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From Orders to Trades:
Some Alternative Market Mechanisms

by

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FROM ORDERS TO TRADES:
SOME ALTERNATIVE MARKET MECHANISMS

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I INTRODUCTION

Of all the edifices built by economists, the competitive market model stands as the tallest and the most elegant. It is a monument to efficiency, decentralization, economy of communication and, if you will, trader sovereignty. The central property behind this remarkable achievement is the power of prices: everything that any given market participant needs to know about the other participants is summarized in a single array of numbers. In the competitive environment, prices are perceived as being beyond the influence of any single market participant, who in his choice of actions will therefore take them as given. When prices are such that all markets clear, the system is said to be in "equilibrium", and the resulting allocation of resources is identified as efficient: no further trading combinations, however complex, would be acceptable to all concerned. Thus, equilibrium competitive prices must reflect the preferences, endowments, and consumption-production opportunities of the market participants, an overwhelming amount of information by any standard. It is however regrettable, though not surprising, that just how equilibrium prices are generated in practice is something about which economic theory has rather little to say. Like most things of great value, they are for practical purposes impossibly hard to get.

But to focus on equilibrium may be an overly limiting approach to the study of markets. This is because the emphasis then becomes one of identifying conditions under which trading will (temporarily) end and on finding equilibrium prices, by no means a simple task, as noted. A more tractable and fruitful approach may be to examine how markets arise
and keep going in the first place and to evaluate alternative rules for generating trades on the basis of their operational effectiveness. It can be said that the basis for opening markets is the perceived opportunity for welfare improvements by trading. The essential ingredient in a market trade is mutually satisfactory re-allocation of quantities among buyers and sellers by the use of prices. If prices and quantities are the language of the market, orders are the messages whereby participants convey their preferences for possible trades. We shall refer to any rule that converts orders into trades as a market mechanism. The market mechanism, then, is a procedure which uses orders as inputs and generates as its outputs trades and (possibly new) prices. These prices are then used by various participants as signals on the state of the economy, and in particular they can be used by traders for subsequent orders, which generate subsequent trades and still new prices.

Under this broader view, the purpose of markets is to facilitate trading. Transactions help traders achieve a better organization of their investment and consumption plans, hedge more adequately against their individual risks as well as share more satisfactorily in the overall risks of the economic environment, and take positions that better reflect their information and their beliefs about the future. There are typically many potentially useful trades even if the number of participants is small and few assets are traded. When there are many assets and financial instruments in a widely accessible, active market, the range of mutually beneficial trading combinations is tremendous. But while each of these trades constitutes an improvement
for all traders, none of them can be objectively singled out as superior from the viewpoint of overall welfare. At the same time, these trades are far from being equivalent, and individual participants are by no means indifferent as to which trade will actually take place. Efficient identification and execution of a high level of desirable trades is an enormously complex task, involving basic economic issues as well as the more obvious technical difficulties. Yet, this is the task that the market's organizers must face and that theory must help resolve.

In the real world, market mechanisms tend to be operated by (a subset of) the traders themselves and occasionally by a third party. When there is one buyer and a few potential sellers (and conversely), the buyer (seller) will often set the quantity and the price will be determined by the lowest (highest) bid. Examples are provided by government contracts and the construction industry. Alternatively, a single seller (buyer) may set the price, and many buyers (sellers) then determine, within limits, the quantity traded, as in the floating of new issues and tender offers. In consumer and industrial product markets, there are often a few large sellers and many small buyers. Here, prices are typically set by the sellers who adjust to the buyers' quantity response by increasing and decreasing inventories and by production adjustments. But if the price is set too low the seller may have to ration his supply. When prices are purposely kept low by government decree, more formal quantity allocations, or rationing schemes, are necessary. This is also an example of the market mechanism in effect being operated by a third party. A second example of this is provided by price setting in
regulated utilities, in which the market mechanism is typically controlled
by a commission which is not a market participant.

