

**The Equivalence of Screen Based  
Continuous-Auction and Dealer Markets**

**By**

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# **The Equivalence of Screen Based Continuous-Auction and Dealer Markets**

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## **Abstract**

The conventional response given to explain the difference between an auction and dealer markets is that auction markets are order driven and dealer markets are quote driven. However this paper argues that there is no fundamental difference between these two alternative trading systems, in the sense that the same set of equilibrium prices will obtain in each market. In dealer markets liquidity is supplied by licensed intermediaries who provide competing price quotes, whereas the auction market allows the free entry of any trader to supply liquidity by permitting the submission of limit orders. In both cases investors face a competitive price schedule, which they can then trade against, and competition between traders in the auction market or between dealers in the dealer market should ensure that liquidity suppliers make no excess profits.

08 July 1997

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## **I Introduction**

The London Stock Exchange is currently involved in a process to determine the appropriate market mechanism for trading equity securities.<sup>1</sup> The purpose of this paper is to contribute to this debate by comparing the properties of the two main alternative stock market microstructures that are being considered by the Exchange: a screen based dealer market, similar to the existing trading system in London, versus a screen based continuous-auction market such as the Paris Bourse.<sup>2</sup>

The conventional response given to explain the difference between an auction and dealer markets is that auction markets are order driven and dealer markets are quote driven. In a dealer market, dealers or market makers post prices at which they are willing to buy or sell securities, and subsequently trade as a principal in the transaction by taking a position in the stock when a market order is submitted, adding the trades to their own inventory. In a continuous-auction market by contrast, there is no intermediary acting as a principal in the transaction; buyers and sellers submit orders stating prices at which they are willing to trade and intersecting orders are matched, with unexecuted orders forming the book against which subsequent market orders may will transact.<sup>3</sup>

However continuous-auction markets may have participants who can be thought of as intermediaries and who may choose to participate in trades. It is our contention that these intermediaries in a continuous-auction market perform the same role as dealers in a dealer market, and therefore the two market microstructures are equivalent. This argument has been discussed elsewhere [Pagano and Roell (1992) and Jacquillat and Gresse (1995)], but we wish to emphasise its implications in terms of the proposals for the structural design of the trading mechanism on the London Stock Exchange.

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<sup>1</sup>**New Electronic Trading Seivices** (London Stock Exchange, January 1996), **New Electronic Trading Seivices** (London Stock Exchange, May 1996), **Stock Exchange Electronic Trading Service**, (London Stock Exchange, October 1996).

<sup>2</sup>We will not consider market microstructures which involve floor trading. Fremault-Vila and Sandmann (1995) provide a comparison of the properties of computerized and open outcry markets.

<sup>3</sup>In a call-auction market an intermediary would function as an auctioneer and match orders by announcing market clearing prices.

## **II The Role of Secondary Markets**

We start by outlining the function of secondary markets on a stock exchange. Stock Exchanges are financing vehicles enabling companies to raise capital to fund investments. Investors initially subscribe to a share issue in the primary market and secondary markets enable investors to transfer their ownership claims of securities. The secondary market allows the initial shareholders to liquidate or increase their holdings at a later date.

Investors trade in the secondary market for two basic reasons. First, investors may have changed their beliefs about the future returns on the security due to public or perhaps private information. Second, the investor may have been subject to some liquidity shock which requires them to exchange the securities into cash to balance another part of their portfolio. An investor is more likely to participate in the primary market if well functioning secondary exists, enabling the investor to liquidate the holding at a fair value. A general principle of capital markets is that a liquid secondary markets allow firms to raise capital in the primary market at the cheapest rates.

Once an investor has made the decision to trade, Garbade and Silber (1979) suggest that a trader faces two risks from trading: (i) Change in the fundamental price from the time of the decision to trade and the time at which the transaction takes place; and (ii) Difference between the fundamental price and the transactions price.

In an environment in which information is generated continuously concerns about the first of these risks is likely to mean that secondary markets will be organised as continuous exchanges to allow trades at any instant in time, rather than as markets that clear periodically. However markets that clear at every instant require potential buyers and sellers to be available to be the counterparty to a trade, and this will determine how important the second of these risks is. The design of the secondary market may affect the numbers of potential buyers and sellers who can be encouraged to enter the market and therefore will determine the difference between the fundamental price and the transactions price.

### **IIA Auction Markets**

Auction markets appear in a number of different guises. The classic auction market is a call auction which clears periodically, and involves an auctioneer who sets prices. Because they only clear at discrete time intervals, perhaps once a day, traders do not have their orders satisfied immediately, but are batched together with other waiting trades. An important characteristic of an

an auction market is that the auctioneer does not take a position in the underlying stock but simply announces market clearing prices to discharge the submitted aggregated buy and sell orders.

Continuous-auction markets allow immediate execution by letting traders execute orders against limit orders submitted earlier by other traders. In a continuous-auction market buyers and sellers submit limit orders stating prices at which they are willing to trade. These orders may be crossed with a previous limit order, allowing the orders to be matched, or if there is no matching at that time the new limit order enters the book and will transact later when a market order or a crossing limit order is submitted.

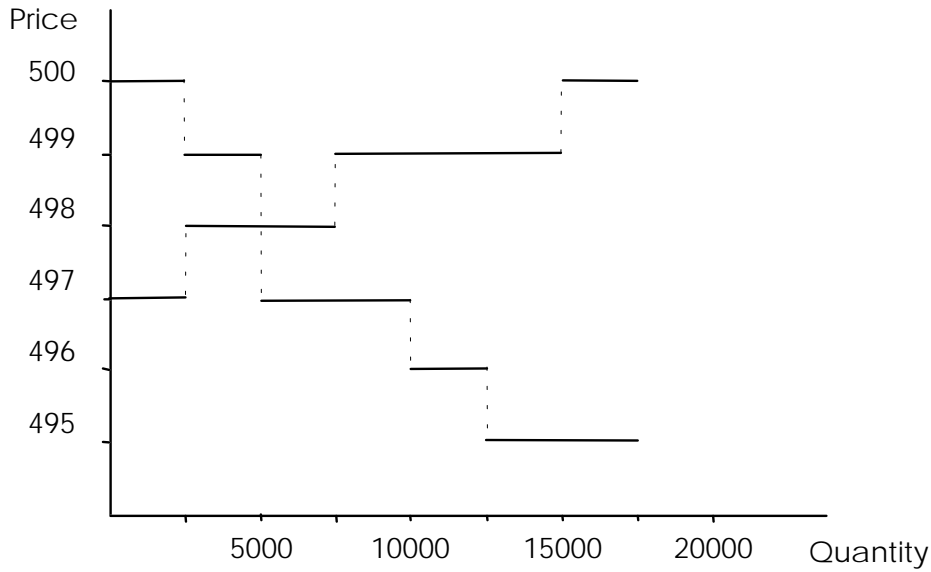
To illustrate the workings of a continuous-auction market, table I lists a number of orders which have been submitted from outside investors while the market was closed. We will suppose that in an electronic system these orders are visible on screens to which all investors or their agents have access.

