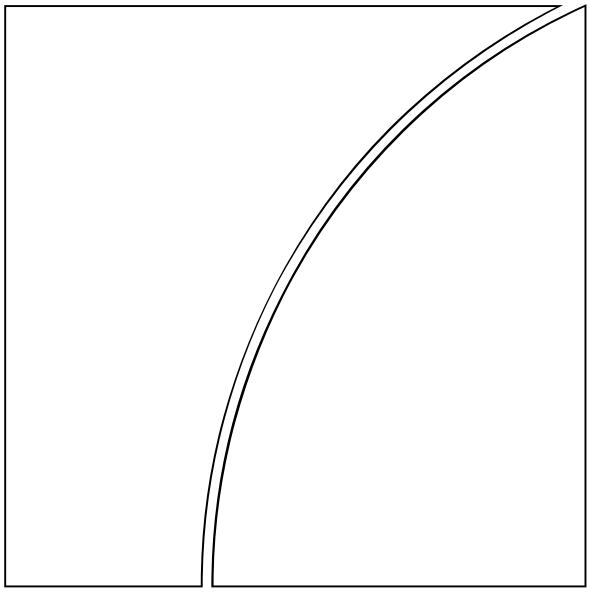
Committee on the Global Financial System



The implications of electronic trading in financial markets

Report by a working group established by the Committee on the Global Financial System of the central banks of the Group of Ten countries

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Preface

The Committee on the Global Financial System (CGFS), known until 1999 as the Euro-Currency Standing Committee, serves as a discussion forum for the central bank community on financial stability questions. The CGFS has frequently been asked to examine the potential implications of innovations in global financial market practices.

Recent projects by CGFS working groups have concerned the functioning of international interbank markets, financial derivatives and the systemic consequences of standard risk management practices.

Last year, the CGFS decided to organise a working group to take a preliminary look at the possible implications of the use of electronic trading platforms for the functioning of global financial markets. The migration of financial trading to electronic platforms merits monitoring because of possible system-wide consequences. The Working Group was chaired by Jos Heuvelman of De Nederlandsche Bank. The Committee was most grateful to Mr Heuvelman and his colleagues for their careful work. The publication of this report is intended to contribute to the general understanding of developments in global financial markets.

The CGFS continues to be interested in this topic, and expects to continue monitoring the significance of changes in information processing and communications technologies for the functioning and stability of financial markets.

Yutaka Yamaguchi

Chairman, Committee on the Global Financial System

Deputy Governor, Bank of Japan

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Chapter 1
Introduction and main findings

One task of the Committee on the Global Financial System (CGFS) is to further the understanding of how financial markets function, with particular reference to central bank operations and financial stability. Electronic trading (ET – defined in Chapter 2) platforms are rapidly gaining ground in financial markets. In March 2000, the CGFS established a working group to examine the potential impact of ET systems on the structure, dynamics and stability of financial markets, and on firms active in these markets. (The mandate of the group is appended in an annex.)

The Working Group on Electronic Trading bases its findings on its own research (including case studies) and discussions with a wide range of market participants, including dealers, end-users and system providers. The members wish to record appreciation of assistance from these institutions. The members met as a group three times, in Basel, New York and Amsterdam.

Since the situation is evolving rapidly, the Group has not tried to make a detailed assessment of which particular systems are used in the various markets and of their market shares. Rather, it has focused on developing an analytical framework that facilitates understanding of the actual and potential changes brought about by ET and analysis of their implications for the stability of the financial system. The analytical framework that is developed fits a wide variety of financial instruments and markets. When using the framework to tentatively assess the current situation, however, the report mainly concentrates on those markets which are traditionally of greatest interest to central banks, ie on the spot foreign exchange and government bond markets.

The structure of the report is as follows. Chapter 2 defines ET systems, places them within a typology of trading systems and markets, and briefly sketches their use. The impact on the structure of financial markets and price dynamics is discussed in Chapter 3. The subsequent implications for financial stability are dealt with in Chapter 4. A glossary explains acronyms and technical terms used in the report.

The main findings are:

Context and use of ET

Electronic systems are used to varying degrees for trading in financial markets, differing between markets, between types of trades and users, and between the various stages of the trading process. The situation is evolving rapidly. ET is the dominant method in the inter-dealer foreign exchange market, and is rapidly gaining ground in the inter-dealer fixed income market. So far, ET has been used less for transactions in these markets between dealers and their customers, although it is growing rapidly in fixed income markets. Strong competition seems to have led dealers to actively promote new systems to their customers in order to retain their business or to attract new customers. At this stage, ET is not significant in the OTC derivatives market, with the issue of counterparty risk being one factor impeding its development.

In general, ET is being applied first to transactions in liquid and homogenous instruments. Current systems are generally more suitable for smaller transactions than for larger transactions. ET is not widely used in markets where counterparty credit risk is significant, unless the system has been designed to manage this risk (for instance through the incorporation of a set of limits).

Impact on market structure, efficiency and transparency

At this stage, the foreign exchange and fixed income markets remain segmented (in terms of access) into an inter-dealer segment and a dealer-to-customer segment. Some institutional investors would prefer to trade directly without intermediation, and technologically this is feasible through ET, but most others indicated that they would rather use a dealer. In the inter-dealer market, trading is moving from bilateral OTC relationships towards a marketplace with more centralised price discovery and transparency. This is happening to a greater extent in the foreign exchange market than in the fixed income markets, where there are several competing systems. The role of voice broking and direct dealing between dealers is diminishing. In the dealer-to-customer segment, some dealers initially established single-dealer systems but, as these proved insufficient for all of the customers' needs, they have since formed various consortia to establish multiple-dealer systems. As it is not clear which

systems will succeed, and since network effects and economies of scale may create a “first mover” advantage, many participants have sought to be involved (as owner and/or user) in multiple systems. All in all, the current market structure can be best described as a hybrid one, where many different trading mechanisms coexist.

It is too early to say how the various markets will develop, but several market participants expect a transition in certain markets to a fairly centralised and open network allowing all market participants to transact directly with each other. This might occur in different ways. For example, multiple-dealer systems (single platforms where customers can approach several dealers at the same time) may widen access to include other dealers, thus enabling inter-dealer trading on the system. Alternatively, inter-dealer systems may give access to end-users. It is also expected that there will be some consolidation of systems, although ET could allow the coexistence of a variety of systems to suit different types of trades and instruments.

The structure of an electronic market may largely depend on the extent to which it is contestable. Although ET is generally associated with low variable costs, entry costs may be considerable if fixed costs for the initial development of the IT infrastructure are taken into account. Initial costs may be mitigated when the existing infrastructure is used, but, even then, first-mover advantages and network externalities may make it difficult to attract business away from established systems. Liquidity does not move easily from one platform to another, unless the alternative is much better. This means that, in spite of the appearance of new competitors, existing players may be able to protect their business interests.

ET is more cost-efficient. Interviews with market participants indicate that in particular the scope for straight-through processing means that ET offers a significant advantage but has yet to be fully realised in most markets. For this to occur, standard settlement and clearing procedures are needed.

ET offers the potential to make markets more transparent. This does not only relate to price discovery and information about the depth of the market, but, on a more micro level, most systems provide the owner with a full log of the transaction behaviour of the users. From a business perspective, this can be valuable information. In practice, there are several reasons why market transparency might not improve to the full extent possible. Furthermore, it was pointed out that full disclosure of trading information does not always lead to better market functioning. In particular, a degree of anonymity seems to have positive effects on the way many markets function.

Greater competition, resulting from lower costs and increased transparency, is putting pressure on dealers’ margins, to which they are responding in different ways. The larger ones may try to compensate for lower margins by chasing more volume; ET can facilitate this by enabling greater scalability. Others unbundle their services and concentrate on certain niches. For instance, they use other dealers to provide a “white label” service to their customers, ie they keep the customer base but outsource (part of) their trading to a larger dealer.

Impact on financial stability

Financial stability is enhanced if markets are efficient, liquid, orderly and resilient. ET could potentially affect all these dimensions. The financial industry is restructuring rapidly and ET facilitates the trend towards fewer dealers. Ceteris paribus, this may lead to less liquidity being provided by dealers, but the reduced costs and greater efficiency of ET systems should make it easier for both dealers and end-users to transact, thus enhancing liquidity. Related to the low cost of arbitrage, the fragmentation of markets was not considered to be a major concern; moreover, it was noted that OTC markets in particular are becoming more rather than less centralised. Contrary to earlier fears, there are so far no firm indications that liquidity has suffered from the introduction of ET, although many systems have still to be tested in volatile times. It was observed, however, that hitherto trading has not moved away from electronic platforms in times of stress. In the same vein, it is not obvious that ET leads to higher volatility.

To the extent that the reduction in the number of dealers might result in a net withdrawal of risk capital from the marketplace, this may hamper the provision of liquidity by dealers in times of stress. It is, however, not clear that dealers are the ultimate providers of liquidity in a crisis, as it is likely that end-users play an important role as well. Insofar as ET facilitates price discovery, it may thus pave the way for a quicker return to a normal trading situation in times of stress. On the other hand, managing counterparty credit risk becomes relatively more important during stressed times. Therefore, the extent

to which ET systems are designed to cope with counterparty credit risk may affect their use in times of stress.

ET has the potential to improve the operational efficiency of individual firms, but also increases the dependency on these systems. So far they have been fairly robust, with only short disruptions to trading. During these times, traders reverted to traditional trading channels and reduced their trading activity. It remains to be seen how markets will function were there to be a prolonged disruption, particularly when traders are no longer familiar with the old trading methods and if trading is concentrated on a single platform. The design of the systems, their robustness and their contingency plans therefore deserve careful attention from both system providers and the authorities.

In some cases, ET is leading to computers dealing with computers, lowering transaction costs and increasing the speed of execution, but also raising concerns as to whether there are adequate controls on systems, for instance relating to whether they allow timely human intervention. Examples include automated execution by systems with pricing engines (used mostly for small orders and the management of dealer inventory).

Chapter 2
Definition, context and use of electronic trading

An assessment of ET and its impact requires a common understanding of what actually constitutes "electronic trading" and its key features. This chapter defines ET and indicates how it differs from traditional markets. Subsequently, the architecture of markets, whether electronic or not, is discussed. The interaction of the various types of market participants is elaborated. Finally, the current uses of ET are summarised.

