Regulatory Issues Raised by the Impact of Technological Changes on Market Integrity and Efficiency

Consultation Report

TECHNICAL COMMITTEE
OF THE
INTERNATIONAL ORGANIZATION OF SECURITIES COMMISSIONS

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Foreword

The International Organization of Securities Commissions (IOSCO) Technical Committee has published for public comment this Consultation Report on *Regulatory Issues Raised by the Impact of Technological Changes on Market Integrity and Efficiency* (Consultation Report). The Consultation Report was prepared by the Standing Committee on Secondary Markets (TCSC2) and discusses a number of issues in relation to technological developments. Some of these issues have already been dealt with and consulted on in previous Technical Committee reports; for instance, reference is made to the Technical Committee report on *Principles for Direct Electronic Access*[1] and *Principles for Dark Liquidity*[2]. While these reports are not subject to renewed consultation, the Consultation Report sets out possible future actions that are designed to assist market authorities when dealing with issues concerning aspects of technical developments that have not been the focus of previous reports.

The Consultation Report will be revised and finalised after consideration of comments received from the public. Following the consultation process, TCSC2 will submit a final report on *Regulatory Issues Raised by the Impact of Technological Changes on Market Integrity and Efficiency* to the Technical Committee for approval.

How/When to Submit Comments

Comments may be submitted by one of the following three methods on or before **12 August 2011**. Important: Due to the extremely tight timelines associated with IOSCO's work in this area, any responses received after this deadline cannot be considered.

To help us process and review your comments more efficiently, please use only one method.

1. E-mail

- Send comments to Mr. Werner Bijkerk at **market-integrity@iosco.org**;
- The subject line of your message must indicate "Public Comment on Consultation Report: Regulatory Issues Raised by the Impact of Technological Changes on Market Integrity and Efficiency ";
- If you attach a document, indicate the software used (e.g. WordPerfect, Microsoft Word, ASCII text, etc) to create the attachment; and
- Please do not submit any attachments as HTML, GIF, TIFF, PIF, ZIP or EXE files.

2. Facsimile Transmission

Send a fax for the attention of Mr. Werner Bijkerk, using the following fax number:
+34 (91) 555 93 68.

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1 FR08/10 Principles for Direct Electronic Access to Markets, Final Report, Report of the Technical Committee of IOSCO 12 August 2010 available at http://www.iosco.org/library/pubdocs/pdf/IOSCOPD332.pdf

2 FR06/11 Principles for Dark Liquidity, Final Report, Report of the Technical Committee of IOSCO available at http://www.iosco.org/library/pubdocs/pdf/IOSCOPD353.pdf.

3. Post

Send your comment letter to:

Mr. Werner Bijkerk
International Organization of Securities Commissions (IOSCO)
Calle Oquendo 12
28006 Madrid
Spain

Important: All comments will be made available publicly, unless anonymity is specifically requested. Comments will be converted to PDF format and posted on the IOSCO website. Personal identifying information will not be edited from submissions.

Your comment letter should indicate prominently that it is a "Public Comment on Consultation Report: Regulatory Issues Raised by the Impact of Technological Changes on Market Integrity and Efficiency."

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Chapter 1 Introduction

The G20 mandate

In November 2010 the G20 Seoul Summit launched an action plan with the purpose of achieving strong, sustainable and balanced growth[3]. The commitment calls for significant policy actions in several areas and reforming the financial sector is a central element of the action plan. With the aim of enhancing the stability of financial markets, the Summit:

> "…called on IOSCO to develop by June 2011 and report to the FSB[4] recommendations to promote markets' integrity and efficiency to mitigate the risks posed to the financial system by the latest technological developments".

The G20 mandate meshes closely with the work that IOSCO's Technical Committee had already undertaken or has underway. However, it provides a very specific focus on the impact of technological developments on market integrity and efficiency, whereas the Technical Committee's previous work had been broader in nature. Thus it requires a fresh consideration of some important issues, over and above the Technical Committee's ongoing work.

The members of IOSCO have worked intensively over the years to improve and, where possible, converge globally their regulatory standards while keeping in pace with market developments. In particular, the work of the IOSCO Technical Committee has focused on protecting the fairness, efficiency and integrity of the secondary markets by establishing common regulatory principles to which IOSCO members have regard. These fundamental principles for the regulation of secondary markets are expressed in the IOSCO *Objectives and Principles of Securities Regulation.*[5] The principles for secondary markets require regulators to ensure the integrity of trading by:

- requiring that the establishment of exchanges and trading systems is subject to authorization and oversight;
- maintaining fair and equitable rules;
- promoting transparency of trading;
- detecting and deterring market manipulation and other unfair trading practices;
- seeking to ensure the proper management of large exposures, default risk and market disruption; and
- reducing systemic risks.[6]

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3 The G20 Seoul Summit Declaration, 11-12 November 2010, available at http://www.g20.org/Documents2010/11/seoulsummit_declaration.pdf.

4 Financial Stability Board.

5 *Objectives and Principles of Securities Regulation*, IOSCO Report, 20 July 2010 available at http://www.iosco.org/library/pubdocs/pdf/IOSCOPD329.pdf.

6 Since the adoption of the revised IOSCO Objectives and Principles of Securities Regulation in 2010.

Related IOSCO work

Recently, as part of this ongoing task, IOSCO's Technical Committee has produced two reports that are of importance to market integrity and efficiency and are discussed in greater detail in this report.

In August 2010, IOSCO published the report *Principles for Direct Electronic Access to Markets*[7], which discusses the electronic means through which market participants and their clients connect to the markets and how these connections should be controlled to avoid risks to market stability and integrity.

In May 2011, IOSCO published the report *Principles for Dark Liquidity*[8], which relates to the use of order types and markets that do not involve trading interests being exposed pre-trade to other participants, and the implications this might have for market efficiency.

IOSCO has also been examining the role of high frequency trading (HFT) in the markets. HFT is a key issue with respect to technology's impact on market integrity and efficiency that IOSCO is still considering. As part of this work, IOSCO has gathered evidence on HFT activity and developments from a North American, European, Australian and Asian perspective via a series of panel sessions with investment firms, trading venue operators, academics and others between October 2010 and February 2011. These took place in San Francisco, London and Sydney in order to gain views from interested parties from different markets and jurisdictions. Much of the evidence that IOSCO has gathered from these sessions is reflected in this Consultation Report.

Purpose and structure of this consultation report

This Consultation Report has been prepared to enable IOSCO to respond to the G20 mandate and has two key functions:

1. it summarises the work undertaken by IOSCO and individual jurisdictions to date in relation to the latest technological developments and what still needs to be done; and

2. it consults on those issues on which IOSCO has not previously formally consulted.

It remains a crucial part of IOSCO's work that it consults openly with interested parties on important regulatory topics. While this Consultation Report seeks comments in relation to HFT specifically, the IOSCO Technical Committee is also open to receiving comments on other aspects of the Consultation Report that are relevant to the latest technological developments and their impact on market integrity and efficiency. The Consultation Report has a particular focus on cash equity markets but also has regard to the derivatives markets where appropriate or relevant.

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[7] See FR08/10 Principles for Direct Electronic Access to Markets, Final Report, Report of the Technical Committee of IOSCO, 12 August 2010 available at http://www.iosco.org/library/pubdocs/pdf/IOSCOPD332.pdf

[8] See FR06/11 Principles for Dark Liquidity, Final Report, Report of the Technical Committee of IOSCO, 19 May 2011 available at http://www.iosco.org/library/pubdocs/pdf/IOSCOPD353.pdf.

For the purposes of this report, IOSCO has employed the following definitions:

Market integrity is the extent to which a market operates in a manner that is, and is perceived to be, fair and orderly and where effective rules are in place and enforced by regulators so that confidence and participation in the market is fostered.

Market efficiency refers to the ability of market participants to transact business easily and at a price that reflects all available market information. Factors considered when determining if a market is efficient include liquidity, price discovery and transparency.

This Consultation Report adopts the following structure:

The existing state of the markets, the risks posed and the action already taken – this chapter summarises the major technological and market developments that have been observed in recent years, outlines the risks that have been identified or may arise regarding each, and summarises the work that has already been undertaken by IOSCO.

High frequency trading – this chapter focuses on HFT as the key issue with respect to technology's impact on market integrity and efficiency that IOSCO is still in the process of considering. It discusses the impact of HFT on the markets and the associated risks.

Regulatory tools – this chapter draws together the key regulatory strands from the preceding chapters by setting out the existing IOSCO principles and other tools that guide regulators to mitigate the risks of technological developments to market integrity and efficiency. This chapter also sets out key suggestions provided by market participants during IOSCO's panels that could enhance the existing regulatory approach to mitigate the risks that are associated with HFT.

Conclusion – this chapter provides a brief conclusion to the Consultation Report, and invites responses from interested parties on a number of questions regarding possible tools to address risks that are associated with technological change.

Annexes – the annexes provide a summary of previous reports on dark liquidity, direct electronic access, screen-based trading, and trading halts and interruptions.

Chapter 2 The Existing State of the Markets, the Risks posed and the Actions already taken

1. The Role of Markets

In the context of implementing the G20 mandate, it is important to seek to ensure that financial markets continue to fulfil their role of financing the real economy, by channelling investments and savings, facilitating capital formation and efficiently allocating and transferring risks.

Financial markets should be efficient, fair, orderly and transparent. Investors should easily and rapidly be able to determine the best available price in the market. Access to markets should be fair. Deep and liquid markets create opportunities for listed companies to raise funds and opportunities for participants to invest and to manage risk. They also embody active and efficient price formation through trading, quickly pricing in news and reflecting changing attitude towards risk.

Efficient markets minimise transaction and search costs, and limit inherent information asymmetries between issuers, investors and their agents that can lead to loss of confidence and reluctance to participate. For instance, investors and market participants fear a lack of information and, especially, the risk of trading with a party that has superior information or manipulative intent.

However, the various types of financial instruments may have different trading characteristics and, equally, various types of participants may have to fulfil different needs. These specificities have to be taken into account in determining the optimal framework in which a market should operate. Derivatives are different from equities and bonds, and institutional investors undertaking sophisticated transactions have different needs to retail investors trading in liquid stocks. The relevance of these differences in assets and stakeholders has to be considered when reflecting the optimal framework in which markets should operate.

2. Major Technological and Market Developments and the Risks they pose

The evolution of markets and, in particular, advances in and expansion of the use of technology in trading have had numerous impacts. They have facilitated the establishment of globally competitive markets and have enabled market participants to reduce transaction time to just fractions of a second[9]. They have provided benefits such as the generation of electronic audit trails, the enhancement of order and trade transparency, and the ability of markets and market participants to develop and apply automated risk controls and of competent authorities[10] to monitor the establishment and use of those controls.

The various benefits arising from technological advances should not however overshadow the risks that these innovations pose to the efficiency and integrity of markets. These changes raise issues that should be addressed by regulators in order to maintain the integrity of financial markets. Any change to the structure of financial markets should be assessed with respect to the objective of preserving their fundamental role for the economy.

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9 James J. Angel, Lawrence E. Harris and Chester S. Spatt, *Equity Trading in the 21st Century*, The Quarterly Journal of Finance, forthcoming.

10 The term competent authority comprises both public sector regulators and self-regulatory organizations.

This chapter of the Consultation Report focuses on some of the most important changes that have arisen directly or indirectly from technological change, which are:

a) algorithmic trading;

b) market fragmentation and dark liquidity;

c) direct electronic access;

d) co-location;

e) tick sizes; and

f) fee structures.

(a) Algorithmic trading

Algorithms have been used in trading for many years but their breadth, variety and complexity has continuously evolved. In its simplest guise, algorithmic trading may just involve the use of a basic algorithm (i.e. a set of rules or instructions) to feed portions of an order into the market at pre-set intervals to minimise market impact cost. At its most complex, it may entail many algorithms that are able to assimilate information from multiple markets in different assets and to use this to implement a high-speed, multi-asset trading strategy that transacts numerous inter-related trades in fractions of a second. For instance, algorithms may now be designed to predict the presence and actions of other algorithms, thereby attempting to stay one step ahead of them. As a result, algorithms are regularly redesigned or decommissioned (the lifetime of an algorithm potentially being gauged in weeks rather than months).

The use of technology in such a way has fostered changes in the profile of market participants. Most obviously, high frequency traders have emerged, who generally use algorithms intensively. Their activities have given rise to considerable interest regarding their impact on market efficiency and integrity. Academic research[11] and anecdotal evidence, including from IOSCO's roundtable sessions, suggest that some strategies employed by high frequency traders provide liquidity to the markets in which they operate and, by using algorithms to identify and exploit price discrepancies between markets, improve the consistency of an instrument's pricing across venues. However, some market participants have also commented that the presence of high frequency traders discourages them from participating as they feel at an inherent disadvantage to these traders' superior technology.

Another concern is that the growing involvement of automated quantitative trading strategies may also contribute to the transmission of shocks across trading venues trading the same product or across markets trading different assets or asset classes. The extent of the impact depends on how individual algorithms are programmed and how they respond to changes in

[11] See for example: (i) Jonathan A. Brogaard, *High Frequency Trading and Its Impact on Market Quality*, working paper, Northwestern University, 2010; (ii) Terrence Hendershott, Charles M. Jones, & Albert J. Menkveld, *Does Algorithmic Trading Improve Liquidity?*, Journal of Finance, 2011; and (iii) Albert J. Menkveld, *High Frequency Trading and the New Market-Makers*, Working paper, VU University Amsterdam 2010.

market conditions. For instance, interconnections between markets, which may be amplified by algorithms programmed to operate on a cross-market basis, may allow for a shock to pass rapidly from one market to another, potentially increasing the speed at which a systemic crisis could develop. This was illustrated by the Flash Crash event of May 2010.

Box: The *Flash Crash* of May 6, 2010

On May 6, 2010, the prices of many US-based equity products experienced an extraordinarily rapid decline and recovery. That afternoon, major equity indices in both the futures and securities markets, each already down over 4% from their previous-day close, suddenly plummeted a further 5-6% in a matter of minutes before rebounding almost as quickly.

Many of the almost 8,000 individual equity securities and exchange traded funds (ETFs) traded that day suffered similar price declines and reversals within a short period of time, falling 5%, 10% or even 15% before recovering most, if not all, of their losses. However, some equities experienced even more severe price moves, both up and down. Over 20,000 trades across more than 300 securities were executed at prices more than 60% away from their values just moments before. Moreover, many of these trades were executed at prices of a penny or less, or as high as $100,000, before prices of those securities returned to their *pre-crash* levels. By the end of the day, major futures and equities indices *recovered* to close at losses of about 3% from the prior day.

The joint report from the staff of the Securities and Exchange Commission (SEC) and the Commodity Futures Trading Commission (CFTC) on these events described the issues raised as follows:

- That under stressed market conditions, the interaction between automated execution programs and algorithmic trading strategies can quickly erode liquidity and result in disorderly markets. High trading volume is not necessarily a reliable indicator of market liquidity, especially in times of significant volatility.

- May 6 was an important reminder of the inter-connectedness of derivatives and securities markets, particularly with respect to index products. The nature of the cross-market trading activity and the continuing convergence between the securities and derivatives markets were confirmed, and hence the need for a harmonized regulatory approach that takes into account cross-market issues. Among other potential areas to address in this regard is the consideration of recalibrating the existing market-wide circuit breakers that apply across all equity trading venues and the futures markets.