The (secondary) securities market is perhaps the most prominent example of
a market with many buyers and many sellers. Here too the market mechanism is
operated by a subset of the market participants (market makers and specialists).
But this is also an area where mechanical (neutral) market mechanisms may
have a potential. The purpose of this paper is to informally explore the
potential for such impersonal mechanisms. This requires us to examine the
salient aspects of the more important market mechanisms discussed in the
literature along with those now in use in extant securities markets.¹

Recall that any detailed specification of the organization of the
securities' market operation implies a specific mechanism. Thus,
different mechanisms use different structures of orders, and can generate
different trades and prices from any given set of orders. As a result,
a careful evaluation and comparison of alternative mechanisms leads
naturally to a number of important questions. To what extent do the
trades generated by the mechanism lead to an efficient resource allocation,
or, equivalently, what extent of desirable further trading is not attained
by the system? Does the mechanism reward complex orders over simpler
ones? Would timely information about "the present state of the market"
benefit insiders? Do the trades generated by the mechanism tend to

¹An introduction to general market mechanisms is given in Beja
and Hakansson (1976).
systematically favor one type of investors over other types? What is the precise role of the "specialist," and can at least part of his functions be executed by automated procedures? What are the implications of market segmentation, either on a regional basis or by types of assets? Presumably, a better understanding of these issues should provide a sounder basis for the design and operation of a national securities market. An explicit analysis of the market mechanism to be adopted would clarify the underlying value judgments, permit a more efficient use of automated procedures, and help make a smoother transition to an improved market system.

II  PURE AUCTION MECHANISMS

We divide the market processes to be discussed into two groups, auction mechanisms and market making mechanisms. Auction processes are considered first.

The Competitive Equilibrium Process

Out of the whole range of acceptable trade combinations that exist when the initial allocation is not optimal, one combination—termed "the competitive equilibrium trade"—has received much attention and extensive analysis. While purely conceptual, a process generating this trade can be described as follows. Suppose each investor submits (either directly or through an agent) a detailed set of limit orders, which are updated at each point in time to represent the investor's situation at
that time. All orders are entered in "the book". The book is continually inspected in a search for some price combination at which all current buy and sell orders are cleared. The market-clearing prices are declared effective, and all orders to buy or sell at the effective price are executed. This process is an interesting starting point for the study of market mechanisms, because under some highly idealized environments it specifies for every non-optimal allocation a corresponding optimal allocation which can be attained in one round of trading. No further transactions are necessary or possible until the situation of some investors change with the arrival of new information on the environment or with the mere passage of time.

Observe that in this idealized process, price changes per se do not constitute relevant new information for the generation of new orders, because investors can fully anticipate all possible prices in their limit orders (which are presumed unrestricted in range or variety). In particular, the limit orders in question can allow for all inferences that can be derived from the realized prices about the information available to other traders. Accurate information on the "state of the market" cannot benefit investors in this process, nor induce them to change their own limit orders.

The competitive equilibrium process is operational only when a market-clearing combination of prices exists. This is guaranteed only if the limit orders are extremely detailed and also satisfy rather strict regularity requirements. An operational market mechanism, on the other

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2 In particular, note that when stop orders dominate the market, equilibrium prices need not exist. This can happen, for example, if many "outsiders" believe that price changes reflect the information of a few "insiders", and therefore wish to buy when prices go up and to sell when they go down. See also the interesting examples of Green (1975) and Kreps (1975), which show that such phenomena can occur even in relatively simple environments, which otherwise conform to the basic assumptions in classical economic analysis.
hand, must specify the market response to any set of submitted orders. The competitive equilibrium process can therefore be at most only a partial description of a market mechanism. Even if it is accepted in spirit, a further specification must be supplied for all those cases when there is no price combination which exactly clears all the orders at hand.

Market Segmentation

When market clearing prices are found, the competitive equilibrium process can generate transactions that attain an efficient allocation in a single trading round. But this desirable property depends critically on the use of extremely complex limit orders. In particular, orders to buy or to sell one asset will in general depend not only on the price of that asset, but also on the prices of other assets. The extent to which complex "joint orders" are feasible in a given market depends on the way the market is organized, or, equivalently, on the specific "mechanism" which is being used. A completely "joint market", where joint orders are totally unrestricted, is theoretically conceivable, but would be highly impracticable even with today's sophisticated electronic computers. Some degree of segmentation in the processing of orders is unavoidable.