2.1 Electronic trading defined

The term "electronic trading" encompasses a wide variety of systems, ranging from simple order transmission services to fully fledged trade execution facilities. In this paper, we adopt a *broad* definition of ET systems. An ET system is a facility that provides some or all of the following services: *electronic order routing* (the delivery of orders from users to the execution system), *automated trade execution* (the transformation of orders into trades) and *electronic dissemination of pre-trade* (bid/offer quotes and depth) and *post-trade information* (transaction price and volume data). In particular, our definition includes electronic systems that do not provide automated trade execution. These systems have found wide acceptance in fixed income and foreign exchange markets in recent years and can affect the market's structure and its dynamics (see Chapter 3 on this issue). In contrast to the broad definition, a *narrow* definition of ET systems is limited to facilities that automate *all* aspects of the trading process, including trade execution. The architecture of fully automated systems is often complex and differences between the various systems can be quite subtle.

Electronic systems differ from traditional markets in several respects. The application of computer technology automates aspects of the trading process and the trading relationship both among dealers and between dealers and their customers. The effect, however, is not merely "to build a better telephone", but potentially to create a new way of trading, different from either floor-based or telephone trading. ET affords users cost savings, increased efficiency and improved risk management capabilities. It differs from traditional systems in the following respects:

- *ET is both location-neutral and allows continuous multilateral interaction.* For trading purposes, the common physical location of users is unnecessary as long as they can connect to the system. However, unlike traditional location-neutral trading, such as telephone-based dealer markets, ET allows continuous multilateral interaction (telephone-based systems are bilateral almost by definition). Consequently, ET systems facilitate cross-border trading and cross-border alliances and mergers between trading systems to a greater extent than traditional markets.
- *ET is scalable.* Electronic systems can be scaled up to handle more trades simply by increasing the capacity of the computer network. With traditional markets, the size of the floor has to be physically expanded, or the number and/or capacity of intermediaries active in a phone-based market increased, a much more costly process. Thus, successful ET systems can potentially

exploit economies of scale and reduce operational costs to a far greater extent than can traditional markets. Scalability also tends to widen the reach of dealers, who have access to a far wider customer base than formerly.

- *ET is integrated.* ET potentially allows straight-through processing (STP), ie the seamless integration of the different parts of the trading process, starting from displaying pre-trade information and ending with risk management. In traditional markets, different systems handle different parts of the trading process (for example, order placement and risk management). It is therefore worth noting that ET does not only affect front office activities, but can also have implications for the setup and functioning of the back office.

2.2 Market architecture

Markets can be described in terms of a number of key features (see Box A below), which can be used to discriminate between various types of trading systems, both traditional and electronic. Based on these aspects of market architecture, two illustrative archetypes can be distinguished.

- In centralised *order books*, the interaction of market participants is fully multilateral. An order book is a largely order-driven market, though some market participants may choose, in effect, to quote continuous prices by maintaining limit orders in the book. The central element is an algorithm, which matches bids and offers subject to priority rules. There is no negotiation within the system. Examples are some stock and futures exchanges. Automated centralised order-driven markets will be referred to as *electronic order books.* It is possible for end-users to trade directly without intermediation in these systems, although, in practice, many systems limit access to dealers. Dealers may participate by quoting two-way prices, but generally they have no special role in providing liquidity in these systems.

- Decentralised markets rely largely on bilateral interaction and are usually referred to as *OTC markets.* OTC markets are typically segmented between an inter-dealer and a dealer-to-customer market and are predominantly quote-driven. Dealers post bid/offer quotes, which are either indicative or firm up to a certain trade size. Prices are determined when a quote is hit. Interaction is bilateral and the price of larger orders negotiated. Examples of typical OTC markets are large parts of the fixed income and derivatives markets. Electronic dealer systems essentially automate enquiries and subsequent trade executions previously conducted over the telephone. If only one intermediary is involved, the system is usually referred to as a *single-dealer system;* if more intermediaries are involved, it is called a *multi-dealer system.*

The architecture of both markets is summarised in Box A. It should be noted that, in practice, a wide variety of market types exist, so that the actual features of the markets are in between the models illustrated there.

Box A

Key features of market architecture

Markets, both conventional and electronic, can be described in terms of some key features including:

- *Access:* in some markets, end-users typically do not trade directly with each other, but do so through intermediaries. In such markets a *segmentation* between the inter-dealer market and the dealer-to-customer market exists.
- *Bilateral or multilateral interaction of order flows:* bilateral interaction generally allows price negotiation and the establishment of relationships. Multilateral interaction refers to the pooling of trading activity on a single platform; it does not prevent actual trades from being executed bilaterally between individual market participants. It usually implies that orders are executed at the best price available to an individual client, regardless of who is the counterparty.
- *Price formation:* prices can be determined within the system (the system provides price discovery) or taken from outside the system (the system does not provide price discovery). Price formation can be *order-driven* (prices follow orders) or *quote-driven* (orders follow prices). Under order-driven price formation, orders are sent to a central location and prices are derived from the interaction of these order flows. Under quote-driven price formation, market-makers quote prices at which they are willing to buy and sell securities. The willingness of customers to transact at these quotes determines market prices, although prices for larger trades are typically negotiated bilaterally. Prices can result either from multilateral interaction between market participants (quotes competing in a central location) or can be predominantly bilateral (fragmented price formation).
- *Need for dealers:* whether execution requires involvement of dealers (or specified market-makers).
- *Transparency*: the amount and extent of information that is disseminated. Under full transparency, systems would provide timely information, both pre-trade (for example, bid, offer and depth) and post-trade (for example, last trade price and volume), and disseminate it widely (to all market participants). However, actual systems offer various degrees of transparency.
- *Anonymity:* whether the identity of the counterparty is disclosed, either pre- or post-trade.
- *Trading protocols*: markets differ according to the type of orders allowed (limit, market, stop, off-market, etc), and rules regarding trading (the minimum tick size, trading halts, openings and closings, etc).
- *Degree of continuity:* whether trading is continuous or periodic. In a periodic trading system, orders are batched and cleared at periodic intervals.

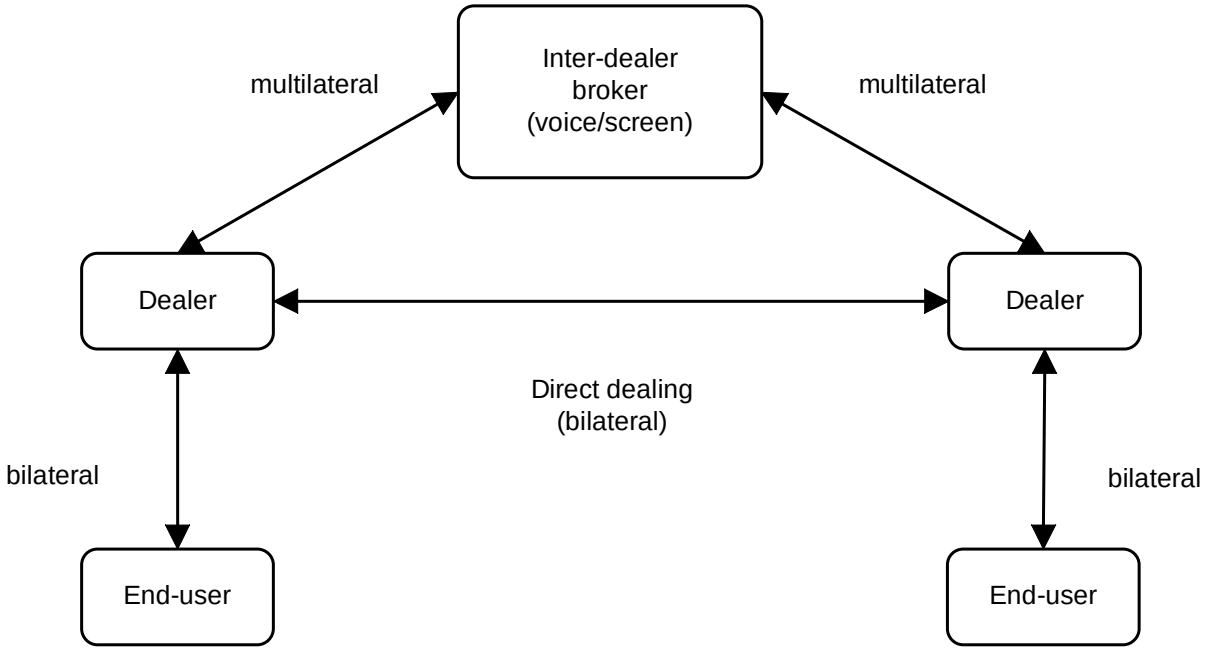
The architecture of order books and OTC markets can typically be summarised as follows:

	Order book	OTC market
Access	No segmentation	Segmentation
Interaction	Multilateral	Typically bilateral
Price formation	Centralised, usually order-driven	Fragmented, quote-driven
Dealers	Often present but not necessary	Necessary for trade execution
Transparency	Potentially high	Limited
Anonymity	Usually anonymous	Not anonymous, but limited disclosure
Trading protocols	Standardised	Not standardised
Continuity	Continuous or periodic	Generally continuous

2.3 Interaction between various market participants

In all types of markets, trading systems act as a nexus between market participants who can interact in various ways. The overall trading process can be described in terms of this interaction. For a proper assessment of the impact of ET, it is necessary to understand the interaction between the various market participants in a typical OTC market such as the foreign exchange or fixed income markets. As discussed, these OTC markets typically involve segmentation between an inter-dealer and a dealer-to-customer market. The interaction of the various market participants in an OTC market prior to the introduction of ET systems is schematically summarised in Figure 1.

Figure 1
Interaction between market participants prior to electronic trading



The end-users provide the underlying supply and demand that ultimately determines prices, although fluctuations in dealers' inventories may affect short-term price dynamics. End-users range in size from individual traders to institutional investors, large corporations and dealers' proprietary trading desks.

