November 29, 2010
Bank of Japan

ELECTRONIC TRADING AND FINANCIAL MARKETS

Speech at the Paris EUROPLACE

International Financial Forum in Tokyo

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1. Introduction

I am honored and delighted to have been given the opportunity to speak at this International Financial Forum, organized by Paris EUROPLACE. Further, it gives me great pleasure to be alongside our long-time friend Christian Noyer, Governor of the Banque de France. Paris EUROPLACE has played an important role both in the growth of the financial industry and in the evolution of financial markets. In particular, it has provided various opportunities for discussion among its members, who represent a broad spectrum of the financial industry. I salute the members for their contributions.

Growth in major economies has slowed substantially since the financial crisis of 2008, and it is now more than ever important to examine the ways in which the financial industry can regain credibility and strengthen macroeconomic fundamentals. This forum provides a timely opportunity to exchange views on the positioning of the financial industry for new growth opportunities. The key to growth in the financial industry is to find businesses which are in a position to grow domestically and internationally, and then to assist these businesses further by providing ready access to risk money. At the same time, we should improve the infrastructure of financial markets, through which money is funneled.

In this respect, advances in information and communication technology (ICT) have already changed the landscape of financial markets, providing a set of powerful tools for financial institutions: These advances have increased the efficiency of trading and settlement, and proved useful in evaluating the price and risk of financial products.

Today, I will focus on one of the most conspicuous ICT-induced changes, that is, the

impressive developments made in recent years in the electronic trading of financial products.[1]

2. Global Expansion of Electronic Trading and the Japanese Market

I will start with an overview of the global expansion of electronic trading, which involves two elements. The first is automated order placement and trade execution, so-called algorithmic trading. The second is the substantial speed-up and improved efficiency in matching orders in the market, that is, the new generation of order-matching engines. Although these two elements have been present since the 1980s and 90s, their global application has been expanding and accelerating particularly rapidly in recent years, thanks to advances in Information and Communication Technology.

Electronic trading has made especially dramatic developments in the equity and currency markets of major industrialized countries. As much as 60 to 70 percent of the amount traded in the United States,[2] and some 50 percent of that traded in Europe,[3] is executed electronically and automatically, according to surveys and recent studies of equity markets. In currency markets, about half of the amount traded is estimated to

[1] The following is partly based on Sugihara, Y., 2010, "Approaches of Market Participants for the Reduction of Transaction Costs: Application of Algorithmic Trading and Trading Venues," IMES Discussion Paper Series No. 2010-J-26, Institute for Monetary and Economic Studies, Bank of Japan (in Japanese).

[2] See Hendershott, T., C. M. Jones, and A. J. Menkveld, 2011, "Does Algorithmic Trading Improve Liquidity?" *The Journal of Finance*, forthcoming (February 2011).

[3] See Hendershott, T. and R. Riordan, 2009, "Algorithmic Trading and Information," NET Institute working paper No. 09-08.

involve algorithmic trading.[4]

Although there is less electronic trading in the Japanese equity market than in the United States and Europe, it is currently a growing focus of attention. *Arrowhead*, the new order-matching engine for cash products on the Tokyo Stock Exchange, has been operating smoothly and steadily since its launch at the beginning of this year. The results have been impressive. The order-response time of cash equity trades has been reduced to only a few milliseconds. Also, in February 2011, the Osaka Stock Exchange plans to launch J-GATE, a new high-speed order-matching engine for equity derivative trading. Proprietary trading systems (PTSs), which correspond to the multilateral trading facilities (MTFs) in Europe, still have only a small market share in Japan, but their trading volume is gradually increasing.

In tandem with these infrastructural developments, algorithmic trading volumes seem to be increasing steadily in Japanese equity markets. Although no official statistics are available, 20 to 30 percent of all orders received by the Tokyo Stock Exchange are placed at co-location sites,[5] which are specially designed for automatic, high-speed trading.[6] This gives an indirect but clear indication of the growing importance of electronic and automated trades in Japan.

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[4] See Table 2 in Chaboud, A., B. Chiquoine, E. Hjalmarsson, and C. Vega, 2009, "Rise of the Machines: Algorithmic Trading in the Foreign Exchange Market," Board of Governors of the Federal Reserve System, International Finance Discussion Papers, No. 980.