The highest degree of market segmentation by assets is reflected in mechanisms which allow no joint orders, so that market clearing prices are determined on an asset-by-asset basis. While this permits a relatively simple operation of the market system, it greatly restricts
the range of transactions that can be attained in a single trading round, and an efficient allocation is no longer assured. For example, suppose an investor considers two assets to be essentially equivalent for his portfolio purposes, and wishes to buy the cheaper of the two. If limit orders for each asset are allowed to depend only on the price of that asset and not on the price of the other, there is no combination of limit orders that will achieve the desired objective in one round. When trading takes time, throughout which information and demands change continually, the opportunity to trade at future rounds cannot solve this problem. New orders will generate new prices, which again cannot be effectively acted on without joint orders. This gives a tremendous advantage to "the man on the spot", who does not have to rely on limit orders and can react personally to prices immediately as they become effective. A similar problem arises when an investor wishes to place a limit order to buy one asset, and plans to raise the necessary funds by the sale of another asset. When joint orders are not allowed, the investor will typically find himself in a non-optimal situation relative to the effective prices, contrary to the theoretical potential of the competitive equilibrium process.  

An asset-by-asset determination of market-clearing prices places an extreme restriction on the extent of portfolio improvements that can be attained with limit orders. This severe restriction is not unavoidable even when a completely joint market is technically infeasible (as it will

3 The effects of market segmentation will be analyzed in greater detail in a forthcoming paper, "Market Segmentation and the Efficiency of Competitive Equilibrium". 

probably still be for at least some time). A higher degree of flexibility is attainable when the market is organized in a number of carefully defined segments, each involving a number of assets. Limit orders for transactions in one asset may depend on the prices of all assets in the same segment, but not on the prices in other segments. A combination of prices for the assets in one segment becomes effective if it clears all orders in that segment. The resulting reallocation of resources in any trading round will be superior to the best that can be attained in a fully segmented market, although generally it will still fall short of the theoretical efficiency of a completely joint market. Furthermore, the degree of market segmentation can be gradually decreased as the technology of automated data processing advances. Segments can be joined together into increasingly larger blocks, in a chain of successive improvements that avoids revolutionary reorganizations. Each step provides investors with a higher degree of flexibility, while they continually learn to take advantage of the possibilities that the improved system can offer.

The effect of geographic segmentation by regions is similar to that of segmentation by assets. In regionally segmented markets, prices in each region clear the orders in that region. Again, investors cannot generate all desirable trades by limit orders. Any discrepancy between the prices of some asset in two different regions is evidence of a failure to execute some desirable trades. The analysis above indicates
that this failure can emerge directly from the independent search for market clearing prices in each region separately.

Since limit orders cannot generate all the desired transactions in a regionally segmented market, investors must choose at each moment the segment or segments in which they wish to trade. Improved communication, with access to up to date information on the current prices in each region, provides an improved basis for this decision.⁴ The elimination of regional segmentation by a National Securities Market transfers the burden of communication from investors to the market mechanism. This, of course, establishes considerable economies of scale. In a totally unsegmented market operating under a competitive equilibrium mechanism, investors can in principle attain optimal allocation without any information on current prices—detailed limit orders can guarantee the desired position whatever the effective prices turn out to be. It is interesting to note that in the present state of technology the efficient long-distance communication needed to establish a national securities market is less of a barrier than the sophisticated computational capabilities needed to eliminate our current segmentation by assets.

Iterative Market Mechanisms Without Intermediate Trading

As we have seen, the idealized competitive equilibrium process cannot function without receiving enormously complex order information from investors. Each market participant is assumed to submit an exhaustive specification of his desired trades contingent on every

