# Electronic trading in wholesale financial markets: its wider impact and policy issues

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*Electronic trading is a force for change across markets, enabling a greater variety of trading arrangements, which in turn can affect the performance of markets and welfare more generally. This article first considers why the extent and speed of adoption of new trading systems has been very different between markets. It then focuses on two important issues raised by recent developments. One is the degree of fragmentation or consolidation of trading arrangements, where it is argued that electronic trading can facilitate either effect. The other is the degree of transparency of trading information, where the hugely expanded possibilities that electronic trading offers highlight the choices in this controversial topic. Policy-makers are interested in the wider impact of changes to trading arrangements on the broader economic and financial system. But policy judgments need to be made carefully because the effects can be market specific, uncertain or even counter-intuitive. Moreover, problems arising in market arrangements may prove short term or self-correcting. These considerations all bear on the judgments on whether or how to intervene to address apparent market failures.*

## Introduction

Electronic trading is transforming financial markets. It can reduce costs, extend participation and remove many physical limitations on trading arrangements. It allows much greater volumes of trades to be handled, and permits customisation of processes that until recently would have been technically impossible or prohibitively expensive. It is a major force for changes in 'market architecture'—the key features of market structure such as participation arrangements, venues and trading protocols.

These effects of electronic trading in turn have a real influence on the prices and quantities that result from the trading process.(2) And they can also affect aspects of a market's 'quality'—its performance across attributes such as liquidity, trading costs, price efficiency and resilience to shocks. This matters because market quality has broader welfare implications—such as through the contribution of the efficiency of the financial system to economic growth and through the performance of markets and their resilience to financial instability. So the impact of electronic trading is of considerable interest to market participants and policy-makers alike.

Many recent changes in securities market arrangements are closely associated with the effects of electronic trading (and wider technological innovation). Some market features that have lasted for years now seem to be changing. There are now choices to be made in market design in areas that were previously dictated by physical limitations. This article highlights some areas where electronic trading has had a particular impact on trading arrangements and discusses policy questions that arise.

## Contrasting developments in electronic trading(3)

Though electronic trading has been used in some markets for well over a decade, its penetration has been very uneven across different sectors. Take-up has been

(1) More comprehensive versions of this article are in Bank for International Settlements (2001b) and Mullineaux (ed) (2002). The authors thank colleagues, associates and participants at a SUERF colloquium for helpful comments. They also benefited from discussions while participating in the Electronic Trading Working Group of the G10 Committee on the Global Financial System.

(2) This is the area of market microstructure literature, which studies the processes/outcomes of exchanging assets under explicit trading rules—O'Hara (1995) provides a theoretical review; see also the survey by Madhavan (2000).

(3) To a lesser or greater extent all financial markets have been influenced by electronic trading developments. For example, Tsang (1999) reviews automation in futures trading, where electronic trading has been well established for some time. Banks (2001) describes electronic trading in a range of markets, with particular focus on the role of the Internet. Reserve Bank of Australia (2001) and Bank of Japan (2001) review developments in their national markets.

affected by the form of existing market structures, regulatory and competitive factors, and the varied needs of traders. Typically, deep, liquid markets, with broadly standard asset classes and straightforward trade types are 'easiest' to migrate to electronic trading. The spread of electronic trading depends also on what is achievable with current trading technology: further innovation will enable further waves of change to market arrangements.

### Equity markets

The liquidity and relative homogeneity of major equity securities make it reasonably straightforward and cost-effective for them to move to electronic trading. But experience in the United States and Europe has been very different even for the same type of assets. The US equity market has seen a proliferation of alternative electronic trading venues, whereas Europe has been more notable for electronic systems being incorporated within mainstream exchanges. The regulatory and competitive environments appear to have been significant influences on these outcomes.

