

# Liquidity and Exchanges, or Contracting with the Producers

BY YARON LEITNER

**L**iquidity is a desirable feature of a well-functioning market. In this article, Yaron Leitner explains how exchanges can provide liquidity. He also discusses his recent research, which explains some contractual problems that may arise in very liquid markets, as well as the potential role of an exchange in overcoming these problems.

Liquidity — a characteristic of a well-functioning market — refers to the ability to trade easily and costlessly. In liquid markets, investors should be able to execute their trades immediately — or nearly so — without incurring significant transaction costs. This should be true for small trades as well as large ones.

In practice, trading involves some costs; that is, markets are not perfectly liquid. In this article, I will describe some of these costs and outline some of the ways in which exchanges can increase liquidity. Then I will discuss results from my recent working paper. In particular, I will show that liquid markets in which

transaction costs are very low can raise a new sort of contractual problem: When an individual can easily find trading partners, he can promise the same commodity to multiple counterparties and subsequently default. I will also discuss two ways to overcome this contractual problem: The first is through collateralized trade; the second is through a very simple type of an exchange with a very minimal role.

## HOW DEALERS CAN PROVIDE LIQUIDITY

When you want to sell an asset (for example, a share of stock), you need to find an individual who wants to buy that asset. One option is to wait until such an individual arrives, then trade directly with him. Another option is to sell the asset to a dealer who will later sell the asset to that other individual. This second option allows you to execute your desired trade immediately.

Dealers help provide liquidity by being ready to buy and sell when-

ever the market is open. In other words, they make a market, and that's why they are also called market makers. Dealers can operate on an organized exchange, such as the New York Stock Exchange, or *over the counter* — a term that refers to a decentralized trade that does not occur on an organized exchange. Each dealer quotes two prices: a bid price and an ask price. The *bid* is the price at which the dealer is willing to buy an asset, and the *ask* is the price at which he is willing to sell the asset. The dealer can revise either price at any time, and the difference between them (ask minus bid) is called the *bid-ask spread*. For example, suppose the dealer thinks the true value of the asset is \$100. To make a profit, he can quote an ask price that is higher than \$100, say \$102, and a bid price that is lower than \$100, say, \$99. This leads to a positive bid-ask spread of \$3.

A large bid-ask spread may represent profits for the dealer, but it imposes costs on the individuals who buy from and sell to the dealer. In contrast, a low bid-ask spread means there are almost no transaction costs from trading. Thus, the bid-ask spread is one measure of how liquid a market is: The smaller the spread, the more liquid the market because the transaction costs of each trade are smaller.

A positive bid-ask spread does not necessarily mean that the dealer makes a profit because, as in any business, there are costs involved in being a dealer. In addition to the standard costs (for example, the dealer's time, setting up a telecommunication network, and so forth), economists have



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suggested two additional costs: the cost of holding inventories and the cost of asymmetric information.

#### Cost of Holding

**Inventories.** To perform his job — that is, to buy and sell upon demand — a dealer needs to hold some shares of the stock in which he makes a market.<sup>1</sup> In other words, he needs to hold an inventory of the stock. (This distinguishes a dealer from a broker, who does not buy or sell stocks on his own account and whose only role is to match buyers with sellers.) After he buys shares from an individual who wants to sell, the dealer needs to hold these shares until another individual who wants to buy arrives. This imposes some risk on the dealer. In particular, the dealer might lose money if the stock's value drops. Of course, any individual who holds stocks takes some risk. The main difference between the dealer and other individuals is that the dealer does not have full discretion in choosing the amount of shares he holds. He buys and sells in order to satisfy other individuals' needs. For example, a dealer might be forced to sell a particular stock at a time when the price is low because of a large buildup of buy orders. To compensate him for the fact that the amount of shares he holds may subject him to more risk than he would choose on his own, he needs to charge fees. Otherwise, being a dealer would be unprofitable.<sup>2</sup>

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<sup>1</sup> The discussion that follows refers to dealers on a stock market, but the ideas apply to dealers in other markets, for example, currency markets, futures markets, options markets, and so forth.

<sup>2</sup> To see how a monopolist dealer (that is, a dealer who faces no competition from other dealers) optimally sets his bid and ask prices taking into account the costs of holding his inventory, read the 1981 article by Thomas Ho and Hans Stoll. Another interesting article is the one by Yakov Amihud and Haim Mendelson, who studied the behavior of a monopolist dealer who faces a constraint on the maximum number of shares he can hold.