⁴See also Garbade and Silber (1976) on the impact of communication technology on market performance.
conceivable effective price for each asset. This kind of planning and workload clearly cannot be considered practical even for the most sophisticated of investors. It has been suggested, however, that the same results could be attained by an iterative process, where at each round tentative prices are declared, and investors respond with their orders for trades at these prices. In the iterative process known as *tatonnement*, declared prices become effective only if all the buy and sell orders which they trigger clear the market. If they do not, no trades are executed, new tentative prices are declared and new orders are submitted until the markets finally clear. As long as no new information arrives while the process goes on, both the prices and the trades ultimately arrived at via *tatonnement* (assuming convergence) are identical to those generated by the idealized equilibrium process. The successive iterations eliminate the need for extensive anticipatory orders. Indeed, no limit orders of any kind are ever necessary in the *tatonnement* process. Some investors may of course choose to submit limit orders in advance to avoid the need for successive responses to changing prices, but such actions are never rewarded by improved trades: as noted, the ultimate transactions are identical to those that would be generated if they responded sequentially to the current (tentative) prices.

**Intermediate Trading Mechanisms**

Trading takes time, and there are few areas where time is more critical than in the securities market. If transactions could occur
only when markets clear on the basis of investor orders alone, then iterative mechanisms such as tatonnement would probably generate no transactions at all. This is because even if the process were to converge to the competitive equilibrium trade without new information, the continuing arrival of new information would make this old equilibrium obsolete. An operational iterative mechanism must therefore explicitly take the passage of time into account. It must strive to achieve in each iteration as much trading as possible, rather than avoid transactions in a search for trades that would be even more desirable. Mechanisms which permit trading out of equilibrium are referred to as "Intermediate trading processes" or "non-equilibrium trading processes".

In intermediate trading processes which attempt to generate the maximal possible volume of transactions in any given iteration, the "short" side of the market can be fully satisfied, while the "long" side must be rationed. A specification of the market mechanism must define both the price adjustment procedure and the trading or rationing rule. The trading rule concerns the price at which relevant orders are executed (e.g. the old price or some new price) and the quantities allotted to each order on the long side (e.g. a fixed fraction of each order, a decreasing fraction for larger orders, etc.).

The possibility of both price adjustments and rationing introduces new dimensions to the trading mechanism. Limit orders are not mandatory, but they have a considerable potential for an improved trade whenever the
effective prices in some iteration differ from the previously "announced" prices. Knowledge that the orders they choose to submit can be rationed will clearly affect the investors' choice, and adds a new element of strategy. Suppose, for example, that an investor wishes to invest a limited amount of money in two assets, and expects his buy order in one of them to be rationed. On one hand, he may want to submit a larger order for the asset which is currently in higher demand, so that after it is rationed he will still get the desired quantity. On the other hand, there is the disadvantage of tying too much of his limited money to an order that he suspects will be only partly fulfilled, thereby leaving him with idle cash and too little of the other asset. His decision will depend on his assessment of the extent of possible rationing. Here again there is a substantial advantage to the man on the spot, who has accurate information on the current state of the market. He can avoid the undesirable guesswork and organize his orders on the basis of his superior information concerning the extent of rationing, and thus obtain the most preferable overall trade.

When each iteration takes very little time and there are no substantial changes in the environment, and if investors' preferences are sufficiently "regular", both tatonnement and intermediate trading processes will ultimately converge to an efficient allocation. But the ultimate net trades and the ultimate prices in each process will be different. They will depend both on the price adjustment rule and on the trading rule implemented at each iteration. Some rules will tend to favor one type of investors, while other rules will favor other types.
Much emphasis has been placed on the "continuity" and "stability" of prices in securities markets.\textsuperscript{5} In terms of the price adjustment rule, this would generally mean that the path from the initial prices to the point of convergence should involve small and monotone successive price changes. One implication of price adjustment rules of this kind concerns the structure of limit orders in intermediate trading processes. When investors anticipate price changes in one iteration to be relatively small, they can restrict their limit orders to the neighborhood of the previous prices. The prices which become effective then serve as a signal on the relevant ranges for subsequent limit orders. Another important aspect of "smooth and monotone" price convergence is the distributive implications. Consider, for example, two basic types of investors. The first type consists of large and active investors. They are continually involved in extensive security analysis, and frequently change their limit orders on the basis of their current assessments. Investors of the second type are more passive. They are not unwilling to buy or sell some securities at prices which they consider a good bargain, but their assessments change relatively slowly and their limit orders are consequently relatively stable. Price changes are thus triggered primarily by the orders of investors of the first type. When they want to sell some assets at the old price, its price goes down, and when they want to buy, the price