**Table I: List of limit orders**

Buy orders			Sell Orders		
2500shares	at	500p or <	2500shares	at	497p or >
2500	at	499	2500	at	498
5000	at	497	2500	at	498
2500	at	496	7500	at	499
5000	at	495	2500	at	500

This list of orders can be represented in terms of a supply and demand diagram in figure 1

Figure 1: Limit Orders in a Continuous-Auction market: Pre-Opening



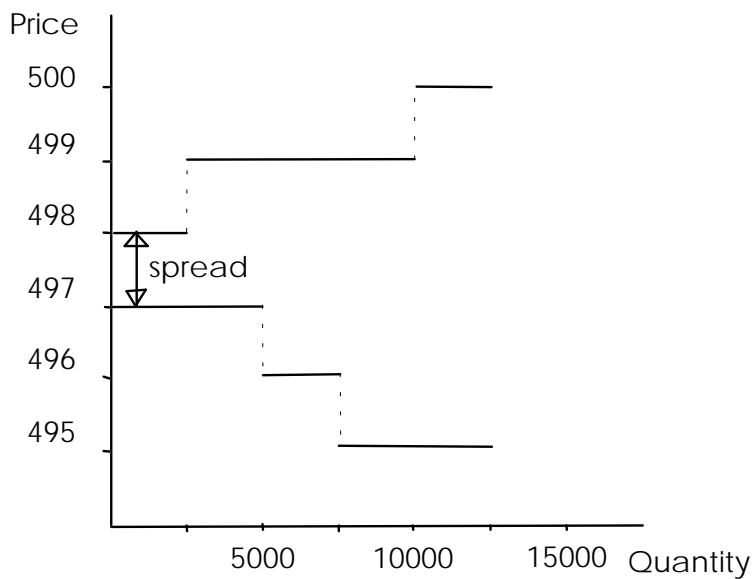
A continuous-auction market needs to have mechanism in place for clearing the market at the opening; typically the market initially clears with a call-auction. In this example an auctioneer or piece of computer software can calculate the market clearing price as 498p, and depending on the exchange's rules, we will suppose that the first 500 orders will execute. The *spread* becomes 497 - 498, and the market moves into its continuous trading phase.

After the opening, and once the crossed orders have been removed, the remaining list of limit orders form the “*order book*”. These remaining orders which form the order book are listed in table II, and are illustrated in figure 2.

**Table II: Limit Orders on the “Book”**

Buy orders			Sell Orders		
5000shares	at	497 or <	2500shares	at	498 or >
2500	at	496	7500	at	499
5000	at	495	2500	at	500

**Figure 2: Limit Orders in a Continuous-Auction: Post-Opening**



In figure 1 the best bid-ask spread representing the lowest ask and the highest bid in the limit order book is 497 - 498. As trading continues throughout the day, orders are submitted to the Exchange. When a *market order* arrives it will *cross* with the nearest limit order. Limit orders may be submitted and will either cross with an existing limit order or if not executed will be added to the order book. In an auction market each trader pays a commission to use the market.

The Paris Bourse is an example of a continuous-auction market, and is described in Biais, Hillion and Spatt (1995). It is an electronic, automated, transparent order-driven exchange, in which investors place either limit orders or market orders. Limit orders can be submitted while the

### IIB Dealer Markets

Dealer markets allow continuous trading, through a dealer who quotes prices, and takes a position in the stock by buying or selling order imbalances. In a dealer market the dealer quotes two prices at which he will trade:

- (i) *Bid price* at which dealer is willing to buy stock, and
- (ii) *Ask price* at which dealer is willing to sell stock.

The dealer will also announce a maximum quantity for which these price quotes are good for.

Table III below shows the information that would be displayed on a typical screen in a dealer market

**Table III: Quotes on Dealer Market**

Market Maker	Bid	Max. volume	Ask	Max. volume
MM 'A'	496	7500	498	2500
MM 'B'	497	5000	499	10000
MM 'C'	495	12500	500	12500

Figure 3 depicts how these quotes can again be represented in a supply and demand diagram

**Figure 3: Bid-ask spread in a Dealer Market**

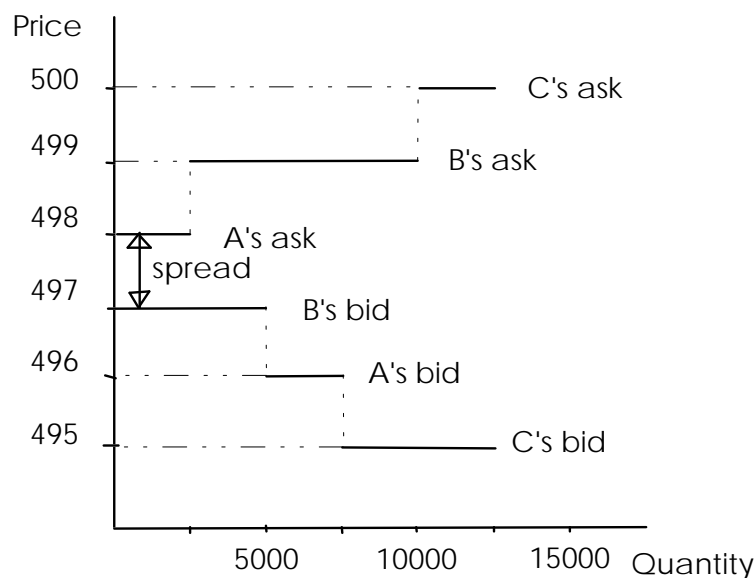


Figure 3 shows that the best bid-ask spread in this market is 497 - 498. Each market maker quotes a bid-ask spread and a maximum trading volume for which these quotes are firm. When a trader wishes to buy or sell, he can trade with the dealer offering the best price. It can be seen that A's ask dominates all the other quotes at small trade sizes. On the other hand B's ask quote dominates C's for trade sizes up to 10,000 shares, but C's ask is firm for quantities up to 12,500.