Various classes of intermediaries can be distinguished by the type of services they provide. Brokers do not take positions or trade for their own account; they are merely conduits for the orders or quotes of others. Dealers take positions and trade for their own account as their primary business and usually make markets for their customers by providing bid and ask quotes. In the process of seeking to profit from a bid-ask spread and exploiting pricing anomalies, they add liquidity to markets and thereby assist their customers in trading and hedging.

Traditionally, when an end-user needed to transact in traditional foreign exchange or fixed income markets, he incurred the search cost of calling one or more of the dealers with whom he had a business relationship. A price would be negotiated and a transaction executed at the best price available.

If the dealer did not want to keep the acquired position, she would either have to find another customer with whom to conduct an offsetting transaction or she would have to go to the inter-dealer market. She could then directly call another dealer to do an offsetting transaction, or go through an inter-dealer broker, where dealers put up the bids and offers at which they are willing to trade. The first type of interaction is bilateral, but the inter-dealer broker channel (bid/offers are transmitted either

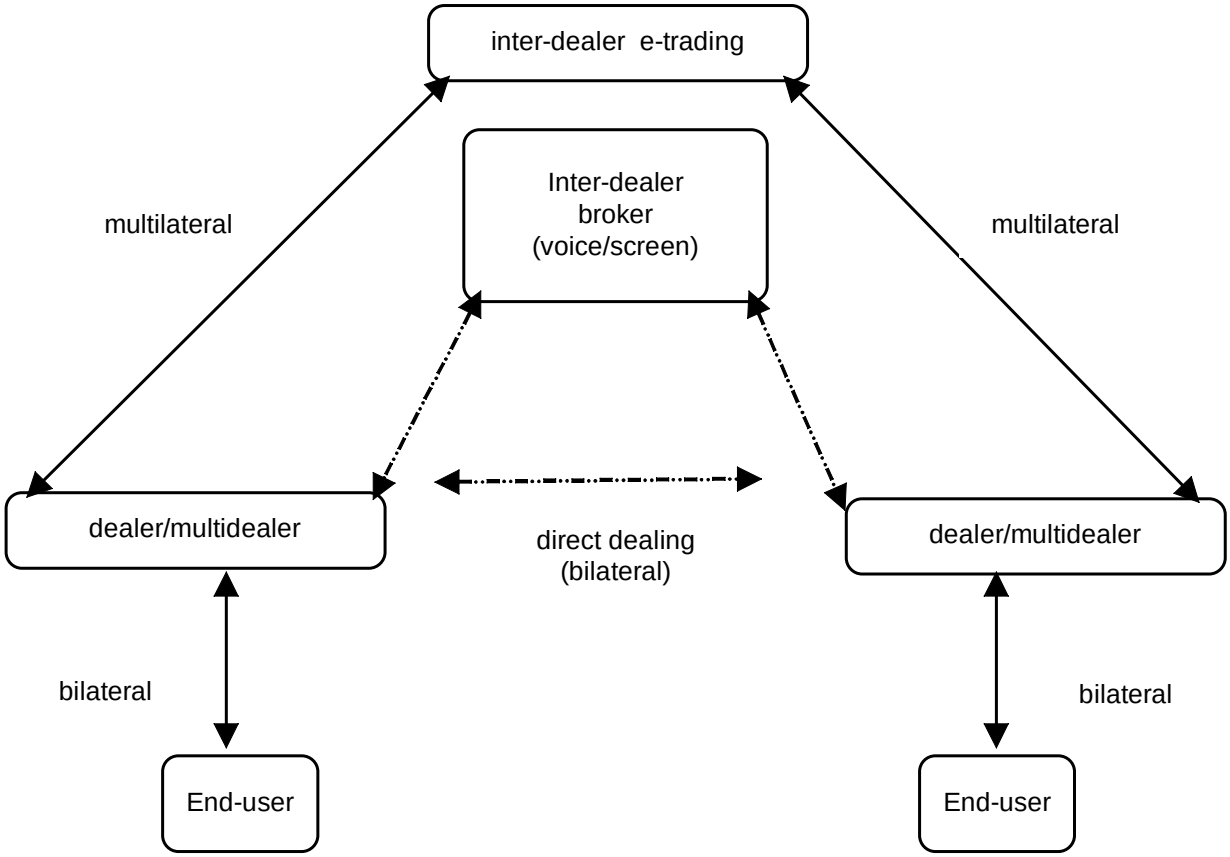
through screens or through voice contact) can be characterised as a multilateral interaction, since all quotes are pooled on a common platform and are thus in direct competition with each other.

Apart from providing price discovery and execution of transactions (provision of liquidity and immediacy) dealers provide other services to their customers, such as research (economic, fundamental, technical), trading expertise, information about the current state of the market and clearing and settlement services.

2.4 Current use of electronic trading systems

Electronic systems are currently used to varying degrees for trading in the markets for foreign exchange and fixed income. Penetration differs between markets, between market segments, between instruments, between types of trading and between the various stages of the trading process. Moreover, the situation is changing rapidly; a dominant system can give way to another in as quickly as a few months. The main impact of ET so far relates to the inter-dealer (voice) broker, who is increasingly being replaced by electronic systems. This does not necessarily imply that brokerage firms are going out of business as they may reinvent themselves by offering an electronic service. Furthermore, electronic trading makes the direct dealing relationships redundant, ie the interaction in the inter-dealer market is becoming increasingly multilateral. The dotted lines in Figure 2 indicate the reduced importance of the direct trading channels and the traditional inter-dealer broker channels.

Figure 2
Interaction between market participants after the introduction of electronic trading



In the foreign exchange market, the inter-dealer market is dominated by ET. There are two systems (EBS and Reuters), each being dominant in certain currency pairs (see Box D). Both voice broking and direct dealing between dealers have become much less important. The penetration in the dealer-

to-customer market is far less advanced at this stage. Many intermediaries have created their own single-dealer sites, replacing (or supplementing) telephone contacts with customers. Several business plans for multi-dealer sites have been announced (for instance Atriax and FxAll), but are not yet operative on a significant scale. There is still a clear separation between the inter-dealer and the dealer-to-customer markets. Even though the technology is available, especially due to the counterparty credit risk involved in foreign exchange dealing, so far the market has not moved to an open network in which end-users and intermediaries have equal access. Firms still want to know before execution of a transaction with whom they are dealing.

In the inter-dealer G10 government bond markets, ET systems are gaining ground rapidly (names often mentioned include BrokerTec, eSpeed and EuroMTS). Several systems are competing for the same business. Since it is not clear which systems will prevail, intermediaries are trying to be involved, as owner and/or user, in several of these systems. Again, in the dealer-to-customer market, the extent to which ET systems are used is less pronounced than in the inter-dealer markets, but it is growing rapidly. A number of multi-dealer systems (examples are Bondclick and Tradeweb) are operating/announced whereby customers can request quotes from several dealers at the same time, putting them in direct competition with each other. These systems are particularly useful for end-users, since many of them are obliged to ask for a number of prices before they can transact. Initially, dealers started by offering single-dealer sites, but these were not able to cater to all of the customers' needs. The subsequent move to multi-dealer sites was therefore partially motivated by the desire to retain their customers and perhaps to pre-empt third-party providers, who were likely to fill the gap.

In the OTC derivatives markets, the use of ET systems has been limited. Again, the counterparty credit risk involved in these instruments is an important reason for its limited penetration. Exchanges do not face this problem if they use central counterparties, which mitigate the credit risk. Therefore, and because of greater standardisation, electronic trading systems are more widespread in exchange-traded derivatives markets.

Beside its applications to secondary trading, ET has the potential to change the primary market (Box B). Issuers might use ET systems to target investors directly, thereby cutting out the intermediaries. However, the dealers provide other services than just finding end-users. They sometimes "guarantee" to a certain extent the primary issue, meaning that, with insufficient demand, they will temporarily take the remainder of the securities on their books, and they act as market-makers in the secondary markets. So far, in the government bond markets, dealers have remained the primary vehicle through which issuers reach end investors.

Box B

Electronic auctioning of securities in primary markets

The application of information technology to the issuance of (dematerialised) securities is gradually making its presence felt. Its main advantage lies in the increased capacity it provides for the exchange of information between all the parties involved. As in secondary markets, the effects of the electronification of primary markets are twofold. On the one hand, the efficiency of traditional distribution channels is enhanced; on the other, increased competition and transparency may potentially affect the structure of the primary markets in the direction of a less prominent role of intermediaries in the distribution of new issues.

Enhanced efficiency of existing distribution channels

Traditionally the auctioning or issuance of securities involves the issuer, the intermediaries and the final investors, who can all benefit from ET-related cost savings, eg from the possible introduction of straight-through processing. The introduction of electronic lines and networks facilitates the transmission of information between these entities and enhances the real-time knowledge of the book-building process. Furthermore, electronic systems may widen the access of investors to the primary markets (ie ET could potentially widen the investor base). Previously underwriters focused on large institutional investors, whereas the scalability of electronic systems now gives borrowers access to smaller institutional and retail investors. So far, however, electronic issuance has been used mainly in parallel with traditional methods and its use has had a limited impact on the existing issuing mechanisms. Final investors still spend much time on the telephone or in person with their dealers before placing an electronic order.

Changes in the market structure

As the efficiency and transparency of the primary markets increase as a result of the use of ET, issuers may decide to access investors directly without involving intermediaries. However, the role dealers perform in the primary market in terms of provision of qualified information and support to the effective placement of securities will be difficult to replace. Whereas ET thus potentially enables disintermediation in primary markets, the extent to which this happens in practice will also depend on whether issuers need intermediaries for other purposes than mere market access. Such additional services may involve underwriting ("ensuring" the issuer of placement) and market-making in secondary markets. Furthermore, intermediaries have the capacity to vet the potential investors, something which issuers will find hard to do. Although disintermediation in primary markets is of a very limited scale, some examples can be reported, notably in the United States. The US Treasury, for example, offers retail investors the possibility to purchase government securities through the Treasury Department's website: investors are allowed to submit non-competitive bids for securities within predefined size limits.