\textsuperscript{5}For example, one of the demands placed on the specialist is that he ". . . maintain a continuous market with price continuity"--see e.g. Leffler and Farwell (1963, p. 212).
goes up. "Small and monotone" price adjustments in intermediate trading mechanisms tend to favor investors of this type relative to the competitive equilibrium process (or equivalently the tatonnement process), in which all transactions are executed at the ultimate equilibrium prices. In intermediate trading processes, the active investors are able to buy at least some quantities at "low" prices when prices go up, and sell some securities at relatively high prices when prices go down. Note that this relative advantage for the active traders in intermediate trading processes with "smooth" price changes is beyond the advantage inherent in the quality of their information, since this advantage would be also reflected in their competitive equilibrium trade. 6

Summary

Among the auction processes we have examined, the idealized equilibrium process and tatonnement appear to have no place in actual markets. The idealized equilibrium process simply demands far too much information from investors and may not lead to market clearing. Tatonnement cannot be carried out without use of significant real time, thus removing the possibility of convergence, a crucial element in its operation. This in turn implies that no trading would ever occur. Processes which rely on rationing thus appear to be the only viable mechanisms of the auction type. While it is clearly too early to fully evaluate the merits of rationing mechanisms at this point, they do have some attractive properties: movement toward (the current) equilibrium with each trade is very rapid and is in some sense "maximal";

6 A more detailed comparison of a simple intermediate trading process and tatonnement is presented in Beja and Hakansson (1975).
at the same time, the communication demands placed on investors are surprisingly low. We also observe that a well defined price adjustment procedure and rationing rule readily lends itself to automated computer implementation. All of these things suggest that market mechanisms of the rationing variety should be formally recognized and carefully analyzed.

III  MARKET MAKING MECHANISMS

The Market Maker

In the pure auction mechanisms described above, each participant submits his order constrained only by his own resources. But, as we have seen, this will either cause trading to break down or require the use of elaborate rationing schemes if trading is to be accomplished at reasonably frequent intervals. An alternative approach, which partly avoids the rationing problem, is to charge certain market participants, called market makers, with the task of "intervening in the market" via market-clearing transactions to "keep the market going". Thus, a market maker or specialist is a participant whose trades are primarily determined not by his own preferences, as expressed by his limit orders, but rather by the imbalance in the orders of other traders. Through some predetermined procedure, the market maker buys an asset which is in excess supply at the effective price, or sells the asset if it is in excess demand at that price. The market maker thus performs a useful economic function, for which there is a potential reward. This reward is in effect a fee paid by the
other participants for the service rendered by the specialist. While the rules followed by extant specialists are given in rather incomplete and vague form, a precise definition of the rules and procedures for market making in a centralized market system can be incorporated into the definition of the operating market mechanism. Doing this would also make the effectiveness and the costs of alternative market making procedures more easily evaluated.

For market making to be at all viable, an excess of buy orders at the effective price must in some sense occur with the same approximate frequency as an excess of sell orders. Whether this is the case depends, of course, on the way the effective price is set. Market making activity is thus closely related to the price adjustment function, and specialists in many of today's organized exchanges do in fact serve a dual role. While careful price adjustments allow for continuous market making, the presence of market makers also permits greater flexibility in the choice of price adjustment rules. We now turn to some aspects of price adjustment when orders are "incompletely specified", as they typically are in actual markets.

Demand Smoothing

The traditional view of the aggregate demand for an asset is that of a smooth downward-sloping function of price, with a net excess demand at very low prices and a net excess supply at sufficiently high prices. The smoothness of total demand guarantees that at some intermediate price, which is neither too low nor too high, an auction market will exactly clear. Taken literally, this could only be achieved by requiring an
infinite number of limit orders for infinitesimally small quantities. With a relatively small number of limit orders, exact clearing of a pure auction market is a matter of coincidence rather than an inherent system property. This is because aggregate demand will typically be a discontinuous piecewise-flat function of the price. For example, with a buy order of 100 shares at $50 or less and a sell order of 300 shares at $48 or more, there is an excess demand of 100 shares at prices below $48, an excess supply of 200 shares between $48 and $50, and an excess supply of 300 shares at prices over $50, but there is no market-clearing price, at which excess demand is exactly 0. The declared effective price will be determined by the particular price-adjustment procedure used in the market mechanism, and will generally depend on the previous price. In principle, outcomes can range from well over $50 to well below $48.