Similarly B's bid is highest for trades up to 5,000, A's bid is best for trade sizes up to 7,500 and C's is best for trade sizes up to 12,500.

In a dealer market the trader pays the spread to use the market. London Stock Exchange is currently organised as a screen based dealer market, in which competing market makers quote prices on the screens and trades take place by telephone. A customer represented by a broker will have access to the quoted prices on the computer screens (Table III) and will typically telephone through to the market maker offering the best quotes to undertake the execution of the transaction, although the LSE does have automatic execution facilities for small trades. Transactions prices and volumes are reported immediately on the screens, except for large transactions [greater than six times Normal Market Size (NMS)] which are reported with a one hour delay, and exceptionally large transactions (greater than 75xNMS) which are delayed until 90% are liquidated with a maximum delay of 5 days.

The New York Stock Exchange is a hybrid auction and dealer market, since it is floor based continuous-auction market with a specialist. The specialist will match orders from the limit order book, but may also quote prices inside the limit order book and trade on his own account, though there are rules governing his behaviour. When a *market order* arrives, the specialist may satisfy it from his own inventory, or will *cross* with the nearest limit order. On the NYSE the specialist is responsible for maintaining an orderly market, and there are rules concerning the movement in quotes.

The London Stock Exchange proposes to introduce an order-driven system for initially FTSE100 stocks.<sup>4</sup> Outside investors will be able to submit market orders or limit orders, through members of the Exchange. Of course members of the Exchange may submit these orders on their own account, and may deal away from the order book, though it is proposed that trades up to 3xNMS are obliged to interact with the order book.

To facilitate block trades the Exchange had originally suggested licensing Registered Principal Traders (RPT's) who in addition would be obliged to quote prices on demand, so that the structure appeared similar to the hybrid system on the NYSE, with competing RPT's rather than a monopoly specialist.<sup>5</sup> However the Chancellor of the Exchequer's statement on

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<sup>4</sup> **Stock Exchange Electronic Trading Service**, (London Stock Exchange, October 1996).

<sup>5</sup> **New Electronic Trading Services** (London Stock Exchange, May 1996),

his intention to replace the market makers' stamp duty exemption with an exemption for any intermediary, reduced the need for this explicit role.

### **IIC Comparison of Characteristics of Continuous-auction and Dealer Markets**

Madhavan (1992) compares a quote driven mechanism with competing dealers with an order driven mechanism which may be organised as a continuous or as a periodic auction<sup>6</sup>. Madhavan argues that in the quote driven system traders know the execution price for their order, whereas in the order-driven system the execution price is not known until after the market clears. Further in the quote-driven system competition between market makers in setting quotes ensures that price quotes are competitive, and market makers make zero profits, whereas in the order-driven system competition between dealers takes the form of competition in demand schedules. The differences in the two systems lie in the sequence of trading, and this leads to differences in the information provided to the players and therefore in the strategic nature of the game.

The traders in the market may be trading on private information or because of a realisation of asset endowments which generates portfolio hedging trades which are not information motivated. Madhavan models the quote-driven mechanism by extending Glosten (1989) to the case of competing market makers. Traders maximise expected utility, and market makers set price quotes to earn zero profits. Equilibrium in this game is a price quote schedule which is a function of the quantity traded, and a corresponding demand function by the traders such that the market makers' quotes are "regret free". The order-driven mechanism is an extension of Kyle (1989) in which traders and dealers maximise expected utilities and have best response strategy functions which are linear in prices. The intersection of these strategies defines an equilibrium price.

Madhavan demonstrates that if there is free entry into the pool of dealers then the equilibrium price-quantity pair for the two systems is the same. However there are differences in the two systems: prices in the quote-driven system are informationally efficient and follow a martingale but prices in the order driven system do not. This is because the order-driven system allows for strategic behaviour in prices and quantities by both dealers and traders, and this strategic behaviour distorts prices, which makes the order driven system more sensitive to the problems of asymmetric information.

Shin (1996) compares a dealer market with an order driven market, and points out that a distinctive feature of these two systems is the move order and consequent information available to the two traders when they take their respective actions. The auction market requires that all traders take their actions simultaneously, whereas in the dealership market the price setters move first and the buyers take their actions after observing the price quotes of the sellers. In the auction market then the traders need to worry about the beliefs of the other side of the market, and Shin shows that in the absence of common knowledge, the auction market may break down.

In these models the functioning of the dealer market is well understood and follows from the earlier work of Glosten and Milgrom (1985), Easley and O'Hara (1988) and Glosten (1989). On the other hand the auction markets are not really continuous-auction markets, but are modelled as interactive auctions where participants submit supply and demand schedules. Recently Rock (1981) and Glosten (1994) have modelled the continuous-auction market, by examining the optimal submission of limit orders by risk-neutral traders facing risk-averse investors who may be informed.

In the current paper we wish to compare the characteristics of a screen based dealer market, and a screen based continuous-auction market. We can see from figures 2 and 3 above that the supply and demand diagrams implicit in the information on the continuous-auction and dealer screens look very similar. In fact the only difference appears to be that the price schedules in the dealer market are not anonymous.

The distinctive characteristics of these two types of market microstructure are listed in the following table

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<sup>6</sup>The market microstructure theoretical literature is surveyed in O'Hara (1995).