- Many trading venues employ their own versions of a trading pause – either generally or in particular products – based on different combinations of market signals. Pausing a market can be an effective way of providing time for market participants to reassess their strategies, for algorithms' parameters to be reset, and for an orderly market to be re-established. This calls for a reflection on circuit breakers or other mechanisms to restrict trading such as limits up/down[12] that it may be appropriate for trading venues

[12] Market-wide *limit up-limit down* requirements prevent trades in individual stocks from occurring outside of specified price bands. They may be coupled with trading pauses to accommodate more fundamental price moves. Such requirements are generally designed, among other things, to protect investors and promote fair and orderly markets where there is extraordinary volatility in stocks.

to have in place. This issue is discussed further in Chapter 4 and Annex 4 of this Report.

- Market participants' uncertainty about when/whether trades will be broken can affect their trading strategies and willingness to provide liquidity. Therefore, clarifying procedures for breaking erroneous trades, using more objective standards, has to be part of the regulatory reflection/work.

- Having a complete picture of the markets upon which decisions to trade can be based in today's world of fully-automated trading strategies and systems is important. This is further complicated by the sheer volume of quotes, orders, and trades produced each second, and uncertainty about, or delays in, market data. Therefore, the standard for robust, accessible, timely and aggregated market data has to be set high. Accordingly, another area of regulatory concern is with respect to the integrity and reliability of trading venues' data processing, especially the publication of trades and quotes to consolidated market data feeds.

The events of May 6 have clearly shown that, in a context of deteriorating market conditions a shock in one market can trigger destabilizing effects on the liquidity and price formation processes of related markets. This clearly threatens both the integrity and the efficiency of the markets. Further academic research has also suggested that the presence of high frequency traders may have exacerbated volatility during these events[13]. Nevertheless it is also important to remember that the events of May 6 occurred within a specific market structure. The US markets have a strong degree of inter-linkage. Due to this interconnectedness shocks in one market are likely to quickly pass on to other markets. Other market regions, e.g. Europe, do not show the same degree of interconnectedness.

However, risks to market integrity and efficiency do not have to arise solely from a major shock such as the flash crash. Regulators are cognisant of the possibility that the confidence of some investors in the efficiency and integrity of the market (and possibly their willingness to trade) by the ongoing development of algorithmic trading and HFT, may lower investors' confidence and, possibly, reduce traditional market participants' willingness to trade. For instance, the use of sophisticated low-latency algorithmic trading techniques may prompt less sophisticated traders to withdraw from the market as a result of their fear of being *gamed* by low latency firms that use faster technology.

Some anecdotal evidence presented to IOSCO suggests this may be particularly true of traditional institutional investors, who, as *fundamental investors*, are supposed to base their trading decisions on the perceived fundamental value of securities. If such participants withdraw, reflecting a loss of faith in the integrity of the market, the information content of public market prices, may be altered as a knock-on effect. This may potentially result in a less efficient price formation process and possibly cause others to reduce their participation.

The increased messaging that has come with extensive use of algorithms raises costs for many participants, including marketplaces, vendors and competent authorities. This is especially true with respect to HFT and is discussed in more detail below. In addition, algorithmic trading, like all electronic trading, results in the need for changes to the way competent authorities monitor trading. Increased algorithmic trading has increased the complexity of

[13] See Andrei Kirilenko, Albert S. Kyle, Mehrdad Samadi, & Tugkan Tuzun, *The Flash Crash: The Impact of High Frequency Trading on an Electronic Market*, working paper, 2010.

surveillance for competent authorities. Having sophisticated systems or algorithms that monitor trading and detect patterns is a necessity in this environment of high speed and complex trading in order to maintain market integrity and confidence.

As HFT is a relatively new area of interest to IOSCO, it is not a topic on which we have previously consulted and Chapter 3 of this Consultation Report is specifically dedicated to it.

(b) Market fragmentation and dark liquidity

The rapid pace of technological progress and regulatory changes in many jurisdictions have resulted in increased competition, in particular between trading venues. This has yielded a number of benefits, amongst which are lower trading fees and enhanced potential for innovation as venue operators aim to compete to attract liquidity. As part of this, though, competition has also led to fragmentation of markets, both in terms of liquidity and information. This has meant that, in many jurisdictions, the search for best price by market participants (including in the context of providing investors with best possible execution) now involves the consideration of multiple sources of liquidity and possibly increased search costs.

These sources of liquidity include exchanges and non-exchange trading venues, such as alternative trading systems (ATS') in the United States and Canada, multilateral trading facilities (MTFs) in Europe, and brokers' internal crossing networks (which are not ordinarily regulated as trading venues) as well as lit and dark liquidity. As a result equity markets, for which on-exchange trading was prominent, have become more fragmented and, in some instances, less transparent. With the further development of multiple trading venues, liquidity in a particular share is often split amongst different pools of liquidity that operate with or without pre-trade transparency. The full benefits of post trade transparency may also be undermined in some countries by the costs and complexity of market data consolidation.

Trading venues continue to develop new and innovative trading functionalities to attract and maintain order flow. The use of *dark liquidity* for the trading of equities and the development of so-called *dark pools* and *dark orders* has increased. This includes the emergence of price-referencing venues, where participants enter orders accepting that the price of any consequent trade will be based on a suitable[14] reference price derived from another transparent market such as an exchange. It also includes the use, on otherwise transparent order books, of orders that are not visible (for instance, orders that are allowed to be hidden on account of being large in scale).

Non-transparent pools of liquidity in equities markets are not a new phenomenon. Traders have always sought ways to preserve anonymity and execute orders with minimal market impact. Dark liquidity has long existed, for example, in the form of orders being held by *upstairs trading* desks and liquidity offered by firms that internalise their order flow. What is new is the degree of automation of trading in dark pools and dark orders on equity trading venues, and the widespread availability of their use. The benefits of using dark order types were fewer in the past because manual handling of orders, typically by a specialist or market maker, was necessary to trade. In recent years, the handling of dark liquidity has been made more efficient due to the use of new technology and trading models. This has resulted in,

[14] For example, in the European context, MiFID requires that "*…the price is determined in accordance with a reference price generated by another system, where that reference price is widely published and is regarded generally by market participants as a reliable reference price*".

among other trends, significant growth in the number of dark pools and dark order types, and raised issues of regulatory concern that are discussed below.

The regulatory focus on dark trading has also brought indications of interest (IOIs) to the fore in some jurisdictions. IOIs are messages that express a party's interest in undertaking a trade. Two types of IOIs may be distinguished. One type is when there are IOIs posted by intermediaries on data dissemination systems or exchanged with another intermediary without any indication of price or quantity. The other occurs when there are actionable IOIs that are sent from a dark trading venue, dealer internalization system or network to a subset of participants in order to communicate the existence of an immediately executable order. These are used with the aim of avoiding information leakage while maximising the opportunity of finding a counterparty. It is unclear to what extent the use of IOIs has increased or changed in recent years as the technological means of communicating them have increased.

The use of actionable IOIs raises regulatory issues in terms of fairness – i.e. the extent to which it is fair that some members of a platform should have information that others do not. An IOI gives the recipient information about trading opportunities not possessed by the public which disadvantages those participants that do not receive the information. It also challenges the general principle of pre-trade transparency established by IOSCO in its report on *Principles for Dark Liquidity*. In Europe, the European Commission in its consultation on the MiFID Review clarifies that "actionable IOIs", which are those that have all the elements necessary for a transaction to take place, should be considered as orders and, as such, be subject to full pre-trade transparency requirements - i.e. they should be visible to everyone or to no one. This is also the position taken by the Canadian Securities Administrators in their recent amendments to the regulatory framework for ATSs and exchanges[15]. The U.S. SEC has proposed (in November 2009) to amend the quoting requirements of the Securities Exchange Act of 1934 (the Exchange Act) to apply expressly to actionable IOIs[16].

Market fragmentation and the presence of dark liquidity may raise concerns around transparency and the efficiency of the price formation process. For example, competition between trading venues leads naturally to fragmentation of market data as each venue separately publishes the trades that take place on its systems. Whilst consolidation services exist to integrate the separate data streams, there is a risk that in some jurisdictions some market participants are unable to afford such services and/or the data itself, potentially affecting the price discovery process for these participants. Similarly, the ability to trade on a dark basis may lead to a less efficient price formation process if the level of trading that remains lit is not sufficient to establish a market price that accurately reflects the totality of buyer and seller interest.

In its 2011 Report on *Principles for Dark Liquidity*, IOSCO identifies a number of issues surrounding the use of dark pools and dark orders in transparent market that relate to:

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[15] See *Proposed Amendments to National Instrument 21-101 Marketplace Operation and National Instrument 23-101 Trading Rules (Request for Comments) available* at http://www.osc.gov.on.ca/en/SecuritiesLaw_rule_20110318_21-101_rfc-notice-proposed-amendments.htm.

[16] The SEC is proposing to amend the definition of "bid" or "offer" in Rule 600(b) (8) of Regulation NMS. "Bid" and "offer" are key terms that determine the scope of the two primary rules that specify the types of trading interest that must be included in the consolidated quotation data: Rule 602 of Regulation NMS and Rule 301(b)(3) of Regulation ATS.

- the impact on the price discovery process where there is a substantial number of dark orders and/or orders submitted into dark pools which may or may not be published;

- the impact of potential fragmentation on information and liquidity searches; and

- the impact on market integrity due to possible differences in access to markets and information.

Where precisely the line lies between a sufficient level of lit trading to maintain efficient price formation and that which would be insufficient is unclear and may differ by instrument. This, and the costs associated with obtaining a clear overall picture of the markets are areas for regulators to explore further.

(c) Direct Electronic Access

As the way in which exchanges and other markets operate has evolved, so too has the means of access to these markets. In modern markets, trading venues are overwhelmingly electronic. This has allowed services to emerge through which a trading venue's member firms are able to offer direct trading connectivity between the venue and the firms' clients. It has also allowed for non-intermediaries to gain direct access to markets. Such arrangements are known as *direct electronic access* (DEA).

There is general agreement that DEA falls into two key categories: intermediated and non-intermediated. Intermediated DEA generally refers to:

(i) customers being given direct access to the market through a registered intermediary's system/infrastructure, i.e. automated *order routing*; or

(ii) customers of an intermediary being given direct access to the market without going through the intermediary's system/infrastructure, i.e., *sponsored* access.

However, in either case, the order is sent to the market as the intermediary's order, i.e., using the intermediary's trading ID (aka mnemonic). The intermediary therefore retains full responsibility for the order.

Non-intermediated direct access generally refers to markets in certain jurisdictions that are permitted to provide direct access to non-intermediaries (i.e., parties other than registered brokerage firms), as market-members and in that capacity connecting directly to the market, without going through an intermediary.

IOSCO's work on DEA, completed in 2010, identified a number of risks posed to market integrity:

- the potential, without proper controls, for a customer to intentionally or unintentionally cause a market disruption;

- an increased risk of non-compliance with market rules, especially where those that directly access markets are not familiar with regulatory requirements;

- credit risk, whereby an intermediary will be held financially responsible for trades that are beyond its available financial resources;

- a lack of information to the intermediary from the market and/or the clearing house regarding the trading by the DEA customer;

- a lack of understanding on the part of intermediaries of the programming in the algorithms used by DEA customers, and

- whether differences in latency arising from different means of connecting to trading systems and locating trading systems close to exchange servers (i.e., so-called co-location, discussed further below) raise any concerns that should be addressed by means other than disclosure and equitable access as provided for in *Principles for the Oversight of Screen-Based Trading Systems*[17].

These risks were broadly addressed by the principles IOSCO established in its August 2010 report, as discussed below.

(d) Co-location

Co-location services exist to house trading systems used by market participants (and potentially other parties, such as data vendors) in a location close to trading venue servers. Such services are generally provided by a trading venue, whether within its data centre or in a location of close physical proximity. By providing co-located firms with the shortest available physical distance to the trading venue's systems, co-location offers the advantage of extremely low latency, an essential ingredient in certain trading strategies typically used by high frequency traders and other firms wanting high speed access to the markets. Trading platforms seeking to attract this type of business, which may generate large transaction volumes (and, more generally, to attract market participants who want extremely low latency), have a commercial interest in offering this service. Its provision has increased considerably in recent years, in part with the building of sometimes massive out-of-town data centres.

Co-location raises issues related to potential distortion of competition between market members, equal access to the market and the cost of such services. These issues could be especially relevant if access to co-location services is limited in the short-run by the physical limit of spare capacity. In particular, the fact that some participants may receive information on order book trading interest and executions sooner than others, and have their orders entered in the trading system more rapidly may raise questions regarding the fairness and integrity of the markets. During discussions with industry participants, including trading venues, some have argued that competition is not materially distorted, as long as any market participant wishing to obtain co-location space can do so on fair terms that apply to all, and that prohibiting co-location would also give rise to other forms of inequity. Similarly, some have noted that, with participants' own data centres located at varying distances from those of their trading venues, there will always be differences in latency between participants. The offering

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[17] *Principles for the Oversight of Screen-Based Trading Systems*, Report of the Technical Committee of IOSCO, June 1990;available at http://www.iosco.org/library/pubdocs/pdf/IOSCOPD4.pdf and *Principles for the Oversight of Screen-Based Trading Systems for Derivative Products-Review and Additions*, Report of the Technical Committee of IOSCO, October 2000, at p. 5, section III, Part 1, available at http://www.iosco.org/library/pubdocs/pdf/IOSCOPD111.pdf.

of co-location services by trading venues may increase the cost to some market participants. This raises the potential issue whether these costs undermine fair access to trading venues.

(e) Tick sizes

A tick is the minimum price movement by which an instrument's price can move. It can range from as much as a hundred euros to a fraction of a cent. The tick will usually depend on the price and/or liquidity of the instrument, such that those with low price and high liquidity will tend to have a lower tick size. Tick sizes are determined by regulation in some jurisdictions, and left to market forces in others (i.e. trading venues determine the minimum tick on an instrument-by-instrument basis). There is a sizeable body of literature on optimal tick sizes, with authors reaching different conclusions. There is no universally acknowledged method for determining optimal tick size.

In Europe, for example, the market fragmentation and competition discussed above resulted in trading venue operators engaging in a race to reduce tick sizes, until the signature in July 2009 of an agreement through which tick sizes were harmonised for the most liquid securities. However, the stability of this agreement may be challenged by competitive motives as it is an industry self regulation measure. Exchanges may have the tendency to reduce tick sizes to compete with dark pools which, using midpoint execution to match orders[18], pose competitive pressures to exchanges that adopt large tick sizes.

Lower tick sizes can benefit retail investors by increasing competition, tightening spreads and lowering trading costs. On the other hand, some panellists at IOSCO's sessions argued that smaller tick sizes inappropriately encourage HFT firms to submit orders that are then cancelled prior to execution. Competitive lowering of tick sizes to attract trading volumes from HFT firms may ultimately affect the price formation process on pre-trade transparent markets. Strategies based on the systematic introduction, amendment or cancellation of orders are made less attractive by larger tick sizes, which can make more meaningful the core principle of time priority, as it becomes harder to step in front of another, older order by offering a fractionally better price. When tick sizes are too small, orders are scattered across a large spectrum of price limits, so that there is no incentive for traders using sophisticated IT strategies to unveil their trading intentions and interests in due time. Specifically, the smaller the tick size, the less expensive it is for one market participant to establish price priority over another market participant. Regulators are trying to balance having markets with robust price discovery, including the creation of incentives to compete by posting limit orders, while at the same time preventing the tick size from being so small that people can be "jumped" for an economically insignificant amount. Thus some argue that lowering tick sizes would:

- reduce market depth at the best bid and offer; and

- lessen the importance afforded to time priority and, consequently, lessen the appeal of posting limit orders.