Chapter 3
The impact of electronic trading on market structure

ET affects the way in which markets operate, mainly because it has an impact on market architecture. As discussed in Chapter 2, broadly speaking market structures are either centralised or fragmented. In centralised markets, price formation occurs centrally through the multilateral interaction of order flows and information is pooled from disparate sources. In contrast, existing market structures in foreign exchange and fixed income markets were traditionally more fragmented, as reflected in a segmentation between an inter-dealer and a dealer-to-customer market. Furthermore, trading in these markets was mostly done bilaterally between the customer and the dealer and transparency was limited. In this chapter, we discuss whether and how ET will enable previously fragmented markets to become more centralised and how it affects the information infrastructure of markets. ET systems can increase centralisation in two ways. If multi-dealer platforms become more popular than single-dealer systems, customers have wider access and better information, although the market remains segmented. Alternatively, trading could move to order books, thus removing the segmentation and making the market interaction even more multilateral. In both cases, information (whether trade-related or not) will potentially be more easily accessible and cheaper to obtain.

This chapter starts with a discussion of how ET improves operational efficiency in both fragmented and centralised markets. Subsequently we examine the impact of ET on price formation, transparency and market access (including the role of intermediaries) and show that, from a *technological* point of view, ET potentially allows fully centralised markets. However, the type of price formation and the actual extent of transparency and access depend on the *design* of the system and the *business models* of system providers. These design features and business decisions, in turn, affect the implicit costs of trading (ie the bid-ask spread and the price impact of trades) in these markets. Whether users migrate to centralised ET markets *in practice* depends on both the explicit and implicit trading costs, as well as various historical factors. In addition, as a consequence of first-mover advantages and network effects the freedom of participants to switch between different systems may be limited. The chapter ends with an overview of the types of instruments and trades that may be suitable for centralised electronic markets.

3.1 Increased operational efficiency

The automation of the trading process has important consequences for the operational efficiency of markets. Increased computational speed allows the simultaneous processing of large amounts of trade-related information, thus enabling integrated solutions to all trade-related processes in financial institutions. As discussed in Section 3.3, increased operational efficiency provides scope for ET systems to reduce the cost of trading.

A large part of the scope for increased operational efficiency is thought to relate to lower order processing costs. Electronic trading makes it possible for trades to be passed straight through to the middle and back offices by linking the execution, confirmation, clearing and settlement of trades with market risk management and operational risk management procedures. This is known as straight-through-processing, or STP, which does away with intermediate manual intervention and so has the potential not only to reduce the overhead costs for back office handling, but also to minimise the risk of errors in trade reporting and record keeping and to make risk management more effective. Market participants are well aware of the benefits of STP, although the general view is that major cost reductions can only be realised when STP is fully implemented. This is more likely if dominant ET systems emerge over time and/or market standards are adopted.[1]

Operational efficiency will also improve because of the automation and integration of other trade-related processes, thus enabling a further reduction in the associated staff costs. Whereas previously

[1] At present, STP is far from universal. There could be a trade-off involved in further standardisation; the linkages required to operate STP may make the trading system more vulnerable to disruption. If STP is provided by the trading platform, all market participants benefit and settlement costs and risks reduce across the market. This outcome can also be achieved, however, if the clearing and settlement infrastructure is separate but has an open architecture to which all trading platforms and market participants can connect easily. Some market participants say they prefer trading systems which do not offer STP centrally because they regard their own in-house STP as a competitive advantage.

human traders were involved in the pricing of all individual transactions, dealers in, for example, the fixed income market now use pricing engines for smaller transactions with customers; they also encourage customers to use single- and multi-dealer trading systems for routing their trades.

Finally, electronic trading systems automate the collection of pre-trade and post-trade information, eg obtaining quotes and requesting execution. By greatly increasing the amount and timeliness of information, the new systems provide greater efficiency and reduce search costs, ie the costs of searching for the best price.

3.2 The impact of electronic trading on market access, price formation and transparency

In Box A in Chapter 2 the basic elements of a market architecture are discussed. The key factors distinguishing centralised and fragmented markets are market access (including the role of intermediaries), price formation and transparency. As discussed in Section 3.3, these elements determine the implicit trading costs of ET systems. The impact of ET on these important elements of the market architecture is dealt with below.

Market access and the role of intermediaries

Electronic trading makes it technically feasible for the market structure to move to a centralised order book, where end-users can transact directly with each other. As a result, the current segmentation observed in OTC markets between the inter-dealer market and the dealer-to-customer market could come under pressure. In practice, however, OTC markets, whether electronic or not, remain essentially intermediated. So far, end-users have indicated that, despite the growth of ET systems, they think the role of dealers will continue to be important in the foreseeable future. The main reason is that some end-users value the personalised research, advice and execution offered by dealers. But the balance of power between dealers and customers seems to be shifting to the advantage of the latter in some markets. Better market access and greater market transparency have put pressure on intermediaries.

As profit margins of intermediaries are under pressure because of an ET-induced increase in competition (through better access and transparency), dealers may reconsider their business models. Some may contemplate either scaling down on trading in commoditised and low-margin products and outsourcing it, or alternatively trying to generate additional volume to compensate for lower margins. A withdrawal from market-making could involve an allocation of less risk capital. The implications of this are addressed in Section 4.3.

As dealers reposition themselves, they may use the potential for “unbundling” of services that ET facilitates. Some may concentrate on research or advising and assisting clients in handling large and complex transactions. Some may continue to trade, but only in niche markets. They may use a “white label” service to cater for their customers, while not bearing the cost and risk of execution themselves. An example is the case of regional banks in Japan using the single-dealer system provided by a city bank rather than trading in the inter-dealer market themselves.

Intermediaries will not only have to consider their role in trading, but also their approach to human resource management, which will change as a result of the introduction of electronic trading. For example, they will possibly require a different mix of skills from their sales force, emphasising advice and relationship more than execution, which will also be reflected in a change from current incentives and pay structures.

Price formation

The main impact of ET on the nature of price formation in foreign exchange and fixed income markets is through centralising trading on a common platform, as can be witnessed in the inter-dealer foreign exchange and government bond markets. More generally, electronic trading systems enable price discovery, whether following from quote- or order-driven price formation. The only exceptions are so-called “crossing networks” (used so far only in the equity markets) that match orders using prices from outside the systems (eg equities are crossed at exchange closing prices). Although price discovery is usually provided by ET systems, it may be fragmented in a market where several competing electronic trading systems operate, unless these systems are electronically linked.

Box C

Electronic trading and price discovery

ET systems have the potential to increase the speed with which price information is relayed to the customer market from the inter-dealer market. In addition, the customer may enjoy a tighter bid-ask spread on the ET system. This implies that price information and spread charged are integrated over the customer and the inter-dealer market, even if these markets are segmented with respect to customers' access.

A case study by the Bank of Japan provides evidence for a single-dealer ET system. Data for one day in the Japanese Government Bond (JGB) market on this system, the non-ET inter-dealer broker (IDB) market for cash bonds and the futures market, were explored. The futures market in Japan has far greater liquidity than the cash market and plays a key role in the price discovery of long-term cash bond prices in the IDB market. Price information in the IDB market is traditionally relayed to the customer market with a time delay and dealer's margin.

Prices on this ET system showed co-movement with futures prices without much delay. This means the time lag in transmitting price information from the futures to the single-dealer customer market became shorter than the previously reported time lag from the futures to the IDB market. The spread in the ET system was set at 0.8 bp, versus the 0.5 to 1.0 bp for actively traded issues in the IDB market. The single-dealer system did not necessarily charge a wider spread than the IDB market, and it did not use simple mark-up pricing, ie pricing to customers reflecting the purchase and inventory costs of the securities involved as well as a margin for the intermediary. These results suggest that the ET system created a new channel of price information and access to better spreads for customers, although the segmentation between the customer market and the inter-dealer market remains with respect to customer access.

This case is an example of the actual use of pricing engines. About 70 JGB prices were updated on the ET system with a significantly higher frequency than observable in the traditional dealer-to-customer market. All in all it seems that the introduction of the ET system provided an opportunity for investors to trade in the JGB market and has provided them with better price discovery.

ET systems may improve price discovery in traditional markets. As electronic trading systems are typically more transparent than traditional OTC markets, the prices they produce may serve as a benchmark for related markets where price discovery is less transparent because of fragmentation or limited liquidity (this is discussed in more detail in Section 4.2). As an example, the continuously updated prices of the highly liquid bond futures and "on the run" government bonds tend to be used in pricing engines that provide quotes for a wide range of less liquid fixed income instruments.

Transparency and anonymity

As discussed in Chapter 2, transparency has two aspects. *Pre-trade transparency* refers to the availability of information about bids and offers. In an OTC market, this means firm or indicative quotes by the dealers. On an order book, it may mean just the best bid and offer orders available, the full depth of the book showing amounts at each price, or something in between. *Post-trade transparency* refers to the public and timely transmission of information on past trades, which may include price, volume and execution time.

ET systems automatically capture all aspects of both pre- and post-trade information, thus making a greater extent of transparency possible than in traditional trading. Price information is potentially more easily accessible and available more quickly. Also, because information technology enables the simultaneous bundling of various information sources, it makes links between related markets explicit to market participants. Furthermore, the pooling of market information on joint platforms enables market participants to make a better assessment of the depth of the market.

Whether electronic trading systems actually do provide more information (including to whom they provide it) depends on the design of the system and is primarily an administrative and business decision by the provider. These decisions reflect the needs and demands of the intended users of the systems as well as the business interests of the owners of the system. Business interests are important in this respect as the strategic non-disclosure of information can be an important element of

the business model underlying the system that is provided. Better access to trade-related information is generally regarded as a valuable asset. Therefore market participants that benefit from information asymmetries (such as dealers) may want to prevent these from disappearing. At first sight, it appears that the improved access to (or lower cost of obtaining) information - facilitated by information technology and further enhanced if markets become more centralised - reduces asymmetries and thus erodes the advantages of those who benefit from them. Nevertheless, it has been suggested that one of the reasons why dealers have been very active in promoting systems in which they rather than third parties are involved is that these systems provide them with more exclusive access to trade-related information. If network effects and first-mover advantages result in dealer-owned systems becoming dominant, then the participating dealers will still be able to benefit from information asymmetries.

Generally, electronic trading systems used in inter-dealer markets are designed in such a way that they provide little information as to the identity of *who* is intending/willing to trade. Many market participants believe that as markets become more multilateral, it will become easier to assume and unwind positions anonymously in electronic systems. If multilateral trading platforms evolve into central order books with central clearing, then trading could be completely anonymous, pre- and post-trade.