#### Cost of Asymmetric

**Information.** Sometimes an individual may have access to information before it is made public. Such an individual is called an informed trader or an informed investor. His private information may be important in determining the value of an asset. For example, after discussions with

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a technology firm's engineers, an industry analyst may conclude that a new computer system is likely to be highly successful. Since this information is not publicly available to all traders, we can think of this analyst as an informed trader.<sup>3</sup> An informed trader can benefit from his private information. If he thinks, based on his information, the price of the stock will rise, he will buy shares of that stock (and if he is correct, the price will eventually rise). Similarly, if he thinks the price is about to fall, he will sell. In other words, an informed trader buys assets that are underpriced and sells those that are overpriced.

Now think about the dealer who stands ready to buy and sell. The dealer cannot distinguish between those who have private information and those who are buying or selling shares for other reasons, such as

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<sup>3</sup> Certain types of trading based on superior information are precluded by law.

rebalancing a portfolio or financing the purchase of a house. But he knows that, on average, he loses money when he closes a deal with an informed investor.<sup>4</sup> Remember, informed traders sell when they believe a stock is overpriced and buy when they believe it is underpriced. This means that, on average, the dealer is buying overvalued stocks and selling undervalued stocks, surely a recipe for losing money. To make up for this loss, the dealer needs to make a profit when he trades with those who are not informed, and the way to do that is to set a positive bid-ask spread. In other words, when there are individuals who have information superior to that of the dealer, a positive bid-ask spread does not necessarily mean that the dealer makes a profit.<sup>5</sup>

#### MARKET STRUCTURE AND LIQUIDITY

Market structure varies across different dealer markets. Since different market designs may have different effects on liquidity, one may ask which market design provides traders with the most liquidity. As we will see, the answer is not that obvious, even if we limit ourselves to structures that are relatively simple.

Thomas Ho and Hans Stoll showed that competition among dealers can lead to a more liquid market in which individuals face lower transaction costs. The basic idea is that if a dealer quotes fees that are

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<sup>4</sup> The idea that a dealer may trade with individuals who have superior information is an example of what economists call an adverse selection problem.

<sup>5</sup> In their article, Lawrence Glosten and Lawrence Harris provide some empirical evidence consistent with the hypothesis that a significant amount of the New York Stock Exchange common stock spreads are due to asymmetric information.

too high, he loses customers to other dealers who quote prices based on their true costs.

In Ho and Stoll's model, all individuals have the same information regarding the value of the stock, so there are no informed investors to worry about. Dealers, however, take into account the costs of holding inventories. These costs may be different across dealers and may vary when the levels of their inventories vary. In particular, the dealer with the largest inventory may be under pressure to quote the best (that is, the lowest) ask price because he wants to get rid of his inventory, and the dealer with the lowest inventory can quote the best (that is, the highest) bid price. Interestingly, competition can lead to a more liquid market, but it does not necessarily imply that dealers just break even. The reason is that the dealer who can quote the best price does not need to quote prices based on his true costs. He only needs to match his nearest competitor's fee.<sup>6</sup>

In contrast, Lawrence Glosten suggests that in some cases, a monopolist dealer, who faces no competition from other dealers, may actually provide more liquidity than competing market makers. Glosten's model applies to specialists on the New York Stock Exchange, where each specialist is the only one who has access to the order book, listing buy and sell orders for a particular stock. Glosten ignores the costs of inventories and emphasizes the cost of asymmetric information. In his theoretical model, when dealers compete with one another, they don't

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<sup>6</sup>An interesting implication of Ho and Stoll's model, consistent with evidence provided by Oliver Hansch, Narayan Naik, and S. Viswanathan, is that the behavior of each dealer depends not only on his own inventory but also on the inventories of other dealers.

have much flexibility in setting their bid-ask spreads — they always quote the lowest fees they can. In addition, each dealer needs to make sure that he does not lose money on any individual trade because if he does, he cannot make up for his losses later. Thus, each dealer quotes prices so as to break even on each trade. In other words, each dealer expects to make zero profit on each trade. In contrast, a monopolist market maker can sometimes set very low fees on particular trades,



even though he expects to lose money, because he can make up for his losses later.

To see why a monopolist market maker can provide a more liquid market, consider a period in which the potential for information-based trade is very high, for example, the period in which a firm is considering a merger.<sup>7</sup> Competing market makers may need to set very high bid-ask spreads to compensate for the money lost to informed investors. This, however, may make trading very costly for all individuals (both informed and uninformed), who, in extreme situations, may simply choose not to trade. The result is that the

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<sup>7</sup>If a firm is contemplating a merger, it may be very difficult for it to keep information from leaking to some investors for whom trading is not illegal.

market essentially shuts down until the relative number of better informed to less informed investors declines, perhaps because the firm announces that it will merge.