(f) Fee structures

Competition between trading venues is reflected in both the structure and the level of fees they charge their members. The main approaches in use at trading venues today include

[18] Midpoint matching refers to buy and sell orders being matched at the midpoint of the best bid and offer prices on the given reference market.

graduated pricing (i.e. lower fees being charged for higher volumes of business), differential pricing depending on the nature of the order (proprietary versus client account), and *maker/taker* pricing (through which a participant will be charged a lower fee for posting an order that does not immediately execute – thereby contributing to the liquidity in the market – than a participant that enters an order that *takes liquidity* by instantly trading). Importantly, the competition in the market means that fee structures are commonly more complex and more frequently reviewed and revised than was the case in the past. The fee structures in place may have changed market behaviours. Currently, public sector regulators in some jurisdictions regulate trading venues' fee structures, but this is not universally the case.

Some types of fee structures may raise questions in terms of the risk of distorting the price formation process. For instance, maker/taker structures can lead to trading strategies aimed at optimising rebates received for providing liquidity versus fees paid for taking it, rather than focusing on the level of the given instrument's price. Fee structures should not result in inappropriate discrimination between members or lead to an overt bias in trading methods. Other regulatory concerns include: the degree to which these structures influence the decision to connect to a particular trading venue; the need for and relevance of publication of fee schedules; and the role that competent authorities should play in this area. Further analysis may be justified with respect to the fairness and impact of fee structures currently used by trading venues.

Chapter 3 High Frequency Trading

1. Background

In the last few decades, the trading of securities has increasingly been carried out in an automated fashion. Many markets have embraced the electronic order book as a fundamental functionality for their market models and abandoned human intermediated floor trading. Advances in computing power, communication technology and programming capability have offered new tools for investment decisions, trading execution and risk management. Technology is now as much part of the fabric of financial markets' microstructure as the regulatory framework. It facilitates the execution of complex strategies and increases the speed of trading. While competent authorities recognize the benefits associated with advancements in technology, the use and impact of automated trading and HFT certainly pose challenges and necessitate monitoring in order to identify and address risks for markets' efficiency and integrity.

HFT is one of the key developments stemming from technological advances. It can be traced back to as early as 2000 and is part of a long trend toward increasing trading automation. However, in the last few years it has become a quantitatively significant feature of modern financial markets.

Factors other than technology and low latency access to the market have contributed to shaping market microstructure and to the emergence of HFT. Extensive reforms to the regulatory framework[19] in major financial markets aimed at promoting competition in trading services have also played an important role. The changing structure of the exchange industry[20] and the emergence of multiple execution venues are considered by many to have created a favourable environment for HFT. In addition, the widespread use of the maker-taker pricing model[21] and lower tick sizes by execution venues have also provided incentives for some HFT firms. Therefore it is important to bear in mind that technology is but one, albeit important, driver in the shaping of modern equity and financial markets.

Even though a number of competent authorities had already started examining automated trading and HFT, events like the Flash Crash of May 6, as described in the previous chapter, have certainly contributed to putting automated trading and specifically HFT at the top of the policy agenda. The event sparked intense and conflicting interest and brought this complex

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19 In the USA, the Security and Exchange Commission introduced in the late 1990 a series of reforms which had a profound impact on the US equity market structure. Regulation NMS (2005) was the last and most far reaching of these reforms and set up the regulatory framework that fostered competition among trading venues see at http://www.sec.gov/rules/final/34-51808.pdf. In Europe the Markets in Financial Instruments Directive (MiFID), which came into force in November 2007, abolished the concentration rule, allowed the emergence of alternatives to traditional stock exchanges and similarly fostered competition. In 2001, the Canadian Securities Administrators introduced the Marketplace Rules that allowed for competition and provided a regulatory framework for alternative trading systems. The Marketplace Rules also impose fair access requirements which cover areas such as fees charged and the offering of co-location services. Recent amendments address indications of interest.

20 In the last fifteen years most major exchanges have abandoned their cooperative or public not-for-profit governance model to become publicly listed for-profit companies. Many exchanges closed their trading floors and adopted fully electronic trading systems. As a result, such exchanges have become very proactive in offering listing and trading services to a variety of stakeholders other than members.

21 The maker-taker model refers to a pricing model whereby the *maker* of liquidity, or passive order, is paid a rebate and the *taker* of liquidity, or aggressive order, is charged a fee.

topic to the attention of an audience beyond market participants, regulators and academics. The importance of HFT to policymakers is reflected in the number of initiatives, consultations and proposals recently put forward by competent authorities:

- In January 2010 the Securities and Exchange Commission (SEC) published a concept release[22] on the structure of the US equity markets. Among other things, the document solicited comment on the impact of strategies employed by HFT on markets' quality and integrity. On May 11, 2010, the SEC and CFTC created a joint advisory committee with the aim of providing advice on emerging regulatory issues.[23] In February 2011, the advisory committee released a report containing recommendations regarding regulatory responses to the market events of May 6, 2010[24].

- In Europe, CESR (now ESMA) issued a call for evidence[25] in April 2010 on micro-structural issues in the European equity markets, including HFT. Following this, the European Commission's MiFID Review consultation document of December 2010 put forward a number of regulatory proposals on automated trading and HFT[26].

- In India, the Securities and Exchange Board of India (SEBI) set up a Technology Advisory Committee in March 2010 to advise on issues relating to HFT, co-location and security issues related to internet based trading.

- In November 2010 the Australian Securities and Investment Commission (ASIC) issued a consultation package[27] on enhancing regulation of Australia's equity markets, including the introduction of competition between exchange markets and the benefits and challenges arising from HFT.

- In April 2011, Canadian Securities Administrators published a rule for comment focussing on the risks associated with automated trading and direct electronic access, including HFT[28].

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22 Aside from high frequency trading, the concept release reviews other developments in the US market structure like non-displayed liquidity, market data linkages and order routing. See *Concept Release on Equity Market Structure* available at http://www.sec.gov/rules/concept/2010/34-61358.pdf.

23 See *SEC, CFTC Announce Creation Of Joint CFTC-SEC Advisory Committee On Emerging Regulatory Issues* May 11, 2010, available at http://www.sec.gov/news/press/2010/2010-75.htm.

24 See *Recommendations Regarding Regulatory Responses to the Market Events of May 6, 2010*, available at http://www.sec.gov/spotlight/sec-cftcjointcommittee/021811-report.pdf.

25 The document also covers developments in market microstructure like sponsored access, co-location services, fee structures, tick sizes and indication of interest. See *Micro-structural issues of the European equity markets*, CESR 1 April 2010, available at http://www.esma.europa.eu/data/document/10_142.pdf.

26 In November 2010, the UK Treasury established a new research project to explore how computer-generated trading may evolve in the future.

27 See *CP145 Australian equity market structure: Proposals*, ASIC, 4 November 2010, available at http://www.asic.gov.au/asic/pdflib.nsf/LookupByFileName/cp-145.pdf/$file/cp-145.pdf.

28 *Proposed National Instrument 23-103 Electronic Trading and Direct Electronic Access to Marketplaces*, requires, among other things, that all market participants that access markets have risk management and supervisory controls, policies and procedures to ensure that the risks associated with electronic trading are appropriately prevented or managed. See *Electronic Trading and Direct Electronic Access to Marketplaces*, OSC, 8 April 2011, available at

- And as noted above IOSCO, in order to fulfil its mandate, organised a series of panels with the purpose of collecting evidence from a number of leading market participants and scholars in market microstructure.

These are just a handful of the initiatives that have been undertaken.

2. Characteristics

Defining HFT is difficult and there is no single agreed definition. Determining a precise definition may not even be practical for regulatory purposes as it could easily become obsolete or the object of regulatory arbitrage, as HFT may be used in different ways across various markets and asset classes. An additional complexity in seeking to define HFT is that it encompasses many players, different organizational and legal arrangements and, most importantly, a wide number of diverse strategies.

It is frequently equated to algorithmic trading. However, whilst HFT is a type of algorithmic trading, not all forms of algorithmic trading can be described as high frequency. Algorithmic trading predates HFT and has been extensively used as a tool to determine some or all aspects of trade execution like timing, price, quantity and venue. Algorithmic trading is used by many intermediaries for their own proprietary trading or offered to their clients and has also become a standard feature in many buy-side firms, mainly with the purpose of devising execution strategies that minimise price impact or to rebalance large portfolios of securities as market conditions change.

A number of common features and trading characteristics related to HFT can be identified:

- It involves the use of sophisticated technological tools for pursuing a number of different strategies, ranging from market making to arbitrage;

- It is a highly quantitative tool that employs algorithms along the whole investment chain: analysis of market data, deployment of appropriate trading strategies, minimisation of trading costs and execution of trades;

- It is characterized by a high daily portfolio turnover and order to trade ratio (i.e. a large number of orders are cancelled in comparison to trades executed);

- It usually involves flat or near flat positions at the end of the trading day, meaning that little or no risk is carried overnight, with obvious savings on the cost of capital associated with margined positions. Positions are often held for as little as seconds or even fractions of a second;

- It is mostly employed by proprietary trading firms or desks; and

- It is latency sensitive. The implementation and execution of successful HFT strategies depend crucially on the ability to be faster than competitors and to take advantage of services such as direct electronic access and co-location.

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http://www.osc.gov.on.ca/en/SecuritiesLaw_ni_20110408_23-103_pro-electronic-trading.htm and http://www.lautorite.qc.ca/files//pdf/consultations/valeurs-mobilieres/2011avril08-23-103-cons-fr.pdf.

HFT is hence a very quantitative trading form. It draws from the latest advances in statistical and econometric techniques and employs state of the art computer and communication systems. Algorithms are used to interpret signals from the market and automatically implement trading strategies that involve round-trip trades that last for just seconds or even milliseconds. HFT firms profit mostly from small price changes and by small but frequently executed trades. The strong focus on speed of execution and portfolio turnover are probably the key characteristics that distinguish HFT from other types of algorithmic trading.

A precise quantitative assessment of the importance of HFT in modern financial markets is challenging. This is partly a reflection of the complexity of defining precisely what HFT is. The structure of trading flows further complicates the task, as most major intermediaries have trading desks that adopt strategies involving HFT alongside traditional proprietary trading. Similarly, some HFT firms access the market through direct electronic access arrangements provided by members firms. To isolate the HFT trading from the rest of the member's trading flow is extremely difficult. Current estimates of HFT are provided by the private sector through surveys and by a handful of academic studies. This lack of precise data on trades and orders complicates a competent authority's task in identifying and addressing issues raised by HFT.

HFT has different degrees of adoption across markets. Robust market infrastructures (i.e. trading and communication systems), liquid and transparent markets, particular pricing schemes (like the maker-taker model) and small tick sizes are usually positively correlated with HFT. According to estimates from the Tabb Group[29], HFT accounted for around 56% of US equity trading in 2010, up from 21% in 2005[30].

Europe shows a similar upward trend and, while starting from just 9% in 2007, HFT already accounts for as much as 38% of equity trading as of 2010. Figures for the first quarter of 2010 provided by Regulated Markets and MTFs in the responses to CESR's call for evidence are broadly consistent with the above estimates showing a market share in the range of 25%-35%. It is believed that the lower share of trading in Europe partly reflects the fragmentation in post-trade services, as clearing and settlement act, at least for equities, as a cost barrier to further growth.

Figures for major Asia-Pacific markets, according to Tabb, show a lower share of trading compared to both the USA and Europe, with HFT representing 10%-30% of trading in 2010. However, as these markets are undergoing the same developments as witnessed in western countries (such as the introduction of faster trading and connectivity systems and the emergence of alternative trading venues) it is reasonable to expect that the proportion of HFT trading will increase to levels more like those observed in the US and EU.

HFT also shows different degrees of adoption across asset classes, much depending on the degree of liquidity of the instrument and the development of the trading and post-trading market infrastructure. Initially used for the trading of more liquid stocks, the equity market remains the one where HFT account for the strongest share of traded volume. Other

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29 See Tabb reports "*European Equity Trading 2010: Maneuvering in the Market*" (October 2010) and "*Next-Generation Algorithms: High Frequency for Long Only*" (December 2010).

30 Given the large number of orders per trade, HFT presence according to different measures could even be greater than these figures suggest.

important asset classes where HFT plays a relevant role are exchange traded funds, exchange traded derivatives, fixed income securities (e.g. US Treasuries) and major currencies.

Although the number of firms specialised in HFT can be substantial, a small number of companies account for a large share of traded volumes. Anecdotal evidence collected by IOSCO through discussions with the industry suggests that a process of consolidation is taking place as the industry matures and the competitive environment offers fewer new opportunities.

3. Strategies Employed

HFT is not a single strategy but it is rather a set of technological arrangements and tools employed in a wide number of strategies, each one having a different market impact and hence raising different regulatory issues. This interpretation was strongly supported by market participants during all the panel hearings held by IOSCO. Many of the strategies that involve HFT are not new to financial markets. What is new is the extent by which these strategies can be pursued using automated trading in general and HFT in particular. Most strategies profit from very small price changes and rapid turnover of capital. It is almost impossible, however, to develop an exhaustive list of all strategies. It is instead useful to group the most widely used strategies into three broad categories: market making, arbitrage and directional.

(a) Market making

A market making strategy involves continuously posting passive limit orders on both sides of the order book in order to offer liquidity to other market participants and, in this way, earning the spread. Profitability is enhanced by the fact that many trading centres apply the *maker-taker* fee structure. This strategy is often called market making but to do so may be inappropriate. Some HFT firms register with the trading venues on which they are members to meet the ongoing obligations associated with being an official market maker. However, this is often not the case, as HFT firms may act instead as informal liquidity providers, avoiding prescribed market making obligations but also failing to gain at least some of the benefits enjoyed by traditional market makers. By looking at traded volumes, HFT firms have become significant participants in the liquidity and price formation process in many markets and instruments and, even when acting informally in this role, have partly replaced traditional market makers. Low latency is of the utmost importance for this strategy since providing liquidity might involve holding a risky inventory position on an instrument for some time. Market risk is minimized by rapidly adjusting posted quotes to reflect the arrival of new information or to adjust inventory. As a consequence, the ratio of orders to trades and the number of cancelled orders are very high in this strategy.

(b) Arbitrage Strategies

Arbitrage strategies take advantage of pricing discrepancies and may involve pure arbitrage between the same instruments traded across different trading venues (e.g. the same stock traded at an exchange and an ATS/MTF), between an index and the underlying basket of securities, or between related instruments (e.g. a security and an associated derivative). Other forms of arbitrage look at statistical deviations from long term, historical statistical relationships (e.g. correlations) among securities. Assuming reversion to the mean, significant deviations from these relationships offer profitable trading opportunities. Arbitrage strategies tend to improve price efficiency by eliminating inconsistencies between

prices. They also tend to consume rather than provide liquidity to the market, as the short-lived nature of arbitrage opportunities makes rapid execution of trades critical.