Increased transparency does not only relate to price discovery. Electronic trading systems also capture information on the various participants in the system. For instance, in multi-dealer systems it is possible to record the search and trading activity of customers as well as the reactions of dealers (in terms of price quality and speed and in terms of “hits and misses”, ie whether a quote request finally results in a trade). It has been suggested that the access to flow information is an important incentive for intermediaries to offer electronic trading to their customers, even if this results in declining profit margins for actual trading. In principle, dealers only have information on their own business conducted via the system. System providers, however, have access to all the trade-related information, which can be highly valuable. Whether and how this information will be disseminated remains an open question.

3.3 Factors driving users’ choice of trading systems

ET involves a change in trading technology that potentially allows new market structures to appear. Whether and to what extent users adopt the new structures depends largely on the explicit and implicit costs of trading in these systems. However, historical factors, as well as potential entry barriers due to first-mover advantages and network effects, also affect the choice of users and so the system with the least cost for a particular user may not actually be chosen. It is also useful to remember that trading costs are specific to the user type. In order book markets, the investor may incur the cost of a potentially greater price impact. The investor has to pay either the cost of a potential price impact in the order book market or the compensation for immediacy of large-order execution in the dealer market. In the former it is determined by the order book conditions and in the latter by the dealer. The choice depends on the investor’s preference.

Explicit trading costs

In most wholesale markets, the explicit costs of trading consist of market access fees, commissions, tax, clearing and settlement costs and staff and IT overheads. While fixed IT costs may currently be higher in ET than in traditional markets, ET has the potential to reduce many of the variable cost components of processing orders significantly. Thus, provided that the trading volume is sufficiently large, the average cost of trading will be lower in electronic markets than in traditional trading. Moreover, the scalability of ET enables market participants to exploit economies of scale to a far greater extent than was possible in traditional markets.

Implicit trading costs

The implicit costs of trading include the bid-ask spread paid to a liquidity provider and the price impact of the trade (ie the extent to which the trade price deviates from the current market price as a result of the trade).

In dealer markets, investors pay the dealer a bid-ask spread as a compensation for supplying liquidity, ie immediacy of execution. The dealer's bid-ask spread must cover his explicit trading costs, his profit margin and a liquidity risk premium (ie the risk of being unable to unwind the transaction at a predictable cost).[2] ET systems potentially reduce all components of the dealer's bid-ask spread. Dealers' explicit costs are diminishing as they rapidly introduce automation. For example, in government bond markets, some dealers have automated the process of trading small customer orders entirely. Customer orders are received through electronic dealer systems and routed directly to automated pricing and order generation systems. Profit margins may also be declining as ET increases competition between intermediaries by making price comparison easier and less costly, especially in more commoditised markets such as government bond and foreign exchange. Apparently, some intermediaries only remain active in these markets in order to have access to flow information that can be used for proprietary trading; for them thin margins are less relevant. Liquidity risk premia may also decline if ET increases market transparency and so enables dealers to better assess market depth when unwinding large positions. Most systems that are currently in use, however, do not provide full transparency. Liquidity premia will also be reduced if ET systems provide greater anonymity than traditional trading methods. Greater anonymity may enable dealers to gradually unwind positions in smaller lots without having to expose their position to other market participants. The view of most market participants is that anonymity is better assured in electronic systems than it was in the traditional inter-dealer markets.

First-mover advantages and network effects

Users' choice of trading systems may be limited by various externalities arising from the nature of the IT industry. So-called "first movers" are able to set the standard for a particular type of trading system, after which users can be "locked in" because the cost of changing over to another system with a different standard is considered too high. Another important issue governing the dynamics of market access is that of network effects. The value of a trading system will depend on the number of people using it (ie the liquidity). Once a system is established as the standard, costs of changeover to other systems may be prohibitive. On the other hand, competition may come from rival systems with sufficient critical mass in related fields that are likely to provide similar network externalities as existing systems. Information companies, for example, have used their dominant position in the provision of market information to offer trading facilities. Factors influencing the evolving market structure are discussed in more detail in Section 4.2.

Historical and institutional factors

Users' choice of trading systems will also depend on the historical evolution of that market and its existing structure (usually referred to as "path dependency"), vested interests and the relative market power of the various institutions that may limit the scope for market evolution. An example of the role of historical factors is provided by the fixed income markets that have historically been dependent on dealers, and so any evolution to electronic order books may be delayed. Customers are apt to be involved in long-term relationships with their dealers, and are comfortable leaving the details of trade execution to them. In our interviews, most customers showed a preference for working with familiar dealers. Moreover, dealers have historically vested interests, which may be an incentive for them to preserve the status quo. In contrast, the traditionally highly centralised markets for European and Australian bond futures moved very quickly from floor-based trading to an electronic order book, as only the existing features of the market had to be automated.[3]

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[2] Bid-ask spread should be analysed in relation to the intended trade size. If, alternatively, an investor chooses to split up a large order and decides to bear the execution risk, he should also consider the price impact or how much the market will move in response to his transactions before the total amount has been executed. The expected price impact also plays an important role for the dealer when setting the premium for which he is prepared to take the execution risk; it constitutes the cost of unwinding the trade. The price impact relates to the 'depth' of liquidity in relation to the order, ie what sort of volume can be expected at each of a range of prices. Generally, ET-related greater transparency benefits the assessment of market depth, but issues of suitability remain (see Section 3.4).

[3] In practice the changeover also involved not only a reduction in operational costs, but also the question of whether network externalities would prevent the market from moving to a new electronic system, ie whether the new system had sufficient critical mass.

3.4 Suitability of financial instruments for centralised ET markets

Our previous discussion indicates that not every instrument and every type of trade is equally suitable for trading on an electronic order book. In particular one can say that a transaction is less suited to an electronic order book:

- if the product is relatively non-standardised. Heterogeneous instruments require a more extensive pre-trade dialogue between counterparties about modalities. For more complex products this dialogue could be done through electronic means, but there is only bilateral interaction;
- if the market is relatively inactive or illiquid. Such markets may not be suitable as there may not be enough limit orders on both sides of the market. However, for instruments where there is not a high demand for immediacy, periodic matching systems, where trades are batched to be cleared at periodic intervals, may be suitable;
- if counterparty credit risk plays an important role. In this case, the instruments involved are less suitable for electronic order books, as there is no control over the counterparty with which one trades. Examples include instruments that cannot be settled by some form of DVP, or can entail large counterparty risks as a result of market movements (such as interest rate swaps). The systems used in the inter-dealer foreign exchange market have mitigated this through incorporating in the system the credit lines that banks have on each other. The futures exchanges have set up a central clearing party that stands between the counterparties and guarantees the performance of the trade to both parties;
- if the trade size is relatively large. Large trades in any instrument generally require intermediation. Due to high pre-trade transparency, the risk of moving the market when trading on an electronic order book is considerable. Customers may be more comfortable working with a dealer for large trades, either electronically or on the phone. They may allow the dealer to work the order or they ask the dealer to transact the block with them and take over the execution risk. Either way, the trader will split up the transaction into small portions and transact it through the “machine”. The anonymity that the ET systems may offer helps here, since it may not be immediately clear to the market that all the portions are coming from the same address. Information about the trade size is therefore initially only known by the dealer involved; to the extent that automation leads to an improved audit trail, chances of detecting front-running activities by the dealer may be higher. In equity markets so-called “crossing networks” are used as a possible alternative venue for these large trades. To encourage large orders, some systems allow hidden or “iceberg” orders that are not visible to other users but have lower price priority relative to visible orders.

On balance, therefore, small or average-sized transactions in liquid, homogenous products, with limited counterparty credit risk, are most likely to move to an electronic order book first. As discussed earlier, this is already happening in the inter-dealer foreign exchange and government bond markets, but with the segmentation between the inter-dealer and the dealer-to-customer market still intact. Some movement towards central markets has therefore taken place, mostly in the interbank segment. In the dealer-to-customer segment we are seeing a move from single- to multiple-dealer sites, where dealers are put in more direct competition with each other for customer business. Thus, trading is still done bilaterally, but there is an interaction between the various dealers on one platform.

In the interviews some market participants noted it is a matter of time before trading in these products takes place on a platform to which dealers and end-users have equal access. However, participants felt that the dealer community, which has a vested interest in the current segmented marketplace, may resist such an outcome. Furthermore, many investment managers indicated that they value the services of the dealers and would rather go through them than trade directly with one another. One reason for that is the issue of immediacy: the dealer provides direct immediate execution, whereas on an electronic order book execution may take time. The issue of counterparty credit risk is also of high importance: unless it is met through a system of credit lines or some kind of central clearing, participants want to identify their counterparties before conducting a trade.

Box D

ET systems in the inter-dealer foreign exchange market

Trading in the inter-dealer foreign exchange market is dominated by ET systems. The most important electronic brokerage facilities are Reuters' Dealing 2000-2 and Electronic Broking Services' (EBS) Spot Dealing System. Participation in both systems is limited to dealers, who anonymously enter bids and/or offers into their terminals. Each user observes both the best bid and offer for a given exchange rate available in the market, as well as the best bid and offer available to that user. The difference between the best market price and the best price available to a given dealer arises from the credit allocation procedure followed by each user. Since dealers will only be willing to take on settlement risk with counterparties for which they have internally approved credit lines, each participant identifies those subscribers with whom it is willing to trade and the credit limit it is willing to allocate to each trading party. That way, a subscriber will only be matched with counterparties with whom it is willing to deal, and for which it has available credit lines. Upon hitting a bid or offer on the system, the two counterparties are revealed to each other and settlement occurs (on T+2). If several banks are offering the same best price, their offers are met on the basis of time (first in, first out). The systems provide automated interfaces with banks' internal systems applications, to allow straight-through processing.

Electronic broking has expanded rapidly in recent years, with each system specialising in certain currencies. This has been at the cost of traditional means of dealing such as through voice broking or direct dealing. The advance of electronic broking owes much to its lower cost, higher efficiency and, most importantly, greater transparency compared with traditional trading channels. The spot foreign exchange market has traditionally been opaque, because of the difficulty in disseminating price information in the absence of a centralised marketplace. Before the advent of electronic broking, dealers - especially the smaller ones - had to enter into a number of transactions to obtain information on available market prices. By contrast, traders are now able to know instantly the "best" available market price, without having to go through an uncertain price discovery process.