The two largest markets in the United States have broadly maintained the framework of their 'traditional' arrangements—the floor trading of the New York Stock Exchange and the telephone/screen-based market of Nasdaq—albeit both with very high levels of automation. This meant that wholly electronic systems were able to position themselves as alternatives, offering trading methods (especially electronic order books) unavailable at mainstream venues. The entry of a number of alternative electronic venues around the Nasdaq market was also encouraged by a regulatory change affecting the display of orders.(1)

In contrast, existing exchanges in Europe moved many of their own systems to electronic trading. Compared with the United States, their environment was probably less influenced by regulation; competitive pressures (including from demutualisations) encouraged exchanges to introduce electronic trading themselves. It has meant less opportunity for separate off-exchange trading systems—it is more difficult for entrants to offer some particular advantage that could not be found on the exchanges.

## Electronic trading(1)

The meaning of 'electronic trading' differs according to context and can encompass a wide variety of systems. Discussions in this article relate to a range of features of electronic trading—including: *electronic order routing* (the delivery of orders to the execution system); *automated trade execution* (the transformation of orders into trades); and *electronic dissemination of pre and post-trade information* (eg bids/offers, depth, transaction prices and volumes—discussed in the box on page 53).

So-called 'traditional' (non-electronic) markets often also include a high degree of associated automation but rely to a greater extent on physical involvement/interaction actually to match buy and sell orders—especially on a trading floor or over the telephone. Though there is no absolute delineation between the two, some characteristics differentiating electronic trading from traditional means are:

- it is location neutral and allows continuous multilateral interaction, whereas for telephone trading only the former applies and for floor trading only the latter;
- it is scaleable—it can allow additional users and exploit economies of scale to a much greater extent than can non-electronic arrangements; and
- it can be integrated—allowing many (or all) steps in the trading process to be linked.

Electronic trading can be applied in various ways to different types of market arrangements—to markets that are: either (i) *order driven*, where prices are established by matching incoming bids and offers according to an algorithm; trading can either be continuous (*order books*) or periodic (*call auctions*), or (ii) *quote driven*, where prices are established by dealers competing for orders by quoting prices at which they will buy and sell.

There are also numerous hybrids, offering some combination of these trading arrangements.

(1) The definition of electronic trading above follows Committee on the Global Financial System (2001), which provides more information on electronic trading. For overviews of electronic finance more generally, see Bank for International Settlements (2001b), which includes a glossary; Allen, McAndrews and Strahan (2002); Claessens, Glaessner and Klingebiel (2000); and Sato, Hawkins and Berentsen (2001).

(1) The regulatory trigger was the SEC's change to order-handling rules in 1997; see, for example, Davis and Steil (2001) and McAndrews and Stefanadis (2000). These country-specific effects illustrate why studies of a single market may not generalise. This is pertinent given Goodhart and O'Hara's (1997) and Gravelle's (2002) observation that the literature concentrates on equity rather than debt markets. Moreover, many studies of equity trading only discuss major US markets.

### Fixed-income markets

Electronic trading is being adopted more slowly in fixed-income markets than in equity markets. Fixed-income products are far less homogenous, with many individually less liquid issues (varying in coupon, maturity, frequency of interest payments, etc). Relative to equity markets there are also fewer but larger trades. These factors all make it technically more difficult and more expensive to introduce automation. Moreover, the decentralised telephone dealer markets typical of fixed-income products were probably less conducive to a rapid, widespread introduction of automation than were the centralised exchanges in equity markets.

Within the fixed-income sector,(1) electronic trading is more widely used in certain government bond markets—reflecting their greater standardisation and liquidity, which (as with equities) makes their trading more straightforward. Platforms have tended to begin trading government bonds, and later expand into other, more heterogeneous, fixed-income issues. It seems that electronic trading of the latter is becoming more feasible as systems develop more effective ways to trade less liquid issues, opening up a much broader market for these securities. (As discussed further in the sub-section on fragmentation and consolidation on page 54.)