It is possible to view one objective of market making as smoothing of the excess demand function where a sudden jump from excess demand to excess supply avoids market clearing. In the above example, this approach would imply an effective price of around $48. If the market maker is bound to clear the market, he must buy 200 shares if the effective price is $48, or sell 100 shares if the price is $47 7/8. A complete specification of the market mechanism must also state which of these two possibilities is to be chosen. For example, a mechanism which uses a "minimal" amount of market making intervention will take the second choice. Another mechanism might specify
the first choice if the previous price was $48 or more, and the second choice if the initial price was less than $48. In general, a demand smoothing mechanism could of course combine market making with rationing, e.g. by having the market maker buy less than 200 shares at $48 or sell less than 100 shares at $47 7/8.

The demand smoothing approach views non-infinite orders as approximations of some underlying smooth demand function. Market making is then used as an expedient for approximating the competitive equilibrium trade that would (presumably) correspond to the underlying demand. In the above example, this approach requires that the effective price be around $48, because the market clearing prices for continuous down-sloping approximations to the given orders "converge" to that value.

Orders as Imperfect Messages

Market prices serve not only to regulate current trades, but also as powerful signals for future economic activities. They affect subsequent orders and trades, as well as investment decisions by individuals and by corporations. When submitted orders are an accurate reflection of sufficiently regular (investors') preferences, the market clearing prices of the competitive equilibrium process are, under certain conditions, efficient signals for production as well as exchange purposes. It would appear desirable to strive as much as possible toward this kind of efficiency in operational market mechanisms. Price adjustment procedures should therefore be guided by considerations that go beyond the satisfactory regulation of current trades.
Simplified (non-infinitiesinal) orders, with their consequent discontinuities in the aggregate demand functions, constitute one source of inaccurate representation of underlying investor preferences. If this were the only factor, it would be reasonable to declare a price that separates net demand from net supply even when complete market clearing is unattainable without extensive market making. There are, however, other important reasons why the current type of submitted orders can induce an imperfect representation of investor preferences. For example, market segmentation (either by regions or by assets) was shown earlier to prevent a complete execution of preferred trades by limit orders. It is possible, however, to compensate for such factors by the choice of declared prices. The market mechanism clearly need not adopt the price which will clear current orders even if limit orders are sufficiently detailed and such a price exists. Judicious use of market making can conceivably increase investor acceptance of certain departures from market-clearing prices.

Improving the Price Signal

Once it is realized that orders can be a less than perfect representation of the environment, the way is opened to a much broader view of the market system. There may be many distorting factors which cannot be individually recognized, but their joint effect can still be studied, and compensating elements can be incorporated into the market mechanism.
The joint effects of a collection of individually unidentifiable factors can best be studied in probabilistic terms. The generation of orders would then be viewed as a stochastic process. If submitted orders represent the environment with some "random noise", the market mechanism may deliberately be used in an attempt to filter out this noise.

An extreme view along these lines, suggested recently in a pioneering stochastic model of market microstructure, pictures the market maker as having independent information on the "true" underlying parameters of the order generating process. He sets prices at some desired levels, and these determine the average rates of buy and sell orders. The precise quantities ordered at any point in time deviate randomly around the average according to a given probability law. Temporary supply and demand imbalances are absorbed by the market maker and do not affect prices, which are based only on long-run behavior. Another stochastic model of demand behavior, presented in this conference, distinguishes two sources of orders to buy and sell: changes in basic information about the environment and idiosyncratically generated random tenders. Both arrive randomly in time, and the way they affect prices is determined by the market mechanism.

How the market mechanism could be used to filter out "random noise" in submitted orders and thus to generate prices which would "better"

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7 See Garman (1976).