A monopolist dealer can also set a very high bid-ask spread, thereby preventing any trade from happening, but he need not do so. By setting a lower spread, he induces individuals to trade, so that some of the private information is revealed through price movements. (For example, the rising price of a firm's stock may indicate that investors have information that the firm will be purchased by another.)

This reduces the cost of asymmetric information, thereby making subsequent trades more profitable. For example, suppose that to break even the dealer needs to set an ask price of \$110 if the potential for information-based trade is high and \$100 if the potential for information-based trade is low. Unlike competitive dealers, who must set a price of \$110 in the first case and \$100 in the second case, a monopolist dealer can quote a price of \$107 in both cases. In the first case, he will lose money (\$3 per trade), but he will make it up in the second case, in which he will gain \$7 per trade.

In practice, market structures are usually more complex, so the choice is not just between one dealer or many dealers who compete with one another. For example, the specialist on the New York Stock Exchange has some monopoly power, but he also faces competition from individuals who submit limit orders.<sup>8</sup> (For example, if an individual wants to buy shares if

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<sup>8</sup> Limit orders are price-contingent orders to sell if the price rises above or to buy if the price falls below a prespecified price.

the price falls below \$50 per share, the specialist will be able to buy only if he quotes a bid price higher than \$50.) In addition, the choice may become even more difficult because different types of investors may prefer different market structures. For example, Duane Seppi showed that it is possible that given the choice between a hybrid specialist/limit order market (like the New York Stock Exchange) and a pure limit order market (like the Paris Bourse), small retail and large institutional investors would prefer the first market, while some mid-size investors would prefer the second.

## LIQUIDITY AND STRATEGIC DEFAULT

**Contracting with Bialystock and Bloom.** Up to this point, we have focused on the role of dealers in providing liquidity, that is, making trade easier and less costly. But when transaction costs are very low (that is, markets are very liquid), a new sort of contractual problem may arise. In particular, when it is very easy to find trading partners, an individual can promise the same commodity to multiple counterparties and subsequently default.<sup>9</sup>

The risk of default exists whenever an individual promises to pay or deliver cash or some other commodity in the future. For example, when I give you a loan, I face the risk that you will not pay me back. Similarly, when you and I enter a forward contract according to which in some cases I pay you (for example, if the dollar appreciates against the yen next month), and in other cases, you pay me (if the dollar depreciates

<sup>9</sup>The discussion that follows applies to individuals as well as to dealers who trade among themselves in the so-called inter-dealer market. Dealers often do so to balance their portfolios.

against the yen next month), both of us face the risk that the other one will not pay what he promised.

An individual may default simply because he does not have the asset he's supposed to deliver. This can be either because of bad luck or because the individual did not make enough effort to ensure that he would have the cash or the asset for delivery. But default can also be strategic, that is, deliberate. In particular, when penalties are not harsh enough, an individual may default even when he has the asset he needs to deliver.

Liquid markets can exacerbate the problem of strategic default by making trading *too* easy. When an individual can easily find partners to trade with, he may have greater temptation and opportunity to promise the same asset to multiple counterparties and subsequently default. The inability to credibly pledge an asset or cash to one and only one party (or, more generally, the inability to engage in contractual relationships with one and only one party) is called *nonexclusivity*.<sup>10</sup> For example, in a forward market (a market where individuals enter forward contracts), nonexclusivity could induce individuals to promise too much relative to their resources, thereby creating liabilities that might exceed their income.

When an individual can enter only one contract, a punishment such as losing his reputation or losing future trading partners can induce him not to default. But when he can enter multiple contracts, losing one's reputation or even going to prison may

<sup>10</sup>To learn more about some recent work that emphasizes nonexclusivity as a contractual problem, read my working paper as well as the articles by Alberto Bisin and Adriano Rampini; David Bizer and Peter DeMarzo; Charles Kahn and Dilip Mookherjee; and Christine Parlour and Uday Rajan.

not be a big enough threat to ensure performance because the potential gain from cheating can be very large. The following dialogue from the movie (and Broadway hit) "The Producers" illustrates this:

- Bloom: "If he were certain that the show would fail, a man could make a fortune...If you were really a bold criminal, you could have raised a million dollars, put on a \$60,000 flop, and kept the rest."
- Bialystock: "But what if the play was a hit?"
- Bloom: "Well, then you'd go to jail...Once the play is a hit, you'd have to pay up all the backers, and with so many backers, there could never be enough profits to go around."