(c) Directional Strategies

Directional strategies, including event strategies, involve un-hedged positions being carried for some (albeit often short) period of time, in anticipation of small but lasting intra-day price changes. Based on past patterns, HFT firms estimate expected price changes triggered by the release of macroeconomic news, corporate announcements or industry reports with a significant impact on market prices. As past events generate recognizable and statistically robust patterns, HFT firms estimate expected price responses to anticipated events. Another directional strategy is a liquidity detection strategy which involves a firm searching for hidden demand for liquidity in the market. Undisclosed demand is liquidity that is not reflected in the order book and in the market price. The strategy profits by moving the price against large hidden buying or selling interest.

4. Observed Impact of High Frequency Trading on Markets

The empirical evidence on the impact of HFT on markets is still scarce due both to a limited availability of appropriate datasets and to the empirical and theoretical difficulties raised by the exercise. The academic literature has so far mainly focused on some measures of liquidity, price discovery and volatility rather than on risks to the integrity of markets as a whole. An analysis of the effect of HFT activity on markets faces two problems. Firstly, disentangling the impact of HFT from other factors is very complicated as the trading environment is highly dynamic and other forces, such as competition and structural changes, are continuously at play. Indeed, the ongoing emergence of HFT has coincided with a period of high market turbulence, regulatory reforms and regulatory actions.[31] Secondly, and as outlined above, HFT is employed in many different strategies, each potentially having different impacts on the markets. These issues call for caution to be exercised in drawing firm conclusions from the existing body of research, and more is needed.

Nevertheless, a growing body of academic and practitioner research has started to investigate HFT and algorithmic trading and it has produced preliminary and mixed results. It is through this research and the empirical and anecdotal evidence gathered by regulators through discussions with market participants during IOSCO's panel sessions, that the risks posed must be measured against the benefits produced. This is done below, with regard to the impact of HFT on markets' efficiency.

Regulatory reforms and technological developments fostered two relevant trends in equity markets in the last decade. On one side the complexity of the equity markets has greatly increased. The number of trading venues has multiplied (creating a fragmented marketplace) thus requiring that investors search several execution venues to find liquidity (which also requires them to develop the appropriate technological infrastructure). The variety of different market models has also significantly increased, with the flourishing of new execution venues that meet different market participants' needs. In many major markets, particularly in North America and Europe, liquidity and complexity is now spread across

[31] Between September 2008 (after the collapse of Lehman) and the first half of 2009 many financial regulators imposed bans on short selling. Some of the bans ruled out *naked* short sales (i.e. where the seller does not borrow the stock) while others also ruled out short sales where the seller manages to borrow the stock (i.e. covered short sales).

multiple venues to an unprecedented degree. The rise in trading velocity may also have had consequences on the ability of some market participants to interpret market information, as evidenced by May 6 events.[32]

On the other side a number of indicators point to an improvement in market quality. Traded volumes have significantly increased (albeit average trade size has fallen substantially) even in the context of one of the most turbulent decades in the history of financial markets. Execution speed has fallen from seconds to as little as microseconds within ten years. Some measures of liquidity have improved with implicit trading costs (like quoted bid-ask spreads) and explicit costs (e.g. trading fees) declining. On the whole, and although May 6 events have shown some limits in the capacity of markets to absorb significant liquidity shocks, equity market liquidity has shown a significant degree of resilience in the context of turbulent markets and a severe financial crisis.

HFT and algorithmic trading have arguably played a significant role in the above developments and have taken advantage of the new trading environment. Some empirical studies[33] suggest that HFT has a positive impact on efficiency of the price discovery mechanism. An important role identified as being performed by HFT firms is that they contribute to price across different trading venues - a function that is particularly important in a fragmented market environment. HFT firms process new market information rapidly and embed it into their quotes and orders, changing market prices to reflect this new information as quickly as possible. This meshes well with the operating model of many investment firms that employ HFT when acting on a proprietary basis. Such firms do not employ research analysts but base their trading on market information (including that which can be inferred from the dynamic of the order book) and broader macroeconomic data.

Liquidity is an important quality of an efficient market. One definition of liquidity is "the ability to trade large size quickly, at a low cost, when you want[34]". It has several dimensions including instantaneous measures of implicit transaction costs (displayed and effective bid-ask spreads) and of quantities posted for trading (depth) and a time dimension (price resiliency and impact of trades). Narrow bid-ask spreads, high turnover velocity[35] and large and continuously displayed depth are all measures which have traditionally been positively correlated with liquid markets. The operational model of HFT requires trading in markets that are already liquid enough to be able to quickly enter and exit from the market. This is a critical requirement for limiting their exposure to market risk.

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32 Liquid markets are usually characterized by high turnover velocity and volumes. The correlation of turnover velocity (which is roughly the ratio between traded volume and market capitalization) with liquidity might however not always hold under turbulent market conditions. As stated in the joint CFTC-SEC Advisory Committee report (p. 13): "The events of May 6 demonstrated that even in a single market setting such as a futures market liquidity problems can arise from unexpected imbalances in the book of orders" Note 24 above.

33 See Jonathan A. Broogard "*High Frequency Trading and its Impact on Market Quality*", unpublished PhD Thesis available at: http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1641387; and Hendershott, Jones and Menkveld "*Does algorithmic trading improve liquidity?*", Journal of Finance.

34 See Larry Harris, "*Trading and Exchanges*", Oxford University Press, 2002

35 Liquid markets are usually characterized by high turnover velocity and volumes. The correlation of turnover velocity (which is roughly the ratio between traded volume and market capitalization) with liquidity might not always hold under turbulent market conditions. As stated in the cited joint CFTC-SEC Advisory Committee report on the Flash Crash: "*…the events of May 6 demonstrate, especially in times of significant volatility, high trading volume is not necessarily a reliable indicator of market liquidity*".

The available evidence fails to find a consistent and significant negative effect of HFT on liquidity[36]. HFT traders are believed by some markets participants to supply significant liquidity in today's markets. At the same time, the emergence of algorithmic and HFT trading occurred along with a significant decline in average trade sizes, with smaller orders posted at the best bid and offer prices. As a consequence, investors with large blocks to trade have sometimes found it hard to execute the trades on lit markets. The impact of HFTs on the ability of an institution to trade orders of large size using algorithms or otherwise could be impacted negatively by HFT. This issue should be analyzed by markets authorities. However, the causality of how the change in average trade sizes has arisen is unclear. It is hard to determine whether it is the operation of HFT that has changed the structure of trading or if it is the concurrent process of fragmentation resulting in participants dividing orders into smaller parcels (so-called *child orders*) and sending them to different venues for execution. The emergence of dark pools of liquidity may also have acted to attract some investors away from the lit public markets, especially if they find it difficult to trade in large sizes on these markets. Moreover, the declining trend in tick sizes and the finer pricing to which this has given rise, as a natural consequence, has resulted in a distribution of liquidity across more prices. Finally, it is questioned by some market participants whether HFT firms provide liquidity to the market on a consistent basis, i.e. whether they continue to do so during turbulent conditions and whether they withdraw from the market. Further research and a more consolidated body of evidence is necessary to assess the real impact of HFT on liquidity.

Volatility is the tendency of prices to change suddenly and unexpectedly. Volatility can be related to changes in the intrinsic value of a security (called fundamental or informed volatility) or can be related to transitory components, such as short term shifts in sentiment or levels of uncertainty. Liquidity and volatility are closely related as more liquid markets are better able to absorb transitory shocks. HFT firms that engage in official market making on trading venues may help to curb intra-day transitory volatility by adding liquidity to both sides of the market. The available empirical evidence is mixed and while some studies suggest[37] that HFT tend to have a stabilizing effect on market volatility, at least during normal market conditions, others provide negative evidence on the impact of HFT on market volatility.

5. Risks Posed to Market Integrity and Efficiency

A holistic evaluation of the role played by HFT in modern markets requires the accurate identification of the risks and challenges posed by this new form of trading. It is useful to group the risks posed by HFT into the following:

- the efficiency of markets;

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[36] A notable exception is a study by Andrei Kirilenko, Albert S. Kyle, Mehrdad Samadi and Tugkan Tuzun titled "*The Flash Crash: The Impact of High Frequency Trading on an Electronic Market*". Their report concluded that HFTs did not change their trading behavior during the Flash Crash. On the three days prior to May 6, as well as specifically during the period when the prices are rapidly going down, the HFTs seem to exhibit the same trading behavior. Namely, HFTs aggressively take liquidity from the market when prices were about to change and actively keep inventories near a target inventory level. During the Flash Crash, the authors conclude that the trading behavior of HFTs appears to have exacerbated the downward move in prices.

[37] See Jonathan A. Brogaard "*High Frequency Trading and its Impact on Market Quality*", unpublished PhD Thesis., note 33 above.

- the fairness and integrity of markets; and

- the stability and resiliency of markets.

(a) Risks to the Efficiency of Markets

An issue raised by some market participants during IOSCO's panels and on a bilateral basis with regulators concerns the quality of the price discovery process in the context of a growing share of trading accounted for by HFT firms. The very short term nature of many HFT strategies, coupled with the risk of high speed, high volume trading algorithms might move the market prices away from fundamental values in the short term and impair the price discovery process that takes place on public and transparent markets[38]. One market participant highlighted, during the IOSCO panels, that maker-taker fees further exacerbate this phenomenon by attracting unwanted trading behaviour. As outlined above, the limited empirical evidence available so far has not clearly identified negative effects of HFT on the efficiency of the price discovery process.

A second concern regards the quality of liquidity provided by HFT firms. The events surrounding the May 6 flash crash suggest that HFT firms, whilst not triggering the crash, rapidly withdrew from the markets as they began to move, thereby intensifying the liquidity crisis. This effect was identified in the joint SEC-CFTC Advisory Committee report. The main concern is that the fast and automatic operation of algorithms by HFT firms may increase transitory volatility in both normal and turbulent market conditions, for example through an error in the programming of an algorithm causing it to buy or sell heavily and unexpectedly. Instances of such errors have certainly arisen. The impact of this phenomenon might be amplified by the difficulty met by some investors in promptly interpreting the effective level of liquidity available in the market.

(b) Risks to the Fairness and Integrity of Markets

HFT firms invest heavily in technological infrastructure like computer and communication systems. The development of successful algorithms also requires very skilled and expensive human resources. Although the technological advantage might decline in the future as technology often becomes commoditised, a challenge posed by HFT is the need to understand whether HFT firms' superior trading capabilities result in an unfair advantage over other market participants, such that the overall fairness and integrity of the market are put at risk. In the case of HFT, it has been argued that this advantage arises due to the ability to assimilate market signals and execute trades faster than other market participants. Some market participants commented to regulators that a loss of confidence in the fairness of markets may result in them reducing their participation in lit markets, or in shifting their trading into dark pools. If this effect is indeed occurring on a significant scale, it may result in a growing concentration of trading (at least in the lit markets) amongst a relatively limited set of market participants[39].

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[38] Kirilenko et al noted that the trading behaviour of HFTs during the *flash crash* appears to have exacerbated the downward movement in prices.

[39] Lee et al suggest that markets dominated by technical trend followers may experience higher incidences of extreme price shocks. See B. Lee, S.F. Cheng & A. Koh, "*An Analysis of Extreme Price Shocks and Illiquidity Among Systematic Trend Followers", working paper*, 2010.

Breaking down the above points, these concerns may be reflected in different ways. One is whether access to technological infrastructures (including co-location facilities) by regulated entities is offered in a fair way. In order to help ensure that the integrity of markets is preserved, it is necessary that access to technological infrastructures is offered in a transparent and non-discriminatory manner to all market participants.

More generally, an academic participating in the IOSCO panel sessions stressed the risk that HFT participation in the market may lead to an *arms race*, as market participants compete against one another to possess the fastest and most sophisticated technology, which is very costly.[40]

The second concern is whether HFT enables the pursuit of some apparently non-abusive practices, such as searching for hidden liquidity and order anticipation, that results in harm to market quality and prejudices confidence in markets if undertaken on a large scale. Large traders have always sought to conceal their trading intentions from other market participants in order to reduce market impact and being traded ahead. In modern markets this entails the use of reserve orders as well as sophisticated algorithms and order management systems that slice a large order into smaller parts for execution on possibly multiple trading venues. Some HFT firms employ very sophisticated systems that look at trading patterns consistent with the presence of significant hidden liquidity. Once liquidity is found, a profitable strategy involves trading ahead of it in anticipation of how the price will be affected by it.

The third concern is whether technological advantage offers HFT firms the possibility of engaging in abusive practices on a larger scale than would have previously been possible. Momentum ignition, quote-stuffing, spoofing and layering[41] are some examples of existing trading practices which may have an abusive and manipulative purpose, and that may benefit from the edge of HFT-style technology and the complex and fragmented nature of modern financial markets.

During panel hearings, IOSCO was not presented with clear evidence of the systematic and widespread use of abusive practices by those engaging in HFT. Hence HFT and market manipulation should be kept as two distinct concepts and should not be automatically equated. However, the submission of large numbers of orders and trades across multiple venues poses significant challenges to market authorities. Many trading strategies used by HFT participants are so sophisticated that they raise an issue as to whether market authorities have the necessary resources to conduct effective market surveillance. It is necessary that market authorities' market surveillance capabilities keep pace with HFT, in terms of both

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40 Foucault, Thierry, Moinas, Sophie and Biais, Bruno, Equilibrium Algorithmic Trading (October 1, 2010). International Conference of the French Finance Association (AFFI), May 2011, available at SSRN: http://ssrn.com/abstract=1834344. This working paper provides a rationale for the presence of such effects. In substance, HFT requires fixed investment (hardware, programming, co-location) but generate profits from it. To the extent that they bear adverse selection costs (a negative externality of HFT), *slow* (or high latency) traders have to invest in algorithmic trading capacities. As a result, investment in HFT might be collectively too high compared to what would be 'socially optimal'.

41 Momentum ignition: with this strategy, the proprietary firm may initiate a series of orders and trades (along with perhaps spreading false rumors in the marketplace) in an attempt to ignite a rapid price move either up or down"; spoofing: is an abusive practice where the use of displayed limit orders are used to manipulate prices; layering: with this strategy a layers the book with multiple bids and offers at different prices and sizes, generating an enormous volume of orders and high cancellation rates of 90% of more. The orders also may have an extremely short duration before they are cancelled if not executed, often of a second or less.

technological infrastructure and market knowledge, in order to maintain a high degree of investor protection in a speed and fragmented trading environment.

Finally, during IOSCO's panel sessions, some market participants expressed concerns that the partial ownership of new trading venues (ATS'/MTFs) by HFT firms might raise possible conflicts of interests in the governance of these market infrastructures (e.g. in terms of the fee structure offered for trading or risk controls).

(c) Risks to the Resiliency and Stability of Markets

Stable and resilient markets boost investors' confidence and participation, which in turn help make markets more liquid and efficient. It is crucial to evaluate whether the automation of trading in general and HFT in particular do not pose additional risks to financial stability and that the benefits produced by HFT do not come at the cost of a more fragile market structure. The Flash Crash of May 6 underlines the importance of regulatory structures keeping pace with technological advances as well as with changes in market microstructure.

The flip side of the price consistency that high frequency traders may bring to markets by employing arbitrage strategies is that extreme price shocks may also be transmitted more easily both between different asset classes and between different trading venues. For example, it has been suggested that the Flash Crash may have been exacerbated by arbitrage between index futures contracts and their underlying index stocks. A clear understanding of the degree by which HFT firms may exacerbate the transmission of shocks across markets is still lacking.

