been the adoption of market structures favourable to HFT.

On these foundations, it is difficult to make projections about the growth of HFT in Europe. Bearing in mind that we appear to have reached certain technological limits, such projections need to take into account factors such as:

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[71] For instance, financial analysts in the banking sector, such as Morgan Stanley's Huw van Steenis and Bruce Hamilton, developed flow trading early in 2009. Note that constrictive provisioning standards for banks could also foster the development of this type of business model in the future.

[72] See, for instance, Fung, Hsieh, Naik and Ramadorai (2008): "Hedge funds: performance, risk, and capital formation", Journal of Finance; August.

[73] This point is developed by Rosenblatt Securities.

[74] Most MTFs are promoted by their users, originally mainly banking consortiums. Hedge-fund HFT operators are also shareholders – like Citadel, Optiver and Getco, which own stakes in Chi-x. BATS, in the United States, was founded in 2005 by one of the leading HFT operators, Tradebot, and has Getco among its shareholders. Note however that MTFs launched recently in Europe by Nomura and UBS, which result from the transformation of internal order-crossing systems into dark pools of liquidity, do not have open capital structures.

- The scope for reducing the cost of post-market processes and more generally explicit transaction costs;
- The possibility (and this is obviously dependent on the previous point) of implementing HFT strategies on new asset classes – especially OTC derivatives;
- Possible change in market structures that are important for HFT strategies (tick sizes, market access, pricing structures, etc.) – under the influence of operators and, where appropriate, market regulations.

III.2.1.2 The effects of HFT on market structure

We will now list the effects of HFT on microstructure, market access and pricing.

- **Effects on the microstructure**

HFT has fragmented liquidity in terms of both time and space.

In terms of time, it has considerably accelerated the **frequency with which orders find their way into order books and are then modified and/or cancelled, and the frequency with which trades occur.** The lifecycles of some orders are now counted in microseconds, and execution techniques are close to the physical limits of transmission of information (transmission of the signal at the speed of light). Examples are given below for a particularly active day's trading on a CAC 40 stock in Paris in April 2010. It appears that some operators are able to modify messages less than 10 microseconds (µs or one thousandth of a second) after sending them to the market, and that orders can in some cases have lifecycles of less than 7 µs.

In spatial terms, competition between trading venues has in Europe sparked a race to **reduce tick sizes.** One initiative of the Federation of European Securities Exchanges (FESE) in the summer of 2010 appears to have put an end to this trend, by promoting an agreement between the various venues concerned aimed at harmonising tick sizes in Europe. Under this agreement, tick sizes can now be reduced to as low as €0.0001 for shares with low prices (less than €0.5).[75] It is interesting to note that the use of tick sizes has fostered greater dispersion of liquidity, now less constrained by restrictive tick sizes (see Chart 13).

[75] Tick sizes vary depending on the value of the shares, thereby representing a relatively stable percentage.

The effects of HFT on the microstructure are many and varied, and we have not covered them all in this brief description. The **multiplication of order types,** for instance, is also in part attributable to HFT, in that it is liable to facilitate the automation of different strategies.[76] In any event, the fragmentation of liquidity **mechanically has the effect of increasing very short-term volatility.**[77] Academic research also shows that liquidity has a natural tendency to cluster at certain periods rather than at others, creating intraday liquidity cycles.[78]

Descriptive statistics – Typical example of an active trading day on a blue chip on Euronext Paris in April 2010

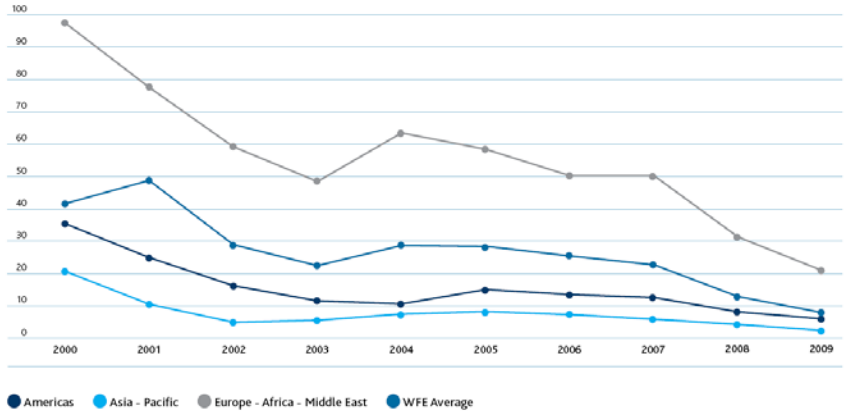
Number of orders during the session:	540,000
Number of messages (new orders, modification or cancellation of orders in the order book, execution of a trade):	800,000
Concentration of order flows (as a percentage of the total number of orders submitted):	
PSI 1	32%
PSI 2	20%
PSI 3	12%
PSI 4	10%
PSI 5	5%
Total of the top 5	80%
Frequency of orders:	up to 600 messages per second (of which 190 from a single ISP)
Shortest lifecycle of an order cancelled before execution	25 µs
Minimum time between 2 consecutive messages from a single ISP:	7 µs

NB: ISPs that achieve gaps of less than 10 µs between 2 successive messages are the 6 biggest issuers of orders (by the number of orders)
Source: AMF - DESM

This change has also has a significant effect on the **average size of trades,** which has fallen considerably. This has prompted a market dynamic in which the growing impact of large orders is increasingly causing them to be fragmented and, potentially, where anonymous execution is sought in dark pools of liquidity.

[76] Pegged orders, for instance, tend to suit the needs of market-making strategies. O'Hara (2010) provides an interesting analysis of match-only orders offered on some American markets (in Europe, it is illegal to dissimulate an entire order), the aim of which is to detect the presence of orders hidden among market-to-limit orders. Interestingly, it is also noted that the liquidity quotes created by the NYSE in 2002 (see Hendershott, Jones and Menkveld (2008)), which were large limit orders for institutional trading executable against aggressive Institutional Xpress orders, have not had as much success as orders aimed typically at satisfying HFT requirements.
[77] When measured on brief intervals, corresponding to the frequency with which trades occur.
[78] Foucault, Kadan and Kandel (2009) offer several references on this subject.