8 Cohen, Maier, Schwartz and Whitcomb (1976).
represent the current underlying state of the economic environment is a difficult question, and the answer must depend on some broader understanding of the system's behavior. An omnipotent market making specialist with unlimited resources could perhaps maintain some predetermined price for a relatively long time regardless of temporary fluctuations in investors' orders. But the total disregard of the potential of orders as a source of relevant information can mean that the fixed price is too low when it should be higher and vice versa. Even if this market maker is "right on average", in the sense that the current trading price is equally likely to be too high as too low, his price signals may still be worse on average than the "noisy" prices which clear current orders. However, if one is willing to abide by an explicit model of system behavior which is based on long experience and careful study, and if an explicit criterion of price performance is agreed on, stochastic control theory can conceivably be of help in constructing price adjustment rules based on current orders which would perform "better on average". In many reasonable stochastic environments, these filtered prices would indeed exhibit some "smoothing" of price fluctuations--a property which today would be considered a desirable effect of specialist intervention. Needless to say, any proposals along these lines should be preceded by careful analysis.

The Costs of Private Market Making

While sophisticated price adjustment rules combined with active market making have substantial economic benefits, their costs must also
be recognized. The net effect will depend on the institutional arrangements that ultimately determine the market mechanism.

Consider first the usual arrangement, which assigns the market making activity to one (or more) of the traders operating on his own account. This involves difficulties of two kinds. First, the market maker must be compensated for his willingness to take positions that do not necessarily coincide with his basic portfolio preferences. This compensation can take both direct and indirect forms, both of which must be carefully evaluated. Second, the limited resources of any trader must have an effect on the rules for price determination. The theory of inventories and stochastic processes shows that if successive net demands on the market maker's inventories are statistically independent and have a zero trend, no amount of initial inventories will suffice to provide the necessary backing for continuing market making of an indefinite duration.\(^9\) Therefore, the market maker cannot sustain a pricing policy that simply aims at the underlying market-clearing prices.

An arrangement that attempts to resolve both of these difficulties in a dealership system is the spread between buy and sell prices. The spread allows for a positive drift in both the dealer's inventories and his cash balances. Besides being economically rewarding, the drift makes eventual failure to continue the market-making activity less than a certainty (though it cannot guarantee an indefinite extension of the

\(^9\) See Garman (1976).
activity with limited resources). If the dealer sells at only slightly above the currently "desirable" price and buys at only slightly below that price, then hopefully only a small fraction of the desired transactions would fail to be executed, and his prices could still serve as approximate signals on the state of the economy. But the dealer's spread offers only a very partial solution to a complex problem. If the buy and sell prices are set independently of the market maker's current inventories, an "unbearable" sequence of random excess orders on either the buy or the sell side is still probable, even though no longer a certainty. On the other hand, if he can avoid some of this pressure by price manipulation (e.g. when the demand and supply that he faces are less than perfectly elastic to price), the advantages of market making may be more than offset by the adverse effects of essentially monopolistic price-setting. As a trader operating in his own best interests, the dealer would rationally set prices that maximize his expected profits (or utility). These profits, however, will be an understatement of the overall costs to the system. As Garman (1976) has noted, the profit maximizing buy and sell prices need not straddle the underlying (equilibrium) market-clearing price, and the price signals can therefore be substantially biased. The detrimental implications concern not only the extent of desirable trades that are left unattained, but also production and investment decisions in the real sector.

In a centralized exchange, a trader designated as a "market making specialist" enjoys undeniable monopoly power. As a specialist, he has
control of the "book" that states all current (market and limit) orders. He determines the price and the extent of his participation in a joint decision which is based on all pertinent data, available only to him. Some "price manipulation" is not only feasible, it is indeed unavoidable—in the absence of a spread this is the specialist's only countermeasure in the face of a random excess of imbalanced orders at what would be otherwise considered an "appropriate" price. 10 But once this possibility is available to him, it is in the specialist's interests as a rational trader to manipulate prices within the range of freedom afforded by regulation and good ethics, and maximize his own utility. In this context, his monopolistic information on the state of the market is invaluable. As indicated above, the costs to the system can again far exceed the market maker's profits.