The heavy reliance on algorithms for trading decisions and execution may pose serious risk when one or more algorithms behave in an unexpected way. As noted above, there is the risk that *rogue algorithms*, i.e. algorithms that malfunction and operate in an unintended way, may trigger a chain reaction and, in turbulent market conditions, withdraw liquidity from the market or impair orderly trading. Such risk is magnified when the speed of trading takes place at fractions of a second.[42]

The high technology requirements of HFT pose capacity challenges at both connectivity and trading engine level. It is important to evaluate whether that trading venues and intermediaries have systems and controls appropriate to a high frequency environment and that appropriate trading control mechanisms are in place to prevent excessive market movements when errors occur.

Direct electronic access is another area where HFT may pose significant risks. When a HFT firm that is not a member of a given venue has direct access to that venue's markets through the facilities offered by a member's systems, it is the member's responsibility to ensure that appropriate risk controls are in place. However, in some jurisdictions non-intermediaries (including HFT firms) may become members of a trading venue, without being regulated by a

[42] For example, in January 2010, NYSE Regulation took action against Credit Suisse Securities (USA) LLC (Credit Suisse) for failing to adhere to the principles of good business practice in that on Nov. 14, 2007, beginning at approximately 3:40 p.m., a Credit Suisse proprietary algorithm routed hundreds of thousands of cancel/replace requests to the New York Stock Exchange for orders that had been previously generated by the algorithm, but, due to an unforeseen programming issue, were never sent by the algorithm. See http://www.nyse.com/DiscAxn/discAxn_01_2010.html.

competent authority. This may weaken the ability of a competent authority to conduct the necessary oversight.

Chapter 4 Regulatory Tools

1. Regulatory Action Taken to Date and Ongoing Work

Against the backdrop of crystallised and possible risks discussed in the preceding chapters, considerable regulatory action has already been taken. To help regulators to develop an appropriate *toolkit*, IOSCO has already undertaken work and produced reports/papers on:

- dark liquidity (as referenced above), transparency and market fragmentation[43];
- direct electronic access (as referenced above);
- oversight of screen-based trading systems[44];
- error trades[45]; and
- trading halts and market closures[46].

Furthermore, and as noted in the introduction to this Report, IOSCO adopted (in September 1998 and last updated in 2010) explicit *Objectives and Principles of Securities Regulation* (Principles). The Principles set out a broad general framework for the regulation of securities, including the regulation of:

(i) securities markets;

(ii) the intermediaries that operate in those markets;

(iii) the issuers of securities; and

(iv) the sale of interests in, and the management and operation of, collective investment schemes.

IOSCO subsequently developed a methodology to illustrate its interpretation of its Principles. The methodology does not alter or expand the Principles but evolves periodically to take into account the latest market trends and developments. The IOSCO Task Force on Implementation of the Principles is currently undertaking just such a review.

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43 See *Transparency and Market Fragmentation*, Report of the Technical Committee of IOSCO, November 2001, available http://www.iosco.org/library/pubdocs/pdf/IOSCOPD124.pdf.

44 See *Screen-Based Trading Systems for Derivatives Products*, Report of the Technical Committee of IOSCO, June 1990, available at http://www.iosco.org/library/pubdocs/pdf/IOSCOPD6.pdf and *Principles for the Oversight of Screen-Based Trading Systems for Derivative Products-Review and Additions*, Report of the Technical Committee of IOSCO, October 2000, available at http://www.iosco.org/library/pubdocs/pdf/IOSCOPD111.pdf.

45 See *Policies on Error Trades*, Final Report, Report of the Technical Committee of IOSCO, October 2005, available at http://www.iosco.org/library/pubdocs/pdf/IOSCOPD208.pdf.

46 See *Trading Halts and Market Closures*, Report of the Technical Committee of IOSCO, October 2002, available at http://www.iosco.org/library/pubdocs/pdf/IOSCOPD138.pdf.

In addition to the above, IOSCO is actively investigating the markets in exchange traded funds (ETFs) and other products such as ETPs, ETNs, ETVs. IOSCO is looking at issues raised by ETFs from different perspectives:

- classification issues and blurring of categories and product designations;
- transparency issues;
- potential conflicts of interest;
- financial stability issues
  - new channels for systemic risks e.g. cross-asset contagion and shock amplification; and
- market integrity and market supervision issues.

IOSCO expects to consult publicly on recommendations regarding these issues, for the purpose of dealing with market integrity, market efficiency and investor protection, in late 2011 or early 2012.

Further, the Task Force on Commodity Futures Markets (Task Force) was formed in September 2008 by IOSCO's Technical Committee, responding to calls for an examination of the functioning of certain commodity futures markets from the G8 Finance Ministers in 2008. Its most recent report was published in March 2009.[47] In the intervening period, the Task Force has undertaken several streams of work on the functioning of commodity derivatives markets, particularly in relation to oil, and made recommendations to improve market transparency and overall functioning for consideration by the G20. The Task Force is currently undertaking work relating to the areas set out in the G20 Seoul Communiqué in November 2010.

In addition, competent authorities are taking more actions at national level to address the risks outlined above. For instance, the US SEC proposed in 2010 that US self-regulatory organizations (SROs) be required to establish a consolidated audit trail system that would enable competent authorities to track information related to trading orders received and executed across the securities markets[48]. A consolidated audit trail system would help regulators keep pace with new technology and trading patterns in the markets. In some jurisdictions, an audit trail across markets trading the same securities has been developed (for example, Canada and Australia).

The SEC also proposed establishment of a large trader reporting system, under which traders reaching specified thresholds would be required to "self-identify" by filing with the SEC[49]

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47 See *Task Force on Commodity Futures Markets*, Final Report, Report of the Technical Committee of IOSCO, March 2009 available at http://www.iosco.org/library/pubdocs/pdf/IOSCOPD285.pdf.

48 See *Securities And Exchange Commission, 17 CFR PART 242, [Release No. 34-62174; File No. S7-11-10], RIN 3235-AK51, Consolidated Audit Trail* available at http://www.sec.gov/rules/proposed/2010/34-62174.pdf.

49 See *Securities and Exchange Commission 17 CFR Parts 240 and 249 [Release No. 34-61908; File No. S7-10-10] RIN 3235-AK55 Large Trader Reporting System* http://www.sec.gov/rules/proposed/2010/34-61908.pdf.

and, on request, US broker-dealers would be required to disclose specified large trader information to the SEC. The US CFTC already has a large trader reporting regime in place[50].

In Europe, as part of the review of the Markets in Financial Instruments Directive (MiFID), the European Commission has consulted on a range of possible measures regarding HFT and related issues. These include whether to require high frequency traders to provide liquidity to the markets on a mandatory basis, whether to place a limit on order to execution ratios to reduce the rate at which orders are submitted and rapidly cancelled, and whether to mandate minimum resting times for orders submitted to order books. The Commission's consultation closed in early February and a draft legislative proposal is expected in the second half of 2011.

Similarly, in Australia, ASIC issued a report on Equity Market Structure in November 2010 together with a consultation paper on proposals to deal with emerging regulatory issues[51]. These proposals included measures on direct electronic access and risk controls for automated trading; volatility controls and changes to pre-trade transparency exceptions aimed at supporting the price formation process on public markets. In April 2011, ASIC announced it intends to undertake further consultation on these issues in Q3 2011 with a view to settling new rules in early 2012.

2. Regulatory Principles and Recommendations adopted by IOSCO

The outcomes from the workstreams highlighted in the bullet points above are discussed below.

(a) Transparency and dark liquidity

Requiring that markets have adequate levels of trading transparency is key to the efficiency of the price formation process and the maintenance of confidence on the part of participants. In 2001 IOSCO published *Transparency and Market Fragmentation*[52] (Transparency Report). In the Transparency Report IOSCO stated that:

> "Market transparency… is generally regarded as central to both the fairness and efficiency of a market, and in particular to its liquidity and quality of price formation."

While the Transparency Report highlighted the importance of both pre- and post-trade transparency and that the wide availability of trading information may attract participation to a market, it acknowledged that transparency may create disincentives for those that trade large blocks or put up capital to facilitate larger trades. The report stressed a need for regulators "to assess the appropriate level of transparency in any particular product market with considerable care."

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50 See Commodity Futures Trading Commission Larger Trader Reporting Program http://www.cftc.gov/IndustryOversight/MarketSurveillance/LargeTraderReportingProgram/index.htm.

51 ASIC Report 215: *Australian equity market structure*, 4 November 2010, available at http://www.asic.gov.au/asic/pdflib.nsf/LookupByFileName/rep-215.pdf/$file/rep-215.pdf, and ASIC Consultation Paper 145: *Australian Equity Market Structure: Proposals*, 4 November 2010, available at http://www.asic.gov.au/asic/pdflib.nsf/LookupByFileName/cp-145.pdf/$file/cp-145.pdf.

52 See footnote 43 above.

The Transparency Report explicitly addressed the risks to transparency arising from market fragmentation. It noted that, with a market's evolution to multiple trading venues, there comes the need to assess whether regulators should –

> "require all trading venues in an asset class to adopt identical, or broadly similar, transparency arrangements… it would be desirable to have a coherent transparency regime for an asset class that applies across all market venues."

IOSCO identified two dimensions for regulators to consider when developing a transparency regime: 1) scope of the requirements; and 2) their application to different trading methods.

The Transparency Report noted that the same approach may not be suited to all platforms or types of trading. For example, with respect to pre-trade transparency, the report stated that the transparency regime should arguably be the same across similar order book venues, but that it may be different for dealer systems or reference pricing systems. However, the report stated that it may be possible to impose the same post-trade transparency regime on all venues, with possibly some differences for large trades.

In May 2011, IOSCO's Technical Committee published *Principles for Dark Liquidity*[53] (Dark Liquidity Report). The Dark Liquidity Report identified and discussed the characteristics of dark pools and dark orders, the regulatory environment in different jurisdictions around the world and concerns with respect to price discovery, fragmentation and market integrity, as outlined above.

The Dark Liquidity Report detailed six principles which are designed to:

- minimise the adverse impact of the increased use of dark pools and dark orders in transparent markets on the price discovery process by generally requiring pre-trade and post-trade transparency and encouraging the priority of transparent orders;

- mitigate the effect of any potential fragmentation of information and liquidity by generally requiring pre-trade and post-trade transparency;

- help to ensure that regulators have access to adequate information to monitor the use of dark pools and dark orders for market monitoring/surveillance purposes and to enable an appropriate regulatory response to market developments; and

- help to ensure that market participants have sufficient information so that they are able to understand the manner in which orders will be handled and executed.

The Principles are set out in detail in Annex 1 of this Consultation Report. In summary, the price and volume of orders should generally be transparent to the public. However, regulators may choose not to require pre-trade transparency for certain types of market structures and orders. In these circumstances, they should consider the impact of doing so on price discovery, fragmentation, fairness and overall market quality. Similarly, information regarding trades, including those executed in dark pools or as a result of dark orders entered in transparent markets, should be transparent to the public. With respect to the specific information that should be made transparent, regulators should consider both the positive and negative impact of identifying a dark venue and/or the fact that the trade resulted from a dark order.

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[53] See footnote 2.

In those jurisdictions where dark trading is generally permitted, regulators should take steps to support the use of transparent orders rather than dark orders executed on transparent markets or orders submitted into dark pools. Transparent orders should have priority over dark orders at the same price within a trading venue. Regulators should also have a reporting regime and/or means of accessing information regarding orders and trade information in venues that offer trading in dark pools or dark orders. In addition, dark pools and transparent markets that offer dark orders should provide market participants with sufficient information so that they are able to understand the manner in which their orders are handled and executed.

Finally, regulators should periodically monitor the development of dark pools and dark orders in their jurisdictions, to seek to ensure that such developments do not adversely affect the efficiency of the price formation process, and take appropriate action as needed.

(b) Direct Electronic Access (DEA)

To effectively manage the risks that regulators have identified with respect to DEA, IOSCO's *Principles for Direct Electronic Access*[54] (DEA Report) determined that market participants that offer DEA should:

- conduct due diligence regarding the potential customer as to whether it is appropriate for the participant to grant the customer DEA,
- introduce pre-execution risk controls, and
- introduce post-trade execution controls.

In IOSCO's view, these steps, taken together, provide a comprehensive risk management framework and are critical to managing the risks of DEA.

In addition to describing DEA arrangements in different jurisdictions and the risks associated with DEA, the DEA Report sets forth principles to guide markets, intermediaries and market authorities and recognizes that each plays a role in managing the risks associated with DEA.

The principles fall into three categories that are set out in detail in Annex 2 to this report.

> *Pre-conditions for DEA* – the pre-conditions for DEA require that intermediaries providing DEA ensure the clients to which such access is granted are suitably knowledgeable and resourced, that an appropriate legally binding agreement is in place between the intermediary and its client, and that the intermediary remains ultimately responsible for any trading that takes place in its name.
>
> *Information flow* – intermediaries should disclose to market authorities, upon request and in a timely manner, the identity of their DEA customers in order to facilitate market surveillance. In turn, markets should provide their members with access to relevant pre- and post-trade information (on a real time basis) to enable these firms to implement appropriate monitoring and risk management controls.

[54] See footnote 1.

Adequate systems and controls – these are essential to ensuring the risks to market integrity and efficiency to which DEA gives rise are mitigated. Markets themselves should not permit DEA unless there are in place effective systems and controls to manage any risk to fair and orderly trading. Intermediaries, for their part, should have in place automated controls, including pre-trade controls, which can limit their DEA customers' trading activity. Intermediaries should also have adequate operational and technical capabilities to manage the risks posed by DEA.

Whilst these principles are related specifically to DEA, it is the case that the requirements regarding appropriate systems and controls apply equally to an intermediaries' own trading or other, non-DEA flow it receives from customers. With this in mind, regulatory authorities globally already require that investment firms have in place suitable controls for the nature and scale of their overall trading business.

(c) *Principles for the Oversight of Screen-Based Trading Systems for Derivative Products*[55]

For over 20 years IOSCO has had in place principles for the oversight of screen-based trading systems for derivatives, that have been periodically reviewed and that remain valid. The trading of derivatives is central to many firms' business models (including numerous high frequency traders), particularly in highly liquid instruments such as index futures. IOSCO published 10 principles in this area in 1990 and supplemented those principles in 2000, in light of the progressive movement of derivatives exchanges around the world towards the adoption of electronic trading platforms for all or parts of their business, and the resulting need for enhanced cross-border cooperation. As stated in the 1990 Report:

> "The regulatory authorities responsible for oversight of screen-based trading systems for derivative products [footnote omitted], whether governmental, quasi-governmental, or private...should articulate the jurisdictional interest and supervisory principles applicable to the organization responsible for the system such as an exchange, the organization...[that] provides...the hardware, software, and/or communications network and related services...the persons authorized to execute transactions on the system such as a broker-dealer...and persons with financial exposure to the system... These principles should reflect the shared objectives of ensuring that, among jurisdictions, the levels of investor protection and regulation are adequate [footnote omitted]."

In supplementing the principles in 2000, IOSCO stated that regulatory authorities should take into account the additional principles in order to promote the effective and efficient control of risks to investors, market integrity and financial stability that may arise from the operation of exchange-operated, screen-based trading systems for derivative products that operate with direct access participants from multiple jurisdictions.