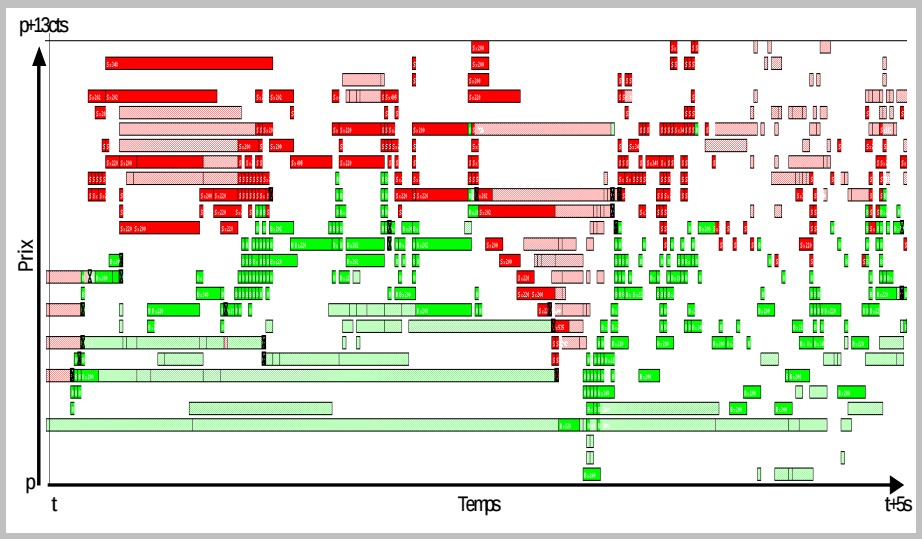
Chart 8 – Reduction in the average size of trades ('000 USD)



Source: World Federation of Exchanges

In overall terms, the nature of liquidity in order books now differs greatly from what it was just a few years ago, in a context where the price-formation process results in large part from the confrontation of algorithms that automate the implementation of various HFT strategies and execution algorithms for third parties.

Chart 9 - 5 seconds of trading on a blue chip on Euronext Paris



The coloured lines correspond to the successive limits of the order book of a blue chip traded on Euronext Paris. Red represents sell orders and green represents buy orders. Dark colours relate to orders from operators using HFT strategies. Crosses represent actual trades. Source: AMF - DESM

- **Effects on market access**

Market latency and related technologies[79] are critical for the success of HFT strategies. Coming on top of membership costs for the various execution venues and the cost of collecting and consolidating information in a fragmented universe, the use of these technologies also has repercussions on operators' industrial organisation.

There are essentially two types of market access aimed at reducing latency: sponsored access and direct access as market members. The first involves brokers – under the responsibility of the investment company – providing market access hardware to their clients. The second designates co-localisation services offered by markets to their members. These services involve physically installing members' trading and execution systems close to the systems managing the markets' order books. On the proviso that they have critical mass, thereby meeting the requirements placed on market members, HFT operators should in theory opt for co-localisation services, which are said to offer the lowest latency. These considerations need however to be seen in the light of the fact that the consolidation of order flows by brokers can reduce trading costs (digressive scale), as we explain below.

- **Effects on the pricing of execution services**

The development of HFT has also had the effect of modifying the **pricing structures** of the various execution venues. This has often involved paying market-making orders, i.e. those that supply liquidity, and charging market-taking orders, which use liquidity (this is known as a make-take fee).[80] However, some regulated markets, including Euronext,[81] have pricing structures that are favourable to proprietary traders; others, such as Deutsche Börse, favour those that use algorithms.[82]

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[79] See II.1.2.

[80] In some cases, such as that of Amex on options (see media release dated 30 September 2009), the pricing structure is actually inverted, so that orders by market takers are charged at a lower rate than orders by market makers are paid (in Amex's case, the announced rates were 3 and 2.5bp respectively).

[81] Jovanovic and Menkveld (2010) note that Euronext "*charges a fixed fee of €1.20 per trade, which for an average size trade of €25,000 is effectively 0.48 basis points. Highly active brokers benefit from volume discounts that can bring the fee down to €0.99 per trade (~0.40 basis points). The act of submitting an order or cancelling it is not charged (i.e., only executions get charged without an aggressive/passive distinction). But, if on a daily basis the cancellation-to-trade ratio exceeds 5, all orders above the threshold get charged a €0.10 fee (~0.04 basis points)*."

[82] Gomber and Gsell (2009) note that for algorithmic orders eligible for Deutsche Börse's Automated Trading Program (ATP), "*depending on the accumulated monthly ATP volume per ATP member, a marginal rebate of up to 60% of trading fees applies*". They further note the underlying definition of ATP transactions: "*The exchange defines ATP transactions as 'all transactions that have been generated by an electronic system of either the ATP member or the ATP member's clients, whereby the electronic system has to determine two out of the three following order parameters: price (order type and/or order limit where applicable), timing (time of order entry) and quantity (quantity of the order in number of securities)' (Deutsche Börse AG 2008, p.1). […] The thereby generated orders have to be channelled directly into the Xetra system without further manual intervention*."

Maker-taker pricing structures have probably benefited HFT operators overall[83] in that they tend to favour market makers. They have in any event more generally been beneficial to HFT by fostering the fragmentation of order flows between specialised platforms in response to the requirements of certain types of operators.

A theoretical model built by Foucault, Kadan and Kandel (2009) shows that pricing tends to become asymmetrical in certain cases: when tick sizes are small (to compensate market makers that do not receive much on small tick sizes), when the market-making side is much weightier than the market-taking side and when the ratio of monitoring costs for market-takers to monitoring costs for market-makers is large.

Table 8 – Asymmetrical pricing structures (make-take fees) in the United States (end-2009)

In cents for 100 shares	**Tape A** (NYSE listed)			**Tape B** (Nasdaq listed)			**Tape C** (NYSE Arca/Amex listed)		
	Limit order (make fee)	**Market order** (take fee)	**Difference**	**Limit order** (make fee)	**Market order** (take fee)	**Difference**	**Limit order** (make fee)	**Market order** (take fee)	**Difference**
AMEX	-30	30	0	-30	30	0	-30	30	0
BATS	-24	25	1	-30	25	-5	-24	25	1
LavaFlow	-24	26	2	-24	26	2	-24	26	2
Nasdaq	-20	30	10	-20	30	10	-20	30	10
NYSE Arca	-25	30	5	-20	30	10	-20	26	6

Negative signs indicate rebates. Source: Traders Magazine, July 2008, cited by Foucault, Kadan, Kandel (2009)

Table 9 - Asymmetrical pricing structures (make-take fees) in the United States (end-2009)

In basis points	**Limit order** (make fee)	**Market order** (take fee)	**Difference**
Chi-X	-0.20	0.30	0.10
BATS	-0.20	0.30	0.10
Turquoise	-0.24	0.28	0.04

Source: Foucault (2010a)

[83] Foucault, Kadan and Kandel (2009) highlight the conflicting views of Getco, known to be a promoter of market-making strategies, and Citadel, which probably develops more directional strategies (which use up more liquidity): "*Getco strongly believes that the advent of maker-taker pricing in the options markets [...] has resulted in numerous benefits [and that] imposing artificial fee caps will harm the quality of executions for options customers, including retail customers*", Getco comments regarding NYSE Arca's proposed rule change to amend its schedule of fees and charges (SR-NYSEArca-2008-075), 2 September 2008. "*Citadel Investment Group L.L.C urges the SEC to address distortions in the options markets caused by the excessive fees that may be charged by exchanges using maker/taker pricing*", Citadel petition for rulemaking to address excessive access fees in the options markets, 15 July 2008.