Chapter 4
The impact of electronic trading on financial stability

The previous chapter showed how ET has the potential to reduce trading costs for market participants, both directly as a result of lower explicit costs of trading and indirectly by encouraging changes to market structure. This chapter considers whether the market developments associated with ET have implications for financial stability, which will be enhanced if markets are:

- efficient: prices balance underlying supply and demand and adjust as smoothly as possible, without excessive volatility unrelated to changes in fundamentals;
- liquid: transactions are executed rapidly without unduly moving prices;
- orderly: equivalent orders are executed at broadly equivalent prices;
- stable and resilient: the above continue to hold at times of uncertainty and market stress.

This chapter first discusses the consequences of ET for efficiency and liquidity. Subsequently an analysis of the implications of the current fragmentation observed in some markets is presented, followed by an assessment of the resilience of markets in times of stress. Finally, the potential operational risks associated with ET are reviewed.

4.1 Consequences of ET for efficient price formation and liquidity

In general, electronic trading should allow orders to reach the market faster because of higher processing speeds than with manual processes. Prices should therefore incorporate information more quickly. By lowering trading costs and widening access to market information, ET should also encourage greater trading activity by existing investors and broader participation in markets (for example, by retail investors). It should also reduce the cost of arbitrage trading. ET facilitates the centralisation of markets by allowing both remote access and multilateral trading. These factors may – at least in theory – boost liquidity. Assuming that deeper liquidity in markets means more efficient price discovery, market prices should better reflect available information about fundamentals, and hence prices adjust more quickly to (even small) changes in these fundamentals.

Some market participants suggest this increased efficiency might also lead to higher price volatility, especially if prices incorporate news more quickly in the short run. On the other hand, it can be argued that, if prices were slower to react, they would have to show bigger moves to catch up with the news. Several market participants have indicated that volatility has become more visible because of improved transparency, but that it has not necessarily increased.

Box E

Automated order-matching in the JGB futures market

Price developments in an order-driven market depend on the order-matching system. The Tokyo Stock Exchange reformed the order-matching system of the JGB futures market in 1998. The new system accelerated the speed of order-matching. However, information on the book changed too quickly for dealers to digest the latest information. In this environment, dealers may have been less confident that their orders would be executed at the prices they expected. Market participants pointed out that the reform led to an increase in price volatility. Seven months later, the Exchange amended the system again to solve this problem.

ET systems may accelerate the speed of both order execution and dissemination of information, including limit order prices and volumes on an order book. Although such an outcome might contribute to price efficiency, higher execution speeds could make it difficult for market participants to absorb the latest information necessary to decide their order strategy. This problem may be more serious in a highly liquid market such as the JGB futures market where over a thousand transactions are executed within a few hours.

In a case study, order flows in the JGB futures market were categorised into eight types based on the relative level of limit price compared to the best bid and best ask, and whether it was a sell or buy order. Dealers' order strategy was analysed by the arrival rate of each type of order, which was estimated by conditional probability on the last order type and the bid-ask spread immediately before the order arrived. In addition, the distribution of order size was examined for each type. Finally, an artificial order-driven market was developed in which order flows were generated using the order strategy observed in the actual data. The first simulation in the artificial market was intended to make it replicate features observed in actual futures markets by adjusting parameters. Based on this model, the second simulation explored how the perception lag of the current state of the order book affected the price development. The result indicated that dealers' misperceptions lead to higher price volatility. Since ET systems may accelerate the speed of order execution and information distribution, the perception lag (caused by the high execution speed) may pose a problem in highly liquid markets where the order book changes frequently. The study suggests that the speed of the execution process must be in line with the speed of the processes that traders use to evaluate the order book, react to information and post new orders.

Another factor bearing on volatility in the very short term is the micro design of the trading system. For example, Box E suggests that changes to the order-matching rule of the order book in the Japanese futures market have influenced short-term price volatility. Traders may need time to recognise the current state of the order book. An imprecise perception of the state due to highly frequent order flows and high speed execution by automated order-matching prevents their order from executing at the

intended price. The example suggests that the speed of the execution process must be in line with the speed by which traders react to price information and post new orders. ET means orders can be executed in a fraction of a second. Unless market participants are able to respond over the same time frame, market prices may overshoot temporarily. The introduction of pricing engines (with automatic electronic order generation systems) by dealers may, however, bring the speed with which they can reprice and submit new orders into line with the speed of the order execution mechanism.

4.2 Market fragmentation and consolidation across trading systems

Chapter 2 describes how ET has encouraged the development of new trading patterns. At present, some markets appear in a state of flux, with trading spread across several platforms supplied by competing providers and across different market types. Fragmentation may have both benefits and costs. The benefits include:

- *Improved pricing efficiency.* Prices from the more transparent electronic order books can be used as benchmarks or reference points for trades in existing markets.
- *Improved efficiency in existing markets.* Competition with new, more transparent electronic markets may force existing markets to lower costs and increase their own level of service. For example, dealers may be obliged to offer greater transparency to their customers.
- *Easy access for end-users.* ET systems may attract new types of end-users, and ultimately benefit some markets through increased liquidity. In particular, retail customers may find it easier to participate in certain securities markets due to increased transparency and lower trading costs.

However, there are also potential *costs* of coexistence:

- *Fragmentation of order flow.* Liquidity may be adversely affected due to fragmentation of the order flow into electronic and non-electronic markets. Of course, this is a potential problem whenever multiple market centres coexist, irrespective of whether some of them are electronic or not. However, the relative ease of setting up new electronic systems means that multiple systems are likely.
- *Costs from the duplication of systems.* These may result from expenses on systems required to enable investors and intermediaries to keep track of prices being quoted and traded in various market centres and from expenses arising from delivering an order from one market centre to another for possible execution.

In practice, most market participants did not see fragmentation as a major concern, in part because new trading technology makes it easier to access and monitor a number of systems simultaneously. It was noted that previously OTC markets were even more fragmented, so these markets are becoming more rather than less centralised.[4] Also, open architecture designs allow different systems to interact and be displayed on a common screen. The process can be facilitated by “adapters” or middleware (software that aims to reduce the costs of investor access by providing a standardised interface across different networks). Taking the process a step further, traders may in the future use a “smart agent” that searches among both markets and dealers for the best place to make a given transaction, taking into account quotes, charges and liquidity. The low cost of arbitrage should therefore keep prices consistent across the market.

Furthermore, most market participants regard fragmentation of systems as typical of the early stages of the product cycle. As a market matures, there may be a tendency for rationalisation towards systems with greater liquidity. Five factors may lead to consolidation: *economies of scale, network effects, standard-setting, switching costs* and *tipping effects.* Economies of scale arise because ET systems, like most information goods, are characterised by low variable costs, the classic condition that tends towards monopoly. Network externalities arise because the benefit of participating in a network increases with the number of other participants. Since traders move to the system offering the most liquidity, the large systems become even larger. There is also the potential for first-mover

[4] For equity markets, particularly in the United States, fragmentation is seen as more of an issue, as discussed in, inter alia, Greenspan (2000). The starting situation there, however, was a centralised market (ie the exchange).

advantages in being able to set standards. Switching costs arise because users become familiar with their current system, and may have linked their back office operations to them, making them reluctant to change to a new system even if it is somewhat better. Once a system becomes established, there may be "tipping" effects: competition may be keen between rival trading systems when none accounts for a majority of transactions, but once one achieves a market share of, say, 70%, it may then rapidly take over almost the whole market.

A system that becomes dominant due to such first-mover advantages may not necessarily be the most efficient. A technically better system arriving later may not attract individual traders to it even if it were socially optimal for all traders to switch. This raises the possibility of predatory pricing; a system being offered at below marginal cost to attract large numbers of subscribers who are then faced with higher fees once the system has an effective monopoly. The dominant players will be those with deep pockets. Some market participants warned that "vested interests" were an important force in the development of the market structure. There is also concern that dominant systems have little incentive to improve.

In some cases, markets will be split with different systems dominant in different parts. For example, there are two dominant systems in the foreign exchange market, each dominating in particular currency pairs. This underscores the point that once liquidity is concentrated on a certain platform, it will not easily migrate to another.

Centralisation of clearing and settlement

Chapter 3 suggested that ET might encourage markets to move towards centralised trading. This might encourage initiatives to offer central clearing of markets, in order to deal with counterparty credit risk. The growing role of central counterparty clearing houses in financial markets has wider implications for financial stability which are beyond the scope of this report. From a narrow trading perspective, however, the removal of concerns about counterparty credit risk may make trading systems more resilient because market participants would no longer be potentially deterred from trading by those concerns, which are likely to increase in times of stress. It should be noted that in stressful times, the robustness of the central clearer becomes a very important issue.

4.3 Market resilience in times of stress

Will trading move away from ET systems in times of stress?

When ET systems were first being introduced, trading tended to move back in volatile times to the more familiar phone- or floor-based systems. This no longer seems to be the case. Most banks interviewed reported no general tendency to move away from ET in volatile times. While liquidity in some ET markets may dry up in adverse market conditions, this was also true for traditional markets. However, some participants cautioned that ET systems had not been tested yet in extreme conditions. It seems that in volatile circumstances trading moves towards the trading systems with the greatest market share, regardless of whether they are electronic, floor- or telephone-based.

An example was in early October 1998, when the dollar/yen rate declined from ¥133 to ¥112 in less than 48 hours. In several financial centres there was a marked migration *towards* ET systems and away from voice brokers. Price action was continuous in these systems with little evidence of gapping (sudden jumps in prices). Dealers were able to use the ET system to track the market price without needing to transact to do so. So unwanted positions which would have unwound very quickly were not taken on in the first place. It may be that the yen appreciated faster because there was less "shock absorption" by intermediating dealers but the return to orderly trading was also more rapid than in similar instances in the past.

Will electronic order books remain liquid in times of stress?