**Table IV: Differences Between Dealer and Continuous Auction Markets**

	Dealer Market	Continuous-Auction
Role of Intermediary	<b>Quotes prices and trades on own account</b>	<b>None specified</b>
Price contingent customer demands?	<b>None</b>	<b>Limit Orders</b>
Ex-ante transparency	<b>Non-anonymous Price Quotes</b>	<b>Anonymous Limit orders</b>
Ex-post transparency	<b>Reported transactions</b>	<b>Reported transactions</b>

There appears to be three differences between auction and dealer markets:

- (i) A dealer market has one or more intermediaries who quotes prices and take a position in the stock, whereas a continuous-auction market has no formally specified intermediary. On the other hand auction markets may feature traders that perform the role of the dealer in that they participate in the market by submitting limit orders and provide liquidity. A dealer market licenses some traders to act as market makers, but in an auction market these same traders are not licensed to provide this facility, but free entry into the market allows them submit limit orders because they anticipate a profitable trading gain.
- (ii) A continuous-auction market allows for the submission of price-contingent or limit orders, whereas the dealer market only permits market orders that are executed at the dealers quotes. The limit orders in the auction market are just the mechanism for ensuring that there are price quotes on the screens.
- (iii) The transparency of these two market structures may be different. In an auction market typically customers can see the limit order book, as in table 1 above, so that pre-trade transparency is such that they not only see the price quotes implicit in the limit order book, but also observe the volumes of trade in the book at each price.<sup>7</sup> By contrast pre-trade transparency in the dealer market will typically only display the price quotes and the volumes of trade for which these quotes are firm, though the identities of the dealers will be known. Once a transactions has been executed, both market structures will have rules about how quickly and how much of the transaction is reported to the rest of the market.

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<sup>7</sup> On the Paris Bourse investors can place limit orders that are not fully visible to other traders. The London Stock Exchange has rejected this facility in **Stock Exchange Electronic Trading Service**, (London Stock Exchange, October 1996) p. 17.

Aside from the issue of transparency to which we return below, it appears therefore that the only difference between these two market structures is that in dealer markets liquidity is supplied by licensed intermediaries who provide competing price quotes, whereas the auction market allows the free entry of any trader to supply liquidity by permitting the submission of limit orders. In both cases investors face a competitive price schedule, which they can then trade against, and competition between traders in the auction market or between dealers in the dealer market should ensure that liquidity suppliers make no super-normal profits.

### **IID Market Transparency**

It is debatable whether the degree of transparency is an innate characteristic of either market structure or whether it may be specified by a series of rules. Ex post transparency of an auction market appears almost automatic since investors can see when a limit order is removed from the screens. Further, in a dealer market Wells (1993) argues that some opaqueness is necessary to protect a dealer who has dealt in a very large trade. However extending the adverse selection arguments of Glosten and Milgrom (1985), this would be unnecessary provided the dealer was compensated with wide spreads for large trades. Although at these widened spreads the uninformed may choose not to participate, and the market may break down. We can identify three layers of transparency:

- 1) Ex ante trade transparency
- 2) Ex post trade transparency
- 3) Identity of transactions parties

Ex ante trade transparency relates to the information that is displayed on the screens before a customer trades. Typically this means limit orders in a continuous-auction market (as in table II) and in alternative price quotes in a dealer market (as in table III). Ex post transparency refers to the publication of a transaction after the transaction has occurred. Both auction and dealer markets will need a set of rules specifying what the reporting regime is. The third layer of transparency concerns the anonymity of the participants in the trade, which again could be thought of as relating to the degree of ex post trade transparency. Auction markets are typically anonymous exchanges, but dealer markets where trades take place by telephone involve less anonymity.

Wells (1993) argues that in a dealer market makers need the protection of delayed publication to provide a market in exceptionally large trades which are very illiquid. Full transparency, if

it reveals book position of market maker, will encourage market makers to provide less liquidity, so that there is a trade-off between liquidity and transparency. Franks and Shaefer (1991) suggest that even if the last trade was immediately published, traders could still trade in "protected mode", so that there is a problem of how immediate publication could ever be meaningfully enforced.

Biais (1993) compares price formation in two alternative market structures which he refers to as fragmented and centralised markets. The difference between these two regimes is that a fragmented market is by definition less transparent than a centralised one. In a centralised market trades are the outcome of multilateral negotiations to which all agents may participate, as for example in a market with a floor or pit. Agents are able to monitor the trades of their competitors and also their inventory positions. Biais also claims that this transparency is also a feature of the continuous-auction of the Paris Bourse. In contrast fragmented markets are much less transparent, and Biais argues that telephone dealer markets are examples of markets in which even though there may be a central screen, deals are the outcome of bilateral transactions negotiated on the phone, at prices within the screen quotes. Surprisingly Biais shows that the average bid-ask spread is the same in the two markets.

Pagano and Roell (1992) compare the price formation process in four alternative market trading systems, where the difference in the trading systems is solely due to the transparency of the market. Market transparency is defined as information about the current order flow. In a dealer market orders are satisfied by a competing dealers, and each dealer only observes the order flow coming to him, and not to competing dealers. In a continuous-auction prices are formed on the observation of the history of the order flow to the market as a whole up to that moment. In a transparent auction market participants can see all the order flow. In a batch auction market participants submit demands to an auctioneer and prices are set on the basis of the aggregate net order flow.

Here we wish to focus on the comparison between the dealer and continuous auction markets, and Pagano and Roell compare these two particular structures by considering a model in which there is a group of customers who wish to trade. In a dealer market these customers trade with individual dealers, and the dealers only see the order flow of their matched customer (not the other customers). In the continuous auction market the customers arrive at the same time, but their trades are modelled as being executed sequentially again through a

dealer, but where at each transaction the dealer can observe the history of the previous transactions. Pagano and Roell demonstrate that the expected trading costs for an uninformed investor are lower in the auction market than the dealer market. However they also show that if the informed trader is allowed to adapt his trading strategy to the market mechanism that he faces then this result may be reversed.

The work by Biais and Pagano and Roell is similar in that the difference between alternative trading structures is modelled in terms of information about the order flow. However it is not clear that the quantity of order flow information is defined by the market mechanism: it is possible to design a dealer market with rules that require instantaneous trade publication, or an auction market may be constructed in which only the best limit orders are displayed and in which trade publication is hidden. In principle the degree of transparency does not necessarily characterise either of these two alternative market mechanisms, though in practice dealer markets and auctions markets may have developed these features.