[5] Co-location is a service that allows market participants to install their devices at data centers of trading venues to minimize the physical distance between data centers and market participants' devices.

[6] According to the Tokyo Stock Exchange.

3. Positive Effects of Expanding Electronic Trading

With its greater speed and diversified trading venues, electronic trading has changed the market microstructure of the financial world. Market participants' trade execution strategies have changed dramatically. High-frequency trading has come to have a greater presence. High-frequency trading can be considered as a type of trading strategy similar to market making and short-term liquidity provision. Various execution strategies, derived and devised from the experience of traders and the results of computationally intensive research, have been transformed into computer algorithms and offered to various investors in the financial market.

These changes have enabled institutional investors to take advantage of cutting-edge tactical executions. Depending on market conditions, many of the algorithmic trading strategies slice block orders into smaller child orders, to avoid the price changes caused by block-order executions, that is, so-called market impact. The expansion of algorithmic trading is leading to fundamental changes in the market: for example, orders are smaller but more numerous than before.

This development in market microstructure has had a positive impact on market functioning, improving investment performance per risk capital through the reduction of transaction costs. In fact in the U.S. market, where algorithmic trading started earlier than other places, it has reduced market-making costs and narrowed bid-offer spreads significantly.[7] Moreover, recalling that algorithmic trading strategies for block trades

[7] See Figure 1–3 in Hendershott *et al.*, 2009, in footnote 2. There is an empirical study on the reduction of transaction costs as a result of MTF expansion in the recent European markets. For details, see Brandes, Y. and I. Domowitz, 2010, "Alternative Trading Systems in Europe: Trading

are designed to reduce their market impact, an empirical study has shown that this type of algorithmic trading contributes to stabilizing intra-day realized volatility. Thus, algorithmic trading may help stabilize market prices, under normal circumstances and most of the time.[8]

There is an additional positive point. Electronic trading enables faster information propagation. Arbitrage trades between individual equities and between markets have increasingly been conducted automatically and at lightning speeds using algorithms. This is likely to boost the efficiency of the financial market and the allocation of scarce resources.

4. Three Challenges Posed by Electronic Trading

Although the expansion of electronic trading has brought many positive effects, as noted, it also has its own negative side with respect to the proper functioning of financial markets. There are three crucial issues.

The first issue is market vulnerability induced by the presence of electronic trading. In particular, algorithmic trading is vulnerable to unpredictable events. On May 6 of this year, the so-called Flash Crash caused a violent fluctuation in prices over some ten minutes in the U.S. equity market. The U.S. Commodity Futures Trading Commission and the Securities and Exchange Commission carried out a joint investigation into the incident.[9] Their Joint Report pointed out that, at the start of the Flash Crash episode,

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Performance by European Venues Post-MiFID," *Journal of Trading*, 5(3), pp.17–30.

[8] See Chaboud *et al.*, 2009, in footnote 4.

[9] See U.S. Commodity Futures Trading Commission and Securities and Exchange Commission,

one algorithm's automated execution of a very large sell order confused and dislocated other algorithms. As a result, many market participants, whether algorithmic or human, refrained from buying, and thus market liquidity decreased sharply, leading to unusual turbulence in several stocks. Some algorithm-based arbitrage trades contributed to spreading this market seizure to a wide range of individual stock prices, leading to the full-blown Flash Crash.

Although algorithmic trading may contribute to market stabilization in normal times, this may not be the case when unexpected events or unknown unknowns occur. Mechanistic algorithms may not be able to respond properly to unexpected and unprecedented events in the same way as humans, who have common sense. In such circumstances, the human brain performs better than the digital computer. Thus, a mutually complementary relationship between algorithms and humans is absolutely crucial. In particular, safeguard should be considered, such as circuit breakers compatible with high-speed algorithmic trading.