A particular concern for financial stability is that trading systems that function adequately in normal market conditions may cease to be effective in stressed market conditions. Order books may be more suited to markets where prices are more certain and information more uniform, and could function less well in stressed markets. Traders may become less willing to post limit orders, thereby reducing liquidity.

Gapping might occur on order books if limit orders are withdrawn from the book because of increased uncertainty and/or an event causes a rush of market orders in one direction, which "run through" the existing liquidity, executing against "stale" orders away from the market price. It is not clear, a priori, whether gapping will be more frequent in an ET system than in traditional markets, although it may be more observable.

Some argue that market-making obligations (which are usually accompanied by corresponding privileges) smooth price adjustment and ensure a certain degree of liquidity in all market conditions. However, the extent to which market-makers would carry out their obligations in very adverse conditions was often questioned. Market-makers are usually committed to quoting two-way prices in an instrument, either continuously or for certain periods within the day, within a predefined bid-ask spread and minimum trade size. Market-making obligations are less often a feature of order books than dealer markets. (An exception is represented by MTS markets, in which designated market-makers must usually maintain bid and ask limit orders of a certain size and within a certain spread for five out of the eight hours during the trading day. See Box F.)

ET facilitates consolidation in the financial industry leading to a lower number of dealers, especially market-makers. The scalability made possible by ET means that more customers and transactions can be served by fewer intermediaries. The reduction in the number of market-makers could lead to a net withdrawal of risk capital from the markets. This could have implications for the ability of market-makers to provide liquidity, especially in times of stress, with risk for financial stability. However, it is not so obvious from previous examples of market turbulence that market-makers did provide liquidity when it was required. There have been cases in various volatile markets where market-makers simply stopped answering their phones. Ultimate liquidity may be provided by those end-users able to take a longer-term view because they are neither leveraged nor subject to daily marking to market.[5] Electronic order books may increase market liquidity in times of stress if these investors have greater direct access to the market. For example, they can post limit orders in order to look for bargains rather than requiring the intermediation of dealers. The visibility of these orders may then help price discovery in the remainder of the market: for example, by setting a floor to a price decline. Thus, the return to normal trading conditions may be accelerated. On the other hand, it can be argued that order books may suffer from reduced liquidity under stress if they involve a central counterparty whose creditworthiness comes under question in stressful times.

[5] The "Johnson Report" (CGFS, 1999) mentions that, in contrast, many leveraged investors, such as banks, brokerage houses and hedge funds, "reduced the scale of their operations and trimmed their risk exposures, responding to pressures from more cautious counterparties and their own need to preserve capital in an environment of heightened uncertainty and a lessened tolerance for bearing risk" during the crisis in the autumn of 1998.

Box F

Market-making activity in MTS markets

MTS (Mercato Telematico dei titoli di Stato) markets are an example of inter-dealer electronic markets for fixed income instruments, whose distinguishing feature is the presence of strict market-making obligations for some participants. Besides having to comply with stringent capital requirements and trading protocols, market-makers have the obligation to continuously post firm two-way prices for a selected subset of securities. Prices usually have to be posted for at least five hours per day and for a certain minimum quantity, and they can be subject to maximum spread obligations. Each market-maker can voluntarily quote other securities as well, facing in this case no constraint on price proposals.

MTS markets provide an example of quote-driven electronic order books. Market-makers' quotations are aggregated in a book according to price and side of the market. To facilitate the handling of large transactions, minimum lot sizes are high and trading rules grant traders a considerable degree of anonymity: price proposals are anonymous and market-makers are not required to show the maximum quantity they are willing to trade; traders can submit multiple orders; the counterparty of a trade is anonymous until the trade is matched.

MTS markets are active in several European countries. They offer to domestic dealers the benefits of continuous price-making activity over a very broad range of domestic securities, according to membership requirements and trading rules set by the major financial institutions for each market that comply with local legislation. An exception is the London-based EuroMTS, configured for trading in European benchmark issues between the largest and most active dealers.

Useful insights into the impact of electronic trading on price formation, liquidity and resilience in times of stress (see Sections 4.1-4.3) can be gained by looking at the experience of MTS markets. First, in the case of MTS Italy (the earliest MTS market, launched in 1988) market-making obligations helped retain liquidity in the least actively traded securities even in periods of high price volatility during the early 1990s.

Second, the launch of EuroMTS in April 1999 provides an interesting case study as to concerns about liquidity fragmentation. Benchmark government bonds tend to be traded both on EuroMTS and on domestic (MTS) systems. An analysis of daily trading volumes and bid-ask spreads of benchmark Italian government bonds (BTPs) quoted on MTS Italy revealed that no substantial change in liquidity conditions occurred in this market in the first five months of activity of the new pan-European network, suggesting that the latter has mainly captured transactions that were previously carried out over the counter. A significant reduction in trading activity was recorded for off-the-run BTPs, but this did not continue in subsequent months. An assessment of liquidity conditions on a more extended period is hampered by the difficulty of controlling for factors that are not related to the propensity of dealers to trade BTPs on MTS Italy, notably the decrease in trading activity that has been registered in most fixed income markets since the second half of 1999.

Finally, a review of the experience with three recently launched domestic MTS systems showed that, while MTS Amsterdam (September 1999) and MTS Belgium (May 2000) have significantly improved the liquidity and transparency of the secondary market and have rapidly accounted for a sizeable share of the secondary market, MTS France (April 2000) has so far attracted relatively low trading volumes as market participants continue to rely on an efficient OTC secondary market with an active network of primary dealers. However, none of these markets has been tested under severe market conditions.

4.4 Operational risk

Types of delays and failures

The growing use of ET systems has been accompanied by a parallel increase in trading delays and outages on these systems. Most incidents appear to have taken place on systems recently introduced by equity and derivatives exchanges. Well established dedicated systems, as used in the foreign exchange and fixed income markets, seem to have experienced fewer problems.

A report prepared by the US General Accounting Office (2000) identified a number of factors responsible for delays and outages. (The report focuses mainly on ET systems used in the equity markets, the online brokerage models where traders use high-speed internet links to intermediaries and through to execution forums, but the general conclusions are likely to be relevant for the foreign exchange and fixed income markets as well.) Most of the intermediaries contacted noted that outages did not result principally from the incapacity of their systems to handle large transaction volumes but rather from upgrades to expand capacity and improve capability. Indeed, the most common reason for system outages involved problems with vendor-supplied trading system software. Apparently, many online firms rely on vendor systems for major parts of order processing, and, when these systems experience problems, outages can result at more than one firm. Trading delays were primarily caused by heavy internet traffic, particularly during periods of high market volatility. These problems were attributed to internet service providers and the equipment of investors. Other reasons for delays and failures include hardware problems, switches from automated to manual order processing in times of stress, problems regarding the overnight updating of databases and breakdowns in telecom equipment.

Implications of trading halts

Despite their frequency and, sometimes, length, outages and delays do not seem so far to have had systemic consequences. The apparent reasons for this are: (i) they have not been too prolonged, so traders were able to delay trades; (ii) in most cases there was no coincident big market news; and (iii) other ways to trade were still available (competing electronic systems or telephones). However, activity was generally lower than on normal trading days because some retail and institutional investors were reluctant to trade without the availability of centrally determined prices, particularly outside regular trading hours when liquidity is low.

Box G

Increased computational speed as a feature of ET

Moore's Law stating that the capacity of computer chips for a given cost doubles every 18 months has so far provided a good representation of the surge in information technology; computational speed has increased dramatically over the last decade. This increase in computational speed not only makes the automation of information- and computation-intensive financial markets possible, it also poses new challenges for market participants. New ET systems have to be integrated in the existing organisation, which as a result also have to be able to handle the speed and complexity of the systems. As an example, we may consider the bond market, where traders now have to quote prices continuously in various systems. These prices have to be updated continuously. As a result, and depending on what systems are used, intermediaries in the bond market may have to post a couple of thousand prices each second on various systems. Because the intermediary can be hit or lifted at these prices instantaneously and the market may move quickly, prices are usually good for only a few seconds. Consequently, the daily number of quotes on a single bond in a single system can be in excess of a million.

For the high-frequency pricing of liquid and straightforward instruments such as government bonds, banks use so-called "pricing engines" that function with little human involvement. Such pricing engines use the realised prices of a limited number of characteristic instruments as a basis. The methodology underlying pricing engines may also be used for arbitrage purposes if other market participants do not update their prices quickly enough. Although pricing engines automate much of the human involvement in trading liquid straightforward instruments, these systems will usually automatically alert their users in case human intervention is required. This can be triggered by a certain event, eg trade enquiries of a certain size, by a certain client, or in case of volatility spiking up. Most systems are equipped with a "panic button" to suspend the automatic generation of quotes in volatile periods, eg prior to the release of important macroeconomic data or in case of major moves in other markets.

In order to minimise the chance of trading halts occurring, system providers and users should give ample thought to the contingency measures and backup procedures incorporated in the system. However, if problems reveal themselves despite all the necessary precautions taken, then one of the

greatest concerns from a systemic point of view relates to what would happen if the culture and infrastructure related to phone trading disappeared as a consequence of increasing reliance on ET systems. So far, when outages have occurred, it has been possible to revert to earlier practices or alternative systems. If trading becomes concentrated on a single ET system, this option may no longer be available. Some market participants are concerned that dealers would no longer have the capacity to operate in a telephone-based dealer market if they became accustomed to trading on a central order book, such as in the foreign exchange market. They may no longer have the required contacts with dealers in a range of other banks to unwind positions. They may also lack the skills to discover market prices in a telephone-based dealer market, where the traditional voice brokers no longer exist. Under stressed conditions, dealers may become unsettled by the lack of a central reference price and could either widen spreads considerably or refuse to answer telephones.

Moreover, other questions remain. Would other trading channels be adequate to substitute in cases of ET breakdowns? Could a major operational failure in a large ET system lead to a loss of confidence in other systems (ie would there be a risk of contagion)? Are there enough private incentives for traders, and their back offices, to undertake special training in order to cope with emergency situations?

The sheer volume of trades poses a further challenge. For example, several exchanges have contingency plans for members to place orders by telephone if the electronic platform is unavailable for long periods. However, questions remain as to how telephone trading could cope with typical volumes in the contracts currently traded on those exchanges.