The final issue on transparency concerns the identification of the counterparties. In general the work of Roell (1990), Admati and Pfleiderer (1991) and Forster and George (1992), all show that if uninformed traders can identify themselves as such, then they will benefit from non-anonymous trading in terms of lower trading costs. We might expect that in a multiperiod world reputation effects will ensure that traders that identify themselves as uninformed through non-anonymous trading will be able to separate from investors trading on the basis of information. Non-anonymous trading will therefore benefit uninformed investors.

In summary although the transparency regime may differ across alternative trading systems, and generally one thinks of auction markets as being more transparent than dealer markets, there is not a unique degree of transparency associated with a particular market structure. The degree of transparency of a specific market microstructure can be customised to the needs of the particular exchange.

### **III A Customer Trading with Liquidity Shocks**

We now intend to demonstrate more formally that there is no fundamental difference between a dealer market and a continuous-auction market in a trading model. We will establish this proposition by examining equilibrium prices in a specific asset pricing model, and then argue that these same equilibrium prices will obtain under either market structure.

To analyse these alternative market structures we must first understand the situations under which investors wish to trade. Investors trade because their beliefs about the returns on the asset have changed, on the basis of private or public information, or because they have suffered a liquidity shock. In order to understand the motivation for an investor trading it is useful to consider a highly simplified market microstructure model proposed by Grossman and Miller (1988) to explain the provision of immediacy when an outside customer wishes to trade.

Suppose there is an investor who suffers a liquidity shock at date 1. This liquidity shock is exactly offset one period later at date 2 by another investor suffering an equal and opposite liquidity shock. If it was not for the asynchronisation of customer order times, these two outside customers could trade simultaneously and net trading would be zero. However because these two customers arrive at the market at different times, there is a temporary order imbalance. We suppose that there are two assets in the economy: cash and a risky asset. The terminal value of the risky asset is a random variable with mean  $E_t$  and variance  $v_t$ , and the time subscript shows that these parameters may change over time on the basis of public information. All investors are maximising the expected utility of terminal wealth, where the utility function is exponential with a constant absolute risk aversion coefficient  $a$ .

At date 1 a customer arrives on the market having suffered a liquidity shock  $i$  but is only able to trade with a group of  $M$  “intermediaries”, who have the same beliefs as the customer since all information is public, but no liquidity shock. We will say more about the role of these intermediaries below, but we may think of them as members of the Exchange with relatively low transaction costs who are able to absorb order imbalances. At date 2 another outside customer arrives at the market with an offsetting liquidity shock  $-i$ . At date 2 the excess demand for the risky asset of the customers who arrived at date 1 is

$$x_2^{cd1} = \frac{E_2 - p_2}{a v_2} - i \quad 1$$

The excess demand of the new date 2 customers is



$$x_2^{cd2} = \frac{E_2 - p_2}{a v_2} + i \quad 2$$

and the excess demand of the M intermediaries is

$$Mx_2^s = M \frac{E_2 - p_2}{a v_2} \quad 3$$

Market clearing at date 2 requires that excess demands are zero which will be satisfied when

$$p_2 = E_2 \quad 4$$

so that the equilibrium excess demand at date 2 of the customers arriving at date 1 is -i. Given this trading at date 2, we can ask what the trading position is at date 1. At date 1 the excess demands of the date 1 customer is

$$x_1^{cd1} = \frac{E_1 - p_1}{a v_1} - i \quad 5$$

and the excess demands of the intermediaries will be the same except they do not experience a liquidity shock. Market clearing at date 1 requires that excess demands are zero

$$Mx_1^s + x_1^{cd1} = 0 \quad 6$$

This market clearing condition can alternatively be thought of as equilibrium in the “market for immediacy”. The first term represents the supply curve for the provision of immediacy, and shows that intermediaries will provide more immediacy the greater is its cost,  $(E_1 - p_1)$ , since intermediaries are buying the asset at a price  $p_1$  below its expected value. The second term reflects the demand for immediacy by the customer suffering the liquidity shock and is a downward sloping function of the cost of immediacy.<sup>8</sup>

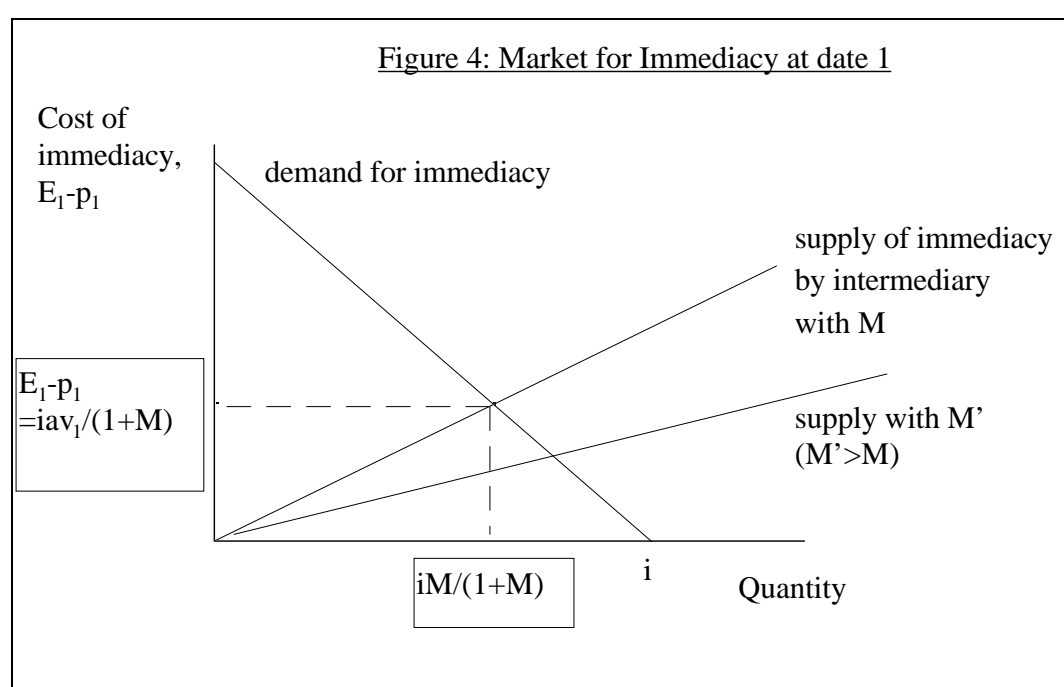
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<sup>8</sup>Note that we are assuming that the intermediaries are acting competitively. Alternatively we might consider the case where the intermediaries act strategically. For example suppose  $M=2$ , and the intermediaries play a Cournot game, then it can be shown that equilibrium demands by each speculator is  $i/4$ , and the equilibrium price is  $p_1 = E_1 - iav_1/2$ , which is lower than the competitive case with  $M=2$  (cf equation (7))