III.2.1.3 Effects of HFT on competition between market and operators

- **Effects on competition between execution venues**

In industrial terms, market fragmentation and the ensuing competition have had two partially contradictory effects. First, they have fostered a differentiation in the offer of services in order to satisfy varied trading requirements. They have therefore been accompanied by a multitude of innovations in terms of market structure (technologies, new types of orders, dark pools of liquidity, etc.) and the emergence of new operators. Second, they have encouraged the use of costly systems capable of "consolidating" these fragmented and complex markets, thereby fostering the consolidation of the markets and the operators capable of trading on them, whether they be brokers or hedge funds. To a certain extent, these effects have been successive, with the multitude of new execution platforms tending to consolidate into a smaller number of operators.

Without addressing the issue of whether MRs, SMNs and crossing networks (CNs) enjoy a level playing field, we note that the boundaries between these different types of operators are becoming blurred as the markets can increasingly be understood as multilateral systems matching the interests of various participants.

- **Indirect effects on brokerage**

It is important to note that changes in the competitive landscape and the development of a high-frequency market structure have had an impact on brokers. In industrial terms, this has clearly translated into a consolidation of the brokerage industry led by a handful of players with global reach, who make a profit from providing access to all venues between which liquidity is split (membership of markets and possibly a direct-access infrastructure), who possess the systems required to consolidate pre-trade information between the various venues (TCA) and interconnect markets (SOR), as well as execution-optimisation know-how (algorithms). It is hard to gauge the effects of this change in the competitive landscape on the well-being of end-investors. Economies of scale achieved by a consolidated industry should benefit end-clients, but some market operators have actually noted an increase in execution costs for institutional buy-side investors[84].

[84] In an article in The Trade dated 15 March 2010 entitled "Buy-side needs more sophistication to cut trading costs", Celent cites the results of a survey of institutional investors, showing that their trading costs have remained stable or increased since the implementation of MiFID, all else being equal: "*the trend behind the numbers – that MiFID has increased transaction costs rather than cut them – still stands regardless of any volatility impact*". More fundamentally, CA Cheuvreux (2010), a broker working exclusively with third parties, claims that its execution costs increased by 24% between 2007 and 2009.

III.2.2 Assessing the effects of HFT on market quality

In terms of algorithmic and high-frequency trading, the academic literature under review tends to concur *with* that cited above, which fostered the adoption of systems resulting in market fragmentation as a means of promoting competition between trading venues (Reg NMS and MiFID) and reduce transaction costs. Generally speaking, it therefore tends to stress the benefits of adopting automated trading facilities, perceived as a technical progress and, as such, a means of increasing market access. In practical terms, academics only have limited access to pertinent data, and empirical research is faced with the difficulty of identifying order flows attributable to algorithmic trading (AT) and, in turn, the HFT subcategory.

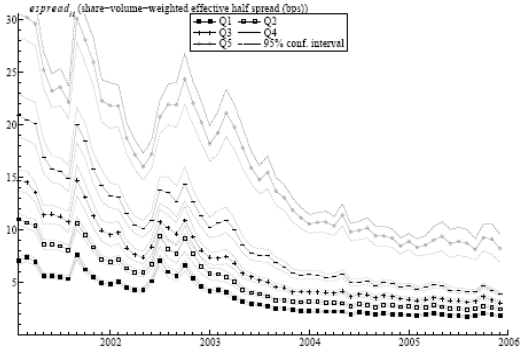
III.2.2.1 The benefits in terms of liquidity still have to be assessed in Europe

Angel, Harris and Spatt (2010) note the improvement in liquidity (in particular a significant fall in realised spreads[85]) in the United States and stress that " *the introduction of computerised trading systems* and *high-speed communications networks allowed exchanges, brokers, and dealers to better serve and attract clients. With these innovations, transaction costs dropped substantially over the years, and the market structure changed dramatically*". Generally speaking, the academic literature echoes the point of view according to which technology increases competition, integrates markets and reduces transaction costs.

This analysis is based on various theoretical studies (see below)[86] showing that the use of automated trading technologies reduces adverse selection and bolsters liquidity. Hendershott, Jones and Menkveld (2010) confirm this perception in an empirical study of the NYSE in the United States. On the basis of an indicator of the prevalence of algorithmic trading – in this instance the number of messages (new orders, annulations, executions) – they show the positive impact of algorithmic trading on liquidity. More specifically, they establish causality between its development and the increase in liquidity, i.e. a big fall in realised and effective spreads (see Charts 10 and 11). One may nevertheless note that while these findings hold for listed blue chips, the same cannot be said for small caps.

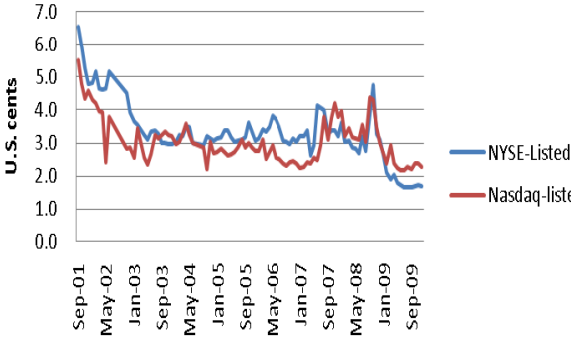
[85] On the basis of securities exchanges' regulatory statistics (see the footnote on 9 for more details on the SEC's rule 605).
[86] See Biais and Foucault (2010).

Chart 10 – Effective spreads on NYSE stocks (by market capitalisation quintiles, Q1 representing the largest capitalisations)



Source: Hendershott, Jones and Menkveld (2010)

Chart 11 – Effective spreads (publication by exchanges by virtue of rule 605 of the SEC, in cents)



Source: Angel, Harris and Spatt (2010)

In the absence of analysis evaluating the impact of the development of algorithmic trading on spreads in Europe over time, we note that liquidity has not increased to the same extent in Europe as it has in America over recent years.

We offer two interpretations. First, liquidity levels were probably not the same at the outset. In the early 2000s, the use of electronic order books was already widespread on European markets, and initial forms of competition between markets had been observed. By contrast, electronic trading was not as well developed in the United States. Decimalisation came relatively late, while open outcry and the privileges of the specialists of the NYSE prevailed until recently. It is therefore probable that the American markets benefited particularly from the competition between markets observed since then, especially since best-execution rules there were favourable to the structures and technologies of modern markets. In fact, if we compare change in effective spreads cited by Gresse (2010b) with those of Hendershott, Jones and Menkveld (2010) in Chart 10, we see that effective spreads on the biggest capitalisations on the NYSE fell from about 15bp[87] in 2001 to roughly 5bp in 2004, where they remained until 2006. Judging from Chart 11, further falls have apparently been noted since 2009, especially on the NYSE. In Europe, Gresse (2010b) shows that spreads on non-financial CAC 40 stocks narrowed from 4.93bp to 4.14bp between October 2007 and September 2009, and from 7.44bp to 5.91bp on those of the FTSE 100.