The principles set forth in the 1990 and 2000 reports are included in Annex 3.

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55 See footnote 44.

(d) Error trades

In October 2005, IOSCO produced a report on error trades[56], defined as "transactions that are executed in error either due to the actions of a market user or through malfunction of a trading system." This report made a series of recommendations for regulators to consider with their market operators. These included (but were not limited to):

- Evaluating the need for and considering the adoption of error trade policies (with suitable flexibility provided around their design);

- Evaluating whether error trade policies are transparent, comprehensive and are invoked on a timely basis in order to promote the predictability, fairness and consistency of actions taken under the policy;

- Evaluating whether cancellation decisions involving material transactions and resulting from the invocation of error trade policies are highlighted to market users;

- Exchanges evaluating the need for measures to prevent error trades, and market supervisors conducting adequate surveillance in the markets they supervise to detect whether error trades are related to problematic market activity.

(e) Trading halts and market closures

IOSCO's 2002 *Report on Trading Halts and Market Closures*[57] made a series of recommendations which regulators should consider. The recommendations included determining if a general continuation in trading of a given security should be permitted where trading has been halted in the initial listing market. More generally, participants should be aware of the basis on which halts might occur and communication mechanisms should be in place so that participants are aware of when halts take place. In addition, the report recommended that, when a primary market is closed because of an "extreme event" or an infrastructure failure, the reaction of other markets, including derivatives markets, should depend on their assessment of all the relevant facts. In general, the report provided regulators and markets with considerable flexibility to tailor their approaches to trading halts and market closures as they saw fit.

Subsequently, IOSCO surveyed its members early this year on automatic control mechanisms in place within their markets. The key lessons from this process are set forth in Annex 4. The survey was prompted in part by comments made during IOSCO's panel sessions by industry representatives and academics that reflected the importance to the markets, of ensuring that appropriate control mechanisms are in place to maintain fair and orderly trading and support market confidence.

In October 2010, the Emerging Markets Committee published a report[58] on market interventions which sets broad guiding principles in implementing measures to intervene in markets.

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56 See footnote 45

57 See footnote 46.

58 See FR09/10 *Effectiveness of Market Interventions in Emerging Markets*, Final Report, Report of the Emerging Markets Committee of IOSCO, 15 October 2010, available at http://www.iosco.org/library/pubdocs/pdf/IOSCOPD333.pdf.

3. Possible Future Actions

Overall, IOSCO believes it has established a coherent framework of regulatory tools for competent authorities to consider and implement as they deem necessary. These have evolved over time to account for market developments and continue to be reassessed. Nevertheless, IOSCO is conscious that, as the markets continue to develop and evolve, additional *tools* should be continuously considered.

During IOSCO's discussions with market participants and academic experts, including various self-regulatory organisations, a range of possible new regulatory tools were suggested. In particular, IOSCO's panel sessions gave rise to numerous suggestions on how regulators' tools could be enhanced to address the risks associated with the technological and market developments that have been seen over the past number of years. Some of the key suggestions provided by participants on IOSCO's panels are set out below, sub-divided by the level at which the proposal would impact.

Level: Trading Firms:

- Given that relatively few jurisdictions currently have regulations that are designed specifically to address algorithmic trading or HFT, market authorities should consider whether tailored regulatory requirements should be introduced, especially in those markets where algorithmic trading or HFT is a dominant component of the market structure. Some presenters suggested that this might include anything from specific stress testing and sign-off processes for new algorithms, to specific charges or a tax on high order entry or cancellation rates;

- Consider whether those firms that are non-intermediary members of trading venues should be subject to registration/authorisation by a regulator in those jurisdictions where this is not already the case;

- Reassess whether requirements for managing conflicts of interest are sufficient in the circumstances where either:
  (i) an investment firm simultaneously conducts client-serving activities and proprietary trading; or
  (ii) trading participants that trade on venues in which they hold an ownership stake;

- Review existing regulatory requirements regarding pre-trade risk controls applicable to intermediaries in order to evaluate whether they are suitable for today's high-speed markets. As part of this, consider banning the provision of DEA to customers if the customer's trading is not subject to appropriate pre-trade controls (i.e. so-called *naked access*), where it is not already banned in accordance with IOSCO's Principles 6 and 7 for DEA (see Annex 2); and

- Assess whether HFT or algorithm traders should provide for specific forms of stress testing and internal sign-off processes for new algorithms, similar to IOSCO's Principle 8 for Direct Electronic Access (see Annex 2).

Level: Markets/Market Operators

- Consider whether trading control mechanisms such as order entry controls to mitigate against anomalous order entry and circuit breakers or limit-up/limit-down systems should be mandated within the markets and, if so, whether venue operators should be permitted to design their own controls or whether they should be harmonised/coordinated across venues (including between interrelated instruments such as a derivative and its underlying). See Annex 4 for a fuller assessment of trading volatility control mechanisms;

- Consider whether there should be common trade cancellation arrangements in place across markets to ensure consistent treatment in the event of a sudden extreme price movement. These arrangements should be coherent in their operation with any order entry controls and volatility controls.

- Consider requiring that market infrastructure operators undertake appropriate stress testing to ensure that their systems are robust in the face of unusual spikes in trading activity, as per IOSCO's Principle 8 for Direct Electronic Access (see Annex 2);

- Consider whether to require market operators to have appropriate testing environments in place to enable participants to stress test their algorithms;

- Assess whether a trading venue's registered market makers should be subject to mandatory minimum criteria so as to ensure that they provide meaningful liquidity support to the market. As part of this, consider:
  (i) clarifying how market making should be defined; and
  (ii) banning so-called *stub quotes* (i.e. automatically-entered quotes that involve an extremely low bid price e.g. 1c and an extremely high offer price e.g. $100k);

- Assess whether specific charges, fees or taxes on high order entry and cancellation rates or messaging rates should be introduced; and

- Consider the introduction of minimum tick sizes and minimum order book resting time.

Level: Market Structure

- Reconsider the appropriate balance between encouraging competition between trading spaces (including between trading venues and OTC space), which helps to reduce trading fees and improves innovation, and promoting the use of transparent, on-venue trading;

- Consider banning *flash orders*, through which trading interest may be exposed on a market for less than a second during which only technically-adept participants are able to react to it, before it is routed elsewhere;

- Evaluate what could be done to improve market surveillance, taking into account the needs of different market structures. A high-level of surveillance of potential unfair activity by market participants is crucial. Up-to-date order screening/monitoring tools

should be implemented (either by trading venue operators or by competent authorities) to help identify trading patterns and prevent inappropriate trading behaviour. Other possible measures could include the introduction of consolidated *audit trails* that are able to track orders, quotes and trades in the market. Other possibilities include introducing large trader reporting requirements (where these do not already exist), and introducing the use of entity identifiers to identify trading on a participant-by-participant basis or to flag algorithmic/HFT orders; and

- Review how existing market manipulation rules and laws apply to computer generated orders and whether activity traditionally deemed manipulative is still appropriate in today's market environment (e.g. layering the book given the common HFT strategy of submitting orders at multiple price points).

IOSCO retains an open mind regarding these proposals and poses a number of questions that would facilitate further discussion in the following section.

Chapter 5 Conclusions and Questions

Markets have evolved considerably in recent years and continue to do so. Technological change is multi-dimensional: relating to the participants; how they connect to the markets; and the markets themselves, while impacting the capability of markets authorities to supervise markets effectively. Whilst developments may have helped foster innovation and choice or improve market efficiency and liquidity, these same developments may also have had negative effects. For instance, whilst algorithms and HFT technology have been used by market participants to manage their trading and risk, their usage was also clearly a contributing factor in the flash crash event of May 6, 2010.

The risks that may be posed to market integrity and efficiency are discussed in depth in this report. So too are the steps that have been taken and could be taken to help mitigate these possible risks. What is less clear is the extent of these risks in practice and what regulatory action should be prioritised. It is with these points in mind that IOSCO invites responses from interested parties on the following questions.

Q1 What impact have the technological developments in the markets in recent years had on your own trading? Has it encouraged, discouraged or had no impact on your willingness to participate on the lit markets, and how does this differ between asset classes and/or instruments?

Q2 What are your views on the suggestion that proprietary trading firms (including HFT firms) that are not currently subject to registration/authorisation by a regulator should be required to obtain such a registration/authorisation? Are there specific regulatory requirements you believe such firms should face?

To what extent do your answers differ if the proprietary trading firm accesses the market as the customer of an intermediary firm through DEA (i.e. under that intermediary's trading rules/codes) rather than as a direct member of the market itself?

Q3 What recommendations, if any, would you propose to strengthen the regulatory requirements around pre- and post-trade risk controls? In particular, what measures, if any, do you think regulators should introduce that relate specifically to the use of and risks posed by algorithmic trading and/or HFT?

Q4 To what extent do you believe the use of trading control mechanisms such as circuit breakers and limit-up/limit-down systems by trading venues should be mandated? If you believe they should be mandated, should venue operators be permitted to design their own controls or should they be harmonised/coordinated across venues (including between interrelated instruments such as a derivative and its underlying)?

Q5 To what extent do you believe market maker schemes offered by trading venues should be subject to mandatory minimum criteria? Should the criteria be determined by the trading venue alone? To what extent do you agree with the suggestion that the use of stub quotes should be prohibited?

Q6 Do you have suggestions for improvements to regulators' surveillance capabilities with respect to the markets and modern trading techniques? Please elaborate.

Who should bear the cost of investing in such capabilities and the cost of operating and supervising the markets in order to ensure fairness among market participants? Please elaborate.

Q7 What do you perceive as the major causes of settlement indiscipline and settlement failures? What steps, if any, do you believe regulators should take to address these causes?

Q8 Have the appropriate steps been taken to limit or manage conflicts of interest that arise where an investment firm simultaneously conducts client-serving activities and proprietary trading or a trading participant is also a shareholder in a venue on which it trades? If you believe conflicts management is inadequate, please explain how this manifests itself and any recommendation you have for how conflicts management could be improved.

Q9 Do you think existing laws and rules on market abuse and disorderly trading cover computer generated orders and are relevant in today's market environment?

Q10 Are there any strategies employed by HFT firms that raise particular concerns? If so, how would you recommend that regulators address them?

Q11 Should charges or fees be imposed on messages, cancellations or high order-to-trade ratios? If so, how should the fees or charges be determined and on what basis?

Q12 Should market operators be required to make their co-location services available on a fair and non-discriminatory basis?

Q13 Should market operators be required to provide testing environments to enable participants in stress test their algorithms? If so, what kind of minimum requirements are reasonable?

Q14 To what extent do you have other comments related to the risks to market integrity and efficiency raised by the issues in this report?

As noted in the introduction to this report, it is extremely important that respondents adhere to the deadline for responses of 12 August 2011.

Annex 1 Principles for Dark Liquidity

The Technical Committee believes that it would be appropriate for member jurisdictions to consider the principles set forth below regarding the regulation of their markets, including the regulation of dark pools and dark orders. Two of the principles relate to transparency of trading activity to the public, with a further four principles also warranting consideration by regulators: priority of transparent orders, reporting of trade information to regulators, information available to market participants and the regulation of the development of dark pools and dark orders.

In general, the principles are designed to:

- minimise the adverse impact of the increased use of dark pools and dark orders in transparent markets on the price discovery process by generally promoting pre-trade and post-trade transparency and encouraging the priority of transparent orders;

- mitigate the effect of any potential fragmentation of information and liquidity by generally promoting pre-trade and post-trade transparency and consolidation of such information;

- help to ensure that regulators have access to adequate information to monitor the use of dark pools and dark orders for market monitoring/surveillance purposes and to enable an appropriate regulatory response to market developments; and

- help to ensure that market participants have sufficient information so that they are able to understand the manner in which orders will be handled and executed.

Despite the concept of dark pools differing across jurisdictions, the Technical Committee notes that the following principles provide a starting point for consideration and analysis by regulators. The Technical Committee also recognises that some jurisdictions are reviewing their regulatory regimes surrounding dark pools and dark orders. Consistent with its statement in the Transparency Report that the same approach may not be suited to all platforms or types of trading,[59] the Technical Committee notes that implementation of the principles may vary according to the type of trading and platform.

Topic 1: Transparency to Market Participants and Issuers

Principle 35 of IOSCO's June 2010 *Objectives and Principles of Securities Regulation*, report states that "Regulation should promote transparency of trading".[60] Section 13.5 (Transparency of Trading) of IOSCO's February 2008 *Objectives and Principles of Securities Regulation* report stated:[61]

- Ensuring timely access to information is a key to the regulation of secondary trading. Timely access to relevant information about secondary trading allows

[59] See footnote 43 - *Transparency and Market Fragmentation*, Report of the Technical Committee of IOSCO, November 2001 page 13.

[60] See footnote 5 - *Objectives and Principles of Securities Regulation*, Report of IOSCO, June 2010, page 12.

[61] See *Objectives and Principles of Securities Regulation*, Report of IOSCO, February 2008, page 42, available at http://www.iosco.org/library/pubdocs/pdf/IOSCOPD265.pdf.

investors to better look after their own interests and reduces the risk of manipulative or other unfair trading practices.

- Where a market permits some derogation from the objective of real-time transparency, the conditions need to be clearly defined.

- The market authority (being either or both of the exchange operator and the regulator) should, in any such event, have access to the complete information to be able to assess the need for derogation and, if necessary, to prescribe alternatives.

Furthermore, the Transparency Report noted:[62]

- The more complete and more widely available is trading information, the more efficient the price discovery process should be, and the greater the public's confidence in its fairness.

- The interest of individual market participants and their customers in transparency levels varies and regulators need to assess the appropriate level of transparency in any particular product market with considerable care.

(a) Pre-trade transparency

Principle 1: The price and volume of firm orders should generally be transparent to the public. However, regulators may choose not to require pre-trade transparency for certain types of market structures and orders. In these circumstances, they should consider the impact of doing so on price discovery, fragmentation, fairness and overall market quality.

Pre-trade transparency involves a market participant making a bid or offer (*e.g.*, price and volume), thereby giving information to the market. The cost of taking the risk and providing information to the market is offset by the possibility of finding a contra-side and, in the case of maker/taker exchanges, by monetary compensation when an order is executed.

Pre-trade transparency plays an important role in mitigating the potentially adverse impact of market fragmentation (which, as noted previously, is a natural result of broader market developments rather than a direct consequence of dark trading) as well as in promoting the efficiency of the overall price formation process and providing information to market participants to enable them to obtain the best terms of execution.[63] Pre-trade transparency provides a further role by providing information to market participants of trading opportunities that they may be able to utilise.

With regard to dark pools and dark orders, regulators should clarify the types of orders that will be considered firm orders. For example, actionable IOIs[64] are intended to attract

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[62] See footnote 43 - *Transparency and Market Fragmentation*, Report of the Technical Committee of IOSCO, November 2001 page 4-5.

[63] CESR report ref CESR/09-355, *Impact of MiFID on Equity Secondary Markets Functioning*, June 2009, pages 22 & 29, available at http://www.cesr-eu.org/popup2.php?id=5771.

[64] IOIs are deemed to be actionable when they explicitly or implicitly inform the recipient about available trading interest within a dark pool with the best quoted prices or better.

immediately executable order flow to the trading venue and present a unique issue that regulators should examine. Regulators should consider treating actionable IOIs as firm public quotes, which should as such be displayed.