Market clearing prices at date 1 satisfy

$$E_1 - p_1 = \frac{i}{1+M} a v_1 \quad 7$$

The left hand side of this expression represents the cost of immediacy: it is the price that the outside customer is willing to pay to offload some of the liquidity shock, and the price that the intermediaries are willing to accept to take on the additional stock.



In equilibrium the price is less than the expected value of the asset, so that intermediaries absorb some of the liquidity shock  $iM/(1+M)$ , knowing that they can sell the asset on at date 2 when the price will revert to the asset's expected value. The date 1 customers hold the remaining quantity of the asset  $i/(1+M)$ . This equilibrium is illustrated in figure 4. Note that as the number of intermediaries increase the equilibrium cost of immediacy falls, and a greater quantity of the liquidity shock is held by the group of intermediaries: in the limit with a large number of (competitive) intermediaries, all of the liquidity shock is held by the intermediaries and the cost of immediacy is zero.

### IIIAi Customer Trading in a Dealer Market

Up to this point we have not specified what the market mechanism is that allows the customer to trade with the intermediaries. Consider first the case where the market mechanism is specified as a dealer market. This can be thought of as a situation where the intermediaries take on the role of competing market makers and quote prices at which they are willing to trade with the customer.

The date 1 customer having suffered a liquidity shock  $+i$  will arrive at the market and be faced with price quotes at the ask of  $p_1$ . The customer will be willing to trade a quantity  $i/(1+M)$  at price  $p_1$  with each of the  $M$  market makers, who will hold this quantity of stock in their inventory. Note instead the customer may trade the entire liquidity block with just one market maker who could then share out the stock between the other market makers, through some inter-market maker trading scheme such as the IDB network on the LSE.

The date 2 customer with liquidity shock  $-i$  will face a price quote at the bid of  $p_2$  given in (4), and will purchase the quantity  $iM/(1+M)$  from the market makers' inventory. In fact at date 2 the quoted ask will also be given by  $p_2$ , so that the spread is zero. The date 1 customer sells the remaining quantity  $i/(1+M)$  that he has held since date 1, to the market makers at the price  $p_2$ , and this is then passed on immediately to the date 2 customer again at the price  $p_2$ .

### **IIIAii Customer Trading in an Auction Market**

Now consider the market mechanism specified as a continuous-auction. There are no market makers in this system, and the intermediaries can be thought of as being traders who do not suffer a liquidity shock. The intermediaries can post limit orders to buy the quantities  $i/(1+M)$  at the price  $p_1$  or below. The date 1 customer after receiving the liquidity shock submits a market order to sell the quantity  $i$ .<sup>9</sup> This will be crossed with the outstanding limit orders and the quantity  $iM/(1+M)$  will be executed, and each speculator purchases  $i/(1+M)$ , and holds this quantity of stock in their inventory. The date 1 customer's non-executed market orders,  $i/(1+M)$ , may remain on the limit order book and will continue to be held by the date 1 customer.

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<sup>9</sup>Equivalently the date 1 customer could post limit orders to sell the quantity  $iM/(1+M)$  at a price of  $p_1$  or above.

At the end of date 1 public information is released and we might expect that limit orders would be revised on the basis of this new information. At date 2 the intermediaries and the date 1 customer post limit orders to each sell the quantity  $i/(1+M)$  at the price of  $p_2$  or above. The date 2 customer with liquidity shock  $-i$  will submit a market order to buy the quantity  $i$  and this will be crossed with the  $M$  subsequent market orders for  $i/(1+M)$  submitted by the  $M$  intermediaries, and the subsequent market order for  $i/(1+M)$  submitted by the date 1 customer.

Note that under both of these alternative market mechanisms the date 1 and date 2 customers trade exactly the same quantities at exactly the same prices. Hence the market mechanism is irrelevant to the equilibrium price and quantity traded.

### **IIIB Customer Trading with Asymmetric Information**

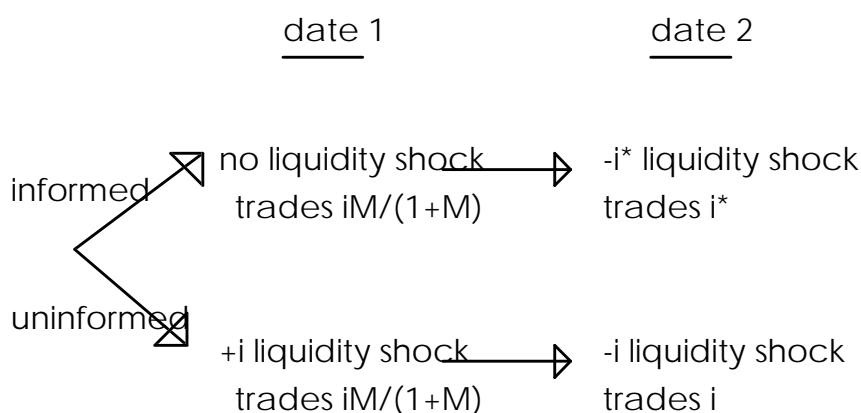
The analysis in the previous section assumed that the only reason for trade was a liquidity shock suffered by the date 1 investor. In this section we will broaden the motivation for trade by allowing for the possibility that the date 1 customer is endowed with private information. Suppose at date 1 there is a probability that the customer is trading because he has information about the date 2 expectation of the terminal value of the risky asset. It is known that this private information will be made public before the start of date 2. Hence there is some chance that the date 1 customer is trading on some short-lived information. We make the further assumption that in this state at date 2 there will be a customer trading with liquidity shock  $i^*$ , where

$$i^* = \frac{M}{a} \left[ \frac{ia v_1 - (E_1 - E_1^p)}{(M v_1 + v_1^p)} \right] \quad 8$$

The reason for this assumption as we shall see, is that it ensures that the intermediaries who participate at date 1 do not get left holding a “hot potato” at date 2, and that at date 2 the equilibrium price will again be equal to the expected terminal price.