[87] The half spreads in the chart need to be doubled to compare them with those of Gresse (2010b).

Another interpretation is simply that HFT has developed more quickly and taken on greater importance in the United States than in Europe, and has had more beneficial effects on liquidity there. In reality, these two interpretations are potentially complementary: on the one hand, there is more to the development of electronic markets than simply that of HFT; on the other hand, the development of HFT can be linked to the presence of arbitrage opportunities and imperfections in the market structure.

In broad terms, the increase in liquidity attributable to the introduction of competition in the markets comes across as being less material in Europe and, if this is confirmed, could stem from the fact that the benefits flowing from the development of algorithmic trading were less substantial there. However, an assertion of this nature can only be put forward as a hypothesis at this time.

Note lastly that there are limits to the notion of liquidity in a high-frequency environment:

- Hendershott and Riordan (2009) show that classic aggregated liquidity indicators are not necessarily relevant, as the nature of liquidity matters particularly: while algorithmic trading can be seen to consume liquidity – on the Deutsche Börse, demand for liquidity attributable to algorithmic trading accounts for 52% of trading volumes on DAX 30 stocks, while the supply of liquidity related to algorithmic trading accounts for 50% – it is important to consider that this liquidity is provided when it is most scarce.
- Hasbrouck and Saar (2009) look more specifically, on Nasdaq's Inet platform, at the role of fleeting orders, which are not intended to be executed and are cancelled less than two seconds after they are submitted to the market. They show that the dynamic underlying strategies consist mainly in tracking prices (repositioning orders when transactions stray from the interest expressed to spur their execution) or searching for latent liquidity – i.e. not simply hidden liquidity, but also that of counterparties that actively monitor the market and are ready to process an aggressive order without making an unconditional expression of interest (by submitting an open or hidden order). They deduce from this that fleeting orders are increasingly part of aggressive strategies and that the classic distinction between market making and market taking is less and less pertinent.

III.2.2.2 Benefits in terms of price formation are generally clearer

Academic research clearly shows the benefits of algorithmic trading in the process of price formation. They explain this phenomenon in theoretical terms[88]. Foucault, Roell et Sandas (2003) show that liquidity suppliers who use algorithms and access the market quickly face less adverse selection risk, which has a beneficial effect on liquidity and the efficiency of price formation. Biais and Weill (2009) argue that there is a "cognitive effect", by virtue of which operators only have limited capacity, linked to the cost of monitoring the markets, to assess the relevant information on the value of securities. Bearing in mind that this slows down the process by which the market prices in information, automated trading technologies come across as being particularly useful as a means of improving the price-formation process and absorbing liquidity shocks. Seen from this angle, algorithmic trading increases the benefit of exchanges at multiple levels: it increases liquidity, reinforces resilience to shocks, reduces transient price volatility and bolsters the market's informational efficiency.

Empirically, studies of both Europe and the United States confirm that algorithmic and high-frequency trading have reduced adverse selection and increased the informational content of trading. This conclusion comes across clearly in the study by Hendershott, Jones and Menkveld (2010) on the NYSE in the United States and that of Hendershott and Riordan (2009) on the Deutsche Börse. Hendershott and Riordan[89] note that "*liquidity demanders use algorithms to try to identify when a security's price deviates from the efficient price by quickly processing information contained in order flow and price movements in that security and other securities across markets. Liquidity suppliers must follow a similar strategy to avoid being picked off. Institutional* investors *also utilise AT to trade large quantities gradually over time, thereby minimising market impact and implementation costs*". All things considered, they conclude, "*AT consumes liquidity when it is cheap and supplies liquidity when it is expensive. AT contributes more to the efficient price by placing more efficient quotes and AT demanding liquidity to move the prices towards the efficient price*".

In a similar vein, Chaboud, Chiquoine, Hjalmarsson and Vega (2010) show that, contrary to perceived wisdom, HFT does not increase volatility observed on a daily basis, that it increases the supply of liquidity in the hour following the release of macroeconomic data, concluding that "*the rapid growth of algorithmic trading has not come at the cost of lower market quality*".

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[88] See Biais and Foucault (2010).

[89] Note that the contribution to price formation is assessed here on the basis of the Hasbrouck model, as described in the first part of this study, and as such accepts the efficient market hypothesis.

We still need, however, to establish more precisely which of the benefits of algorithmic trading on price formation is more specifically attributable to high-frequency trading.

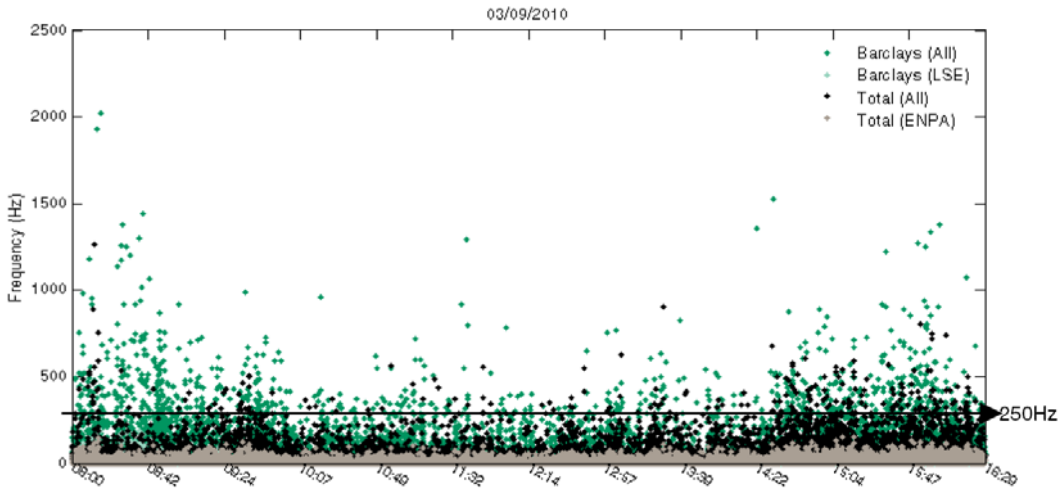
III.2.2.3 Open questions on the effects in terms of collective well-being

In this context, there would appear to be two main questions in terms of the effects of algorithmic and high-frequency trading on well-being: questions on the capacity of HFT operators to exploit informational advantages to the detriment of collective well-being and questions on the short-term dynamics created by the new high-frequency market structure.

- **The effects of algorithmic trading in terms of well-being can be ambivalent**

CA Cheuvreux (2010b) notes that informational thresholds transform, for most operators, execution into a probabilistic exercise: the frequency with which orders are renewed is such that in most cases the state of the order book at the time when an order arrives in the market differs from that when the order was actually sent to the market.