### Foreign exchange markets

Electronic trading has had an important presence in the inter-dealer spot foreign exchange market for more than a decade. In the major currency pairs probably some 50%–70% of turnover is now conducted electronically, up from 40% in 1998.(2)

Though the previous structure of the market was a fragmented bilateral telephone market, similar to fixed income, foreign exchange experienced an early and widespread adoption of electronic trading (notably through the EBS and Reuters systems in the inter-dealer market). This reflects the extremely liquid, homogenous nature of the product, which can be readily traded in standardised units.

## Market architecture and market quality

As electronic trading changes market structure, it influences significantly the performance of these markets. Most obviously, substantial falls in trading costs can be attributed directly to the effects of electronic trading.(3) The impacts on other aspects of market quality are more varied and may be unclear or controversial. Two such areas relate to the transparency of trading information and the degree of market fragmentation.

### Effects on transparency

Electronic trading creates the *potential* for a high degree of transparency across the whole trading process. In principle, systems can disseminate real-time pre and post-trade information market-wide. For example, electronic order books can facilitate greater transparency by showing a list of trading opportunities. Conversely, other systems can operate with minimal information leakage, for example eliminating any information about pending orders, enabling users to avoid giving away valuable, potentially market-moving information to competitors.(4)

Though electronic trading enables greater choices about transparency, there is no simple answer about the appropriate form and degree of disclosure. Decisions are market-specific. Factors include the role of the information in attracting liquidity to the system, users' needs (for example, whether retail or wholesale business, or whether immediacy of execution matters) and the commercial value of the data. Different classes of

(1) Fixed-income systems proliferated in type and number in the late 1990s, though few achieved significant volumes and the market is clearly rationalising. An annual survey by the Bond Market Association (2001) identified some 68 systems in the United States in 2000, up from only 11 three years earlier. However, by 2001 only 49 were still in operation.

(2) Data cited in Galati (2001). For further discussion of the development of electronic trading in foreign exchange markets, see Chaboud and Weinberg (2002).

(3) Numerous studies demonstrate cost reductions, typically by a third to a half. See, for example, Domowitz, Glen and Madhavan (2001), Domowitz and Steil (2001, 2002) and Jiang, Tang and Law (2002). Savings can occur across all components of trading costs—explicit costs (such as physical overheads), bid-ask spreads and market impact costs (ie the adverse effect on price due to information about the trade leaking out ahead of its execution). Moreover, trading costs are one of the more direct indicators of the broader welfare benefits from electronic trading. Domowitz and Steil (2002) present evidence that associates lower trading costs with a lower cost of equity capital, which has macroeconomic significance.

(4) Such systems are a response to the issues noted in the box opposite, that in a transparent environment, wholesale traders may disguise these orders in some way to avoid giving away information on their strategy which may lead to the market moving against them. The pre-trade opaque class of systems allow traders to input their true order preferences with complete accuracy since the information is only 'seen' by the computer system. If the implementation of such systems gives 'appropriate' incentives in trading behaviour (such as to input 'truthful' orders), one result could be greater efficiency of price formation.

## Transparency

Transparency is the ability of market participants to observe information about the trading process—pre-trade information concerns order sizes and quotes, while post-trade information centres on prices and quantities of executed trades. Other considerations include the timeliness of the information, which (subset of) participants can observe certain aspects, and pre and post-trade anonymity (whether identities are revealed). For a discussion, see O'Hara (1995).

The precise arrangements and rules regarding transparency vary greatly between markets and sectors within them. Segregation largely according to transparency regime has long been a feature of markets' organisation. Notably, virtually all exchanges have particular arrangements for block trades ('upstairs trading'), with lower transparency requirements than their main market, often in the form of delayed publication. Whereas in retail markets, greater transparency is seen as desirable, largely due to its role in consumer information and protection.

Transparency arrangements affect the balance of information among market participants. Evidence from a range of studies (see Madhavan (2000)) demonstrates that this influences the degree of information in the order flow, price discovery and liquidity.(1) While in many respects inconclusive, the literature (see, for example, Ganley *et al* (1998)) highlights that changes in transparency rules often benefit one group of participants at the expense of another.