With complementary probability the date 1 customer may be uninformed and trading because of the liquidity shock  $i$ . In this state at date 2 as before there is a customer with a negative liquidity shock  $-i$ . The possible states of the world are represented in figure 5.

Figure 5: States of the World in Asymmetric Information Model



At date 1 when the intermediaries observe a trader wishing to sell, they are unable to distinguish between whether the trader is selling for information or liquidity reasons; though by date 2 information will be symmetrically distributed. As noted by Glosten and Milgrom (1985), the intermediaries will update their beliefs about the distribution of the terminal value of the asset when they observe a seller at date 1, and we assume that the posterior distribution will have mean  $E_t^p$  and variance  $v_t^p$ , so that the demands from the  $M$  intermediaries will now be

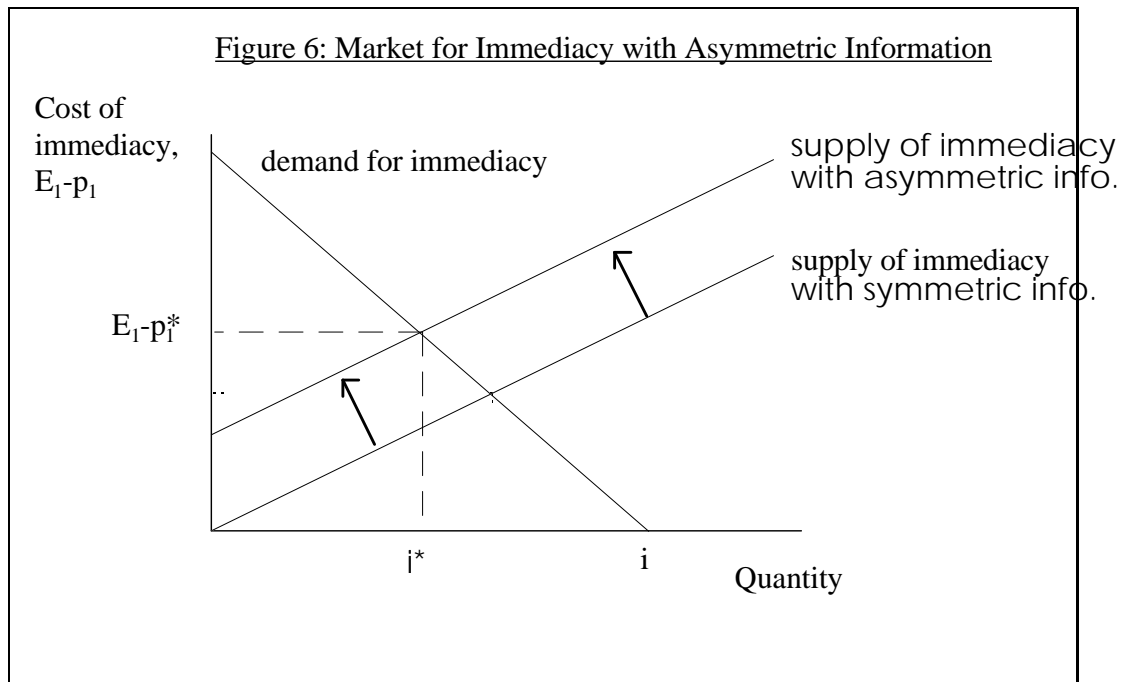
$$Mx_1^s = M \frac{E_1^p - p_1}{a v_1^p} \quad 9$$

If the date 1 customer is trading because of the liquidity shock then the date 1 excess demands of this customer are as before in equation (5), but market clearing at date 1 now results in the new equilibrium price which reflects the possibility of informed trading given by

$$p_1^* = \frac{ME_1^p v_1 + E_1 v_1^p - iav_1^p v_1}{Mv_1 + v_1^p} \quad 10$$

This price will be lower than  $p_1$  if  $E_1 - E_1^p > ia(v_1 - v_1^p)/(1+M)$ , so that in this case the supply of immediacy curve will shift upwards and in equilibrium the cost of immediacy will be higher

and intermediaries will hold less of the order imbalance. In fact the quantity traded at date 1 will be given by  $I^*$ .



At date 2 public information causes beliefs to be revised, and the reverse liquidity shock customer enter the market with liquidity shock  $-i$ . The intermediaries trade  $i^*$  with these new customers as will the date 1 customers who still have the quantity  $i-i^*$  to sell to the date 2 customers. The price will be  $p_2=E_2$ . The equilibrium is illustrated in figure 6.

Suppose instead at date 1 that the customer was selling for information reasons. This trader must mimic the excess demands of a genuine liquidity trader given in equation (5) since any other trading strategy would reveal at date 1 that the trader was information motivated. The equilibrium price at which the intermediaries are willing to trade is still  $p_1^*$  and the same quantity is traded at date 1. At the start of date 2, the private information is made public and beliefs become symmetric again, the date 2 liquidity customer enters the market wanting to trade  $i^*$  with the intermediaries, and the date 2 prices are again  $p_2=E_2$ .

These same equilibrium prices would result in either a dealer or an auction market. Whether a dealer or a limit order trader is supplying the liquidity they will be equally concerned about the likelihood of trading with an informed trader, and will adjust their price quotes at which they are willing to trade accordingly. So again there is no difference between the equilibrium price in the dealer or auction markets.

#### **IV Members, Intermediaries and Market Makers in the New London System**

In a dealer market the market makers will typically be licensed to supply liquidity, in contrast to an auction market where there is free entry to the ranks of liquidity suppliers. On the otherhand market makers in a dealer market have an obligation to make two way prices at which they are committed to trade, whereas intermediaries in a continuous auction market have no responsibility to trade and can choose whether or not to participate in a transaction.