Chart 12 - Frequency of the renewal of the five best limits of two blue chips and informational threshold of an operator located 2 ms from the market*



* Legend: the dots above the horizontal line designate the frequency with which the order book is renewed so that an operator located 2 ms from the order book can only utilise pre-trade information on a probabilistic basis. Source: CA Cheuvreux (2010b).

Hendershott, Jones and Menkveld (2010) note that, on the NYSE, in contrast with effective spreads, realised spreads do not narrow when algorithmic trading is practised: "*Surprisingly, we find that algorithmic trading increases realised spreads and other measures of liquidity supplier*

revenues. This is surprising because […] we thought that […] algorithmic liquidity suppliers were low-cost providers who suddenly became better able to compete with the specialist and the floor […] thereby improving overall liquidity by reducing aggregate liquidity provider revenues. Instead, it appears that liquidity providers in aggregate were able to capture some of the surplus created […]". "To put it starkly, in a world without algorithms, liquidity supplier revenues depend on the degree of competition between liquidity supplier humans. In a world with algorithms, liquidity supplier revenues depend on the degree of competition between algorithms. Our results suggest that, at least immediately […], there was less competition between the best algorithms, perhaps because new algorithms require considerable investment and time-to-build." In other words, HFT could benefit from a competitive rent stemming from their technological advantage.

Jovanovic and Menkveld (2010) demonstrate empirically using Euronext and Chi-x data, that the "middlemen" (meaning market making proprietary traders) have informational advantages over average *investors* and that they exploit them effectively by reacting more quickly to market information – and in the right direction. The impact in terms of well-being stems from two antagonistic effects: while adverse selection is initially high, HFT reduces its importance (which has a positive effect on volumes processed and liquidity). By contrast, if adverse selection is initially low (or non-existing, if no operators have an informational advantage), the arrival of HFT can create a phenomenon of adverse selection and reduce collective well-being (which has a negative impact on volumes processed and liquidity). The empirical findings are not conclusive, as the participation of HFT comes with both an increase in liquidity (reduction in quoted spreads) and a reduction in trading volumes.

- **Short-term dynamics still need to be analysed**

- "High-frequency" liquidity cycles are generally noted by empirical literature on the equity markets.[90][91] Different theories have been devised to explain them. Foucault, Kadan and Kandel (2009) put forward a model that ascribes the responsibility for such fluctuations to the asymmetry *between* market-monitoring costs borne by suppliers and consumers of liquidity and in maker-taker pricing. Again factoring in market-monitoring costs, Biais and Weill (2009) study the capacity of limit orders to absorb transient liquidity shocks and describe the ensuing cyclical fluctuations:

[90] On this point, Foucault, Kadan and Kandel (2009) cite Biais, Hillion and Spatt (1995), Coopejans, Domowitz and Madhavan (2003), Degryse, De Jong and Van Rvenswaaij, Wuyts (2005) and Large (2007).

[91] Note too that Chaboud, Chiquoine, Hjalmarsson and Vega (2010) show that HFT increases the intraday correlation between trades in the currency markets as well. Among possible explanations, they note that the "*algorithmic strategies used in the market are not as diverse as those used by non-algorithmic traders" and that "many institutions use similar algorithms*".

"*After a liquidity shock, there are two phases. First, there is a 'buyers' market', in which the flow of sell* orders *exceeds the flow of buy orders and trades hit the bid quote. During that phase, the bid-ask spread is initially high, but progressively tightens, while in parallel, the depth in the order book builds up. Second, there is a 'sellers' market' in which the flow of buy orders exceeds the flow of buy orders, and trades hit the ask side of the order book. The dynamics generated by our model match the stylised facts on order books, with clustering of activity at the best quotes, undercutting, and serial correlation in order types.*

Our model also sheds light on the consequences of the increased computerisation of markets and the growth *of algorithmic trading. Our analysis implies that these changes imply an increase in trading volume and an even stronger increase in message traffic, corresponding to frequent cancellations and modifications. These results also corroborate empirical evidence.*"

These models accordingly describe how HFT fits in with market dynamics and explain its prevalence. However, analysis of how HFT impacts classically observed cyclical fluctuations is still only in its early stages. Does it play a destabilising role by amplifying liquidity shocks? Or does it help absorb them? These two possibilities are not mutually exclusive, assuming that they come into play successively, or, in other words, that market-making strategies alternate with directional strategies. In this case, it would be worthwhile, from a regulatory angle, to question the capacity of operators, and particularly HFT operators, to provoke these fluctuations (not necessarily intentionally), and to gain from them.

Whatever the answer, market movements observed over recent years (especially in the second week of August 2007 and, more recently, on 6 May 2010 in the United States) throw these short-term dynamics in the equity markets under a new light.[92] They highlight in particular the news of Khandani and Lo (2007), who, on the basis of an analysis of fluctuations observed in August 2007, note an increase in risks (described as systemic) stemming, on the one hand, from the interconnection between markets and, on the other hand, from the role played by market makers. In other words, the effects of deleveraging linked to the subprime crisis on the long/short equity strategies of some hedge funds were compounded by a sudden withdrawal of liquidity suppliers. The "Preliminary findings regarding the market events of 6 May 2010" of the SEC and the CFTC reiterate similar questions on market interconnections (namely between ETFs and futures markets and those of the underlying equities) and the role of market makers.

[92] On the detail of the events of 6 May 2010, see the SEC-CFTC "Preliminary Findings Regarding the Market Events of 6 May 2010", dated 18 May 2010.

IV. RISKS TO FINANCIAL REGULATION INCURRED BY NEW MARKET STRUCTURES

New market structures carry new types of regulatory risk. Four main risks have been identified here. Better controlling such risks will, in all cases, require more detailed observation and a reduction in the factors of analytic complexity that characterise them. From a more operational point of view and for the regulator's future use, this section will raise certain questions deemed important in highlighting outstanding issues and research needs.

IV.1. Risks to market quality and financial system efficiency

IV.1.1 Market quality has not worsened, but requires more in-depth analysis

As we saw previously, academic research has made an especially valuable contribution to analysing liquidity and market quality.

To sum up, normal liquidity indicators suggest that market quality has not worsened significantly on fragmented markets. On the whole, liquidity has increased significantly in the United States, while the trend is less clear in Europe. Perceptions also depend rather closely on the indicators considered. They are generally clearer in quoted spreads than in effective spreads. The trend realised spreads observed by Hendershott, Menkveld and Jones (2010) on the NYSE is counter-intuitive. Observing market depth only at "best limits" probably makes less sense for high-frequency trading on markets on which the average tick and transaction size have dropped (see Gresse, (2010b)). More fundamentally, Hasbrouck and Saar (2009), as well as, potentially, O'Hara (2010), suggest that the traditional distinction between liquidity making and liquidity taking be revisited, given that limit orders generated with high frequency are not necessarily intended to be executed.