Some flavour is given in the following stylised examples. A tension between post-trade transparency and liquidity can occur in a multiple dealer setting such as in many government bond markets. Faced with an unpredictable flow of large customer orders, dealers with a continuous presence in the market seek to manage risks arising from sharp variations in their inventory of securities by inter-dealer trading to rebalance their holdings. Were stricter post-trade transparency imposed in terms of requiring more rapid publication of large transactions, it would reduce dealers' opportunity to conduct this inventory adjustment. This could increase their risk management costs—which may be passed onto customers—and could lead to a less efficient allocation of risks in the market. Both liquidity and price discovery could be impeded (see Gravelle (2002) for a further explanation).

Equivalent tensions with pre-trade transparency requirements can arise where transactions contain (and are motivated by) private information reflecting legitimate investor research/beliefs or portfolio strategy. Were disclosure imposed that revealed 'too much' about intended trades, it could effectively expropriate that private information for the public trading venue. The predictable result of such rules would be that traders would act to minimise the cost of the loss, for example by splitting the trade to reduce the observable information content or by switching venues to avoid the regime. Or they might exit the market if their business is no longer viable.

(1) Madhavan (2000) surveys results regarding transparency from theoretical, empirical and experimental literature. Much of the work uses underlying models based on asymmetric information—these consist of two classes of market participants, informed traders with private information on future asset values and uninformed (liquidity motivated) traders, and explores how these groups trade under different conditions. Such models are mostly applicable to equity markets, in which private information on assets plays an important role. There is also a range of models based around inventory adjustment, consisting of dealers who attempt to restore their inventories to some desired level by adjusting their quotes and trading behaviour. These fit closer with the structures typically seen in fixed-income and foreign exchange markets.

trading systems lend themselves to different forms of transparency: the style of information concerning a call market differs from that readily available from an order book or a dealer arrangement. Moreover, regulatory requirements may influence the decision.

There is strong regulatory interest in this area. In large part this stems from concerns over market integrity and fairness. Regulatory and policy instincts typically—and probably rightly—are attuned to the benefits of greater transparency.(1) However, and as set out in the box above, this highlights the importance of recognising that insistence on greater trading transparency may, beyond a certain point, be detrimental to aspects of market quality such as liquidity and price formation.

(1) In many areas of public policy greater openness is widely recognised as beneficial to processes, expectations and outcomes—disclosure practices in accounting and the transparency of the monetary policy process are two important such cases.

### Effects on fragmentation and consolidation

Electronic trading can exert both fragmenting and consolidating influences. For example, in fixed-income and foreign exchange markets, new systems consolidate areas that formerly relied on fragmented, bilateral telephone communication. By contrast, in equity markets, typically dominated by centralised exchanges, alternative trading venues can increase apparent fragmentation. Yet equity markets' numerous mergers, alliances and linkages can also be associated with electronic systems' ability to consolidate sources of liquidity and harness efficiencies.

There is no single measure against which to evaluate these effects. For example, if individual venues can offer a wider choice of order routing, order flow may seem more dispersed. Alternatively it may matter little how many underlying venues exist if linkages can give traders seamless access to a range of markets (eg as single screens combine information from multiple venues—'virtual consolidation').

Fragmentation and consolidation raise clear issues about market quality. Probably best known are arguments that alternative trading venues in equity markets act to fragment and so reduce liquidity in the 'main' market. The importance of liquidity(1) is well known—reducing trading costs by narrowing bid-ask spreads and giving depth such that prices are less affected by particular trades. Liquid markets are better placed to absorb shocks than less liquid ones, contributing to the robustness of financial systems. Moreover, liquidity is an important ingredient of price discovery and hence price signals for the wider economy.