On the London Exchange in return for agreeing to quote firm prices market makers are compensated with a number of “market maker privileges” . These privileges include exemptions from stamp duty, and some other fiscal benefits, access to IDB screens and non-revelation of equity holdings above 3% of company equity. The requirement on the part of market makers to quote firm prices is however more apparent than real, since it is feasible for market makers to quote very wide spreads, such that no customer would wish to trade. In this sense market makers are no different from intermediaries in an auction market who submit limit orders well away from the “fouchete”. On the NYSE specialists have a formal obligation to maintain price stability and this is enforced by requiring price quotes to move by no more than a tick between successive transactions.

The new trading services proposed by the London Stock Exchange centres on an order-driven market for FTSE100 stocks, in which outside investors can submit market and limit orders through members of the Exchange, and members may submit orders themselves. Members of the Exchange may act as principals or agents when dealing with or on behalf of clients. When acting as an agent the member will act on the client’s behalf and use the order book unless a better price can be obtained away from the order book. When acting as principal the member will trade with the client, though the member must still route the order through the limit order book unless the member can offer the client a better price. In general if the price that the member can obtain is inside the best prices on the order book, the member may trade away from the order book, but otherwise there is an interaction requirement that the trade must go through the order book.

The obligation for the member to interact with the order book applies for all trades above the minimum order size at or outside the best prices on the order book, though the maximum extent of this obligation is at 3xNMS, and to trade at least this quantity through the order

book when dealing in larger trades away from the book. All trades whether transacted through or away from the book will be published immediately, except for worked orders which are those trades where the firm has committed to fulfil an order and has agreed a worst price at which any of the deals will be done. These trades would be published immediately after the whole order has been completed.

From the point of view of an investor the trading mechanism will operate as follows. For a relatively small order the investor will take it to a member of the Exchange, who may choose to act as a agent or principal. If the member acts as an agent then he will route the order through the order book, and submit either a market or limit order depending on the investor's instructions. Market orders may be of two types. "Fill and kill orders" execute immediately in part or in full with the remaining unexecuted part being rejected. "At best orders" either execute immediately in full or are rejected. Limit orders execute immediately either in part or in full, with the remaining unexecuted portion being added to the order book. The member can only act as a principal if the price which he gives to the investor is better than the price obtainable on the order book. In the case of a large trade the member may still act as either principal or agent, though it is likely that in either capacity the member will trade away from the book, by contacting other members or other investors to find a counterparty to the trade. In this case the member is obligated to trade at least 3xNMS through the order book, to ensure the integrity of the order book.

In this new system not only is the order book central to the trading system, but so is the role of exchange members. The function of the members of the exchange replaces that of market makers in acting as intermediaries in the system: not only do the members stand between the customer and the order book, but the members are able to act in either a principal or an agency capacity. The fact that the members are able to act as principals means that their role is very similar to market makers in the old system. The difference is that unlike market makers, the members will not advertise the price quotes at which they are willing to trade. This function is now taken over by the order book, though members are at liberty to submit orders onto the order book and hence contribute to the supply of liquidity.

Thus the new market structure proposed on the LSE can be seen as a combination of the NYSE, Paris and existing LSE systems. Like the NYSE the system will allow for members who may choose to participate in trades or route trades through the central order book. Like



the Paris Bourse the central limit order book will be fully visible on television screens to which any member may have access. Like the existing LSE system the members will be in competition with each other, and may act as principals, and in the case of large trades will involve working an order away from the central order book. In fact these similarities with existing systems is reinforcing the main argument of this paper that dealer markets and continuous auction markets are equivalent. All of these trading mechanisms feature competing intermediaries who supply liquidity by submitting prices and quantities at which they are willing to trade. Outside investors then trade against these price schedules.

In the new market structure the term market makers will be abolished, though their function will be replaced by members of the exchange who act as intermediaries. The term 'intermediary' is important under the new system, since the Chancellor of the Exchequer has proposed exempting intermediaries from paying stamp duty on stock exchange transactions. It is proposed that the definition of an intermediary will depend on the length of time that the stock is held. One measure of the length of time that intermediaries temporarily hold securities fulfilling their intermediary role is the inventory half-life. This is the time taken for inventories to recover one-half of their initial value after they have suffered a shock. Snell and Tonks (1995, 1996) estimate the average half life of inventories as 5.5 days for a sample of less liquid stocks, and an average of 1.5 days for liquid stocks. These numbers are a little lower than the average of 7 days found by Madhavan and Smidt (1993) in their analysis of NYSE stocks.

## **V Conclusions**

In this paper we have argued that screen-based continuous-auction and dealer markets are equivalent. Both trading systems feature intermediaries who are responsible for providing liquidity. In dealer markets liquidity is supplied by licensed intermediaries who submit competing price quotes, whereas the auction market allows the free entry of any trader to supply liquidity by permitting the submission of limit orders. In both cases investors face a competitive price schedule, which they can then trade against, and competition between traders in the auction market or between dealers in the dealer market should ensure that liquidity suppliers make no excess profits. In practice the operation of these two alternative trading systems may be different because of the transparency requirements in the two regimes, but it is the design of the transparency system that is the crucial factor and not the

design of the trading mechanism. Provided that the transparency regime is similar the two systems will be equivalent.

In assessing the proposed changes on the London Stock Exchange we believe the move to an order driven system cannot harm the provision of liquidity, since the current market makers in their new role as intermediaries, are at liberty to submit limit orders in the new system in addition to those submitted by outside customers. The new market structure proposed on the LSE can be seen as a drawing on a number of features associated with NYSE, Paris and existing LSE trading systems and these similarities reinforce the main argument of this paper that dealer markets and continuous auction markets are equivalent. All of these alternative trading mechanisms exhibit competing intermediaries who supply liquidity by submitting prices and quantities at which they are willing to trade. Outside investors then trade against these price schedules.

The innovation of the new trading system on the London Exchange is the introduction of the limit order book. However the new system is not really replacing market makers, but is renaming them as members, and combining their operations with a central limit order book. These members may act as principals in transactions and therefore continue to take on a dealer role, but in addition these members face additional competition from the order book through which outside investors may also supply liquidity.

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