In this literature, the liquidity benefits of fragmentation are mirrored in the price discovery benefits of trading algorithms and high-frequency technologies (see 3.2.2.2 above). Counter-intuitively, cyclical, short-term fluctuations (considered as "natural" liquidity cycles) and the increase in very short-term volatility (inevitable when the frequency of transactions increases) have not been found to harm market quality. These short-term dynamics are however subject to further study. On the whole, analyses – empirical ones in particular – of HFT's effects on liquidity,

and of its prevalence in the long-run, in a field in which relevant data are costly and even regulators do not possess a complete picture, remain scarce[93].

IV.1.2 Organising fragmentation requires specific rules

- **Rules on demarcating the competitive landscape and market structure innovations**

Financial markets, and secondary equity markets in particular, render a public service, in particular by helping discover prices that are then broadly disseminated to all economic actors. MiFID has had the effect of fragmenting markets, in order to organise competition between execution venues. It is now worth looking at the demarcations of the competitive landscape.

As has been amply demonstrated in the microstructure literature, this issue is best addressed by observing the factors in this area that are closely linked to the specificities of market structures. The question is therefore to what extent the market structures involved should be considered to be public goods or, on the contrary, as mere parameters of competition. Of particular interest are the restrictions that should be set:

- **on market opacity**

In a context in which opacity (understood as the lack of pre-trade transparency) on trades raises fears over public price discovery and liquidity (see Hendershott (2010)), it is necessary, first of all, to measure its extent statistically (in its various forms) and its trend over time[94]. In addition to obstacles involving the availability of information and statistical methodologies, estimating the extent of opacity is also an analytical challenge, given the large number and complexity of structures that make it possible to conceal all or part of the expressed interests and strategies for dynamically managing public displays of interests.

As such opacity is increasing, its impacts are worth examining. This is an analytical challenge, given that the benefits of some opacity must be weighed against its undesirable effects on liquidity and price discovery (see 2.2, above).

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[93] Additional information requests from the SEC (see footnote 50) could help change this state of affairs in the United States.

[94] Bloomberg News; *Investment Banks to Report European Dark-Pool Trades*, of 24 May 2010 seems to suggest a shift in declaring transactions on banks' crossing networks. This shift should make it possible to better analyse the effects of opacity on the market as a whole.

When examined more closely, innovation generates major challenges. O'Hara (2010)[95] underlines this by asking "What is a quote?", and investigates the meaningfulness of market participants announcing their interests. The author approaches the issue from two points of view: 1) what restrictions should be placed on innovation in types of orders meant to limit divulgation of information to the market?; and 2) conversely, how should we interpret orders that are visible and executable but that are cancelled so fast that they have almost no chance, in practice, of producing a transaction (artificial quotes, or "stealth orders" as they are called by the AMF)? Another issue is the meaningfulness of automated multilateral comparison of orders when they contain certain expressions of interest for a private circle of potential counterparties, such as the indications of interest (IOIs) in some dark pools. Given that such automated comparisons no longer carry an obligation to announce orders publicly, where is the border between a bilateral over-the-counter trade and a public market?

- **on order pricing**

Any limits to be set on free pricing of orders by the markets and pricing structure (asymmetries depending on the type of participant). Foucault and Colliard (2010) note – while not fundamentally questioning the market benefits of competition between trading venues – that excessively low explicit trading commissions can be a source of concern. The reason for this is that the lower costs generated by competition between markets can, in some cases, promote strategic behaviour by investors that is likely to reduce transaction volumes and lead to an inefficient allocation of their roles. Accordingly, in some particular cases, reduction in explicit trading costs can result in sub-optimal equilibrium levels in terms of collective welfare.

Asymmetric pricing of orders can lead to undesirable effects, as noted by Angel, Harris and Spatt (2010): "*The distortions arise because orders are priced on different bases in different markets. The problem is large and growing larger as bid-ask spreads and commissions decrease. It has distorted order routing decisions, aggravated agency problems among brokers and their clients, unlevelled the playing field among dealers and exchange trading systems, produced fraudulent trades, and produced quoted spreads that do not represent actual trading costs.*" US best execution rules that are not calculated "cum fees" probably exacerbate these perverse effects. However, their presence must not be underplayed in Europe, where the authors' recommendation: "*that the [financial regulator] requires that all brokers pass through the fees and liquidity rebates to their clients*" could also be applied.

[95] Maureen O'Hara is a Professor of finance at Cornell University, Ithaca, NY, and also a member of the ITG board of directors.

- **on setting price ticks**

The comparison made by CA Cheuvreux (2009) between NYSE Euronext and the LSE found a "spatial atomisation" of liquidity after a reduction in price ticks[96], and its effects are worth looking into.

Ample research has found benefits to liquidity when price ticks are reduced (i.e. not constrained on the downside, as appears to be the case on the LSE (see chart)). At first, this resulted from the work of Christie, Harris and Schultz (1994), who found evidence of collusion by Nasdaq market makers[97] (back then, they only traded on price ticks of ¼ dollars!). Reducing price ticks clearly reduces the minimum spread possible between the best bid and ask prices (the minimum theoretical spread), and competition clearly requires the possibility of improving on existing prices. However, the liquidity benefits of reducing price ticks can be contested on some grounds. Based on a study on the effects of reducing price ticks at Euronext Paris in 2001, Bourghelle and Declerck (2002) denounce the negative impacts of such tick size reduction on transparency[98]. Intuitively, in the recent context, it seems that, beyond a certain threshold[99], reducing price ticks provides material benefits only for a few high-frequency traders able to make large numbers of low-profit transactions, whereas it incurs a significant collective cost from the resulting increase in the number of stealth orders, as well as new possibilities for manipulation. CA Cheuvreux (2009) thus suggested: "*Automatically, a coercive tick size increases the weighting of passive orders and limits small orders aimed at manipulating the market. Furthermore, as the order book density is* higher*, the amount needed to deform the order book is higher. This results in higher risk and thus a higher investment*".

[96] Note that competition in price ticks is a European phenomenon. In the United States regulations require higher price ticks than those that were set by the market.

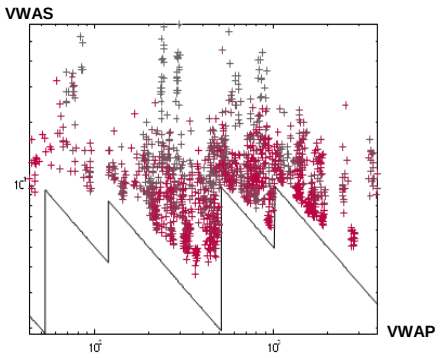
[97] See Christie, Harris and Schultz (1994), and Christie and Schultz (1994).

[98] "*It appears that a new pricing grid does not necessarily lead to change execution costs but it changes the level of transparency in the liquidity supply*".