With respect to pre-trade transparency, the Technical Committee:

- notes that, although dark liquidity has long existed as a way for traders to preserve anonymity and execute orders with minimal market impact, the automation of dark pools and their widespread availability are a more recent phenomenon; moreover, the business strategies behind the use of dark liquidity have changed (e.g., some users of dark pools break-up large orders into smaller ones);

- recognises that different market segments have different trading needs depending on the type of order (e.g. large orders may incur market impact costs if subject to full pre-trade transparency obligations);

- acknowledges these needs, and therefore suggests that it may be appropriate to have different levels of pre-trade transparency apply to different market structures or different order types; and

- recognises that pre-trade transparency is an issue under review in many jurisdictions.

Regulators may choose not to require pre-trade transparency for certain types of market structures (e.g. call markets, reference-pricing venues) or certain types of orders (e.g. large orders of institutional investors that do not wish such orders to be displayed), taking into account the impact on price discovery, fragmentation, fairness and overall market quality considering in particular the relative overall proportion of dark trading compared to lit trading.[65]

In general, however, regulators seek to promote a trading system that fosters order interaction, takes into account the costs and benefits to investors of limited pre-trade disclosure and seeks to ensure that all investors, in particular retail investors, receive best execution. Regulators should thus continually monitor the use of dark pools and dark orders in transparent markets to consider whether there are potential risks to the price discovery process.

(b) Post-trade transparency

Principle 2: Information regarding trades, including those executed in dark pools or as a result of dark orders entered in transparent markets, should be transparent to the public. With respect to the specific information that should be made transparent, regulators should consider both the positive and negative impact of identifying a dark venue and/or the fact that the trade resulted from a dark order.

Post-trade transparency is the dissemination of information about trades to the public after the trade has occurred. As stated earlier, post-trade transparency is important for the price

[65] Some regulatory regimes may permit investors to keep their trading interest to themselves and not compel them to quote it publicly, as long as they do not share it.

discovery process and the efficient functioning of markets. For example, reduced information asymmetries provide investors with a better informed view of the market, improve the price discovery process and have a potentially positive effect on market liquidity, thus enhancing market confidence. Post-trade transparency can play a role in mitigating the potential negative impact of market fragmentation[66] by revealing which market has offered the best price.

The Technical Committee noted in section 13.3 (Securities Exchanges and Trading Systems) of IOSCO's February 2008 *Objectives and Principles of Securities Regulation* report that "Information on completed transactions should be provided on the same basis to all participants. Full documentation and an audit trail must be available."[67] Whilst this reference was made in relation to exchanges primarily, it is equally applicable to other types of trading platforms. As noted above, the importance of providing such information aids in the price discovery process.

The Technical Committee notes that dark pools in many jurisdictions are already required to publicly disclose information about executed trades. This information does not, however, necessarily identify the trading venue on which the trade was executed. Regulators should consider whether it is appropriate to require the identity of the dark pool operator to be revealed and, if so, how (e.g. trade by trade and real time; trade by trade and end of day; or end of day and aggregate volumes in individual stocks).

In this context, clear reporting rules and standards, including certainty about which party to a trade should report the trade, may assist regulators in ensuring post-trade information is accurate, complete and comparable. In addition, regulators should consider the benefits of having a consolidated tape to report all trades from all venues, both lit and dark.

Topic 2: Priority of Transparent Orders

Principle 3: In those jurisdictions where dark trading is generally permitted, regulators should take steps to support the use of transparent orders rather than dark orders executed on transparent markets or orders submitted into dark pools. Transparent orders should have priority over dark orders at the same price within a trading venue.

Regulators that generally permit dark trading in their jurisdiction should look at ways to incentivize market participants within the regulatory framework to use transparent orders. The phrase in the principle, "rather than dark orders", does not necessarily mean that dark orders in all cases should be discouraged. Rather, the key interest is in taking steps to help ensure that there are *adequate transparent orders* in the marketplace. This might be facilitated, for example, by providing for trade through protection for transparent orders. Dark orders that interact with the open order book should generally match with other undisplayed and displayed orders according to the price-visibility-time priority.[68] The

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66 Comments earlier in the Final Report regarding fragmentation being a natural result of broader market developments are equally applicable in relation to the discussion of post-trade transparency here.

67 See footnote 61 - *Objectives and Principles of Securities Regulation*, Report of IOSCO, February 2008, page 43.

68 However, in some jurisdictions and in limited circumstances, it may be possible to allow dark orders to have priority over transparent orders. For example, regulators in Canada have considered the contribution of post-trade transparency of large orders in the price discovery process and have therefore

promotion of transparent orders helps to ensure that sufficient liquidity remains in transparent markets to support the price formation process and the orderly overall functioning of equity markets.

In determining whether incentives for displayed orders are appropriate, regulators should take into account the nature of the equities market and its operating rules and the pre- and post-trade transparency regime. Regulators may also wish to consider the interaction of orders between and within venues. Thus, for example, rather than incentivising the use of transparent orders on transparent markets, regulators may choose to have limited exceptions to pre-trade transparency (e.g. by limiting waivers in those jurisdictions in which they are available).

Topic 3: Reporting to Regulators

Principle 4: Regulators should have a reporting regime and/or means of accessing information regarding orders and trade information in venues that offer trading in dark pools or dark orders.

In order to understand the market structure issues posed by dark pools and to monitor trends in trading and trading behaviour for regulatory purposes, it is important that regulators have access to accurate, timely and detailed information regarding trades executed through dark pools, as well as dark orders traded on transparent markets. Important objectives include (1) seeking to ensure the ability of a regulator to monitor and detect trading activity across markets and products that may give rise to market integrity issues; and (2) seeking to ensure that the regulator possesses a sufficient level of detail and aggregation of order and trading data across markets/products so that it can reliably identify the nature of the trading activity and market developments and properly monitor the development of dark pools and dark orders in their jurisdictions. Key information would include the price, symbol, volume, parties to the trade and the venue upon which the trade was executed. The Technical Committee notes that in general, regulators already have the authority to request information regarding trades conducted in dark pools or resulting from dark orders.

It is particularly important for regulators to have access to accurate information regarding the volume of trading that occurs in dark pools as well as the volume of trading that occurs as a result of dark orders executed on transparent markets. In many cases, dark pool operators make public volume statistics that could be interpreted as misleading as they may include routed orders to other trading centres or other forms of *double counting*. Accurate reporting to regulators or access of regulators to information should help to discourage such misleading practices.

Regulators should therefore require that information recorded and provided to them accurately reflects the trading conducted in dark pools and dark orders in transparent markets, and that trading facilities provide such information in a timely fashion and using common conventions (e.g., how to treat orders that are routed away for execution).

Regulators may wish to use this information for a number of purposes, including assisting in tracing orders for market monitoring/surveillance purposes.

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proposed to allow large, dark orders to execute against each other without first having to execute against lit orders at the same price on the same trading venue.

The Technical Committee notes that these regulatory purposes may be achieved by different ways. For example, information could be provided to regulators on an ongoing basis or upon request. In determining the appropriate regime, regulators should consider the nature of the particular market and the applicable pre- and post-trade transparency regime.

Topic 4: Information Available to Market Participants about Dark Pools and Dark Orders

Principle 5: Dark pools and transparent markets that offer dark orders should provide market participants with sufficient information so that they are able to understand the manner in which their orders are handled and executed.

It is important that market participants understand the way in which dark pools and dark orders in transparent markets operate.

In its February 2008 Objectives and Principles of Securities Regulation report, the Technical Committee noted, in relation to order routing and trade execution, that:

> "[t]he system's order routing procedures must be clearly disclosed to the regulator and market participants. They must be applied fairly and should not be inconsistent with relevant securities regulation (e.g. client precedence or prohibition of front running or trading ahead of customers). The order execution rules must be disclosed to the regulator and to market participants. They must be fairly applied to all participants... The rules and operating procedure governing these matters should be available to market participants."[69]

Dark pools or transparent markets offering dark orders should help ensure that market participants are provided with detailed explanations of:

- how trading occurs;[70]
- how dark orders interact with transparent orders;
- which orders have priority;
- whether IOIs are disseminated, what information they include and to whom they are disseminated; and

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[69] See footnote 61 - *Objectives and Principles of Securities Regulation*, Report of IOSCO, February 2008, page 44.

[70] For example, trading facilities should be clear about the level of anonymity given to the participant's orders, whether anti-gaming controls are in place, whether IOIs are allowed and the types of information contained in the IOI, what type of order flow populates the dark pool and the nature of the interaction between client and proprietary order flow. Comprehensive lists of questions are contained in a number of publications, for example, Greenwich Associates, *The Top Ten Questions for Dark Pool Providers*, July 2008; ITG, *Are You Playing in a Toxic Dark Pool? A Guide to Preventing Information Leakage*, June 2008; Aité Group, *Dark Pools 2009, Not so Dark Anymore*, September 2009; and TABB Group, *Trading in the Dark in Europe: Choice and Complexity on the Cusp of Change*, October 2009.

- policies and procedures that are intended to facilitate the management and disclosure of conflicts of interest and that provide clarity around who has access to information about the dark pool and/or dark orders.

This information should be provided to market participants so that every participant has the tools necessary to understand the nature and risks of trading in that market. This will facilitate informed decision making regarding potential trades. It will also help to ensure that trading is conducted in a fair, orderly and efficient manner. Such information should be provided in trading manuals, policies and procedures and rulebooks for trading facilities that offer dark orders and dark pools.[71]

Regulators should consider requiring appropriate disclosure of information to market participants by dark pool operators and operators of transparent markets that offer dark orders. Furthermore, regulators should consider whether to examine/inspect such operators (periodically or on a *for cause* basis) concerning the disclosure to market participants of material information as described above.

Topic 5: Regulation of the Development of Dark Pools and Dark Orders

Principle 6: Regulators should periodically monitor the development of dark pools and dark orders in their jurisdictions to seek to ensure that such developments do not adversely affect the efficiency of the price formation process, and take appropriate action as needed.

In its 2006 report entitled *Regulatory Issues Arising from Exchange Evolution*,[72] the IOSCO Technical Committee noted that:

- Regulatory authorities should have adequate arrangements to keep the changing market environment under review and to identify emerging issues in a timely fashion.

- Regulatory authorities should assess whether the changes being made by exchanges require any adjustments to the regulatory framework for an individual exchange or for exchanges generally, and should address any such need for changes promptly.

- Regulatory authorities should carefully assess the impact on resources of any changes to the regulatory model for exchanges, and ensure that the core regulatory obligations and operational functions of exchanges are appropriately organised and sufficiently resourced.[73]

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71 The Technical Committee recognises that it is equally important for a market participant to understand their intermediary's smart order routing logic, since it may direct customer orders to one or more dark pools, or may direct dark orders. Thus, although it is beyond the scope of this project and the remit of SC2, it is good practice for regulators to consider appropriate intermediary disclosure obligations to market participants regarding how and when orders, placed by the intermediary on behalf of its customers, may be handled (manually or electronically), including when their orders may be dark or directed to dark pools.

72 IOSCO Technical Committee report, *Regulatory Issues Arising from Exchange Evolution*, November 2006, available at http://www.iosco.org/library/pubdocs/pdf/IOSCOPD225.pdf.

73 Id. at page 31.

Whilst these comments were originally made in relation to competing exchanges, they equally apply to dark pools and orders. As more dark pools evolve and equity market structures continually change, it is important that regulators monitor the development of dark pools to evaluate whether they do not adversely impact on the price discovery process. Moreover, as discussed in topic 3, it is important for regulators to monitor the level of trading being executed through dark pools along with the volume of dark orders being executed on transparent markets to help ensure that sufficient liquidity is being displayed on transparent markets. Where regulators are concerned that the development of dark trading may adversely impact the price discovery process, they should take appropriate action to address such a distortion. Such steps could include a review of the regulatory framework under which the execution of dark orders may take place with the goal of increasing pre-trade transparency. This could lead, in some jurisdictions, to a reduction of such dark orders.

Annex 2 Principles for Direct Electronic Access

Pre-Conditions for DEA

The principles in this category all deal with what steps should be taken before DEA is granted to a customer and clarifies the ultimate responsibility for DEA arrangements.

(1) Minimum Customer Standards

Intermediaries should require DEA customers to meet minimum standards, including that:

- Each such DEA customer has appropriate financial resources; and

- Each such DEA customer has appropriate procedures in place to assure that all relevant persons: 1) are both familiar with, and comply with, the rules of the market; and 2) have knowledge of and proficiency in the use of the order entry system used by the DEA customer.

Market authorities should have rules in place that require intermediaries to have such minimum customer standards.

This principle addresses risks associated with allowing access to markets outside of the infrastructure or control of the market intermediaries' traditional risk management approach. It indicates that appropriate due diligence should be carried out when granting DEA and that customers should have knowledge of market rules and the order entry system to avoid the potential of negatively impacting market integrity.

(2) Legally Binding Agreement

There should be a recorded, legally binding contract between the intermediary and the DEA customer, the nature and detail of which should be appropriate to the nature of the service provided. Each market should consider whether it is appropriate to have a legally binding contract or other relationship between itself and the DEA customer.

This principle addresses the need to enter into a written agreement between the market participant and customer to whom DEA is granted. The purpose of the contract is to restrict, condition or otherwise control how those customers will use the intermediary's infrastructure to transmit orders, as well as to seek to ensure that there is compliance with market rules.

(3) Intermediary's Responsibility for Trades

An intermediary retains ultimate responsibility for all orders under its authority, and for compliance of such orders with all regulatory requirements and market rules.

In those jurisdictions where a DEA customer is permitted to sub-delegate its direct access privileges to another party (a sub-delegatee), the intermediary continues to be ultimately responsible for all orders entered under its authority by the sub-delegatee and should require the sub-delegatee to meet minimum standards set for DEA customers in general. There should be a recorded, legally binding contract between the DEA customer and the sub-

delegatee, the nature and detail of which should be appropriate to the nature of the service provided.

Principle 3 addresses the issue of the ultimate responsibility for DEA arrangements, including where access rights are sub-delegated to a third party.

Information Flow

(4) Customer Identification

Intermediaries should disclose to market authorities upon request and in a timely manner the identity of their DEA customers in order to facilitate market surveillance. In those jurisdictions where sub-delegation is permitted, the intermediary also has such responsibility to the market authorities with respect to any sub-delegatees.

This principle is designed to ensure that market authorities have the ability to identify the source of orders or trades to facilitate market surveillance and enforcement of market rules.

(5) Pre and Post-Trade Information

Markets should provide member firms with access to relevant pre- and post-trade information (on a real time basis) to enable these firms to implement appropriate monitoring and risk management controls.

Principle 5 is designed to ensure that intermediaries are provided with the relevant pre- and post-trade information so that they can take the appropriate steps to manage their risks.

Adequate Systems and Controls

(6) Markets

A market should not permit DEA unless there are in place effective systems and controls reasonably designed to enable the management of risk with regard to fair and orderly trading including, in particular, automated pre-trade controls that enable intermediaries to implement appropriate trading limits.

(7) Intermediaries

Intermediaries (including, as appropriate, clearing firms) should use controls, including automated pre-trade controls, which can limit or prevent a DEA Customer from placing an order that exceeds a relevant intermediary's existing position or credit limits.