However, it is also argued that additional execution routes can improve market liquidity and quality. They can stimulate innovation and variety in trading services and heighten competition to cut costs. And the alternative trading arrangements may directly consolidate liquidity rather then fragmenting it. For example, they might offer new systems that:

- can trade less liquid assets by sweeping them into automated trading of portfolios that offer certain characteristics. The securities are pulled into a larger liquidity pool rather than being traded individually; and

- may allow more effective trading; for example, by facilitating periodic call auctions. These concentrate trading activity at a single point in time, so may suit the trading of less liquid securities (whose limited volumes may otherwise have traded thinly over a longer period)(2).

Developments to date indicate that technology can quickly develop which overrides negative effects of fragmentation. The powerful influence of network effects in this area (see the box opposite) also means that a proliferation of similar trading systems, which individually attract little liquidity, might be expected to be a transitory phenomenon. Those that become established will need both to offer some real improvement and—crucially—to attract, retain or link to a sufficient amount of liquidity.

## Discussion of policy implications

Electronic trading technology enables new forms of market architecture that a few years ago would not have been possible. As well as offering these choices in market design, it presents policy-makers with questions.(3) Notable issues include:

- frameworks for regulation: especially whether to (continue to) differentiate the institutional status and oversight regimes applying to exchanges and to non-exchange trading systems;

- the appropriate level of detail for regulatory involvement in microstructure matters: for example, whether transparency rules are necessary and can be enforced, and in what degree of detail; or whether fragmentation of markets requires an active response to protect the price formation process; and

- cross-border issues highlighted by remote access to trading, including: whether countries' different regulatory regimes lead to problems caused by

(1) Characteristics of liquidity in markets are discussed in the policy context in Bank for International Settlements (2001a) and from a theoretical perspective in O'Hara (1995). There is more discussion of electronic trading and market quality in Allen, Hawkins and Sato (2001). Some evidence on electronic trading and market resilience is discussed in Committee on the Global Financial System (2001).

(2) For example, Steil (2001) describes how the Warsaw Stock Exchange, re-established in 1991, initially traded stocks in a weekly call, moving to daily calls and later (for some stocks) to continuous trading as volumes grew to give sufficient liquidity.

(3) For examples of policy questions and discussions see: Boisvert and Gaa (2001) for Canada; Financial Services Authority (2000) and Wisbey (2000) for the United Kingdom; US Securities and Exchange Commission (1998) and Unger (2001) for the United States.

## Network economics effects(1)

Network economics effects feature strongly in trading systems and help to explain commonly observed features of markets—such as consolidation of market liquidity, the advantages experienced by incumbent trading systems, and 'tipping effects' when a market shifts from one centre to another. The underlying economics of these features occur in a number of industries that are structured around a network arrangement, such as telecommunications.

In these markets, positive network externalities arise because the value of the network to each participant rises as other participants join. Telephones are a traditional example—in the early days of telephony it was relatively unattractive to join the network since there were few other participants to whom to make calls. However, as the number of subscribers increased, the opportunities for making and receiving calls also increased, enhancing the usefulness and value of the network for all participants, making all users better off.

These positive network externalities similarly apply to market liquidity. All other things being equal, it is better to participate in a bigger than a smaller trading network, since each trader brings additional trading opportunities/liquidity. Positive feedback comes about as a liquid market attracts more participants, all participants benefit from the additional liquidity, making the network more attractive to others, and so on.

In the absence of rigidities or other barriers, the presence of these network externalities in a market would imply a tendency to consolidation. In the trading context, this would work to bring isolated pools of liquidity together.

However, such consolidation may not occur around an 'optimal' system. One reason is 'first mover advantage'. An incumbent system may have gained a critical mass of users simply because it was the earliest available. A system that comes to the market later may face formidable hurdles to attract a viable level of participation, even if it offers a better product. Potential users need to believe that the costs of switching to the new system are worthwhile. Moreover, they must expect that enough other users will also switch to make the new system an effective, liquid trading venue.