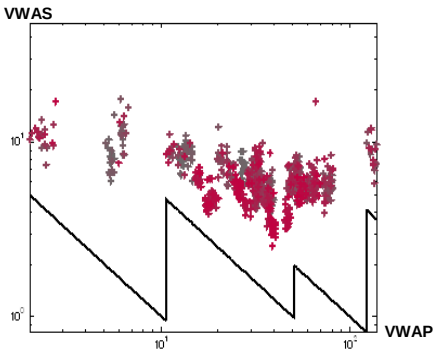
[99] In the absence of regulatory restrictions, the industry (led by FESE) last July agreed to recognise two "tick size schedules" meant to break off the tick war mentioned by CA Cheuvreux (2010). For some stocks, these harmonisation tables allow price ticks of one thousandth of a cent.

Chart 13 - Relation between volume-weighted average spread (VWAS, in %) **and volume-weighted average price** (VWAP)

London Stock Exchange (FTSE 100)



NYSE Euronext (CAC 40)



Note: Each point shows the relation between the volume-weighted average price of a share during a trading session (VWAP, x axis) and its actual spread (VWAS, y axis); moreover, the density of the red depends on the volumes traded. Each point therefore depicts three indicators per security during for a given trading day. The actual spread (between a transaction price and the mid-price of the spread prevailing at the time of execution) and relative spread (relative to the mid-point of this spread), expressed in basis points (bp) can therefore not be below the relative price ticks (ticks relative to price), which is depicted by a black line. Price ticks depend on the share's price (hence the "skips" in this line). Naturally, the relative tick decreases as a function of price, hence the slopes between two skips. Source: Crédit Agricole Cheuvreux Quantitative Research.

- **on binding best execution rules**

Academic research into microstructures notes that, while fragmentation is very favourable to competition between trading venues, its benefits nonetheless depend on market participants' incentives to consolidate markets. According to O'Hara and Ye (2009), and Foucault (2010a), setting best-execution rules probably makes a big contribution to the impact on market liquidity of Reg NMS in the US and MiFID in Europe.

Expansion in HFT has had the indirect effect of promoting a concentration of market intermediation by participants who have sufficient critical mass to make the most of their rapid access to all relevant markets and technical trading and execution systems (algorithms). Few studies have been done on the impact of competition between trading venues on financial intermediation. Moreover, the extent and structure of OTC equity markets has been little explored.

IV.2. Risks to fair access

Academic research possesses tools for analysing the effects of shifts in market structure on the welfare of various market participants. In a teaching model based on the distinction between high-frequency traders and "low-frequency participants", Biais and Foucault (2010) find that market equilibriums could exist that do not enhance collective welfare. Accordingly, they propose a game theory model combining the possibilities of adverse selection phenomena that are unfavourable to low-frequency investors and the possible occurrence of exceptional, systemic-type liquidity shocks. On these bases, they show that (Nash/prisoner's dilemma) inefficient market equilibria are possible in which the expansion in algorithmic trading does not fully serve collective welfare. In such cases, the use of algorithms by some leads other market participants to do likewise even though this is not collectively optimal in terms of welfare. Theoretical work and above all empirical work remains to be done in this area.

More precisely, in a high-frequency market context, a number of factors seem likely to favour the emergence of adverse selection phenomena and thus raise issues on how "low-frequency" participants are to participate in the market (even more important when they possess information relevant to the fundamental value of securities).

Two main types of issues are identified here:

- Issues over access by various participants – notably institutional (or retail) investors – to techniques used for HFT proprietary trading and their ability to fully benefit from competition between these participants. Despite arguments developed by Rosenblatt (2009) and Kearns, Kulesza, Nevmyvaka (2010) to alleviate media fears in this area, the social cost of the intermediation services indirectly rendered by HFT participants remains to be evaluated, and their profitability is a closely guarded secret. More precisely, given its importance for market structure, identifying factors in HFT profitability is important for those who want to anticipate its medium-term future.
- Issues of asymmetries of information that are likely to benefit market intermediaries. On the demand side, it is worth asking how able clients of intermediaries are of judging the quality of executions by their brokers (and, where applicable, the quality of algorithms used)[100]. This is obviously due to the cost of such an evaluation and of the high-frequency

[100] According to an article in the New York Times of 24 July 2009, entitled "Stock Traders Find Speed Pays, in Milliseconds: "*You want to encourage innovation, and you want to reward companies that have invested in technology and ideas that make the markets more efficient," said Andrew M. Brooks, head of United States equity trading at T. Rowe Price, a mutual fund and investment company that often competes with and uses high-frequency techniques. "But we're moving toward a two-tiered marketplace of the high-frequency arbitrage guys, and everyone else. People want to know they have a legitimate shot at getting a fair deal. Otherwise, the markets lose their integrity.*"

data needed. But in a context in which the factors in opacity in order flows continue to increase and in which pre-trade information must now be used probabilistically (see Cheuvreux (2010)), this also raises fundamental and theoretical questions on which evaluation standards are relevant. Regarding the offer of intermediation services, this issue in fact involves the management of conflicts of interest that may arise between intermediaries' proprietary and third-party trading activities.

Menkveld, Sarkar, van der Wel (2009), for example, show that bond market intermediaries possess informational advantages that they exploit for their own account[101]. It remains to be seen whether a parallel exists on equity markets, and if so, how great the resulting social cost is. We might add that this point is not merely theoretical and has potentially very concrete implications in regulating market access techniques, pre-trade transparency and, beyond that, best execution obligations.

IV.3. Risks to operational resiliency of equity markets

The goal here is, on the one hand, to identify the nature of extreme risks to equity markets and their potentially systemic nature, and, on the other, to evaluate the capacity to control them and the practical means of doing so. Where risks can be managed, it is necessary to measure the cost of managing them. The events of 6 May 2010, have led to a re-evaluation of risk-management systems used in the United States[102]. However, it seems that, quite aside from the matter of possible malfunctions in these systems, the risks linked to the short-term dynamics of equity markets could have increased recently, without being precisely qualified or measured (see III.2.2.3 above). Three points are worth making here:

- The value of executing transactions with little latency time has led to the development of direct execution access through which a market member can, either for proprietary trading as a market intermediary, or on behalf of a client, use resources and infrastructures that shrink the times needed for transmitting orders to the market and for

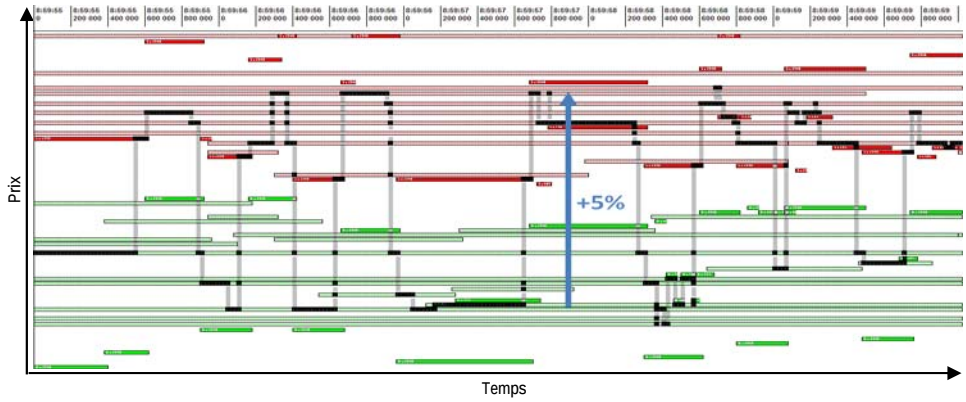
[101] "*Our results provide evidence against the market maker being just an uninformed liquidity supplier. On the contrary, he seems to actively speculate on private information signals*."