The threat of default because of nonexclusivity can make everyone worse off. Individuals may simply be afraid to trade with one another when they expect their contracting partners to default. In my working paper I suggest two mechanisms for enforcing exclusivity: collateralized trade and an exchange.

**Collateralized Trade Enforces Exclusivity...** Exchanges often require that individuals put up some collateral in the form of cash or other financial securities, such as stocks and bonds. (These are referred to as margins.) Over-the-counter trades often require collateral, too.

We often think of the *direct effect* of collateral on reducing strategic default: Since you lose the collateral, you have less to gain from defaulting. But collateral also has an *indirect effect*: Since individuals have limited resources, collateral requirements limit the number of bilateral contracts they can sign. (We are assuming that in pledging the collateral, the individual gives it over to a third party for safe keeping — like an escrow account — which limits his ability to pledge the



same collateral for multiple contracts.) This, in turn, limits the potential gains from a strategy of signing lots of contracts and defaulting on all of them. In other words, collateral requirements help achieve exclusivity. As we have seen, with exclusivity, existing punishments (for example, losing future trading partners) become more effective in reducing strategic default. Therefore, an individual may credibly promise to repay more than the amount of cash he posts as collateral.

#### ...But Collateral Is Costly.

While it is true that collateral can reduce default, collateral also has economic costs. Probably the most important of these costs is that the cash posted as collateral could have been invested elsewhere, for example, in some promising project. Economists refer to this type of cost — the opportunities forgone — as an *opportunity cost*. In other words, posting cash as collateral is costly because individuals could have made better use of the cash.

While the opportunity cost of collateral is likely to be more significant, there are also out-of-pocket costs involved in posting collateral, such as the legal costs of establishing clear rights of ownership and the monitoring costs of safekeeping the collateral to ensure it is not used for other purposes. The bottom line is that although collateral requirements can enforce exclusivity — thereby reducing strategic default — this may be too costly a solution.

## CREATING AN EXCHANGE TO ENFORCE EXCLUSIVITY

Another way to control for the fact that individuals may make too many trades relative to their capital is to set up an exchange that imposes limits (called position limits) on the number of contracts individuals can

enter.<sup>11</sup> Interestingly, to carry out its role of enforcing exclusivity, the exchange does not need to play other roles many real world exchanges play, such as matching buyers and sellers, acting as a dealer, or guaranteeing performance in the event of default. The exchange in my research paper is simply an institution to which pairs of individuals can report the fact that

**Even though its *only* role is to set limits on the number of contracts individuals can report, [an exchange] can make everybody better off.**

they have entered a bilateral contract. Even though its *only* role is to set limits on the number of contracts individuals can report, it can make everybody better off.<sup>12</sup>

Clearly, if everyone obeyed the position limits set by the exchange,

<sup>11</sup> There are other reasons why real-world exchanges impose position limits. For example, position limits are sometimes intended to prevent investors from manipulating prices.

<sup>12</sup> Of course, this does not mean that other roles are less important. It simply means that the role of enforcing exclusivity can be analyzed separately. Real-world exchanges almost universally carry out more than one function. However, it is often helpful to think about the minimal conditions for an institution — like an exchange — to be useful. This is one of the motivations for my working paper. Understanding the logical foundations of an exchange (as well as other financial institutions) may be important in addressing some practical questions, such as what the effect of competition among exchanges is or whether exchanges should be regulated.

the problem of nonexclusivity would not arise and everybody would be better off. But how can the exchange make sure that everyone obeys these limits? While it may be easy for the exchange to monitor the number of contracts individuals enter through the exchange, it may be difficult and sometimes even impossible to monitor contracts that individuals may choose to enter off the exchange.

**Reporting Trades May Be Voluntary.** One of the main results in my working paper is that the exchange can enforce exclusivity, even if it can monitor only the contracts individuals choose to enter through the exchange. In fact, individuals will *choose* to let the exchange know about *all* their trades, even if they do not have to and even if there is some small fee involved in doing that.