IOSCO does not dictate what types of controls must be put in place or at what level. However, IOSCO is of the view that intermediaries should use electronic controls to limit their risk exposure to protect customers and the clearing organization. In addition, it should be the obligation of the intermediary to ensure that the controls it is using are effective. The use of electronic controls is particularly important where a customer with DEA uses algorithms. In the view of IOSCO, there is no convincing rationale for not using automated credit limit controls, particularly where the failure to sue them may expose participants and the market to unacceptable risk.

(8) Adequacy of Systems

Intermediaries (including clearing firms) should have adequate operational and technical capabilities to manage appropriately the risks posed by DEA.

IOSCO believes that it is necessary for market authorities to take appropriate steps to assure that the systems of the intermediaries and markets operate properly, and have adequate capacity to accommodate trading volume levels and respond to conditions that may threaten their operation. This should include comprehensive planning and capacity and security testing and ensuring that they retain the appropriate technical expertise to manage and operate the systems.

Annex 3 Principles for the Oversight of Screen-Based Trading Systems for Derivative Products (from the 1990 and 2000 reports)

The Principles from the 1990 report were as follows:

- The system sponsor should be able to demonstrate to the relevant regulatory authorities that the system meets and continues to meet applicable legal standards, regulatory policies, and / or market customer or practice where relevant.

- The system should be designed to ensure the equitable availability of accurate and timely trade and quotation information to all system participants and the system sponsor should be able to describe to the relevant regulatory authorities the processing, prioritization, and display of quotations within the system.

- The system sponsor should be able to describe to the relevant regulatory authorities the order execution algorithm used by the system, i.e. the set of rules governing the processing, including prioritization, and execution of orders.

- From a technical perspective, the system should be designed to operate in a manner which is equitable to all market participants and any differences in treatment towards classes of participants should be identified.

- Before implementation, and on periodic basis thereafter, the system and system interfaces should be subject to an objective risk assessment to identify vulnerabilities (e.g. the risk of unauthorized access, internal failures, human errors, attacks, and natural catastrophes) which may exist in the system design, development, or implementation.

- Procedures should be established to ensure the competence, integrity, and authority of system users, to ensure that systems users are adequately supervised, and that access to the system is not arbitrarily of discriminatorily denied.

- The relevant regulatory authorities and the system sponsor should consider and additional risk management exposures pertinent to the system, including those arising from interaction with related financial systems.

- Mechanisms should be in place to ensure that the information necessary to conduct adequate surveillance of the system for supervisory and enforcement purposes is available to the system sponsor and the relevant regulatory authorities on a timely basis.

- The relevant regulatory authorities and / or the system sponsor should ensure that system users and system customers are adequately informed of the significant risks particular to trading through the system. The liability of the system sponsor, and/or the system providers to system users and system customers should be described, especially any agreements that seek to vary the allocation of losses that otherwise would result by operation of law.

- Procedures should be developed to ensure that the system sponsor, system providers, and system users are aware of and will be responsive to the directives and concerns of relevant regulatory authorities.

IOSCO subsequently reaffirmed the 1990 principles and added to them as part of a review of screen-based derivatives trading that culminated in 2000. The additional principles that were added at that time were as follows:

- Regulatory authorities with responsibilities arising from the operation of cross-border markets for derivative products (relevant regulatory authorities) should develop cooperative arrangements and coordinate supervisory responsibilities, consistent with each authority's responsibilities and in a manner that promotes regulatory effectiveness and avoids the imposition of unnecessary regulatory costs.

- Each regulatory authority with responsibilities related to a cross-border market for derivatives (whether in respect of the market operator or the market participants) should be prepared to share relevant information in an efficient and timely manner. In developing cooperative arrangements, regulators should attempt to identify in advance the information needed, the sources of that information, the manner in which the information can be obtained and the channels through which it can be shared.

- The applicable regulatory requirements in the jurisdiction of each relevant regulatory authority and the framework for regulatory coordination and cooperation should be transparent.

- In considering their approach to cross-border markets for derivatives, access jurisdictions should take into account whether the initial jurisdiction authorizing the market operator applies the IOSCO *Objectives and Principles of Securities Regulation* (September 1998) and the 1990 Principles as supplemented above.

Annex 4 Trading Control Mechanisms

This annex examines a range of trading interruptions and other control mechanisms that trading venues may have in place.

Trading interruptions

Generally a distinction can be made between two main categories of trading interruptions: discretionary interruptions and automatic trading interruptions.

While both forms of trading interruptions are necessary to maintain a fair and orderly trading environment, the focus of this annex is on automatic trading interruptions. This device enables markets to react in the shortest time to market imbalances that might be caused, amongst other factors, by high speed electronic trading.

Discretionary trading interruptions are normally imposed in anticipation of the imminent release of material news about the issuer or in reaction to extraordinary events. The decision is taken by the market or the regulatory authority which means that, due to the human decision process, a time lag is created before the trading interruption comes into force. Discretionary trading interruptions are, for example, trading halts related to the dissemination of material information, trading halts for suspected fraudulent or manipulative activity, trading suspensions for an issuer's failure to meet listing standards or disclosure obligations and market closures resulting from extraordinary events. Concerning discretionary trading interruptions reference is made to the IOSCO's 2002 Report on *Trading Halts and Market Closures*.

The term *automatic trading interruption* generally refers to a trading interruption on the basis of non-discretionary pre-set parameters. Such an interruption may be triggered when large fluctuations in a security's price or the market generally jeopardize an orderly market place. This happens automatically with minimum reaction time (although, where one trading venue reacts to a suspension on another trading venue by suspending trading itself, a time lag of some degree may well result). The duration of automatic trading interruptions is usually shorter than that of discretionary ones. Automatic trading interruptions include circuit breakers.

Circuit breakers

Generally speaking, circuit breakers are measures that stop trading temporarily on a co-ordinated, often market wide level and are generally provided for in the exchange/market rules.

Circuit breakers mostly trigger a trading halt when a reference index exceeds pre-set trigger levels or limits. Typically, a jurisdiction has multi-level circuit breakers that close the market for a set period of time if the market falls a certain percentage, and then for a longer time if the market falls even further. The duration of the circuit breaker halt depends on the percentage the market falls and the time of day the circuit breakers are triggered (from few minutes to the whole day). During that time all trading and quotation is halted.

Some jurisdictions provide for various circuit breakers in different situations e.g. in the USA amongst others a stock specific short sale circuit breaker was introduced that once triggered will enable long sellers to stand in front of the line and sell their shares before any short seller.

This is designed to prevent a further reduction in price of a specific stock that has dropped more than 10% in one day.

Price limits

The markets in several jurisdictions use price limits to lessen sharp swings in security prices. Price limits are generally provided for in the exchange/market rules.

Price limits prohibit trading at prices below or above a pre-set limit. Once the limit is reached different measures are applied by markets. Some markets automatically halt the trading of the security for a certain time. Others allow trading within the limit while automatically rejecting orders outside the limit (sometimes called limit up- limit down model).

The limits may be static or dynamic or a combination of both. A dynamic limit is usually based on the last traded price while a static is based on a certain reference price. For example Euronext provides for a dynamic limit (+/- 2% compared to the last order) and a static one (+/- 10 % as compared to a reference price e.g. opening price).

Trading Limitations

Generally trading limitations (in some jurisdictions called liquidity replenishment points (LPRs) or volatility interruptions) refer to interruptions from automatic executions in continuous trading to curb exceptional market movements. They are generally provided for in the exchange/market rules. The trading phase is changed from immediate matching during continuous trading to slow or auction trading. Following this trading, limitations do not induce a trading halt but a change of the trading phase and generally last for some minutes before the next scheduled trading phase is carried out. The next trading phase is initiated either automatically or after existing orders have been manually verified.

Trading limitations are triggered by market specific volatility parameters e.g. if the potential execution price is outside a dynamic (e.g. deviation from last price trades) or static (e.g. last auction price of the same trading day) price range.

Almost all member jurisdictions have in place automatic trading interruptions. Most common are circuit breakers, followed by price limits and trading limitations. The measures may be applied to all listed products (e.g. shares, bonds, futures, options) traded on regulated markets and most jurisdictions do provide for one or all of these measures in equity and derivative markets . Two European MTFs - Turquoise and BATS Europe - have no circuit breakers in place but use price limits as automatic trading halt functionality. In the US, pursuant to FINRA rules, ATS' as well as other broker-dealers trading over-the-counter are required to observe trading halts of the listing market for a security.

In some jurisdictions markets can modify price variation limits that trigger a trading interruption under specific circumstances. For example in the event of strong volatility the Frankfurt Stock Exchange may on a per product basis broaden the price ranges that trigger a volatility interruption, so called fast market phase. In such a phase volatility interruptions would occur less frequently.

In most jurisdictions market members are immediately informed about a trading interruption e.g. via the trading system. Few jurisdictions even release the information in real time via the exchange website.

Most jurisdictions however do not publish the triggering limits or price ranges. This is to prevent market participants from using the information as a trading strategy with the risk of manipulating the market.

Generally automatic circuit breaker, trading halts or trading limitations remain in place for a limited time and trading may resume automatically thereafter. As regards derivatives markets some jurisdictions mentioned that trading interruptions resulting from a trading imbalance, may trigger an additional intraday margin call by the clearing house in order to limit the risk borne by the clearing house.

As a rule automatic trading interruptions are intended to mitigate sharp fluctuations on markets in times in which markets are deemed to be excessively active and sudden and unusual movements may occur. Whether the markets are halted or the markets are converted to slow trading the intention is to take speed out of the market, to be able to determine if orders which could move the market dramatically are legitimate (e.g. no error trades) ensuring that the price formation process is orderly. Most jurisdictions mention this, the prevention of panic sales and the overall goal of ensuring fair and orderly markets in the event of rapid and irrational price movements as rationale behind the measures.

Coordination of trading interruptions on a national and cross border level

On a national level some jurisdiction do provide for a coordination of automatic trading interruptions across multiple markets, e.g. simultaneous halts in equity and derivatives markets. In these jurisdictions the market rules for automatic trading interruptions are initially coordinated by the regulator, a self regulatory organization or are imposed by law. Coordination and information mechanisms are in place, e.g. the market operator has to inform other markets, the regulator and the public when an automatic trading halt is triggered.

However, most jurisdictions mentioned that while trading interruptions are triggered on a regulated market quoting and trading may continue on other trading venues like ATS'/MTFs or OTC markets or even on other regulated markets. This was due to the short period of time an automatic trading interruption would last.

Most jurisdictions noted that an automatic trading interruption based on events that occur outside of their jurisdiction would not be applicable within their markets.

There are no specifically designed cooperation and information sharing agreements to assist markets and regulators in administering automatic trading interruptions in cross-border multi-listed securities and related derivatives and there is no legal obligation to do so. For example while in Europe Article 41 Markets in Financial Instruments Directive (MiFID) coordinates the suspension and removal of financial instruments from trading short-term automatic trading halts triggered by "technical reasons" (e.g. price volatility, system breakdown or purely local reasons) are outside this scope and no coordination takes place currently.

Concerns/Issues

Member jurisdictions expressed concerns when an automatic trading interruption is triggered with regard to a security that is listed in more than one jurisdiction. It was especially noted that in case no common thresholds parameters are used there is generally a risk of an unlevel playing field. Further to this it was mentioned that due to a missing formalized information

exchange there was a risk of being unable to take appropriate actions promptly. However, jurisdictions also noted that because of the generally short duration of automatic trading interruptions it appears that there is little potential for significant *spill-over* trading to flow into markets in other jurisdictions. This risk was only seen for longer term trading interruptions when jurisdictions have overlapping trading hours.

One jurisdiction noted that high order volume created by HFT in combination with direct market access/sponsored access scenarios makes it more difficult to follow the chain of orders. This might cause an issue where volatility interruptions do not end automatically and the actor needs to be identified in order to verify an order entry in a timely manner. Another jurisdiction mentioned that a requirement for platforms to cooperate in an immediate manner in respect of market surveillance issues does not seem practicable in real time scenarios.

Several European member jurisdictions indicated that the developments in technology and recent events (flash crash), have highlighted the need for harmonization of trading interruptions across jurisdictions and for coordination of these mechanisms across venues trading the same security. Potential benefits in establishing a harmonized regime in the EU were seen. However many member jurisdictions underlined that harmonization and coordination of trading interruptions should be analysed and carefully considered. Amongst others it was mentioned that different market microstructures (market making model, continuous open order book, and continuous auction model) very likely contribute to different volatility regimes.

During IOSCO's panel sessions, some industry representatives advocated the introduction of harmonized rules for automatic trading interruptions, while others noted that individual markets regulation is necessary to enable markets to differentiate themselves (driver of competition). It was argued that harmonization of e.g. circuit breaker rules, for all markets may not be needed due to different national market structures. This was illustrated by differences in the US and EU markets. There is no regulation in the EU that forces order routing (in contrast to the US under Regulation NMS). Thus, movements in one EU market may not necessarily have automatic knock-on effects.

While all industry representatives at IOSCO's panel sessions strongly supported the need for having automatic trading interruptions as such, some of them raised doubts as to whether systems that briefly halt trading (circuit breakers) are for the investors' good. Instead some of them were in favour of limit-up/limit-down systems that would prevent investors from trading beyond parameters that would trigger circuit breaker without freezing trading altogether.

Envisaged amendments to current regimes

Different jurisdictions indicated that amendments to the current regimes are envisaged.

Canada and the USA mentioned concrete initiatives.

In addition, last year, the SEC approved, on a pilot basis, stock-specific circuit breakers for securities included in the S&P 500 index. The pilot was subsequently expanded to include additional securities. Unless extended, the pilot for these stock-specific circuit breakers will expire on the earlier of August 11, 2011, or the date of adoption of limit-up/limit-down rules. Accordingly, these stock-specific circuit breakers may be replaced over the coming months

with limit-up/limit-down rules to temper intra-day price swings[74]. Beyond certain thresholds, the limit-up/limit-down model would prevent investors from trading beyond certain parameters, but would allow traders to continue buying and selling stocks within those parameters and not freeze trading in that stock altogether.

In Canada the self regulatory organization (Investment Industry Regulatory Organization of Canada, IIROC) published in November 2010 a notice requesting comments on a proposed single stock circuit breaker (SSCB) program that would apply across all equity marketplaces in Canada. Further to this, the Canadian Securities Regulators (CSA) is developing a rule which aims to mitigate the risks associated with electronic trading. It includes a harmonization of marketplace volatility parameters across all venues at levels determined by the IIROC.

Australia indicated that no harmonized trade suspension and extreme price movement regimes do exist currently since there was no competition for execution services at the market operator level. However, with the introduction of competition such regimes would be implemented.

Singapore mentioned that in light of recent technological developments, price limits may be imposed on both broad market indices and individual securities listed or traded on securities exchange similar to those currently in place for futures contracts.

In the public consultation by the European Commission on the Review of MiFID, dated 8 December 2010, it is proposed that market operators implement proper risk controls and arrangements to mitigate the risk of errors generated by automated trading leading to disorderly trading. In this context circuit breakers are mentioned, as an example for helpful mechanisms in order to reduce the risk of erroneous trading and its potentially substantial effects on market stability.

[74] See *SEC Announces Filing of Limit Up-Limit Down Proposal to Address Extraordinary Market Volatility*, SEC press release, 5 April 2011, available at: http://www.sec.gov/news/press/2011/2011-84.htm. See also proposed "Limit Up-Limit Down" NMS Plan at: http://www.sec.gov/news/press/2011/2011-84-plan.pdf.