[102] Note here that the characteristics of circuit breakers and best execution that are specific to the US have generated effects that are particular to their market structure. The SEC's in-depth analysis can therefore not be applied, as is, in Europe.

execution latency[103]. From this point of view, managing risks is a critical part of the order execution chain and thus becomes a parameter of high-frequency trading strategies. Among the various factors likely to have exacerbated equity market risk, the importance of these new market access technologies should be evaluated precisely.

- Identifying the thresholds beyond which fluctuations become risky is also a crucial issue. The chart below identifies sudden cyclical fluctuations in the theoretical opening price of almost 5% in amplitude and that probably result in "resonance" from two algorithms entered during the last five seconds of the opening auction of a Euronext 100 stock recently observed. In this context, it is worth looking into the threshold beyond which such disruptions must be considered harmful to the markets' price discovery mechanism and their normal operations.

Chart 14 – Five seconds preceding the opening auction prices of blue chips listed in Paris



Source: AMF-DESM

- In contrast, setting circuit breakers on such fluctuations probably does have an impact on the risks that they produce. For example, it is possible that market participants' reactions upon approaching the thresholds could be influenced by the fear that their orders will not be executed promptly. This would make the fear of exceeding the threshold a self-fulfilling prophecy and lead to an interruption in trading. The capacity of high-frequency market participants to identify trends of this type and to adopt strategies to exploit them

[103] IOSCO (2009) describes in detail the various direct execution access techniques and the risks that they are likely to incur for regulators. The IOSCO Technical Committee is expected to approve a series of recommendations in this area, particularly on the criteria for selecting beneficiaries of sponsored access, the contractual responsibilities and obligations of the markets, their members, and the clients of these members when intermediaries are involved, on control standards and market entry screens (applicable to intermediaries and markets).
Under the oversight of their regulators, platforms that currently authorise sponsored access (Chi-X, LSE, Euronext) have subjected this mechanism to screening and preliminary verification of orders, the parameters of which are under the member's responsibility and control, even if these screens are not geographically located in the member's systems.

may also, where applicable, affect fluctuations. In other words, an analysis of fluctuations useful to regulators should probably take risk management mechanisms into account endogenously.

It is therefore important that academic research help identify and qualify the risks incurred by market fluctuations in a new structure, some of whose dynamics are not controlled. In this regard, microstructure research appears to be hindered by the structuring effects that risk-management systems have on the market.

IV.4. Risks to market integrity and surveillance

Manipulative and abusive strategies are rarely new. They generally consist of strategies based on abusive use of informational advantages (front running, insider trading, etc.[104]), strategies consisting in giving false or misleading information to the market in order to incite behaviour from other market participants and then to exploit that behaviour (spoofing/layering[105], momentum ignition[106], etc.), and anti-competitive behaviour (abusive market making, for example). However, the possibilities for manipulation and/or the difficulty in detecting it is likely to be exacerbated by fragmentation, the increasing diversity of market structures (order confrontation algorithms, types of orders, price ticks, etc.), the development of derivatives markets, structured products, the growing interconnection between asset classes, and the complexity of products. Algorithmic trading techniques also provide new tools for automating illicit strategies.

Some authors note this trend while pointing out certain new possibilities. Angel, Harris and Spatt (2010) note the risks of front running in securities that are correlated but that belong to different asset classes: "*Although front-running a customer's order in the same instrument is illegal, we are concerned about front running in correlated instruments. For example, buying S&P 500 futures contracts while holding a large open customer buy order in an S&P 500 ETF (to profit from the expected price impact of the customer order) should be illegal since arbitrageurs will*

[104] Front running consists in a financial intermediary's attempt to profit, for its own account and in contradiction with its fiduciary responsibilities, from information that it possesses on its client's orders.

[105] Spoofing strategies consist in a market participant displaying one or more orders that are contrary to its real interests, in order to incite other participants to do likewise and then to withdraw these orders when they risk being executed. The goal is to create a pricing dynamic that is favourable to the participant's real interests and then to exploit that dynamic by making a transaction. Layering is a type of spoofing that consists in multiplying and sequencing the display of such orders in the limits of the order book, to boost the misleading image of the order book.

[106] Momentum ignition strategies, meanwhile, consist in making a transaction and, in some cases, displaying other orders in the same direction, in order to incite other market participants to do the same and to create a directional price movement. By unwinding the initial transaction through a transaction in the opposite direction, it is then possible to exploit the dynamic that has been created. Such strategies, which, in practice, are hard to distinguish from speculative transactions, require a manipulative intention from the start.

quickly shift the price impact of the broker's order in the futures market to the ETF market where it will increase the cost of filling the customer's order". CA Cheuvreux (2009) notes the risk incurred by narrow price ticks: "*the current tick size regime represents a weaker market constraint on NYSE Euronext than on the LSE, and […] the available space thus remaining favours order book manipulations*".

Along the same lines as CA Cheuvreux (2010a), O'Hara (2010) has observed the proliferation of orders that are not truly meant to be executed (so-called artificial quotes) and suggests: "*While arguably such quotes could be part of some complex (arcane?) trading strategy, a more disquieting explanation is that they are used in a new form of manipulation that works off of algorithmic trading and crossing. If a quote is never intended to be traded at, is it really a quote? The potential for manipulation arises from two sources: the predictable behaviour of trade algorithms and the use of reference prices for crossing networks*". It would therefore appear that technical innovation and market structures raise rather fundamental issues on how to characterise certain behaviour as regards market integrity or, at the very least, the need for a more precise delineation between authorised and illicit strategies.

One last point: risks to market integrity must be regarded against a backdrop of the means that market oversight authorities have to detect and punish abuses. The cost of such oversight is considerably augmented by the mass of data and technical and human means that it requires[107] and by the need to broadly coordinate policies in this area on an international scale. Economic challenges are therefore involved and this must be considered at an initial stage of market organisation.

[107] Section VI Consideration of Costs and Benefits of the Proposal on a consolidated audit trail by the SEC of May 26, 2010 estimates the cost of setting up a real-time order-tracking system in the United States in billions of dollars.

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Publisher:
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01.53.45.63.65

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