Why would this be so? Keep in mind that when you and I agree not to report a trade, I'm not the only one keeping a secret from the exchange — so are you. By not letting the exchange know that you and I have signed a contract, I give *you* the opportunity to enter more contracts than permitted by the position limits. For example, if the position limit is three, and I agree to enter a contract with you without reporting it to the exchange, you now have the opportunity to enter a total of four contracts. But your incentive to default deliberately on all your contracts — including the one you have signed with me — is greater when you can sign four contracts rather than three. This is because in my model the potential benefit if you don't need to deliver on any of your contracts is unlimited (and gets higher the more contracts you enter), but the potential loss if you do need to deliver is limited because of individuals' limited liability (that is, you lose the same amount of cash whether you enter three contracts or four). Therefore, to prevent your

default, I will insist on reporting our trade to the exchange.<sup>13</sup>

**Position Limits Need Not Be Binding.** Surprisingly, to make sure that individuals do not have the incentive to cheat by not letting the exchange know about some of their off-exchange trades, the exchange may need to set position limits that are nonbinding. For example, the exchange may need to allow each individual to enter three contracts, even though he actually enters only one. To see why, remember the example above in which everyone reported all his trades to the exchange except for you and me — we were thinking of cheating by not reporting our trade. And suppose that you would choose to strategically default only if you could enter four contracts or more, and that if you do not sign contracts with an intention to default deliberately, your best choice is to sign one contract and deliver as promised.

Now think about the effects of different position limits on your incentives. If the position limit is

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<sup>13</sup> You might ask: “How do I know you will stop at four contracts? Why not five, or six, or more?” My discussion relies on the assumption that when two individuals are trying to decide whether to cheat by not reporting their trade, they simplify their decision-making problem by assuming that all other individuals report all their trades to the exchange. If I assume that everyone else is reporting all trades to the exchange, the maximum number of contracts you can enter increases by exactly one when you and I trade off the exchange. So we basically show that if everybody reports all their trades to the exchange, no one can gain by not reporting. Students of economics (as well as other fields) may recognize this as an example of Nash equilibrium. (To learn more, read a book on game theory, such as those by Robert Gibbons; Martin Osborne and Ariel Rubinstein; or Drew Fudenberg and Jean Tirole.)

three and you and I sign a contract without reporting it, you will have the opportunity to enter a total of four contracts. You will do so and default on all of them — including our contract — so I will insist that we report our trade to the exchange. Now suppose the position limit is lower, say, one. If we don’t report our trade, you will have the opportunity to enter a total of only two contracts, so I am assured you will not strategically default. Since I’m not worried that you will default on our contract, it makes sense for us to trade off the exchange and avoid the reporting cost. But this means that the position limit was *too low*. The position limit must be high enough so that every potential cheater stays honest because he knows his partner will double-cross him. That is, position limits need to be low enough to enforce exclusivity, but not too low.<sup>14</sup>

## CONCLUSION


In the first part of this article, I explained how dealers can help provide liquidity and mentioned some of the costs of doing that (the cost of holding inventories and the cost of asymmetric information). Implicitly, the goal was to allow individuals to trade as easily and costlessly as possible. I also showed that it is not obvious what the best way to do that is. For example, competition among

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<sup>14</sup> Usually, the concept of Nash equilibrium refers to deviations (that is, cheating) by single individuals. Here I extend the concept to include deviations by *pairs* of individuals, and I add the requirement that deviations by a pair of individuals will be self-enforcing, so that no individual of a deviating pair will double-cross his partner.

market makers can increase liquidity, but in some cases, a monopolist dealer can actually provide more liquidity.

In the second part of this article, I showed that liquid markets, in which it is very easy to find partners for trade, can raise a new sort of contractual problem: nonexclusivity. In particular, individuals can make too many trades relative to their capital and subsequently default. Then I showed how an exchange with a very limited role can overcome that problem. In particular, I demonstrated that by setting limits on reported trades, the exchange can make everyone better off — even if reporting is voluntary. I also showed that sometimes position limits must be nonbinding in the sense that traders will always choose to trade fewer contracts than permitted.

Models like mine may be useful in thinking about other complicated real-world issues, such as the information the exchange should reveal to its members regarding other members’ trades or the types of markets in which it will be most valuable to form an exchange.<sup>15</sup> Of course, an exchange is only one type of financial intermediary. Concerns about how to enforce contracts with nonexclusivity may also be useful for thinking about the design of other types of financial institutions. 

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<sup>15</sup> For example, my model shows that in some cases the exchange should not reveal the exact number of contracts an individual has entered — it should reveal only whether the limit was reached. My model also shows that the benefits from an exchange are higher when the market becomes more liquid or when individuals have more intangible capital, such as reputation.

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