The Japanese equity market has not been immune from this type of market disruption. There have been several instances caused by large but erroneous orders that were filled instantly. Learning from these incidents, Japanese brokerage houses are now required to refrain from placing orders that exceed a threshold amount, to prevent the execution of mistaken orders.[10] Moreover, a new market safeguard has been introduced which is compatible with high-speed trading. Just in time for *Arrowhead*'s launch, the Tokyo

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2010, "Findings Regarding the Market Events of May 6, 2010," available at http://www.sec.gov/news/studies/2010/marketevents-report.pdf

[10] See Article 5 in "Regulations Concerning the Establishment of an Order Management System by Association Members," by the Japan Securities Dealers Association.

Stock Exchange instituted a new trading rule, requiring a one-minute pause at order-matching when sequential execution of a single order causes a large price impact which exceeds a certain price-change limit.

The second question that electronic trading, or high-frequency trading in particular, poses to the market, is the issue of possible new ways of manipulating the market, and how to detect and prevent such illegal activities in the age of lightning-speed order execution. Some algorithms incorporate information available on limit-order books to estimate current supply-demand imbalances that might be open to exploitation. Note that such information gathering activities are necessary for properly functioning markets, and that human dealers are also engaged in similar activities. At the same time, it is true that illegal attempts to manipulate the market may be hidden behind such information gathering activities. We all remember the many lengthy and complicated probes of illegal market manipulation in the past. The point is that high-speed algorithmic trading makes such illegal market manipulation ever more sophisticated and harder to detect.

There is particular concern about plots involving algorithm traders alone. For example, one algorithm trader may try to drive the price in its favor by intentionally manipulating other algorithm traders by instant quote stuffing, which human traders could not recognize visually, being carried out at lightning speed. Since only algorithmic traders are involved, an investigation of this type of plot would entail scrutinizing a tremendous number of order records, making it difficult to detect illegal manipulations in a traditional way. Here, the appropriate application of information

technology can be most effective. To put it differently, regulators and overseers should arm themselves with technology comparable to that used by high-speed villains themselves, though there is still a long way to go in this area.

The third issue, which is more technical but more profound in nature than the previous two issues, is the question of how to avoid over-reliance on high-frequency traders as liquidity providers. A research paper on the background to the Joint Report on the Flash Crash reveals an interesting fact.[11] Toward the end of the Flash Crash, some high-frequency traders intensified their activities as market liquidity declined dramatically. Declining market liquidity meant the absence of their usual trading counterparties, and thus these high-frequency traders repeated and intensified their automatic high-speed trading among themselves. Their activities led to sizable price volatility in a very short period of time.

It should be noted here that, even though high-frequency traders supply liquidity to the market by offering a limit order and thus make a position when it is hit, these high-frequency traders try to close the position immediately after the original transaction. This is indeed why such traders are called "high frequency" traders. Consequently, when there are large demand-supply gaps among non-high-frequency traders in the beginning, it is not at all likely in the end that the liquidity provided by high-frequency traders is sufficient to fill these gaps. Moreover, if the market is dominated by mechanistic traders, who react to microscopic directional changes in

[11] See Kirilenko, A., A. S. Kyle, M. Samadi, and T. Tuzun, 2010, "The Flash Crash: The Impact of High Frequency Trading on an Electronic Market," preprint, available at http://ssrn.com/abstract=1686004.

prices rather than to market fundamentals, market prices may deviate further and further from the fundamentals once a demand-supply gap emerges. The Flash Crash is a perfect example of this, where the end result was just the contrary to the supposed stabilization.

This serves to remind us of the utmost importance of market diversity, with respect to sellers and buyers, their strategies, and their referenced information. I would like to insist again that, in order to make markets function well, it is essential to have both non-high-frequency investors and high-frequency traders, of various kinds. Just focusing on high-frequency traders is rather misleading in understanding the impact of electronic trading in financial markets.

5. Closing Remarks

As I have documented so far, advances in information and communication technology have sent ripples and waves over the entire financial industry, providing new opportunities for growth and efficiency. At the same time, these advances pose serious challenges to maintaining market stability and integrity. Thus, to take full advantage of these opportunities, we should work together to maintain the stability and integrity of the financial market and, thereby, the financial system itself. This should be done in a timely manner, so as to cope with the rapid developments in technology.

As a market participant, the Bank of Japan will continue to promote the stability, efficiency, and integrity of the financial system.

Thank you for your attention.