Perhaps more alarming would be the prospect of a system continuing to operate but generating incorrect results. It may take a while for this to become apparent, by which time a large number of incorrectly processed transactions would have occurred, particularly in systems with complicated price determination algorithms. There would be great potential for legal arguments about the status of such deals.

Another source of concern is that ET systems could prove to be overly automatic if control mechanisms were not adequate. Safeguards have been incorporated into some systems, such as the automatic questioning of orders well away from the last sale price or of unusually large size. This should guard against keystroke errors.[6] In fast moving markets there has been occasional confusion over the "big figure" (ie in foreign exchange quotes, the digit before the decimal point), although admittedly this is not likely to be a greater problem than under voice-based systems. Moreover, such an incident would have to achieve massive proportions before creating a systemic threat. The issue of proper controls and safeguards becomes increasingly important as automated procedures and pricing engines are used for the generation of orders, ie when computers trade with computers. If this were to become a widespread phenomenon, small programming or pricing errors could have serious implications, as they could trigger a "reaction" from another computer: all in all a process that may be difficult to reverse or control.

There are also concerns that operational risks may increase as more systems move onto the internet, which may be more prone to delays and failures and less secure against hackers and viruses than are dedicated systems. So far, most system providers continue to use proprietary networks rather than the internet on grounds of security and reliability, but the trend seems to be towards increasing interoperability, open standards and (in due course) mainstream internet access. In addition to the adequacy of encryption technology, systems should incorporate "backups" in case key components break down. There is a danger that the current rush to get rival systems operating may mean that systems are not adequately tested before introduction.

[6] One incident in 1999 was reported involving a junior trader accidentally entering a $100 million instead of a $100,000 transaction into a system, which did not have controls or limits preventing the immediate execution of this trade. Reversal of the trade is reported to have cost $50,000.

Annex
Mandate of the Working Group

The Working Group will assess trends in the use and nature of electronic trading in financial markets and will study the potential implications thereof for financial stability. The study will focus on how these systems function and on their actual and potential impact on market structure, price dynamics and overall financial intermediation. To this end, the study is likely to concentrate on wholesale secondary markets.

In doing so, the Working Group will cover the following issues:

It will provide an **analytical framework** with which to assess the key factors characterising the wide range of electronic systems. These factors relate to the microstructure of markets covered by electronic trading, the role of market participants and the price formation process. A definition of electronic trading will be proposed and a typology of systems assembled. This framework will be used to analyse the changes brought about by electronic trading in the areas of market structure and functioning.

It will address issues for **financial stability** with particular emphasis on the implications of electronic trading systems for market structure, behaviour of market participants and financial intermediation. The study will look at the resulting impact on price dynamics, in both normal and stressed situations, with a view to assessing systemic risks. Case studies might be conducted to assess the impact of electronic trading systems, particularly on the robustness of the financial system.

To this end, the Working Group will meet with a representative sample of market participants - brokers and dealers (large and small), investors and system providers - and will draw on existing public and private reports as well as available market analysis, to take stock of observable trends.

The Working Group may also consider the implications of electronic trading for central bank operations; it will not address the regulatory issues related to electronic trading or the operational and risk management implications for individual institutions or trading systems.

The Working Group will coordinate with Basel-based groups on related topics, such as the BCBS and the CPSS on related topics. The Group plans to finalise a report before year-end. Its report might serve as input for discussions in related groups focusing on different aspects of electronic trading. In addition, it is proposed to explore the possibility of publicly releasing the report.

Glossary

These are the meanings assigned to terms in this report. Other documents may use some terms in other ways. Terms in *italics* in definitions denote a cross reference.

Access	The possibility to participate in a market.
Anonymity	Non-disclosure of identities of counterparties (pre-trade or post-trade).
Back office	Organisational unit responsible for post-trade activities such as *clearing* and *settlement*.
Bid-ask spread	Difference between buying and selling price quoted by a *dealer*.
Block trade	Large, potentially market-moving trades.
Broker	Firm which operates in a market on behalf of other participants to arrange transactions without being a party to the transactions itself (cf *dealer*).
BTP	Buono del Tesoro Poliennale. Medium- or long-term fixed income security issued by the Italian government.
Centralisation	Tendency for trading activity, price determination and information generation to be concentrated in a single market.
Clearing	The process of transmitting, reconciling and sometimes confirming instructions to transfer instruments prior to *settlement*.
Contestable market	Market where potential competitors can readily enter (and exit) and compete effectively with existing firms.
Counterparty credit risk	The risk that the market participant on the other side of a transaction will default (cf market risk and operational risk.)
Crossing system	System matching buy and sell orders at a price determined in another market. Such systems play no part in *price discovery*. Also known as “price-taking systems”.
Dealer	Firm whose primary business is entering into transactions on both sides of wholesale financial markets and seeking profits by taking risks in these markets (cf *broker*).
Depth	Amount of outstanding orders pending (possibly at different prices) on either side of the market.
DVP	Delivery versus payment. Simultaneous exchange of instruments and payment.
EBS	Electronic Broking Services. ET system for trading foreign exchange.
Economies of scale	Situation where unit costs drop as volume increases.
Efficient market	Market where prices balance underlying supply and demand and adjust as smoothly as possible, without discontinuities or excessive volatility unrelated to fundamentals.

Electronic order routing	Delivery of orders to *execution* system.
ET	Electronic trading. In broad terms, this refers to any use of electronic means of sending orders (bids and offers) to the market, *electronic order routing*, automated centralised *execution* and subsequent dissemination of price and volume information. See Section 2.1 of the report for a more detailed discussion.
End-users	Market participants who provide the underlying supply and demand in a market. They range in size from individual retail traders to institutional investors and large corporations.
Eurex	A Swiss/German electronic derivatives exchange offering trading, *clearing* and *settlement* on one platform.
EuroMTS	See *MTS*.
Execution	The matching of orders or trade proposals which turns them into actual trades.
Explicit trading costs	Costs such as market access fees, commissions, tax, *clearing* and *settlement* costs and staff and IT overheads (cf *implicit trading costs*).
Front-running	Illicit practice of *dealer* using information from a customer order to trade before that order is executed.
Gapping	Large discontinuous movements in prices.
Hidden order	An order invisible on the *order book*.
IDB	Inter-dealer broker, specialist *broker* who acts as intermediary between *dealers.*
Iceberg order	See *hidden order.*
Immediacy	Possibility to execute an order immediately.
Implicit trading costs	The bid-ask spread and impact on market price of a trade (cf *explicit trading costs*).
Inter-dealer system	ET network between *dealers*, sometimes involving obligations on them to act as *market-makers* (eg BrokerTec, eSpeed, EuroMTS).
Limit order	Order to buy a specified quantity up to a maximum price, or sell subject to a minimum price (cf *market order*).
Liquid (market)	Three aspects of liquidity are *tightness*, *depth* and *resiliency*. It is characterised by the ability to transact in a market without markedly moving prices.
Market-maker	*Dealer* obliged to quote buy and sell prices in return for certain privileges within a market (sometimes used to refer to anybody who provides quotes).
Market order	Order to buy (or sell) a specified quantity at the prevailing price (cf *limit order*).
MTS	Mercato Telematico dei titoli di Stato. An electronic *inter-dealer system* for trading Italian government debt. There are now MTS systems in other

	European national bond markets as well. EuroMTS is a platform for euro-denominated government bond benchmarks of nine euro area countries.
Multilateral interaction	Price determination by more than two market participants.
Multi(ple) dealer system	System allowing customer to examine quotes from a number of dealers simultaneously (eg TradeWeb).
Network effect	Tendency for liquid markets to attract further *liquidity* as market participants want to trade where others are already actively trading. Sometimes referred to as "demand side economies of scale".
Open architecture	System design based on publicly available and standardised software, enabling easy interlinkage (cf *proprietary system*).
Order book	A centralised market where prices are determined by an order execution algorithm from participants sending firm buy and sell orders (cf *quote-driven* or dealer driven).
Order routing	Delivery of messages from *end-users* to the *execution* system.
Orderly trading	Conditions under which similar orders execute at similar prices.
OTC	Over the counter. Bilateral transactions not conducted on a formal exchange.
Outage	Interruption to operation of a market.
Price discovery	Determination of prices in a market (cf *crossing system*).
Price formation	The incorporation of new information in the pricing process. It is influenced by specific market rules.
Pricing engines	Automated order/quote generating systems that automatically generate prices and/or orders.
Proprietary system	System that can only be used with a specific market or dealer (cf *open architecture*).
Protocol	A set of rules governing trading, eg the types of orders allowed (*market order*, *limit order*, stop-loss, off-market, etc), minimum tick size, rules to halt trading, special rules for openings and closings.
Quote-driven	A usually decentralised market where a class of participants, possibly *market-makers*, post bid and ask quotes, often indicative, with prices being determined through bilateral negotiation.
Resilient market	Market which continues to function in an *efficient*, *liquid* and *orderly* manner at times of great price uncertainty and market stress.
Scalability	Ease with which additional participants or transactions can be accommodated.
Settlement	Completion of a transaction by exchange of instrument and funds.
Single-dealer system	ET system offered by one dealer to its customers which only provides access to information/facilities offered by this single dealer.

Smart agent	An enhanced search engine that can compare across different sites to find the best deal.
STP	Straight-through processing: the capture of trade details directly from front office systems to *back office*. Completes automated processing of confirmations and settlement instructions without the need for rekeying or reformatting data.
System provider	Market participant which provides the infrastructure for trading (eg a stock exchange, *EBS*).
Tightness (market)	A measure of *liquidity* derived from the bid-ask spread (difference between buying and selling quotes).
Tipping	Tendency for a system provider that has achieved a dominant market share to move to (a near) monopoly.
Trade reporting	Sending of information concerning transactions to the market overseer.
Trader	Employee of *dealer* or *end-user* paid to operate in financial markets.
Transparency	Ability of market participants to observe (pre-trade) quotes, (post-trade) prices and volumes in a timely fashion.
Unbundling	Separate provision of (and charging for) products and services previously offered jointly.
White label	Arrangement whereby an intermediary makes available transaction services to its customers under its own brand, while channelling the resulting transactions through another organisation, with a view to saving costs. The provider of the white label product may specialise in transaction services and may be in a better position to benefit from economies of scale.

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