These hurdles may mean that users feel 'locked in' to a dominant system, in which case a sub-optimal equilibrium can be sustained. This position can arise whether a system has become dominant through first mover advantage or through consolidation. In the latter case, even if the consolidation occurred around an efficient, technically advanced system, if it comes to be a (near-) monopoly the incentives to maintain those advantages can be eroded. The well-known problems of monopoly pricing, technical inefficiencies and abuse of dominant market position may arise.

However, it is by no means inevitable that dominant market positions will be sustained. If an alternative system manages to attract users, it too can enter a virtuous circle of positive feedback. Once a critical level of participation is achieved, the market can tip away from the incumbent and towards the alternative. This switch can be abrupt. It was seen when Eurex within around six months in early 1998 took all the volume in the futures on the ten-year German Bund contract from the previously dominant LIFFE floor.

(1) This box draws on Shapiro and Varian (1999), which explains the impact of positive network externalities on industries, and Domowitz and Steil (2001), which analyses how network externalities apply to securities trading.

regulatory arbitrage; and clarification of legal and regulatory jurisdiction.

In any decision, policy-makers face multiple objectives and make different trade-offs—there is no unanimity on what constitutes 'optimal' trading arrangements. For example, securities regulators may focus on market integrity and consumer protection while central banks concentrate on systemic risk and financial stability implications. However, a number of general factors bear on any policy in this area.

**Perspective**. Policy-makers' objectives are aimed at market quality and welfare more generally, which suggests that market architecture itself should be seen as an intermediate target towards these goals. (This is illustrated below.) An example comes from the uneven, sometimes counter-intuitive, effects of transparency

rules. Making greater transparency a policy objective in itself risks ignoring potentially negative effects on market quality—and hence on broader investor welfare and the effectiveness of the economy and financial system. Indeed, were transparency to be 'maximised' as a policy end in itself, that aim could prove precisely at odds with these wider objectives to which policy is typically addressed.


**Market differences and uncertainties**. The many differences between/within individual markets suggest avoiding a 'one size fits all' approach and being wary of imposing detailed, cross-market rules at a high level. Added to this is the imprecise understanding of the net effects of changes in market structures and rules. There are also striking ambiguities—for example, that electronic trading is credited with both fragmenting liquidity and enabling its consolidation from disparate sources. These uncertainties and ambiguities argue for caution in policy-making.

**Network effects in fast-changing markets**. Policy judgments are difficult in innovative markets. They need to tread a difficult line between imposing requirements that restrict innovations, while maintaining market integrity and confidence in periods of rapid change. The questions concerning market fragmentation show that problems may be sustained, or temporary, or even illusory. Given that such concerns change rapidly, and that problems may prove self-correcting, the presumption may be that intervention is inadvisable unless there is demonstrably a sustained problem. Network effects in markets, however, can limit the scope for self-correction. It may also be necessary to act to deal with even 'temporary' problems if they are clearly detrimental to an important sector of a market.(1)

As a final comment, new trading technology itself may help resolve many difficult issues in market arrangements. For example:

- offering better information on market performance and behaviour, which can help oversight and understanding of markets. For example, the fulfilment of market-maker obligations could be monitored automatically, or erratic market movements, whether due to trader errors or more fundamental reasons, could be identified rapidly;

- directly providing solutions to problems, such as the means to build information systems or link fragmented pools of liquidity; and

- helping participants to make better-informed decisions, for example by enabling appropriate transparency arrangements and providing better information on order routing and assets' features.

No one can predict the precise form of new market structures. But it is clear that electronic trading technologies have already hugely expanded the possibilities, decisions and policy questions and changed the way practitioners and policy-makers think about the design of market infrastructure. It cannot be long before the issues discussed in this article cease to be particularly 'associated with electronic trading' but simply referred to as choices in market architecture.

(1) Where action is deemed preferable (for example where correcting market forces are believed to be weak), there will also be differing regulatory stances about solutions. These could range from ensuring facilitating frameworks such as clear legal codes, through action on competition policy such as removing restrictive practices, to specific micro-rule-making on, say, trading protocols.

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