Placing both price determination and quantity matching in the hands of traders who "specialize" in particular securities has another detrimental effect in a centralized securities market. It reinforces the market's segmentation by assets and places obstacles on the path towards a joint price determination based on joint limit orders. As is often the case, organizational problems may at some point exceed the computational problems.

Automated Mechanisms

Price determination and quantity matching are the two basic functions of the market mechanism. Today's mechanisms relegate much of these

10 I.e. the price that would clear orders if they represented perfectly the current preferences of investors.
functions to a subset of traders called market makers or specialists. The system can benefit from their judgment and experience, at the cost of potential side effects on prices induced by their limited resources and their self-interest. Policy statements, regulation, and control can restrict these side effects by limiting the range of exercised judgment. Clearly, a better understanding of the market mechanism and the economic environment permits a more explicit statement of the desired objectives and procedures of the market mechanism. The range of decisions that are not fully specified and therefore left to the specialist's judgment can then be more meaningfully restricted, along with the range of potential price effects not explicitly identified in the stated policy. At the extreme, a complete and accurate statement of the price adjustment rule, specifying the desired price response for every contingency, would completely eliminate the range of situations which are left undetermined in the adopted policy. A fully defined policy would leave no room for vagueness and would require practically no human interpretation and interference. It could in fact be incorporated into the automated processing of orders in a centralized securities market.

How flexible might a fully automated market mechanism be? It can definitely choose the market clearing prices when they exist. Combined with some form of market making, it can also perform the demand smoothing function without difficulty. Filtering possible "noise" in submitted orders appears to be more of a problem. However, sophisticated automated
procedures for noise filtering are being successfully used in all facets of modern life, from missile control to home television, from election outcome prediction to medical diagnosis. Today's computers are certainly capable of much more than just summing a high volume of orders, and can explicitly take into account many more factors than the human mind is able to handle.

If the price determination function is automatically performed by a central computer, who will undertake the market making activity? Designated market makers can still be assigned this function, even if they have no control over prices. They will of course have to be rewarded for their services. The fact that this service need no longer be monopolized can lead to lower costs. The cost of market making in each asset could be borne by the traders in this asset, who directly enjoy the benefits. Alternatively, and perhaps even preferably, these costs could be borne by all traders through the general commissions paid to the exchange for all its services. In this case, the market maker would be a sub-contractor to the exchange for specific compensated services, very much like a computer company would be paid for computing services.

There is of course no inherent reason why the market making services must be relegated to a sub-contractor. Just as the exchange may decide to buy its own computer and do its own computing, so it may choose to do its own market making. Pooling the resources of its membership, the constraints on the exchange's market making activity would be far less
binding than on any subset of designated traders. Furthermore, when
market making is done directly by the exchange, it need not necessarily
be backed by excessive inventories of securities—short positions may on
average be largely offset by long positions, thus bypassing the default
risk assumed by individual private traders. With weaker constraints on
the extent of possible market making, prices will have more freedom to
do the job they were designed to do—efficient communication of information.

IV CONCLUDING REMARKS

The establishment of a national securities market is potentially
much more than just improved communication and efficient processing of
a large volume of orders. It is an opportunity to reassess the most
basic aspects of the market's operation, and to design a system that
provides the best possible answers to the complex issues involved. The
most important trade-off is between the communication requirements (the
detail of order specification) and the desirability of the resulting
trades. Reduced segmentation, demand smoothing, and noise-filtering were
suggested as useful steps in the desired direction. In any case,
crystallization of overall policy is naturally accompanied by automatiza-
tion of the market mechanism. Two quantity matching devices, easily
computerized, show particular promise in conjunction with automated price
adjustment procedures. One is based on rationing and the other would
function as a single mechanical specialist for all securities. Both are
quite tentative at this stage and are surrounded by numerous questions
requiring substantial further exploration.
The decision on the market mechanism has both overall welfare ramifications and distributional implications. In consequence, it will undoubtedly involve not only economic issues but also social and political aspects. But a clear statement of the alternatives and an improved understanding of the system behavior they induce is an important first step. Such a statement provides the basis for a more meaningful discussion and helps to focus the research that is needed.
References


